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THE METHANOL CONVERSION AUTOMOBILE REACTOR LABORATORY TESTS RESULTS

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S u m m a r y . The given results of the bench tests of the automobile methanol conversion reactor are suggested for a minibus. The effect of a number of engine regime indicators on the reactor's efficiency has been evaluated. Fig.2, Sources 21.

K e y w o r d s : motor, reactor, methanol, conversion.

INTRODUCTION

Most forecasts on the development of energy and transport mention that piston internal combustion engines will in future keep playing a leading role on the transport. Predominant types of the power plant vehicles are the internal combustion engines (ICE) using oil fuel. The main consumer of gasoline and diesel fuel is the road transport.

When using the oil rationally, it will remain the most important source of energy for a long time. However, its resources are not limitless, and now one needs to search for some other alternative sources of raw materials for the production of motor fuels, which himmotological properties enhance the engine's efficiency and reduce the toxic emissions of the exhausted gases [1, 2, 3]. The use of methanol as the primary fuel and gasoline additive has confirmed the effectiveness of its impact on the operation of engines [4, 5, 6]. However, it revealed such drawbacks of methanol as: difficulty in starting a cold engine, vapor locks in the power supply system at increased temperatures, the complexity of a homogeneous mixture in the cylinders, increased engine wear and reduced oil life [7]. It is possible to overcome the above mentioned drawbacks by using the method of hydrogen gas through methanol conversion on board the vehicle with the utilization of the exhaust gases heat (EG) [8-13].

RESEARCH OBJECT

The main objective of the tests was to determine the thermal characteristics of the automotive methanol conversion system developed at the Chair of ICE of the East Ukrainian National Volodymyr Dahl University [14, 15, 16].

The research problem is to determine the dependence of the degree of methanol conversion on the temperature, exhaust flow, and engine operation. To assess the technical and operational characteristics of the reactor (fig. 1) of the automotive conversion of methanol [18] one need to know the amount of disposable exhaust heat to heat the reaction chamber to the optimum temperature of the catalyst at a given flow of methanol.

The tests were conducted in the laboratory of internal combustion engines of the Institute of Engineering (machine – building problems) Sciences of Ukraine on the bench engine 4CH9,2/9,2 (four-cycle), equipped with the conversion of methanol system and the reactor shell and tube type with a bulk catalyst. The engine was used as a source of heating fluid (EG) and worked on gasoline. Methanol conversion products (MCP) via analyzer were released into the atmosphere.

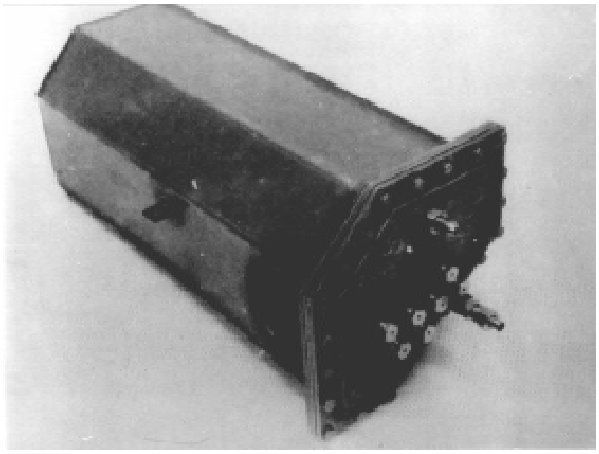

Fig. 1. The general scheme of the methanol conversion reactor

Fig. 2 shows a schematic diagram of the methanol conversion system to power the engine MCP. Liquid methanol from the tank 9 is pumped 8 into the evaporator drive 7. Vaporized methanol was fed into the superheater 4, where it reached the temperature required for the conversion process. After that, the vapors of methanol were directed to the catalytic reactor 5, where they were converted into the hydrogen-containing gas.

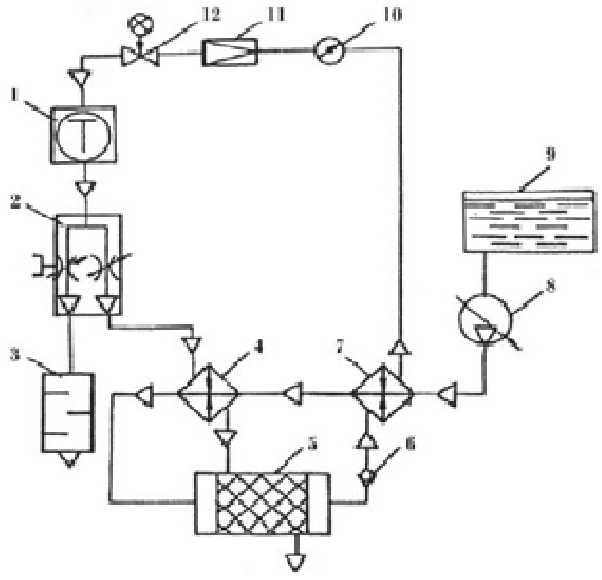

Fig. 2. The scheme of the automobile methanol conversion system

Converted gas mixture passed through the shell side of the evaporator drive 7, giving away the heat for the process of evaporation of liquid methanol. Evaporator pressure was controlled by a manometer 10.

The return valve 6, located between the reactor 5 and the evaporator 7, prevented any MCP back into the working space of the reactor with the engine off. The pressure reducing valve 11 regulated the level of pressure on the MCP set on the entrance of the engine cylinders 1. The solenoid valve 12 shut off the converted products into the engine when it was stopped.

To realize the endothermic dissociation of methanol, the heat of the engine exhaust gases is utilized. From the engine the exhaust gases from the engine were fed to the distributor 2, from where depending on the thermal conditions of the reactor they were directed entirely to the superheater 4 and reactor 5 or partially recirculated around the above mentioned three devices through the muffler out to the atmosphere.

The bench tests of the conversion system showed that the application of the system of the heat flows (EG) regulation by means of the throttle through the bypass channel protected the catalyst from overheating [17].

The tests of the reactor included the following steps:

-installation and tightness of the reactor, including the heating and after cooling;

- preparation and loading of catalyst, its activation and training;

- test of the activity and selectivity of the catalyst by varying the temperature in the reaction chamber, the engine operation, space velocity of the methanol;

- grading of the reactor and the ICE exhaust engines;

- control of the EG heat flow through the reactor;

- analysis of the MCP composition.

The parameters of the engine, the exhaust gas flow and temperature in the exhaust engine were defined with the engine at steady-state conditions of the European driving cycle, warm-up and load-on.

The temperature state of the reactor was estimated by using thermocouples installed in the cavity shell side (exhaust gases inlet and outlet in the reactor), and in the catalyst tubes of the reaction chamber. To control the exhaust gas temperature in the reactor and MCP flexible cable-type thermoelectric converters TCK-1,5 (1,5 mm in diameter) have been used.

The catalyst loaded into the reactor amounted to 2,25 L with bulk density of 3,3 kg/l, the water contents in the initial methanol were 2,5% by weight. The Institute of Organic Chemistry of the Russian Academy of Science developed a catalyst based on intermetallic compounds (IMC), which was a mixture of intermetallic $LaNi_3Co_2H_4$ hydride and nickel metal

binder in the following ratio: intermetallic hydride - 66 ... 80%, nickel - 20 ... 34% by weight.

Since in the beginning of the work there was an effect of the gradual development of IMC catalyst, to reduce its period the training and the activation of the catalyst by blowing inert gases (helium, argon), and then with hydrogen at a space velocity of 2500 h^{-1} has been carried out.

RESULTS OF RESEARCH

The activation took place at both ambient temperature and when the catalyst was heated to 250 ... 360^{0}C. To prevent the air going into the reaction chamber, during the reactor cooling there was an inert gas passing through it with a low flow (0,3 – 0,5 l/min), and instead of blowdown the reaction chamber was cooled in a static mode under the pressure of inert gas, for which the inlet and outlet valves had been installed. To maintain the temperature of the catalyst the reactor was provided with the changed mode of the engine or by restarting some of the exhaust gases past the reactor and through the bypass channel [19]. Pre-evaporation of methanol was carried out in the evaporator coil of 6 m (8 mm in diameter) wound around the exhaust pipe of the engine and shielded with a foil. Methanol feed to the reactor was realized by an autonomous gear pump with an electric drive. Methanol consumption ranged from 2,42 to 6 l/h that corresponded to a space velocity of methanol vapors 1100 – 4000 h^{-1}. Once the reactor was heated, a temperature at the length of the reactor tubes with the smallest possible gradient was maintained due to the periodical restart of the exhaust gases through the bypass.

Experimental data have shown that the methanol conversion reactor is extremely inertial. Thus, the heating time of the reaction chamber with the idling engine to the temperature that ensures the conversion of 65% with the methanol consumption of 2 kg/h, varies from 15 to 20 minutes.

The further tests have shown a low degree of conversion (50%), that's why an autopsy of the reactor reaction chamber was performed. The need for visual control of the catalyst was explained by the presence of a significant amount of MCP catalyst dust. Catalyst wear took place in the area of the exhaust gases inlet, characterized by high temperatures and significant dynamic effects from exhaust flow, resulting in vibration.

When the engine is stopped and the main feedline of the MCP is switched off, and when the reactor is cooled, the pressure in it is lower than the atmospheric one which results in creating conditions when air and moisture get into the reaction chamber and further poisoning of the catalyst if there is no proper tightness.

Once the reactor was recharged and the catalyst was activated with hydrogen, the tests of the system of heat flows regulation were continued for such modes of engine: n = 1800 min^{-1}, M_t = 49 Nm and n = 2000 min^{-1}, M_t = 78,5 Nm with a variation of the methanol consumption according to the scheme "3-6-3 kg/hour." The maximum temperature of the catalyst was maintained in the range 380 ... 420^{0}C by letting some of the exhaust gases go through the bypass. In alternating mode of the methanol fed to the reactor, the time needed to restore the temperature of the catalyst layer was not more than 10 ... 15 min with a smooth regulation of EG flow through the bypass.

The contents of the target (H_2 and CO) and by-products of methanol conversion were determined by chromatograph "Gazohrom-3101." According to the chromatographic analysis of the reaction, there were no by-products, such as methyl formate and dimethyl ether in the reaction products (see table 1). It should be noted that the water contents in MCP were less than in the original methanol, which indicates that the reaction was going with CO conversion with steam and carbon dioxide emission. Gaseous MCP consisted mainly of CO and H_2 at a high, up to 93% conversion rate of methanol. Methane was formed in small quantities.

Table 1. The methanol conversion automobile reactor laboratory tests results

Mode of ICE		Temperature of EG in the shell side cavity of reactor, ^{o}C	The space velocity of methanol vapors, h^{-1}	Methanol conversion products composition, % rev.					
n, min^{-1}	M_t, Nm			H_2	CO	CO_2	CH_4	CH_3OH	H_2O
1750	48,1	253	1625	53,1	31,1	6,9	1,2	7,2	0,4
1750	48,1	269	0	49,7	35,1	10,6	-	-	-
2000	XX	249	1700	64,9	30,1	4,9	-	-	-
2000	84,4	257	1500	60,0	38,1	0,4	1,5	-	-

Applying of tendered positioners with padding negative feedbacks on movement, pressure, temperature, power etc., possessing a number of advantages as contrasted to used earlier, namely: by absence of a static error of regulation; by a fast response time, regulator performance; by absence of self-oscillations in a broad band of change of parameters, that is favorable has an effect for durability of drives and results in reduction a dynamic error of regulation on 20 %, transient period on 50%, and increase of accuracy of positioning.

Outgoing from above-stated, it is possible to draw a conclusion, that the reviewed drives on the basis of controlled valves - amplifiers due to high static and response characteristics are perspective for applying in pneumatic drives of mechanical systems.

During the experiment a qualitative picture of the heat exchanges between the engine's EG and the reactor reaction chamber has been obtained, as well as some features of the behavior of the catalyst of intermetallic compounds when heated by exhaust gases heat have been identified. Thus, it was found that when the catalyst was activated and trained, and when it worked for 6 hours as a bench engine (with vibration, changed heat flows), its abrasion occurred.

This leads to the effect that the catalyst is constantly taken away from the reaction chamber to the MCP and the need to install the filters with pores of at least 4…6 mm at the reactor outlet.

The developed supply system of the MCP engine provides only a partial conversion of methanol and can be a source of on-board hydrogen-containing additive to the traditional fuel [20].

This additive is an effective way to improve the dynamics of combustion in gasoline engines, because of the homogenizing of the hydrogen, gas and air mixture, where the hydrogen acts as an igniter (promoter). It provides an efficient engine operation with a deep depletion of the fuel and air mixture and a sharp reduction in toxic emissions. The greatest impact on the workflow has a relatively small additive MCP 25 ... 30% by weight in the total fuel. The savings of the mixed fuel (by weight) at low loads of the engine amounts in this cases 17 ... 35% compared to gasoline [21].

CONCLUSIONS

1. These features of the methanol conversion reactor in terms of bench tests and the physical picture of a number of processes allow to eliminate the detected defects and to find the ways for further research on improving the process of the heat exchange and reactor design.

2. The studies have shown that the time for cooling and heating of the reactor is much longer than the time for changing the modes of engine operation (especially when driving on the urban cycle), that's why the reactor in thermochemical regeneration system can be considered as a static element, and the system controlling the heat flows can be used for controlling of the temperature level that does not exceed the maximum allowed for this type of catalyst.

3. There are two ways to increase the degree of methanol conversion: either to raise the temperature of the exhaust gases by additional combustion of some fuel, or to reduce the heat losses in the shell side of the reactor cavity by means of intensification of heat exchange (the creation of a boiling layer, the porous battery, by using the heat pipes, etc.).

4. The studies have confirmed the effectiveness of use of MCP as a fuel to improve fuel economy. Further efforts should be focused on creating effective low-temperature catalysts of methanol conversion on the porous carrier and the designs of heat exchangers.

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РЕЗУЛЬТАТЫ СТЕНДОВЫХ ИСПЫТАНИЙ АВТОМОБИЛЬНОГО РЕАКТОРА КОНВЕРСИИ МЕТАНОЛА

Виталий Баранов

Аннотация. Приведены результаты стендовых испытаний автомобильного реактора конверсии метанола, разработанного для микроавтобуса. Оценено влияние ряда режимных показателей работы двигателя на производительность реактора.

Ключевые слова: двигатель, реактор, метанол, конверсия.

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RESEARCHES OF PRODUCTION OF THE SPATIALLY REINFORCED CARBON-CARBON COMPOSITION

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Summary. The results of the research in the field of scientific basis creation for technological manufacture preparation of reinforced carbon- carbon compositions (CCC) are given. The concept of CCC production with rectilinear location of reinforced fibers is presented. The results of theoretical and experimental investigations explaining the functions of technological production preparation are analyzed. They are: to provide the adaptability to manufacture, to work out the technological processes (TP), to create the control system and the system of TP operation, to design and to make the facilities of technological equipment. The results of TP testing and equipping which confirm that they are successful ones are given.

Key words: thermo- loaded parts, carbon- carbon compositions, the functions of technological production preparation, technological production readiness.

STATE OF PROBLEM

Making of modern constructions (structures) used under the conditions of high temperatures and higher thermo mechanical loadings is not effective without carbon-carbon composition (CCC) usage. CCC is used to make nozzle blocks, bells, tips of the chute vehicles, besides they are used in the elements of steering and mobile engines of space vehicles, that allows to extend substantially the resources of the construction serviceability and raise their efficiency [Sanin, Kuchma, Dgur 1999, Starchenko, Kushchenko, 2010]. CCCs get the highest characteristics at the even, rectilinear location of carbon braids without any damages in the material while the matrix and fibers work jointly in the material [Sokolkin, Votinov, Tachkinov 1996]. When the arms race was stopped the consumption of CCC by space-rockets had been reduced greatly. Converting CCC usage is developing. They began to be used widely for the production of friction and anti-friction products, crucibles and press-forms; in medicine for the production of implants and others. The volumes of CCC world production are constantly being increased, because the technologies have been mastered by the Chinese People's Republic, India, South Korea and other countries. The improvement of CCC production technology in the whole world is considered to be of priority directions, determining the defense and scientific -technical potential of the state, due to them. [Guryn, Zelenskiy 1999].

CCC operating characteristics and its competitiveness are determined by the level of the achieved production. Considerable scientific-technical potential is accumulated in the area of CCC production in Ukraine. The method of Chemical Vapor Infiltration is developed and improved under the supervision of Professor V.A.Gurin (CVI) [Guryn, Zelenskiy 1999]. The technologies of pre-forms making are developed and their experimental production is created. To increase the efficiency of CCC production is possible due to the reduction of resource usage while preparing the braids for processing and making pre-forms, upgrading CVI pre-forms. To provide technological readiness of CCC production it is necessary to create scientific base of technological pre-production and their realization, and it is an important scientific-engineering problem [Chesnokov, Gaydachuk, Potapov, Guryn 2008].

CONCEPTION OF PRODUCTION

A part and CCC is made simultaneously. Stabilization of part properties is possible only at steady operation of all TP for CCC making that allows to reduce the safety margin of parts and the product weight in the whole. To provide TP stability the requirements to every TP must be determined and their interconnection must be found out.

In spite of the variety of CCC production methods [Sokolkin, Votinov, Tachkinov 1996] the following order of TP is obligatory: the preparation of carbon braids to process them into pre-forms; making of pre-forms; satiation of the pre-forms with matrix carbon; machining. To prepare manufacturing process for CCC production the functions of technological production preparation are realized on the basis of scientifically-grounded approaches. They include: the provision of construction technology, the development of TP; planning and making of technological equipment facilities; control and operate of TP.

The concept of CCC production includes the followings principles:

- The application of present production base of highly-productive CVL method.
- The provision of favourable conditions to perform every TP of CCC making on the basis of technological criteria determination for every TP.
- The application of technological methods to increase the pre-forms gas-penetrability, keeping the location linearity and uniformity of reinforcing fibers.
- Complex automation of production processes and TP control.
- The application of resource-saving technologies, allowing to achieve the level of waste less production.

PROVIDING OF ADAPTABILITY TO MANUFACTURE

For the estimation of technological rationality the quality vector of output characteristics for the production objects is applied:

$$K_i = \left(K_{i,1},\ K_{i,2},\ ...,\ K_{i,j}\right), \qquad (1)$$

where: $K_{i,1}, ..., K_{i,j}$ are private qualitative characteristics after I TP.

Such characteristics as durable, geometrical and the others received by the measurement are used as private characteristics of the production objects. The complete list of measurable characteristics is given in the specifications for TP performance.

It is necessary to use unification of principles, to develop efficient TP with a high indication of production flexibility while designing parts made of CCC and developing TP. Indications of adaptability to manufacture also refer to the parameters of construction rationality and TP. To find out the indexes which fully reflect the achievement of optimum expenses to produce such parts is only possible on the basis of a technological cycle analysis of their production. To optimize the technological cycle the model covering all stages of CCC parts making is built, and classification of models according to the part levels is made. [Chesnokov 2010]. TP models are interdependent. The analysis of TP interdependence for CCC parts making is done. [Chesnokov 2010]. The initial parameters of processes, the factors influencing the TP motion and the output parameters are revealed. The requirements to TP stability are determined, from which the indexes of adaptability to manufacture are received.

The models of bars strong interaction while assembling and under pressure test are the models of TP stage which connect the bars characteristics and the stability of automated pre-forms assembling. [Chesnokov 2010]. The behavior of bars interaction depends on the correlation of attended bars diameters (vertical d_B and horizontal d_Γ) and the step of vertical bars t location, measured perpendicular to the given bar [Chesnokov 2009]. Mating with tension results the bars deformation, which gives the bar curve axis and section deformation. The curvature of bar axis is determined taking into account the displacement of contiguous cross section relatively to each other, and the contact deformation is determined examining the contact of cylindrical bodies made of the same material. Tension is fully compensated by the sum of deformations:

$$\frac{\left(d_B + d_\Gamma\right) - t}{2} = \frac{5P_i H_B^3}{6\pi d_B^4 E_в}\left(1 + \frac{9d_B^2 k_G}{2H_B^2}\right) + n_\delta \frac{1}{2}\sqrt[3]{\frac{36\left(1-\mu_п^2\right)^2\left(d_B + d_\Gamma\right)}{E_п^2 d_B d_\Gamma}P_i^2}, \qquad (2)$$

where: P_i – is the force of bars interaction; H_B –is the height till the guiding plate; $E_в$, $E_п$ –

are the modules of bars pressure lengthwise and transverse the fibers; $\mu_п$ – is Poisson coefficient of transverse fibers; k_G – is a relativity coefficient of module characteristics for the examined material $k_G = \frac{E_в}{G}$.

Equation (2) after transformations to the cubic kind is solved relatively P_i for bars interaction at d =$d_г$=d using of Kardano formula. In a general view the function of bar interaction forces can be presented as:

$$P_i = f(d; H_B; t; E_в; E_п; k_G). \qquad (3)$$

Efforts of different directions received by bars while assembling of pre-forms and the conditions of durability depending on the type of receiving loading are determined. Bars strength must correspond to the followings conditions:

$$[\sigma_в] \geq \sigma_в = \frac{4N}{\pi d^2}; \qquad [E_в] \geq E_в = \frac{P_i\left(3H_в^2 + \pi^3 k_G d^2\right)}{3d^4}, \qquad (4)$$

where: N – is squeezing force, acting to the bar; $[\sigma_в]$, $[E_в]$ are maximum values of a parameter.

It is determined that at a single bar the resistance effort of the bar penetration into the pre-form is considerably less than in a layer. It is noted that it is impossible to use bars as a layer while having a tension in bars mating. [Chesnokov 2008].

The bars loading conditions during the pre-forms assembling are considered to determine objectively the bars strength characteristics. The force P_{ycm} for the separation P_p is determined on the basis of bars tests for their stability. Their efficient characteristics module Yunga $E_в^э$ and strength limit $\sigma_B^э$ which are used in calculations as maximum values taking into account the coefficient of margin of safety are determined from the conditions of bars loading.[Chesnokov 2010].

The model of gas penetration reveals the connection of pre-forms parameters and TP and their making with efficient of CVI. [Chesnokov 2010].

The opened porosity is the important index of efficient satiation. The cavities connected between each other by means of ducts are appeared in the pre-forms between reinforcing materials. The form and sizes of ducts depend on the type of pre-forms and the forms of reinforcing material. Pores space figuratively is divided into transport and inter-fiber pores to determine the penetrability of different pre-forms. [Chesnokov 2009]. The reagent motion along the transport pores is described which is widely used in the theory of filtration using Darsi equation taking into account Klinkenberg effect. Gas motion along inter- fiber pores is described considering gas sliding along the walls of capillaries. The coefficients of penetrability for the reagent motion in inter- fibers are defined.

The parameters which reflect the change of gas penetrability through inte-fiber pores are determined on the basis of the analysis of received dependences and the coefficient of relative penetrability through inter- fiber pores, reflecting a change gas-penetrability while changing the structure or pre-forms parameters is introduced:

$$k_{np} = \frac{1}{d}\left(\frac{1-\varphi_{cm}}{\varphi_{cm}}\right)^2, \qquad (5)$$

where: φ_{cm} – is filling the bar with fiber.

To increase the pre-forms gas-penetrability it is offered to remove connecting pre-forms after assembling. [Chesnokov 2009]. In this case fibers occupy all free space, limited by fibers of different directions. Such a state is called a free form. If the shape of a section is changing the filling of the bar with a fiber is changing too. The changing into a free shape of a bar section influences the coefficient of relative pre-forms penetrability and it confirms that it is necessary to remove binders from bars after pre-forms assembling. It is impossible to remove earlier applied binders and that's why on the basis of the analysis of substance chemical composition and its usage as binder, oxygen has been chosen which hasn't been used as a binder for Km before.

As a result special indexes of adaptability to manufacture reflecting TP stability and the suitability of a received semifineshed item for steady operation of subsequent TP for CCC making are determined additionally to the indexes of adaptability to manufacture, recommended by GOST 14.205-83 Chesnokov 2009].

DEVELOPMENT OF TECHNOLOGICAL PROCESSES

TP structure and the requirements to the technological stages of bars examining for carbohydrate binders are grounded in the paper. [Chesnokov 2010]. The processes taking place at TP stages are studied to find the best parameters for bars making; the model covering the whole TP for bars making and pre-forms assembling is made. [Chesnokov 2010].

At the stage of impregnation-pressing the impregnated braid is presented as a capillary-porous body in the inner part of which the liquid filtration occurs. The dependence of maximum pressure in a semi finished product at pressing from the parameters of process is received. The influence of an angle of a die input cone and the semi finished product on the relative parameter of maximum pressure in a die and on the motion resistance through a die is determined by a great number of models. [Chesnokov 2010]. Single-factor experimental researches of the stage [Chesnokov 2010] defined the degree of technological parameters influence on the impregnation quality which was estimated by the applied binder mass. As a result main significant factors of this stage such as impregnation pressure and the binder concentration are determined during the experiment.

The process of drying is investigated to find a rational mode of heat transfer. The mechanism of binder motion while drying the semi finished product depending on the temperature gradient directions and moisture content is determined. To increase the bar monolithic nature and the drying processes intensification the efficiency of warming-up inside part of the semi product by means of electric current is grounded. [Chesnokov 2010] The blowing with heated air is used to remove efficiently the moisture from the surface. The experimental research of the drying stage allowed to define the range of the applied energy. It is possible to operate the binder distribution along the bar section by tension (stage factor), applied to the carbon braid.

At the stage of shaping binder redistribution relatively to fibers which are in the inner part of the semi product occurs in a die input cone. For calculations the binder is a viscous plastic system and is described by Shvedov-Bingama generalized equation. The semi product motion resistance through a forming die consists of overcoming shaping pressure, lateral side friction and tripping forces [Chesnokov 2009]. As a result of preliminary single-factor experiments the rational location of forming dies and basic significant factors of this stage such as a diameter and a number of forming dies are determined. [Chesnokov 2009]. Application of the «cascade» shaping by dies with a less diameter allows to reduce the fibers damage and stabilize the bar diameter.

As a result of the researches of the broach stage the influence of broach method on the ellipse and bars axis curvature is determined. [Chesnokov 2008].The binder broach at all technological stages is recommended to be performed with the help of a drive bobbin the diameter of which is 4 m. Received bar ellipse is to 0,03 mm and axis curvature is done by casual factors, namely by oscillation of braids tension and their location along the bar section.

To receive the model covering all TP of bars making and reflecting interconnection of TP stages of TP, the planned multivariable experiment is made. As a result of preliminary researches five key factors were determined and according to the experiment plan the range of varying was divided into four levels. Sixteen different factor combinations have been repeated three times, the order of experiments making was determined by the table of random numbers. During the experiments the followings response parameters were controlled: the bar diameter, the bar stability and stratification, the binder mass in a bar, the semi product motion resistance through spring-tongue and pilchard die. Results are processed by the mathematical statistics methods, the regression equations are received, designing response factors are found out.[Chesnokov 2010].

The TP model of bars making is included into the model of CCC parts making as a structural module. The TP optimization of bars making is performed taking into account the TP interconnection of CCC making. [Chesnokov 2010]. Geometrical and strength characteristics of bars influence the forced parameters of pre-forms automatic assembling and its stability. The objective function of optimization was to increase the minimum coefficient of bar margin of safety at pre-forms assembling. Optimization results are presented in [Chesnokov 2010]. Using the accepted values of the varied factors the bars parameters and pre-forms assembling are calculated. Having received minimum coefficient of bar margin of safety 22 it provides the stability of pre-form assembling. The results of conducted researches give scientific bases to develop TP for braids preparation to be assembled with the

guaranteed providing of the given technological characteristics; the methods of quality control for the braids preparation are developed.

The pre-forms assembling is executed by two operations: the installation of vertical bars into the guide plates and the piling of horizontal bars layers, the structure of operations execution is defined. The installation of vertical bars is carried out by bars replacement on a vibrating plate into the holes and after hitting into them they move along them. The piling of horizontal bars layers consists of feeding the bar by rollers along the guide between the rows of vertical bars at a given depth and its trimming. Having chosen the set of bar layers the pressure test and the pre-forms turn is performed; the set of layers is done according to a given height.

To learn the mechanism of bars motion on a vibrating surface and to find out the rational vibration parameters the motion of massive bars depending on the vibration direction and intensity is described. [Chesnokov 2009]. The dependences are experimentally confirmed; almost 100% of braid filling by bars under the action of vibration is received.

The results of complex tension researches, arising at the stage of a bar feeding while piling horizontal layers [Chesnokov 2008], allowed to define the nature of bar interaction with rollers and the parameters of a feeding device; the bar behavior in a guide and critical force of a bar stability loss is defined. The force parameters of a bar feeding into a pre-form from the depth of introduction and the distance to the guide plate are experimentally investigated. Results having been received earlier refer to the theoretical dependences of bars interconnection quite well. [Chesnokov 2009, Chesnokov 2008]. The parameters of a feeding device are defined.

Researches of pressure-test force parameters of horizontal bar layers are conducted for pre-forms of structure 4D-l; the effort dependence of pressure test from the given step of layers piling and the pre-forms size are defined. The parameters of knot pressure test are determined.

If it is necessary pre-forms bar trimming is executed but with minimum damage of a bar butt end. The frequent trimming of high-modulus fibers results the rapid wear of a cutting edge. The researches influenced the angle and the cutting tool type on the tool durability and on the bar butt end deformation haves been made. [Chesnokov 2009]. Design execution of a knot and tool angels is determined; tool durability is increased by 4 times.

CONTROL AND OPERATION OF TECHNOLOGICAL PROCESSES

A model of functionally-technological interconnection of the pultrusion installation knots and technological stages allowing to define the controlled parameters and the location of control sensors is developed. Automatic TP control system taking into consideration time delay during which a semi product moves to the next stage is developed. The algorithms of TP adjustment are received [Chesnokov 2009].

The system of the installation placement and its interconnected coordinates which are used to pile the layers of horizontal bars is developed. The algorithms and dependences are received to calculate the co-ordinates of supporting points of a feeding device. A kinematical scheme of installation is developed. The installation system to operate and control knots is developed [Chesnokov 2009].

The system to control products at the production stages according to the data of assembly line and selective choice allows to signal that it is necessary to conduct TP and the knots states parameters monitoring.

The analysis of methods of CCC parts test for nozzle confirmed the high cost of natural tests conducting and their harmful ecological consequences. The results of comparisons of CCC samples test conditions working with high temperature plasma nozzle confirm that it is possible to use plasma for comparative tests.

DEVELOPMENT OF FACILITIES OF TECHNOLOGICAL EQUIPMENT

On the basis of operation analyzed results ofbraids preparation and pre-forms making basic principles of technological equipment facilities planning are defined. Special attention is paid to provide rational parameters and stability of the technological stages, to minimize the production costs. The indicated principles are realized by module arrangement of equipment, by complex approach to automation and operation of technological equipment.

Setting up braids preparation for processing with pultrusion has a module arrangement; New knots structures providing the technological modes are developed. Technological possibilities of the installation cover the bars of all sizes. The installation productivity while making the basic

dimension-type of bars $\varnothing 1{,}19^{+0{,}03}_{-0{,}02}$ mm (on the basis of braid three additions of UKN-5000) is 2,0 m/min, that allow to produce bars 860 gr/hour.

Facilities of technological equipment are designed for pre-forms making, including the equipment with vertical bars setting and with setting up layers piling of horizontal bars. The equipment is aimed at cored pre-forms making with sizes not exceeding external ∅530 mm, the hole is ∅245 mm and the height is to 350 mm.

To increase the productivity while setting up the layers piling of horizontal bars two independent knots for bar feeding are placed. High accuracy of placement and bar feeding is achieved using the foot-pace drives. The developed scheme of installation operation is realized with the use of a micro-processor system of drives control. Software and installation control system allowing to introduce framework parameters to pass to the process of pre-forms making of another dimension-type or form are developed. The equipment is aimed at the CCC mass production.

Using the equipment with vertical bars setting by vibration allows to reduce time for operation comparing with a manual method by 64 times. The labour intensivety of layers piling of horizontal bars of indicated dimension-type of pre-forms was 240 people /hour that by 6 times less than comparing with the manual assembling. Received pre-forms (fig.1) are suitable for a CVI compression.

Fig. 1. A model is of ring (after treatment) and cylindrical pre-forms

CONCLUSIONS

The result of the executed work on creation of scientific bases for technological pre-production of CCC reinforcing fibers is given. As a result the conception of CCC production based on the application of CVI performs is developed; the interconnection of TP models for CCC making is classified and found out. Characteristics of TP stability are found out and on their basis the indexes of adaptability to manufacture are determined; the technological stages of bars making are investigated, the TP models with the purpose to increase TP stability are received and optimized. The requirements are systematized and the methods to calculate the knots of technological equipment are determined; the principles of TP automation for braids preparation and pre-forms assembling, algorithms and software are worked out; principles are developed and facilities of technological equipment are worked out. All this allowed to improve the engineering-economical indexes of CCC making. While producing bars and pre-forms the specific consumption of material is reduced to the level of waste less production, the economy of carbon braid producing pre-form of maximum size is 18, 6 kg. The time which is necessary to make a pre-form is cut by 3, 9 times (by 1100 hours).

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ИССЛЕДОВАНИЯ ПРОИЗВОДСТВА ПРОСТРАНСТВЕННО АРМИРОВАННЫХ УГЛЕРОД-УГЛЕРОДНЫХ КОМПОЗИТОВ

Алексей Чесноков

Аннотация. Приводится обзор результатов исследований в области создания научных основ технологической подготовки производства пространственно армированных углерод–углеродных композитов (УУК). Приведена концепция производства УУК с прямолинейным расположением армирующих волокон. Анализируются результаты теоретических и экспериментальных исследований, раскрывающих функции технологической подготовки производства: обеспечение технологичности, разработка технологических процессов (ТП), создание системы контроля и управления ТП, проектирование и изготовление средств технологического оснащения. Приведены результаты апробации ТП и оснащения, подтверждающие успешность исследований.

Ключевые слова: термонагруженные детали, углерод-углеродный композит, функции технологической подготовки производства, технологическая готовность производства.

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IDENTIFICATION OF VEGETABLE ORIGIN FIBERS FOR CHILDREN'S CLOTHES

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Summary. The most competitive sewing goods of children's assortment are those which are made of textile clothes such as cloth, yarn, thread which in definite amount include as components of vegetable fibers (cotton cloth, flax, hemp and so on). However, due to the development of industry producing chemical fibers (artificial, synthetic and so on) and their usage in native light industry they don't meet the standard requirements of manufactured goods produced by Ukrainian factories. That's why, to identify the vegetable origin fibers the research results of their structural peculiarities with the help of microscopy are given in this paper.
Key words: cotton, flax, hemp, jute fibers, microscopy.

INTRODUCTION

Nowadays the specialists consider that the most useful textile goods of children's assortment are those which have only fibers of natural origin in their structure, namely 100% cotton, flax, hemp, i.e., maximum quantity.

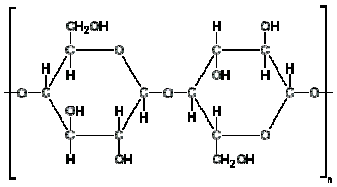
Sewing goods made of above-mentioned textile materials meet the physiological –, hygienic, operational and economic requirements and they are also very competitive. We can confirm it in that case when, for example, we add flax in technologically justified proportions into cotton fibers while forming yarn. But having such artificial fibers of chemical origin such as viscose, polynomial, viscose modified with protein, viscose acetylating, cupric ammonia, acetate, two (die) and three acetate and so forth which are made on the basis of cellulose from different kinds of trees; the quantity of cotton clothes without any additions and impurities particularly for children's assortment has greatly decreased. The reason is that the work of such enterprises is suspended or all manufacturing plants producing above-mentioned materials such as dyes (staff), finishing agents, different kinds of finishing and are destroyed (for example, XXK, city of Kherson) and more over, the price for cotton is growing. First of all it resulted to the reduction of volume production of sewing factories, particularly those ones which produced clothes of different assortment for newborns, nursery, pre-school and junior school group children, the clothes which are made of native textile materials consisting of 100 per cent cotton fibers and painted with ecologically clean staff. Instead of it, ready-made goods and textile materials produced by other countries (for example, China, Turkey, Italy and India) have appeared, but due to their nature of fibers and the difference of certification documents, practically it's impossible to refer them to cotton assortment or to such one which meets the requirements of the standards for mentioned customers' group. This fact and such a situation can be explained by the lack of laboratories and specialists dealing with the identification of (both qualitative and quantitative) fiber materials and every day goods; the problem arose and the actuality of which is obvious.

OBJECTS AND PROBLEMS

The purpose of the paper is scientific-experimental researchers concerning the fibers of vegetable origin in textile materials with the help of a microscope. The object of the research is the identification process of vegetable origin fibers with the help of microscopy. The subject of the research is fibers of vegetable origin.

RESEARCH ANALYSIS

It is known [1-14] that the fibers of vegetable origin (FVO) such as cotton, flax, hemp, jute, knave and so on are formed by one or a complex of natural cells of a complicated chemical compound consisting of celluloid, pectin, lignin, nitrogen, fatty- wax substances and also of water and pigments. The most important component of fibers of vegetable origin among the enumerated ingredients is considered to be cellulose. Cotton has 97 % of it, flax has 79 % of cellulose, and jute has 71 % of it. Depending on its quantity fibers of vegetable origin are characterized by different physical-mechanical, physiological- hygienic, chemical, technical-hygienic and then by consuming indexces. In general, cellulose is a linear highly- polymeric compound which is referred to the group of higher hydrocarbons and which is built of elementary an- hydro- D – glucose links. Empirical equation of cellulose is $(C_6H_{10}O_5)_n$, and the structural one has the following kind:



MAIN RESULTS OF THE RESEARCH

It is stated that depending on the vegetarian period (90 to200days) the amount of cellulose and other components is constantly increased what happens to the improvement of its super molecular structure and then to the improvement of its physical-mechanical and hygienic properties That's why, to estimate the suitability of cotton fibers such index as puberty degree is used.

Cotton fibers are divided into 11 groups of puberty (puberty coefficients); namely, from 0 till 5 points at 0,5 interval (fig. 1). Overripe fibbers are estimated by 4,5 till 5,0 points, while not fully ripe ones are estimated by 0 till 1,0 point sand those that can be used for the technological process (making yarn, dying) must have the puberty coefficient from 2,0 till 3,5 points.

Taped shape and length winding are the main features of cotton fibers during their identification with the help of microscope. Besides, the main characteristic feature of cotton ripe fiber is its cross section which has a volumetric circular shape deformed on a plane.

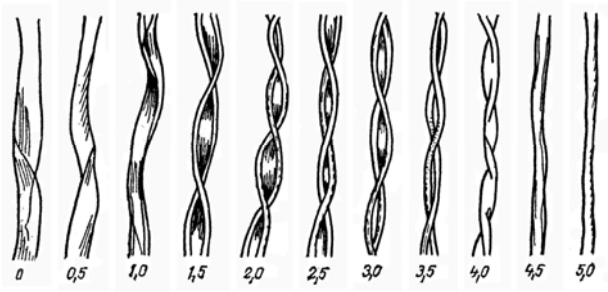


Fig. 1. Shows the active standards to estimate the puberty degree of cotton fibers using a laboratory (microscopic) method during the process of their vegetation

Textile linen made of cotton fibers is mercerized, that is, processed by sodium hydroxide solution using special machines (till 18% concentration) at temperature not more than +25 degrees Centigrade. Under the influence of a special reagent chemical, physical-chemical and structural changes of cellulose and then of fibers are taking place. So, chemical reactions carry to the formation of alkaline cellulose, physical-chemical ones carry to the intensive fiber swelling and changing of cellulose properties, increasing its cross section (diameter) due to the shrinkage [2,3]. As for the structural changes, they occur at a super molecular level and carry to the changing of elementary link arrangement in macro- molecular cellulose. Such even very short alkali contact with cotton fiber causes not only the changing of its longitudinal shape but also a lateral shearing; microscopic bunch researches of mercerized and non-mercerized samples testify it (fig. 2).

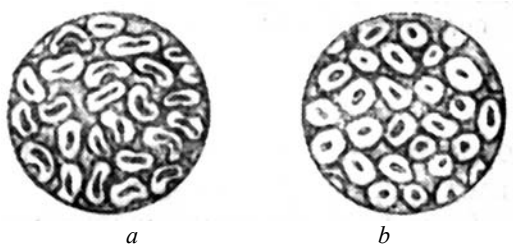


Fig. 2. Lateral shearing microscopy of cotton fiber bunch: a – non- mercerized; b – mercerized

Such fibers as flax, hemp, jute and other fibers belong to the fibers of vegetable origin but flax and hemp are the most common in Ukraine. Mentioned fibers refer to the "basted" class and make the sufficient part of raw materials for textile industry thanks to its physiological-hygienic, mechanical and operational features. Elementary fibers gathered in basted bunches are located in a pare chemical zone of stalk having the length from

15 till 125 cm and the thickness from 15 till 18 microns [2].

General longitudinal view of elementary basted fibers under the microscope doesn't greatly differ (fig.3).

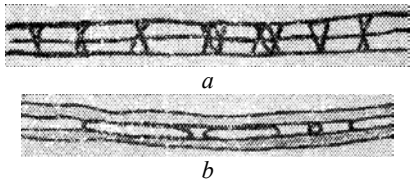


Fig. 3. General longitudinal view of elementary fiber under a microscope: a – flax; b – jute

But their lateral shearing says that there is a difference in the structure particularly in a fiber zone which to our mind is the most compact formed in flax and jute stalks (fig.4).

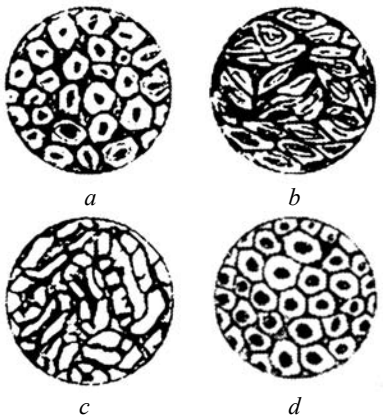


Fig.4. Lateral shearing microscopy of fiber stalks of vegetable origin: a – flax; b – hemp; c – ramie; d – jute [4]

Mentioned fiber formations are located round the plant circle in pare chemical zone and consist of a number of single elementary fibers joined with each other so called by middle plates; the microscopy of flax stalk bunch testifies about it best of all (fig. 5).

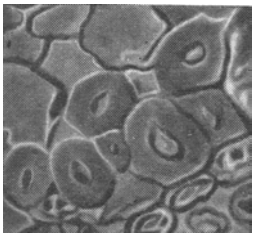


Fig. 5. Lateral shearing microscopy of flax fiber bunch [2]

CONCLUSIONS

So, with the help of microscopic analyze method we have a practical possibility to find fibers of vegetable origin among many others. They are cotton, flax, hemp, jute because every mentioned type is different from others by their structure – morphological composition, appearance, the cellulose quantity and non-cellulose components (wax, protein, ash, lignin, pectin and others) and by their properties. It gives the possibility to identify fibers of vegetable origin according to their attitude and influence to the chemical solutions of acid, alkaline and neutral nature particularly to copper ammonia compound $[Cu(NH_3)_4]OH_2$.

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ИДЕНТИФИКАЦИЯ ВОЛОКОН РАСТИТЕЛЬНОГО ПРОИСХОЖДЕНИЯ ТКАНЕЙ ДЛЯ ДЕТСКОЙ ОДЕЖДЫ

Инесса Дейнека, Анатолий Мычко, Галина Репка

Аннотация. Наиболее конкурентоспособными швейными изделиями детского ассортимента являются те, что изготовлены из текстильных материалов (ткань, пряжа, нити), в состав которых в определенном количестве включены волокна растительного происхождения (хлопчатобумажные, льняные, конопляные и т.п.). Но, в связи с развитием индустрии получения химических волокон (искусственных, синтетических) и их использование в отечественной легкой промышленности приводит к несоответствию требованиям стандартов произведенных товаров на украинских предприятиях. Поэтому, для идентификации волокон растительного происхождения, в статье приведены результаты исследования их структурных особенностей с помощью микроскопии.

Ключевые слова: хлопчатобумажные, льняные, конопляные, джутовые волокна, микроскопия

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MODELING THE MOTION OF PARTICLES IN THE PNEUMATIC TRANSPORT MILLS

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S u m m a r y . The modeling of coal particles motion in the curvilinear streams of the pneumatic transport mills was done. The trajectories of particles motion and their velocities in the moment of impact at the angle pipes dash elements of pneumatic transport mills were calculated.
K e y w o r d s : modeling, milling, curvilinear stream, pneumatic transport, coal powder processing.

INTRODUCTION

Presently in many processes coal burning powder coal is widely used. On most Ukrainian thermal power-stations anthracitic and carbonaceous powder culm is mainly used. Coal flaring effectiveness depends on its milling fineness that determines additional expenses of energy in coal powder processing systems [Turushin 2010].

One of effective thin milling methods is impact of solid particles at a hard balk. This method can be realized by the air stream acceleration of particle and their impact at the angle pipes dash elements of pneumatic transport mills [Turushin 2009]. This device is intended for coal powder processing systems and allows to combine the milling process and pneumatic transport of coal, intended for flaring in the burners.

Among the number of basic construction and technological parameters, that bear influence on coal milling efficiency of the developed device, are the particle size and its velocity at the moment of impact at dash element and the angle of attack. The angle of attack depends on the trajectory of particle motion in the angle pipe. Thus, mathematical description of two phase flow is required with the use of CAM programs and computing systems.

The last years researches in the examined problem area [Hughes 1986, Tritton 1988, Hauke 1994, Hoekstra 1999, Hauke 2001, Soulaïmani 2001, Coulson 2002, Syomin 2004, Syomin 2009, Dmitrienko 2009], are mostly devoted to the motion of curvilinear streams in cyclone and separator devices, vortex and cyclone burners, vortex mixers and etc. Issues, related to the motion of coal particles in the acute-angles of pneumatic pipes, are practically not examined by researchers. A necessity for such research arose up due to the study of material milling regularities in the process of pneumatic transport.

Development of mathematical model of coal particles motion in the angle pipes with taking the construction and technological device parameters into consideration will allow to determine the influence of basic factors on the milling process. Modeling results can be used in development of engineering methods of basic parameters calculation for pneumatic transport mills.

MODEL AND GOVERNING EQUATIONS

For the effective milling of coal in pneumatic transport mills, the angle pipes are used with the turn angle δ from 60 to 90^0 [Lenich 2011]. Schematically the construction of the angle pipe is presented on a fig. 1. A section of angle pipe is a square. The internal edge is rounded, the external is acute-angled. The dash element *1* is set leveled with the external wall of the angle pipe to impact and mill the particles of material.

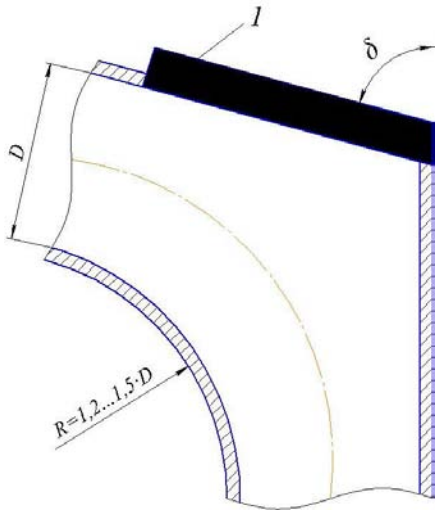


Fig. 1. The construction of angle pipe of pneumatic transport mill

The specific features of pneumatic transport mills application in the industrial systems of coal powder processing are large Reynolds numbers with pressures or Mach numbers, for which the motion of working environment is developed turbulent.

Depending on the number of particles, there are streams with a low and high concentration and superconcentrated streams. At a low concentration, the motion of two phase stream is determined by hydraulic description of liquid motion. This results in the necessity of hydrodynamic modeling of single phase swirling flow in the angle pipe of pneumatic transport mill with the use of the detailed models.

Supposition that a liquid is a continuous environment makes consideration of molecules ensembles unnecessary and allows to use the Navier-Stokes equations of motion. Equations of motion take into account that physical properties of liquid remain unchanged, and external forces field is absent. Our application describes the isothermal flow where the energy conservation equation is decoupled from the system.

The Navier-Stokes equations solved by default in all single-phase flow interfaces are the compressible formulation of the conservation of mass and momentum [Batchelor 1967, Bruus 2008]:

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{u}) = 0 ; \tag{1}$$

$$\rho \frac{\partial \mathbf{u}}{\partial t} + \rho \mathbf{u} \cdot \nabla \mathbf{u} = -\nabla p + \nabla \cdot \left(\mu \left(\nabla \mathbf{u} + (\nabla \mathbf{u})^T \right) - \frac{2}{3} \mu (\nabla \cdot \mathbf{u}) \mathbf{I} \right) + \mathbf{F} , \tag{2}$$

where: ρ is the density, kg/m^3;

$\boldsymbol{u}$ is the velocity vector, m/s;

p is pressure, Pa;

$\mathbf{F}$ is the volume force vector, N/m^3;

T is the absolute temperature, K;

μ is the dynamic viscosity, Pa·s;

$\mathbf{I}$ is the single diagonal tensor.

Particle tracing was done assuming that the impact of the particles on the flow field is negligible. It was then possible to first compute the flow field, then, as an analysis step, calculate the motion of particles. The motion of a particle is defined by Newton's second law [Coulson 2002]

$$m \frac{d^2 \mathbf{x}}{dt^2} = \mathbf{F}_p \left(t, \mathbf{x}, \frac{d\mathbf{x}}{dt} \right), \tag{3}$$

where: $\mathbf{x}$ is the position of the particle, m;

m is the particle mass, kg;

$\mathbf{F}_p$ is the sum of all forces acting on the particle, N.

Examples of forces acting on a particle in a fluid are the drag force, the buoyancy force, and the gravity force. The drag force represents the force that a fluid exerts on a particle due to a difference in velocity between the fluid and the particle. It includes the viscous drag, the added mass, and the Basset history term. Several empirical expressions have been suggested for the drag force. One of those is the one proposed by Khan and Richardson [Coulson 2002]. That expression is valid for spherical particles for a wide range of particle Reynolds numbers. The Reynolds particle number is defined as

$$\mathrm{Re}_p = \frac{\left| \mathbf{u} - \mathbf{u}_p \right| d_p \rho}{\mu}, \tag{4}$$

where: $\mathbf{u}_p$ is the particle velocity, m/s;

d_p is the particle diameter, m.

The empirical expression for the drag force according to Khan and Richardson is

$$\mathbf{F}_p = \pi \frac{d_p^2}{4} \rho \left| \mathbf{u} - \mathbf{u}_p \right| \left(\mathbf{u} - \mathbf{u}_p \right) \left[1,84 \mathrm{Re}_p^{-0,31} + 0,293 \mathrm{Re}_p^{0,06} \right]^{3,45} \tag{5}$$

As practice shows, the most optimal is two-parametric «$k-\varepsilon$» model of turbulence, based on the balancing of generation averaging streams of turbulent energy dissipation in every point [Armfield 1986, Aksenov 1996, Syomin 2004].

As a resulted system of differential equations is elliptic it is necessary to set boundary conditions for entire computational domain. For simplicity of task and programmatic realization we apply universal «hard» boundary conditions which allow to compute the flow field. On the walls the velocity

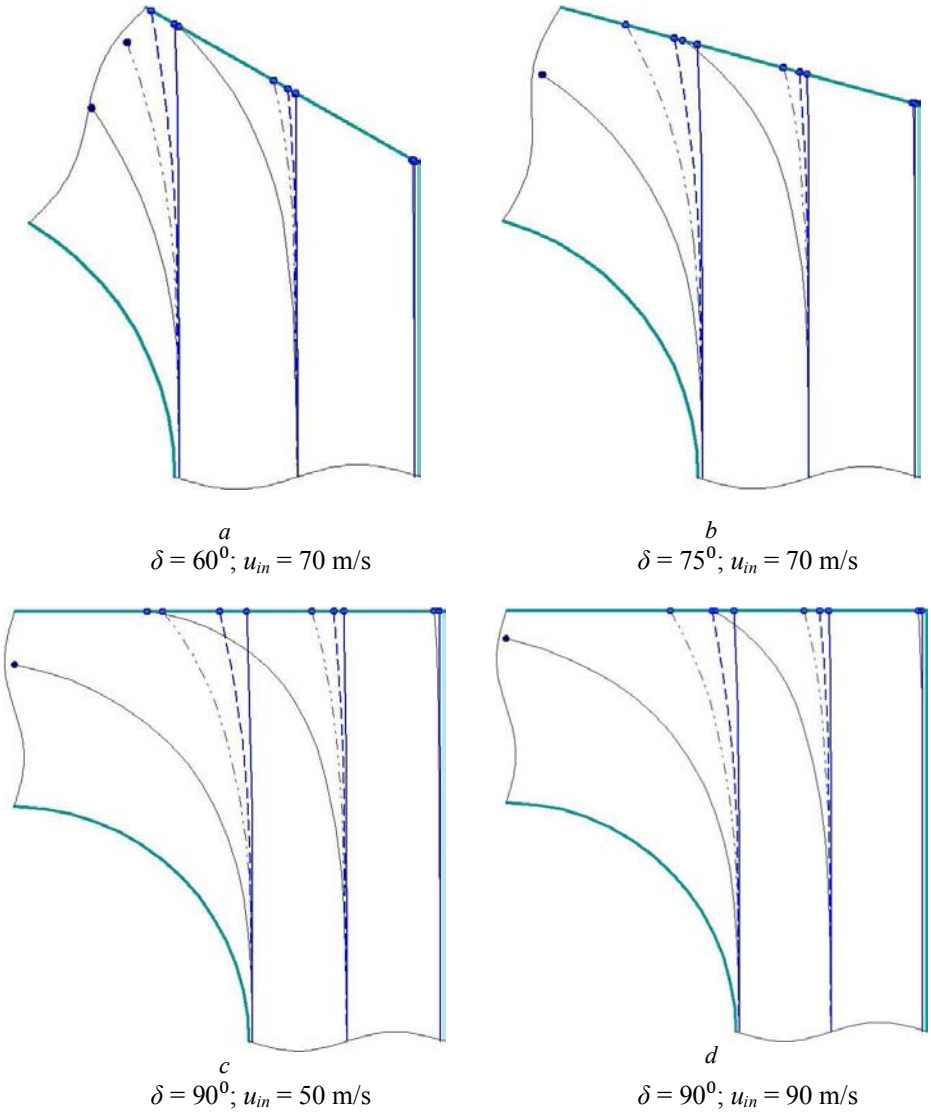
is set to zero, as a result of liquid adhesion to the walls $u_w = 0$; in the angle pipe inlet section the velocity of flow is set to u_{in} as a result of experimental researches; in the angle pipe outlet section static pressure is $p_{out} = 0$.

A number of software products is now developed for the numeral simulation of liquid and gas flows. One of such products is a “Comsol Multiphysics”.

RESULTS

The numerical modeling of particles motion in the angle pipes of pneumatic transport mills was carried out in the software package «Comsol Multiphysics 4.2».

The angle pipes with transversal section dimensions 50×50 mm, turn angle δ = 60, 75 and 90^0 and velocities on the inlet u_{in} = 50, 70 and 90 m/s were examined. The anthracite particles as a solid phase with the density ρ_p = 1700 kg/m^3 were taken. The sizes of particles were d_p = 20, 50, 100 and 400 μm. The trajectories of particles motion are presented on a fig. 2.



a $\delta = 60^0$; $u_{in} = 70$ m/s

b $\delta = 75^0$; $u_{in} = 70$ m/s

c $\delta = 90^0$; $u_{in} = 50$ m/s

d $\delta = 90^0$; $u_{in} = 90$ m/s

Fig. 2. Particle trajectories:
——— d_p = 20 μм; - - - - - d_p = 50 μм;
– – – – – d_p = 100 μм; ——— d_p = 400 μм

It's obvious from a fig. 2, that particles with $d_p \leq 20$ μm near the internal wall of the angle pipe and in the centerline of it move along the flow line and their trajectories are curved. As a result, these particles impact at the dash elements tangentially or leave the angle pipe with the flow without impact.

Particles with sizes $d_p \geq 100$ μm practically don't change the straightforward trajectories because of their greater mass and amount of kinetic energy. Angle of attack for such particles $\alpha = 90^0 - \delta$.

Near the external wall, all particles impact at the dash elements without curving of trajectory, because of small curvature of flow line.

In the moment of impact at the dash elements the particles positions on a fig. 2 are marked with points, the positions of particles with $d_p = 20$ μm (near the internal wall) that leave the angle pipes were also marked. For each of these points the absolute velocities of particles u_{imp} were calculated. Decrease of particles velocities in the moment of impact is characterized by relative velocity $\bar{U} = u_{imp} / u_{in}$. Dependency of relative velocity $\bar{U}$ on the turn angle δ of the angle pipes for $u_{in} = 70$ m/s is presented on a fig. 3.

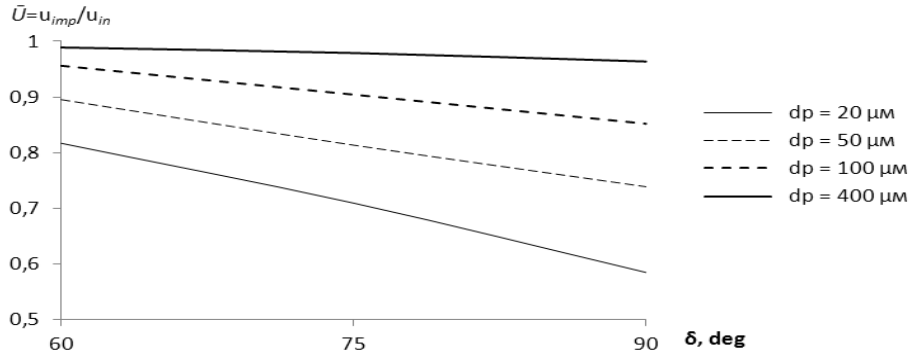


Fig. 3. The diagram of dependency $\bar{U} = f(\delta)$ for $u_{in} = 70$ m/s

As we can see from fig. 3, with the increase of turn angle δ of angle pipes the relative velocities of particles $\bar{U}$ in the moment of impact decrease. Thus the greater size of particle, the greater relative velocity $\bar{U}$ of its motion. For the particles with sizes $d_p = 100$ μм $\bar{U}$ is 0,85…0,96; for $d_p = 400$ μм – $\bar{U} = 0{,}96…0{,}99$. For the particles with greater sizes $\bar{U} \rightarrow 1$, that well conforms to the results, obtained by other authors [Kesova 1991, Varaksin 2003].

CONCLUSIONS

1. The character of anthracite particles motion in the angle pipe is determined by turn angle of the angle pipe, flow velocity and sizes of particles.

2. There is a maximum size of anthracite particle $d_p = 100$ μм, greater than which the trajectory of particle is near to the straight line regardless of the angle pipe configuration and flow velocity.

3. Anthracite particles with $d_p > 400$ μм don't change the direction of motion in the angle pipes, their velocities in the moment of impact at the dash elements are roughly equal to the flow velocity.

4. The obtained modeling results show that this construction is possible to apply practically at velocities and particles sizes which are used in pneumatic transport systems.

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МОДЕЛИРОВАНИЕ ДВИЖЕНИЯ ЧАСТИЦ УГЛЯ В ПНЕВМОТРАНСПОРТНОЙ ИЗМЕЛЬЧАЮЩЕЙ УСТАНОВКЕ

Дмитрий Дмитриенко, Сергей Ленич

Аннотация. Проведено моделирование движения частиц антрацита в криволинейных потоках пневмотранспортных измельчающих установок. Определены траектории движения и скорость частиц в момент удара об отбойные элементы колен пневмотранспортных измельчающих установок.

Ключевые слова: моделирование, измельчение, криволинейный поток, пневмотранспорт, пылеприготовление.

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ACCOUNTING OF ARC WELDING PROCESS SPECIFICITY IN INNOVATIVE TECHNOLOGIES

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S u m m a r y. In the given paper results of probes on introduction in welding manufacture of innovative techniques are stated. The role in economy of welding manufacture of designers, metallurgists and process men of manufacture is considered at introduction of techniques saving up resources. Fig. 6, source 43.
K e y w o r d s : welding, economy, innovative techniques.

INTRODUCTION

Problem statement. Innovative technologies get connected with welding production industry very dynamically. Many factors affecting welding processes, change depending on the used technology considerably and on introduction of innovative decisions. However, not enough time is dedicated to researches of economic effect of the accepted innovative decision. Setting of norms of welding works, pre-welding and post-welding operations, expense of electric power, welding materials, and finally the cost of the welded good are conducted on the set (classic) dependences [Gracheva K.A., 1984., Gretskiy Y.Y., 1995., Skulskiy V.Y., Logins V.P., Lipodaev V. N., Pavlovskiy V. I., Losi E. P., Savoley N. I., 1988., Tereshenko V.I. and others, 1987., Shebeko L.P., Gitlevich A.D., 1986.] without taking into account specificity of innovative technology.

Analysis of the last researches and publications. To innovative technologies of welding production, foremost, we can account resource-saving methods of welding and treatment:

- welding with the forced concomitant cooling [Wells M.E., 1986., Gedrovich A.I., Druz O. N., 2002., Gedrovich A.I., Gidkov A.B., 2000., Gedrovich A.I., Gidkov A.B., 2000., Gedrovich A.I., Druz O.N., 2002., Gedrovich A.I., Druz O.N., Panteleev M.V., 2005., Gedrovich A.I., Gidkov A.B., 2003., Gedrovich A.I., Gidkov A.B., 1999., Eremin E. N., Kulishenko B. A., Barmin L. N., 1976., Gedrovich A.I, Galtsov I.A., Druz O.N. and others, 2002., Kanonenko V.Y., 1996., Kasatkin B.S., Lobanov L. M., Pavlovskiy V.I. and others, 1973., Labeysh V.G., 1983., Lobanov L.M., Pavlovskiy V.I., Loginov V.P., Pashin N.A., 1990., Gedrovich A.I., Galtsov I.O., Druz O.M., 2002., Savitskiy M.M. and others, 1999., Skulskiy V.Y., Logins V.P., Lipodaev V.N., Pavlovskiy V.I., Losi E.P., Savoley N.I., 1988.];
- welding with the use of activators of melting ability of arc [Asnis A.E. and others, 1982., Gvozdetskiy V.S., 1974., Gedrovich A.I., Druz O.N., 2003., Gedrovich A.I., Druz O.N., Panteleev M.V., 2005., Gedrovich A.I., Gidkov A.B., 2000., Kanonenko V.Y., 1996., Lenivkin V.A. and others, 1978., Lenivkin V.A. and others, 1989., Paton B.E., Voropay N.M., 1979., Pohodnya I.K. and others, 1991., Savitskiy M.M and others, 2000., Druz O.N., Gitnaya S.V., 2010.];
- transition from heavy-gage sheet constructions to light-gage with saving of working (operating) descriptions of the welded good [Gedrovich A.I., 1998., Gracheva K.A., 1984., Gretskiy Y.Y., 1995., Shebeko L.P., Gitlevich A.D., 1986., Yurev V.P., 1972.];
- use of the high-localized sources of the welding heating, such as plasma, electronic ray, laser [Gedrovich A.I., Druz O.N., 2003.].

Problems unsolved before. The analysis of works stated above shows complication of decision of economic effect from introduction of concrete innovative technology. In technical literature, there is no method of comparison of «classic» technologies and methods of welding of concrete wares with innovative technologies. What the doubts in financial viability of the use and introduction of such technologies are from.

RESEARCH OBJECT

Task statement. On the simplest examples to consider a role in the economy of welding production of designers, metallurgists and technologists of production at introduction of innovative technologies.

RESULTS OF EXPERIMENTAL RESEARCH

Exposition of basic material. Designer decisions have direct influence on forming cost of the welded construction. We will consider this influence on an example (fig. 1).

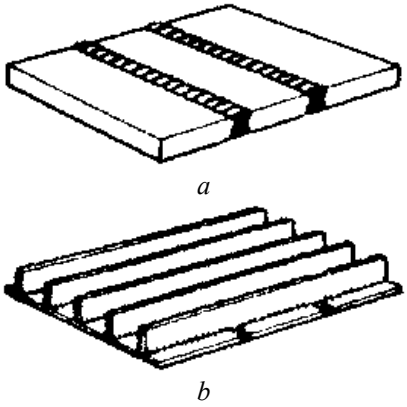

Fig. 1. Variants of designer decision of creating a welded good with identical operating descriptions: a – from a heavy-gage sheet metal; b – from a light-gage sheet metal

On the fig. 1 the welded good is shown in two structural variants: a) – solid cross-section from construction steel, b) – from the thin-walled elements of identical inflexibility and durability, from high-resistance steel.

It is visible from the resulted example, that expenses on welding on the second variant will be considerably higher, as it is necessary: for welding of high-resistance steel to use the preliminary warming [Kahovskiy N. I., 1968., Gedrovich A.I, Galtsov I.A., Druz O.N. and others, 2002., Savitskiy M.M. and others, 1999.] up, to conduct retraining of welders for transition from a variant a) to the variant b), to lower speed of welding for reduction of heat input and providing of necessary plasticity of the welded connection, to enter additional operation of correction, because of strengthening of deformations of good [Gedrovich A.I., 1998.] or concomitant cooling, that requires creation of the special adaptations (stands, conductors, sprayers etc.) [Gedrovich A.I., Druz O.N., 2002., Gedrovich A.I., Druz O.N., 2003.]. Thus, innovative replacement of heavy-gage sheet metal on light-gage sheet metal, except for the decline of amount of the metal used in construction, does not give an economic value. Transition to light-gage sheet metal is economically inadvisable considering the rise in the prices of construction making process.

Large influence on the cost of the welded construction is performed by the requirements to quality of the welded connection, which must be grounded with the special care, depending on responsibility of construction. For example, «It is impermissible for weldes to have bugs», as absolute absence of bugs in practice in the real terms is unattainable. All bugs have the certain degree of admission [Motsohin S.B., 1985., Troitskiy V.A., Radko V.P. and others, 1983.].

The metallurgist of enterprise, after the decision by the designer of requirements to the welded good, chooses optimum material of good and welding materials (electrode, protective environment) answering these requirements. Nowadays many innovative developments in area of welding materials have quality certificates, however there are no reliable data about their application on concrete wares and materials in production terms. Such position hampers, and sometimes even eliminates the possibility of their choice by a metallurgist. The metallurgist of enterprise will more likely choose «classic» tested on some production or on the experience welding materials which pass through the entrance checking system of production necessarily. An error in the choice or use of new materials (before not applied on concrete constructions) can result in the severe losses of time on the repair welding, to the change of technology and accordingly to the increase of cost of good. Thus, the choice of new welding materials by a metallurgist is complicated and can be economically inadvisable in comparison with the materials applied before.

A technologist-welder chooses the process of welding, mode and equipment. He also makes operative decisions of problems that are inevitable arising up in production terms. The choice of

welding process is determined by the sizes of the welded construction, possibility of its turn over, providing of the best terms of welding, access to the joints, possibility of automation and mechanization of process, present qualification of welders, present equipment and etc.

One of most difficult items is the choice of welding process and its technological modes. More frequent only the choice of welding process is dictated by minimum energy consumption.

We have conducted the analysis of welding methods on energy consumption for the welded connection of the type C4. For example, power input was determined on the joint single-pass welding of two sheets from construction steel (type of the connection C4) 4 mm thick (GOST 8713-79). 1 m adopted length of weld, production is single, for all arc methods of welding as a source of feed the semiconductor rectifier of the type VDU-1001-1001 is used. The modes of welding were adopted from help data. The results of decision of power input are represented on fig. 2.

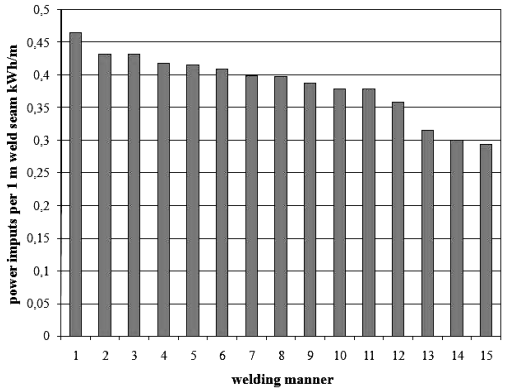

Fig. 2. Cost sharing of electrical energy per 1 m of weld of the connection C4 for various ways of the arc welding in protective gases [Druz O.N., Gitnaya S.V., 2011.]: 1 – automatic welding in the environment of inert gases (Ar); 2 – automatic welding under water by a bare wire without additional defense; 3 – automatic welding under water by the powder-like wire PPC-AN5; 4 – automatic welding under water by the powder-like wire PPC-AN1; 5 – automatic solvent sealing on copper-melt backing; 6 – automatic welding in the protective environment CO_2; 7 – automatic welding in a mixture by a $85\%CO_2+15\%O_2$ electrode wire with additions Ce and La; 8 – Automatic solvent sealing on melt backing; 9 – automatic welding in the mixture $85\%Ar_2+15\%CO_2$; 10 – automatic welding in the mixture $70\%CO_2+30\%O_2$; 11 – welding in the environment of aquatic steam; 12 – automatic welding in SO_2 on the layer of activator (melt); 13 – automatic welding in a mixture $85\%Ar+15\%CO_2$ on the layer of activator (melt); 14 – automatic welding in the protective environment Ar on the layer of activator (melt); 15 – automatic welding under water by a bare wire with the additional defense CO_2

However, not taking into account such distributing of consumption of energy and performance of welding methods (fig. 4), cost of 1 m of weld doesn't coincide with it, so it results in additional expenses on the receipt of the welded connection (cleaning, assembling under welding, pay-envelope of welders and auxiliary personnel, expenses on repair and maintenance of setting, welding materials and etc) [Gracheva K.A., 1984., Gretskiy Y.Y., 1995., Tereshenko V.I. and others, 1987., Shebeko L.P., Gitlevich A.D., 1986., Yurev V.P., 1972., Druz O.N., Gitnaya S.V., 2011.].

From a fig. 2 and fig. 3 we can see, that minimum energy consumption, while other things are equal, have the methods of welding in protective gases (and their mixtures) with activators, and also radial methods of welding. Welding under water and welding in the environment of aquatic steam can be considered welding in an active gas environment, consisting of products of decomposition of water (and steam) and gases selected at dissociation of powder-like wires charge.

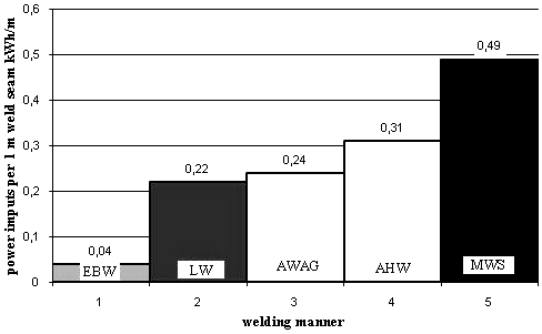

Fig. 3. Cost sharing of electrical energy per 1 m of weld of the connection C4 for various ways of the welding [Druz O.N., Gitnaya S.V., 2011.]: EBW – electron-beam welding, LW – laser welding, AWAG – automatic arc welding in active gases, AHW – automatic hidden arc welding, MWS – manual arc welding

Most localization of input of heat can be created at heating of the welded good by a laser and electronic ray. An arc with a consumable electrode is a relevantly high-localized source of heat. The less localizing heating is performed by the arc of indirect action. The least localized is entered warmly in the welded good by gas-welding flame.

Most maximal power is practically attained at the electroslag welding ~250 kW and electric arc welding ~100 kW. Electron-beam welding options are characterized the range of powers to 50 kW. Some less maximal power ~30 kW current is seen

in setting for welding by a laser. Maximal power of the practically applied gas-welding flame is limited ~10 kW.

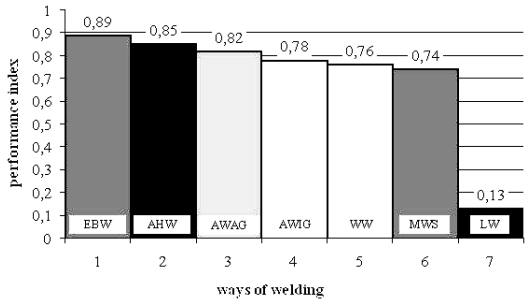

Fig. 4. Distributing of middle output-input ratio (performance index) of various ways of welding [Druz O.N., Gitnaya S.V., 2011.]: EBW – electron-beam welding; AHW – automatic hidden arc welding; AWAG – automatic arc welding in active gases (CO_2); AWIG – automatic arc welding in inert gases (Ar); WW – welding by a powder-like wire; MWS – manual arc welding by a stick electrode; LW – laser welding

Electronic ray, welding arc characterized by the use of energy (on the effective input of heat in the welded good) source by the most high value of performance. The power use of laser and gas flame is considerably less effective.

We can see from the above-mentioned data, that on the given stage of welding technologies development it is necessary to work above perfection, foremost in arc welding and the environment of protective gases and their mixtures, as one of most resource-saving and methods of receipt of unsectional connections that simple in realization (automations). Thus, the least energy consumption of welding process is not the basic criterion of innovative welding technologies choice.

On an example we will consider the choice of parameters of arc welding process, as most perspective for introduction of innovative technologies. One of economic indicators of arc welding methods is productivity of pad weld. On the fig. 6 we can see dependences of pad weld speed on the strength of welding current.

Prospects of further researches. Researches in area of arc welding methods in active gas environments theoretically and practically are most perspective. In East Ukraine National University there have been developed methods of welding in a complex protective environment, and also methods of the use of complex protective environment in different welding technologies, for example, forced concomitant cooling and reduction of concentration of welding aerosols in the working area of welder. On the received results of researches 8 patents of Ukraine have been gotten and candidate's dissertation prepares to defense.

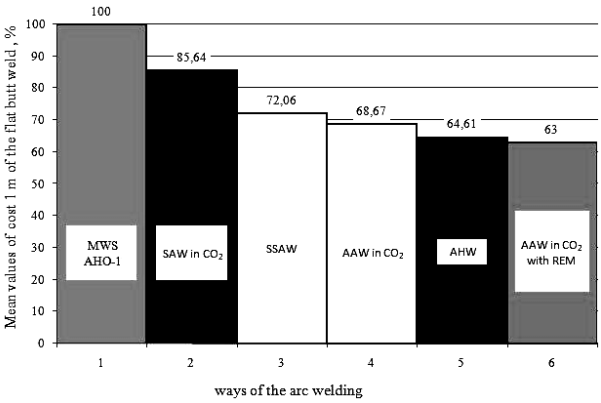

Fig. 5. Mean values of cost 1 m of the flat butt weld C4 at the thickness of sheet 4 mm in relative units (the hang-the-expense approach method of welding is accepted after 100%) on various ways of the arc welding [Druz O.N., Gitnaya S.V., 2011.]: MWS AHO-1 – manual arc welding by the custom-made electrode of the AHO-1 brand, SAW in CO_2 – semi-automatic arc welding in the protective environment CO_2, SSAW – semi-automatic submerged arc welding, AAW in CO_2 – automatic arc welding in the protective environment CO_2, AHW – automatic submerged arc welding, AAW in CO_2 with REM – automatic arc welding in the protective environment CO_2 with additions of rare-earth metals to the electrode

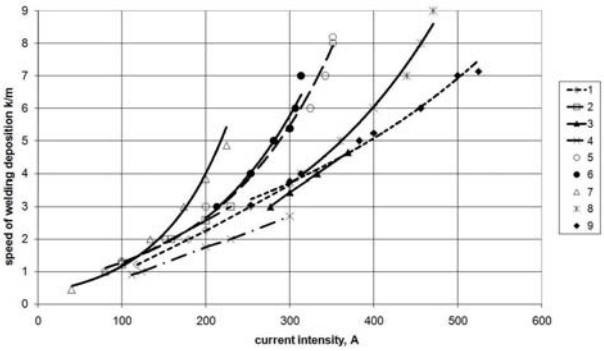

Fig. 6. Dependence of productivity welding deposition of arc methods of welding on strength of current [Druz O.N., Gitnaya S.V., 2011.]: 1 – manual arc welding, electrode with basic coverage; 2 – manual arc welding, electrode with cellulose coverage; 3 – manual arc welding, electrode with retile coverage and ferrous powder; 4 – manual arc welding, electrode with retile coverage; 5 – welding in a protective environment the CO_2 wire the diameter 1,2 mm; 6 – powder-like wire the diameter 1,6 mm (brands – FCW AWS E6XT5); 7 – welding in a protective environment the CO_2 wire the diameter 0,8 mm; 8 – powder-like wire the diameter 1,6 mm (brands – FCW AWS E6XT1); 9 – powder-like wire the diameter 2,4 mm (brands – FCW AWS E6XT1)

CONCLUSIONS

1. Introduction of innovative technologies in welding production requires the account of specificity of every welding process.

2. For introduction of innovative technologies the methods of welding in active gas environments are most perspective.

3. Application of plasma, electron-beam and laser methods of welding are justified only in case of impossibility of the use of other methods of welding.

4. From point of financial viability innovative technologies are not always justified (acceptable).

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УЧЕТ СПЕЦИФИКИ ПРОЦЕССА ДУГОВОЙ СВАРКИ В ИННОВАЦИОННЫХ ТЕХНОЛОГИЯХ

Олег Друзь, Светлана Житная

Аннотация. В данной статье изложены результаты исследований по внедрению в сварочное производство инновационных технологий. Рассмотрена роль в экономике сварочного производства конструкторов, металлургов и технологов производства при внедрении ресурсосберегающих технологий. Рис. 6, ист. 43.

Ключевые слова: сварка, экономия, инновационные технологии.

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AN INFLUENCE OF ADHESION MODEL ON THE RESULTS OF LOCOMOTIVES DYNAMICS SIMULATION

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S u m m a r y : The results of the locomotive dynamical behavior modeling with different wheel –rail contact sub – models are presented. It is shown, that the choice of wheel-rail contact model has significant impact on the simulation of locomotive motion in traction regime with high creep values, even when it's running on the straight track.
K e y w o r d s : wheel, rail, contact, creep, traction, dynamics

INTRODUCTION

A study on the wheel – rail frictional interaction brought the "adhesion coefficient (force) characteristics" concept – the dependence of the adhesion coefficient (force) on the creep vector inside the contact area. However the term "creep", its calculation method and its value is different in various sources.

The creep in wheel – rail contact arises by two different reasons:

- as the reaction on the tractive (braking) moment applied to the wheelset axle;
- kinematical parameters of movement

It is often met that the first term is ignored in the locomotive dynamics simulation, and this can lead to significant errors.

OBJECTS AND PROBLEMS

The scheme of wheelset running on the track is shown on fig. 1. Wheelset is moving with linear speed V, left and right wheels are rotating with angular speeds w_{left} и w_{right} thereafter. Let's denote by r_0 mean rolling radius of the wheel , and by r_{left} и r_{right} - left and right wheel contact radius. The distance between initial contact points is denoted by d.

The creep components are usually defines as ratio of projections of the relative movement speed of the wheel and rail points to the linear movement speed:

$$\xi_x^i = \frac{\mathrm{Pr}_x(\bar{V} - \bar{w}_i r_i)}{\bar{V}}$$
$$\xi_y^i = \frac{\mathrm{Pr}_y(\bar{V} - \bar{w}_i r_i)}{\bar{V}} \qquad (1)$$
$$\varphi^i = \frac{\mathrm{Pr}_z(\bar{w}_i r_i)}{\bar{V}}$$

where: ξ_x - longitudal creep, ξ_y - lateral creep, φ - spin, r - contact radius, i = *left, right*

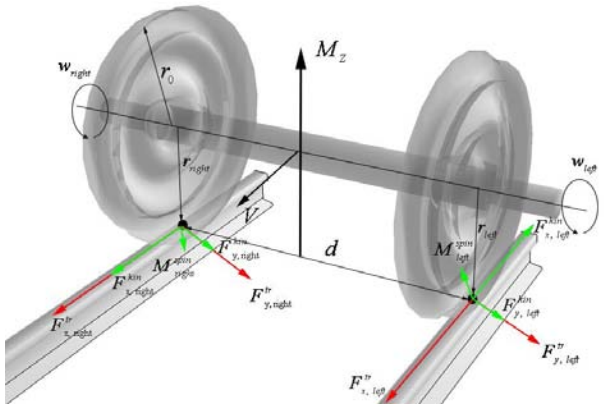

Fig. 1. Wheelset movement scheme

It is often met that creep, calculated with expression (1) is expressed in percents.

The schematic representation of adhesion characteristics is shown on fig. 2.

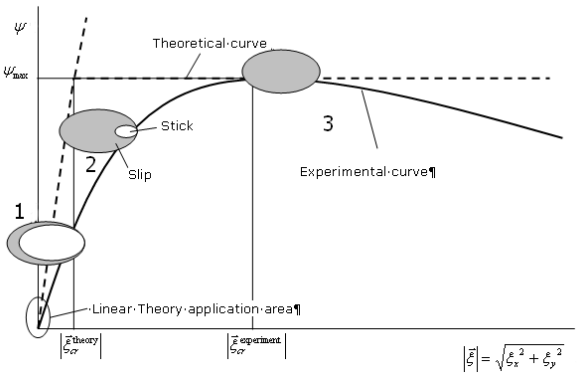

Fig. 2. Creep – adhesion coefficient curve

As it can be seen from fig. 2, creep force characteristics has maximum, which is reached at some value of creep – critical creep $\vec{\xi}_{cr}$. When the creep is lower then $\vec{\xi}_{cr}$, the adhesion process is stated as normal, and when the creep is higher then $\vec{\xi}_{cr}$ boxing is progressing.

An overwhelming majority of adhesion mathematical models, that explains the adhesion characteristics development, are based on the Osborne Reynolds "On Rolling-Friction" work, published in 1876. He has determined, that when the roller is rolling over the plain, the way passed by the center of the roller during one turn differs from it circle length. Osborne made a assumption that contact zone is split into stick area, where true slip is zero, and slip area, where true slip is higher then zero.

The followers of this approach [Chollet 2007, Kalker 1967, Kalker 1973, Kalker 1982, Kalker 1990, Kalker 1989, Pascal 1993, Piotrowski 2005, Piotrowski 2008, Polach 1999, Popovici 2010, Quost 2008, Vollebregt 2011 and others] state that with a small relative sleep ($\bar{\varepsilon} << \bar{\varepsilon}_{cr}$) almost all the contact zone is stick zone (see fig.2, first position). While the relative sleep grows, stick area becomes smaller, and the slip zone becomes bigger. (see fig.2, second position). When the $\bar{\varepsilon}$ exceeds $\bar{\varepsilon}_{cr}$, the whole contact area will be slip.area (see fig.2, third position).

A linear theory of the J.J. Kalker [Kalker 1967] is the most widespread rolling friction theory:

$$\begin{bmatrix} F_{tx} \\ F_{ty} \\ M \end{bmatrix} = -Gab \begin{bmatrix} C_{11} & 0 & 0 \\ 0 & C_{22} & \sqrt{ab}C_{23} \\ 0 & -\sqrt{ab}C_{23} & abC_{33} \end{bmatrix} \begin{bmatrix} \xi_x \\ \xi_y \\ \phi \end{bmatrix} \quad (2)$$

where: C_{11}, C_{22}, C_{33}, C_{23} are Kalker coefficients;

a, b –contact ellipse semiaxis;

G – shear modulus.

C_{11}, C_{22}, C_{33}, C_{23} coefficient values for different a/b ratios and elastic properties of the materials can be found in [Kalker 1967]. This solution has high computational speed, but it is limited by the vanishingly small creep (see fig.2). It is assumed, that $V \approx w_{left} r_{left} \approx w_{right} r_{right}$. Then the expressions (1) are then look like [Iwnicki 2006]:

$$\begin{aligned} \xi_x^{left} &= -\xi_x^{right} = -\frac{\Delta r}{r_0} \\ \xi_y^{left} &= \xi_y^{right} = -\alpha \\ \varphi^{left(right)} &= \frac{\sin \gamma_{left(right)}}{r_0} \end{aligned} \quad (3)$$

where: α - wheelset yaw angle, γ - wheel profile conicity; $\Delta r = r_{left} - r_{right}$ - rolling radius difference.

Another popular model of J.J. Kalker is simplified theory and it's program realization FASTSIM [Kalker 1982]. This model is used as standard for wheel - rail interaction simulation. It is widely used in railway vehicle dynamics simulation, including locomotive dynamics simulation. The last one is totally unacceptable, since the simplified theory is developed on the base of linear one, which has area of application limited by the vanishingly small creep as it was mentioned above.

For all the models mentioned above a critical creep values are lower the tenth of percent, and that is much less than experimentally measured once.

A review on the experimental studies given in work [Kostyukevich 1991], has shown that the critical creep, measured by different researches, is varying for 1 to 15% and even to 20%, depending on the frictional contact conditions.

Thus the usage of adhesion models, based on Reynolds theory, in locomotive dynamics simulations, especially in traction (braking) regimes can cause significant errors.

Having the aim to investigate the influence of friction model choice on the dynamical behavior of the locomotive, lets's examine a model of six axle locomotive (TE116), explicitly defined in [Gorbunov 2002]. The design model is shown on fig. 3.

The next premises were are made before the construction of the model:

- All bodies of the system (locomotive body, bogies' frames, traction motor, wheelsets and wheel treads are considered perfectly rigid.

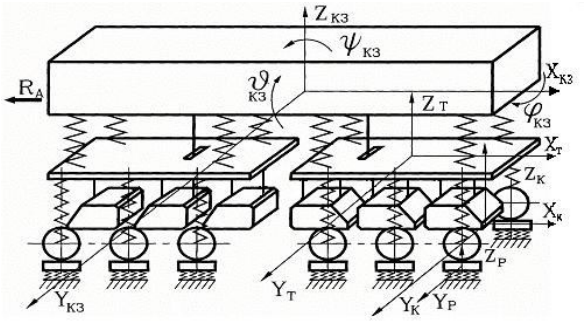

Fig. 3. Design model of six axle locomotive

- Nonlinearities in axleboxes during the lateral run of wheelsets, in pivot units according to the lateral displacements of the bogies, in the support of the locomotive body during the yawing are considered
- The action of the hydraulic and frictional oscillation dampers in axlebox suspension and in the bodie – bogie links
- Train and locomotive running resistance forces are considered
- The simulation is performed in the locomotive traction, braking and stopway regimes
- A traction force value is determined for each wheel separately, depending on the linear velocity of the vehicle, sliding speed of the contacting bodies, frictional condition, wheel –rail profiles and their orientation.
- The longitudinal velocity of the locomotive is determined in the process of the motion differential equations integration and no limitation is put on it.
- A railway track is considered as discrete inertial beams of infinite length, which are laying on the elastic – dissipative or visco - elastic foundation and are under the influence of the vertical and lateral forces, applied at the wheel- rail contact points.
- Wheel tread and rail can have new or worn profiles.
- A wheel flange – rail friction is considered when the once flangeway clearance is exceeded.
- The electrodynamical processes in the engine action are considered.
- During the running process the longitudinal vibrations of the train are considered
- Torsional stiffness of the wheelset axle is considered.

Models [Kalker 1982] and [Golubenko 2012, Golubenko 2011, Gorbunov 2011] were used as sub - model of the adhesion.

A contact model [Golubenko 2012] is formulated in the next way: to find reaction from the foundation (rail) with the prescribed frictional conditions; relative orientation of wheelset and track, vertical load on the wheel, form and elastic properties of the bodies, rigid slip vector.

This model is formulated without traditional separation of the contact problem into normal and tangent, allowing to take into account the mutual influence of normal and tangent stresses, and that is important in case of conformal contact surfaces of wheel and rail (contact in the flange zone for example).

Another feature of the model [Golubenko 2012] is using the empirical dependence of the rolling with sliding friction coefficient on the temperature in the contact zone under the different frictional conditions. The examples of this dependence can be found in [Kostyukevich 2011].

On fig. 4 the adhesion characteristics, obtained with the use of model [Golubenko 2012], for different frictional conditions specific for mines are shown.

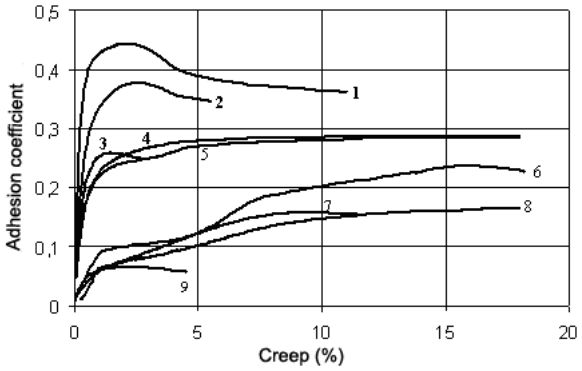

Fig. 4. Adhesion characteristics for different wheel – rail frictional conditions: 1 – thin layer coal dust; 2 - thin layer rock dust; 3- clean dry rail; 4 – thick layer rock dust; 5 – thick layer coal dust; 6- wet rail; 7 – liquid - coal – rock blend; 8 – watery coal - rock blend; 9- motor oil

In the current paper a locomotive motion in the traction regime is studied. Locomotive is running on the straight horizontal track with maximum power and 20 m/s velocity. A flangeway clearance is $\pm$ 7 mm. Adhesion coefficient is equal to 0,26. The critical creep for a model [Kalker 1982] – 0,1%, and for a model [Golubenko 2012] – 1.56%.

On fig. 5. the dependence of the longitudinal creep (fig. 5,a) , lateral creep (fig. 5,b) and first wheelset lateral displacement (fig. 5,c) on the way passed are presented. For the all plots curve 1 corresponds to the model [Kalker 1982], and curve 2 - model [Golubenko 2012]. As it can be seen from the plots the selection of the adhesion model has significant influence on the locomotive dynamics simulation.

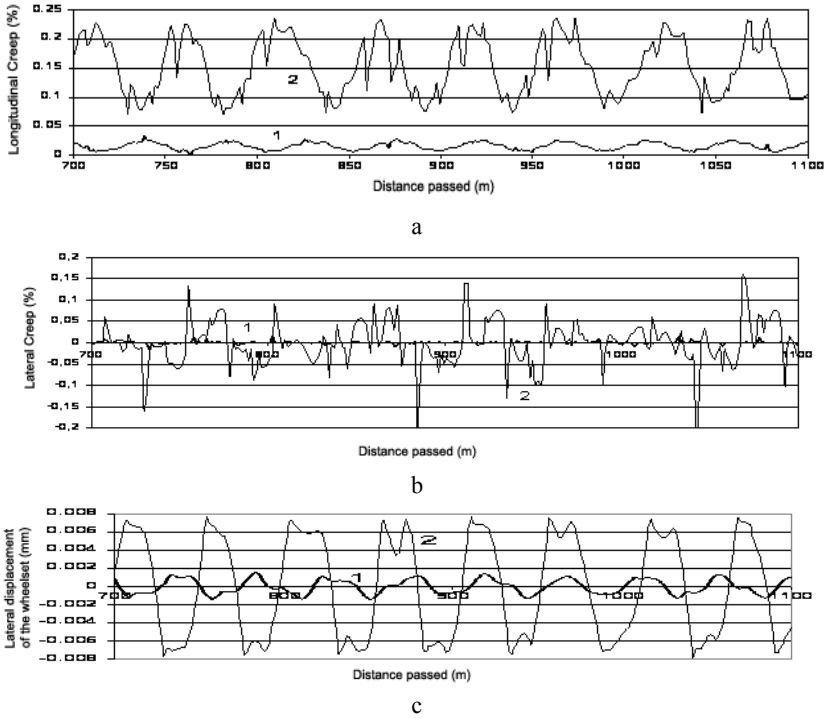

Fig. 5. The dependence of longitudinal creep ξ_x (a), lateral creep ξ_y (b) скольжения, first wheelset displacement (c) on the way passed

CONCLUSIONS

The use of adhesion models, based on Reynolds theory, in locomotive dynamics simulation, can cause significant errors when locomotive is moving in tractive (braking) regime.

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ВЛИЯНИЕ МОДЕЛИ СЦЕПЛЕНИЯ НА РЕЗУЛЬТАТЫ МОДЕЛИРОВАНИЯ ДИНАМИЧЕСКОГО ПОВЕДЕНИЯ ЛОКОМОТИВОВ

Александр Голубенко, Александр Костюкевич, Илья Цыгановский

Аннотация: В статье приведены результаты моделирования динамики локомотива с использованием различных подмоделей контакта «колесо - рельс». Показано, что выбор контактной модели существенным образом влияет на результаты моделирования движения локомотива в режиме тяги при больших значениях скольжения даже при движении в прямой.

Ключевые слова: колесо, рельс, контакт, скольжение, тяга, динамика

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CONCEPTUAL BASES OF THE ORGANIZATIONAL AND TECHNOLOGICAL PROVIDING ECOLOGICALLY OF SAFE MINING PRODUCTION

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S u m m a r y. Presently in the basic mining regions of Ukraine there was a difficult and dangerous situation, caused that the technogenuous loading on a natural environment from development of deposits of minerals became so considerable, that put such regions on the verge of ecological catastrophe. In these terms the special sharpness is acquired by the problem of development of the new going near realization of deposits which must simultaneously provide minimization of ecological harm and increase of economic efficiency of production. The conceptual bases of such approach developed authors are expounded in this article.
K e y w o r d s: conception, development, mining industry, technology, ecologically-economical approach, ecological safety.

INTRODUCTION

Ukraine is one of the largest mining countries of the world. On a production capacity and scale of mountain works its mining complex is included in four the largest among countries with the developed mining industry. This complex is conducting in the structure of industry of Ukraine and its economy, by submitting one of the most large sources of the financial entering the state budget.

However lately the basic mining regions of Ukraine ran into a serious problem, consisting in that over the protracted intensive development of deposits of minerals brought to considerable violations of the state of natural environment in by Donetsk, Pridneprovsk, Kirovograd, Lvov-Volynsk coal pools, Krivorozhsk iron-ore pool, Nikopol-marganets pool. To beginning 2000 years these violations attained such scales, that the indicated regions appeared on verge of ecological catastrophe.

The followings displays have such violations:

– scale changes of the geomechanical state of bowels of the earth, which result in the mass moving and bringing down of surface, technogenuous earthquakes, mountain-rock shots [1, 4, 5];

– that brings violation over of the hydrogeological state of bowels of the earth, causing the uncontrolled moving of considerable volumes of underground waters, to drainage of large areas of earthly surface, water-flooding of considerable territories, solinization and sources of drinkable water-supply [7, 9, 17];

– violation of chemical composition of air as a result of the troop landings of toxic and chemically active gases from work of equipment, explosive works and gas-outcoming of breeds, broken mountain works [2, 4, 10, 11];

– change of chemical composition of soils as a result of their contamination the pulverulent particles of useful minerals and in passing extractive mountain breeds, which have cardinally different chemical composition from composition of soil [3, 4].

All of these processes sharply put the problem of necessity of urgent decline of the

techogenuous loading from activity of mining enterprises on an environment, that decisions of problem of ecological safety of mining production and his enterprises.

1. Basic complications of decision of ecologically-economical problem

The decision of foregoing problem restrains a temper the followings factors:

– by absence of the scientifically grounded going near development, planning and introduction of technology and techniques which provide the decline of the negative influencing of mining production on an environment;

– by the insignificant volume of technological and technical decisions which would provide ecological safety and economic effective development of deposits simultaneously;

– by absence of the scientifically grounded directions of development of mining enterprises in the conditions of intensification of production, complication of geotechnical and economic their operating conditions;

– by the low rates of conducting of researches of system-economic aspects ecologically safe functioning of mining enterprises.

Researches of row of organizations are devoted the decision of problems of ecologisation of mining complexes of Ukraine. The most meaningful fundamental results are got the group of scientists of such universities of Ukraine, as the East-Ukrainian national university the name of V. Dal, Donetsk national technical university, National mining university and Krivorozhsk technical university. During the last researches were 10 years conducted and the complex of developments of conceptually-theoretical and applied character is executed for the decision of this problem. These developments are taken in the general problem-oriented work «Development and introduction of high-effective technologies of ecologically defense orientation of production complexes of Ukraine» which includes developments on such directions:

– conceptual theoretical bases of the ecologically-economical going near providing and organization of ecologically defense mining production [1, 7, 10, 11, 12];

– analytical researches, laboratory and industrial experiments on the different aspects of planning of technological processes and mountain equipment for perfection of production processes in sending of decline of their harmful impact environmental and providing of economic efficiency of development [6, 13, 14];

– scientific grounded methods of calculation of parameters and methods of management the processes of guard of bowels of the earth, earthly surface, water environment and atmosphere at development of deposits [13, 14, 18];

– scientific bases of development of system-economic aspects of the complex use of natural resources, increase of ecological safety of mining production, organization of production and management enterprises [19];

– technological decisions on realization of development of deposits of minerals with the use of facilities, removing the dangerous production troop landings ecologically [15, 16, 18, 20];

– to recommendation on determination of ways of further improvement of ecologically-economical activity of mining enterprises [1, 7, 14, 18].

Theoretical positions of this work served basis for development of new technologies and modernization of activity of mining enterprises which do not have analogues in world practice and oriented to the decline of the negative influencing of mining production on the state of natural environment with the simultaneous providing of high economic efficiency of mining. The substantive conceptual provisions of this work are set forth below.

2. Features of innovation-investment activity in area of mining production, as basis of introduction of ecologically defense technologies

One of major terms of providing ecologically of the safe and economic effective functioning of mining production is the grounded innovation-investment policy of enterprise, taking into account influence of ecological factor on parameters and results of development of minerals [6, 8]. Absence of account of this factor during organization, planning, planning and management of mining operations can result in serious negative economic and social consequences. The exact estimation of character of this factor and his displays in the concrete terms of development of deposits allows correctly to forecast all of its consequences (which can have catastrophic displays), plan, organize and develop economic activity of enterprises, providing high economic results at minimum negative influence on a natural environment.

Actuality of account of ecological factor in activity of mining enterprises especially increases in market economic conditions in connection with the necessity of decision of contradictions of economic task on a joint «nature-market». This task arises up in connection with natural incuriosity of business enterprises in the investment of financial means in nature protection measures, for lack of line arrived, to prolongation in time of offensive of responsibility for the inflicted ecological harm, lacks of coincidence of interests of enterprises and recipients (population, other enterprises, state). The special attention is required by the questions of management the processes of technological innovations, as the last not only determine affecting of production natural environment, but indissolubly related to control of inventories of natural resources and their rational use (booty without losses and decline of quality), that determines the economic results of development straight.

Market relations stipulate the necessity of consideration of ecological problems of mining production from point of ecologically-economical approach. It is special underlined in conception of steady ecologically-economical development, formulated in the «Global program of actions - Notice on 21-th age», accepted at conference «environment and development», conducted under an aegis UNO (Rio de Janeiro, 1992). Positions of this program are required by introductions of the system of estimation of activity of industrial enterprises from point of prevention of possible negative ecological consequences from their functioning. Thus, grounded, that achievement of the put purpose is impossible a way only technological development, for this purpose it is necessary to subordinate it achievement all of innovative activity, because ecological problems engulf all of complex of technological, technical, organizational, scientific, economic aspects of production. Only by the complex going near his innovative development it is possible to attain balance as between society, production and natural environment.

More justified from the economic point of view is other going near the decision of ecologically-economical problem, namely is the ecologically oriented restructuring of industries of industry of exploiting natural resources. Under restructuring the change of character and methods of production-economics activity of enterprises is understood. The purpose of such restructuring is:

– minimization of volumes of engaging in exploitation of natural resources (supplies of deposits) at the receipt of necessary amount of commodity products;

– reduction of volumes of wastes at the production of basic goods forget of the most complete extraction of useful component from the obtained source of raw materials;

– application of technologies, eliminating harmful influences on an environment at implementation of technological processes (for example, passing to the biological kinds of fuel, nonexplosion separation of useful mineral etc.), in case formation of wastes the last must in good time join in the single production chain of their use as sources of raw materials for other productions.

Innovative activity of enterprises in the conditions of restructuring must execute the followings functions: acceleration of structurally-technological alteration of production; decline of ecological risks at introduction of innovations; increase of level of skilled and scientific and technical potential; providing of co-operation of science, production and financial-credit sphere. Taking into account the last function evidently, that «ecologisation» process of structurally-technological alteration of enterprises must be examined in indissoluble connection with innovative and investment activity.

It is necessary to mark that besides realization of the ecologically oriented restructuring of basic production of industrial enterprises, a large value is acquired by reformation and development of market mechanisms of ecologisation, namely creation of favorable organizationally-economic terms for an innovative enterprise in area of ecologically safe production. From all of types of innovative activity their special kind was already selected in this direction – ecologically clean technologies. With every year amount of users ecologically grows clean products in the whole world, including in Ukraine. A basic task here consists of creation of terms, when enterprises, realizing such technologies, will be able to get an economic effect from their activity commensurable with the sizes of capital financial investments in a production.

3. An economically-lawful mechanism of providing of activity is in ecologically defense activity of mining enterprises

A large value in ecologically-economical direction has legal base. Due to realization of effective economically-lawful mechanisms of management an economy such terms of production

activity of enterprises, at which to the managing subjects is economic advantageous to observe a nature protection legislative base, reduce the level of harmful influence on a natural environment, must be created, to warn (but not to liquidate) his appearances, search the methods of rationalization of production due to the use of new resources-saving and ecologically defense technologies of mining, and also technologies of processing of its by-products.

The economic mechanism of ecological management, certain the base laws of «About to the guard of natural environment, operates in Ukraine». Due to the economic instruments of this law bases of requiring payment natureusing and economic tool are worked comes forward the unique mean, allowing to provide the receipt of financial resources, necessary for the removal of harmful influence on a natural environment. However, the substantial lacks of domestic economic mechanism of ecological management are the followings: he is unable to interest commodity producers in conducting of nature protection measures due to the personal money funds; not corresponds with other economic indicators and levers of economic activity; it is not enough operatively and effectively reacts on the dynamics of economic and ecological processes in the state.

Presently positive tendencies, directed on introduction of conclusions of conception of steady ecologically-economical development, register in the industrial regions of Ukraine. It means that the process of gradual building (integrations) of ecological factor began in the system of modern production, and also in the economically-lawful mechanism of functioning of market. An ecological enterprise develops as a result of it, and, consequently, the market of ecological business is formed. That the sphere of ecological technologies becomes the object of profitable commercial activity. As a result of it there is a certain infrastructure, including a few independent directions business of activity in area of mining production, main from which followings:

– creation ecologically of safe and resource-saving technique and technologies of realization of development, providing a high performance and economic efficiency of implementation of technological processes at minimum negative influence on a natural environment;

– utilization of wastes of processing of obtained useful minerals (wastes of production) as sources of raw materials for other productions;

– use of the materials got in passing;

– production of devices for control of the state of environment;

– ecological reproduction.

4. Direction of utilization of wastes of mining production and his economic value

It is necessary to mark that mining industry of Ukraine and its enterprise carry monoproductive character (booty of one concrete mineral at development of deposit) mainly, which the far of hard, liquid, gaseous and aerosol wastes appears at. That mastering of deposits carries complex character neither on the use of the obtained source of raw materials nor on the use of the materials got in passing. In accordance with conception of steady development its converting must one of actual directions economic activity of enterprises of this production become into multifood [1].

Results of theoretical, experimental researches and experimental tests, showed that a multifood production at the complex mastering of deposits was the substantial factor of decline of basic unit of mining production cost, because the additional types of commodity sources of raw materials turn out in this case. Due to this factor the prime price of basic commodity raw material goes down on 10-20% and more. Pre-condition of drawing on this reserve is a presence on Ukraine from the developed industrial infrastructure of potential users of passing products and their participating in investing of projects of utilization of the materials got in passing from a mining production.

Development of industry of processing and utilization of wastes on modern technical and technological basis in combination with the innovative model of steady development allows complex to decide the ecological, economic and social questions of alteration of economic mechanism of mining industry. To the most essential constituents of this aspect behave: engaging of the second raw material in an economic turn; development of the specialized powers on processing of wastes; issue of the special equipment for utilization of wastes; production of new types of products (build materials, fuel bricks, methane and other); introduction of control the system by utilization of wastes within the framework of created technoparks and innovative-technological centers; increase of technological level of basic production of mining enterprises due to introduction of front-

rank scienceful technologies; conducting of the special research works on the having a special purpose programs; creation of new workplaces [19, 20].

By priority direction of development industry of processing of wastes, infrastructures of its service on the basis of progressive scienceful technologies there is creation of technological parks (techoparks).

CONCLUSIONS

Arising up lately in the basic mining regions of Ukraine the serious problem of the extraordinarily high technogenuous loading on a natural environment demanded decision of a number of tasks, directed on providing of possibility of the further large-scale and economic effective mining at the maximal decline of display of harmful for ecology production factors.

The analysis of terms which resulted in such consequences, and also economic and technological feasibilities which are possessed by the scientifically-industrial complex of Ukraine, executed authors showed that this problem can be decided. Its decision must be carried out on the basis of the new going near methods and organization of functioning of mining industry and its enterprises.

Complication and many-sided nature ecologically-economical problems so high, what only during complex realization of measures on all of the indicated directions realization ecologically of safe mining production is possible in activity of mining industry and its enterprises.

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КОНЦЕПТУАЛЬНЫЕ ОСНОВЫ ОРГАНИЗАЦИОННО-ТЕХНОЛОГИЧЕСКОГО ОБЕСПЕЧЕНИЯ ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ ГОРНОГО ПРОИЗВОДСТВА

Сергей Гребенкин, Виктор Рябичев,
Владимир Павлыш, Артём Тищенко, Юрий Тищенко

Аннотация. В настоящее время в горнодобывающих регионах Украины сложилась неблагоприятная ситуация, обусловленная высокой техногенной нагрузкой на окружающую природную среду за счет интенсификации процессов добычи минерального сырья, что ставит регионы перед угрозой экологической катастрофы. В этой связи особую остроту приобретает проблема развития новых подходов к совершенствованию технологии добычи с целью обеспечения минимизации экологических рисков при возрастании экономической эффективности производства. В данной статье авторами рассматриваются вопросы развития концептуальных основ современного подхода к организации экологически безопасного горного производства.

Ключевые слова. Концепция, развитие, горная промышленность, технология, эколого-экономический подход, экологическая безопасность.

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X-RAYSTRUCTURAL RESEARCH OF PRODUCTS OF CAVITATIONAL EROSION OF METALS

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S u m m a r y . The results of qualitative and quantitative X-ray phase analysis of products of cavitational erosion of metals surfaces are presented in this article. The obtained data allow to suggest that the main reason of cavitational erosion of metals surfaces in the water is the chemical influence of cavitational environment.
K e y w o r d s : cavitation, erosion, diffractogram, powder sediment.

INTRODUCTION

Cavitational destruction is one of the reasons which causes the intensive wear of equipment: blades of the pumps, surfaces of the pipelines etc. In spite of the problem of cavitational destruction has been analysed for a long time, the mechanism of this phenomenon isn't known till the end so far. That's why the research of the mechanism of this destruction is the actual task, as if the reason of the phenomenon is clear, the destruction of screws of speed vessels, blades of the pumps can be predicted and it'll be possible to prolong their exploitation [1-7].

In the modern works erosion is regarded as the result of periodical load of the surface with spherical waves, generated in the zone of whip of cavitational bubbles and high speed liquid micro streams, which can destroy even super durable materials [8-16].

RESEARCH OBJECT

The results of the research of products of the surface destruction with X-ray structural methods, which allow to determine both the chemical composition of the sediment and its physical condition, that make it possible to find out the mechanism of the destruction of solid surface under ultra-sound cavitation are given in this work. The ultra-sound dispergator UZDN-2T with electrical power of 400 W and frequency of 22 kHz was used for studying the interaction between cavitation and the surface of the attachment.

To study the influence of cavitation on the metals surface the fixed on the magnitostricror attachments from different materials were put down into the 100 ml glass with distilled water. The glass was in the thermostat to prevent heating. The time of ultra-sound processing varied from 15 h till 20 h, after which the liquid was evaporated under the flat temperature, and the sample of abandon powder sediment was made for the X-ray structural analysis. Moreover the control of changing of the attachments mass was made during the process of erosion. The initial mass of the iron attachment was 44,437 g. Its mass after 30 h of ultra-sound cavitation became 43,751 g. The mass decreased on 0,686 g. The initial mass of copper attachment was $50{,}080 \pm 0{,}005$ g, but its mass after 20 hours of cavitational influence became $49{,}612 \pm 0{,}005$ g.

On the fig.1*a*, *b* the photos of the surface of the iron attachment before and after the influence of ultra-sound cavitation are given.

On the fig.2*a*, *b* the photos of the surface of the copper attachment before and after the influence of ultra-sound cavitation are proposed.

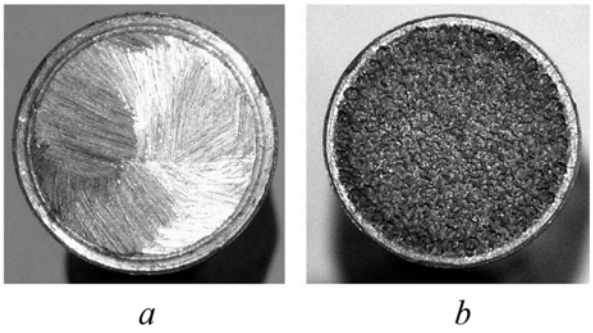

Fig.1. The surface of the iron attachment: *a* – before cavitation; *b* – after 30 hours of the influence of ultra-sound cavitation. The initial mass of the iron attachment - 44,437 g, after 30 h of ultra-sound cavitation– 43,751 g

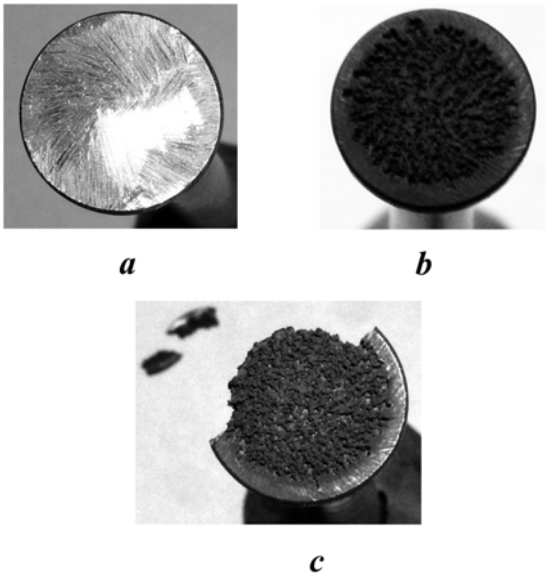

Fig.2. The surface of the copper attachment: *a* – before cavitation; *b* – after 20 h of the influence of ultra-sound cavitation; *c* – after the extra 20 h of the influence of ultra-sound cavitation. The initial mass of the copper attachment – $50{,}080 \pm 0{,}005$ g, after 20 hours of the cavitational influence – $49{,}612 \pm 0{,}005$ g

The powder sediment pressed in side ditches with the inner volume of 10 mm in diameter or 0,5 mm in depth. The side ditches were fixed in the station GP-13 of the goniometer GUR-9 of the X-ray diffractometer DRON-4. Diffractograms of the powder sediment, obtained under the ultra-sound influence on the copper attachment, were taken under the following conditions: the wave length of radiation λ=0,154 nm under the accelerated tension of 29 kV and current of 15 mA. Splits, limited the size of X-ray radiation, for shooting were 0,5×4×0,25 mm. Ni filter was used to filter K_β radiation. The shooting of diffractograms was made in step by step regime: angles $2\theta=10^0$-150^0 with the step of $0{,}1^0$ and the time of exposition of 5 s (fig.3,*b*-1) and 10 s (fig.3, *b*-2). Diffractograms of the powder sediment, obtained under the ultra-sound influence on the iron attachment, were taken under the following conditions: the wave length of radiation λ=0,1936 nm under the accelerated tension of 25 kV and current of 15 mA. Splits, limited the size of X-ray radiation, for shooting were 0,5×4×0,25 mm. Mn filter was used to filter Kβ radiation. The shooting of diffractograms was made in step by step regime: angles $2\theta=6^0$-150^0 with the step of $0{,}1^0$ and the time of exposition of 30 s (fig.3-1) и 20 s (fig.3-2). The initial mass of the iron attachment was – 44,437 g. Its mass after 30 h of ultra-sound cavitation became – 43,751 g. The mass decreased on 0,686 g.

The received diffractograms of the powder sediment, obtained under the ultra-sound influence on the copper attachment are given on the fig.3a,b and on the iron attachment on the fig.4a,b.

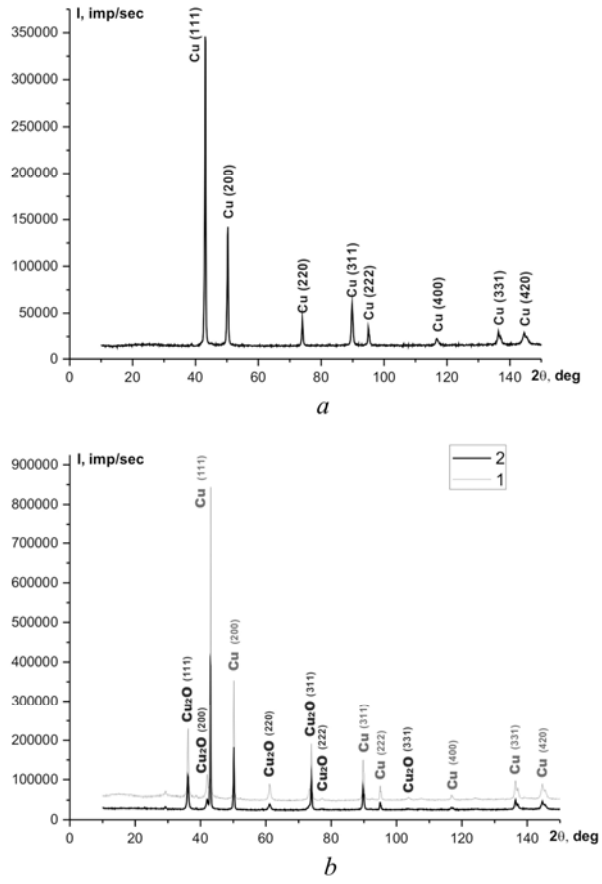

Fig.3. Diffractograms: *a* – copper attachment before cavitation; *b* – powder sediment after cavitation (1 – 20 h of ultra-sound cavitation; 2 – after extra 20 h of ultra-sound cavitation)

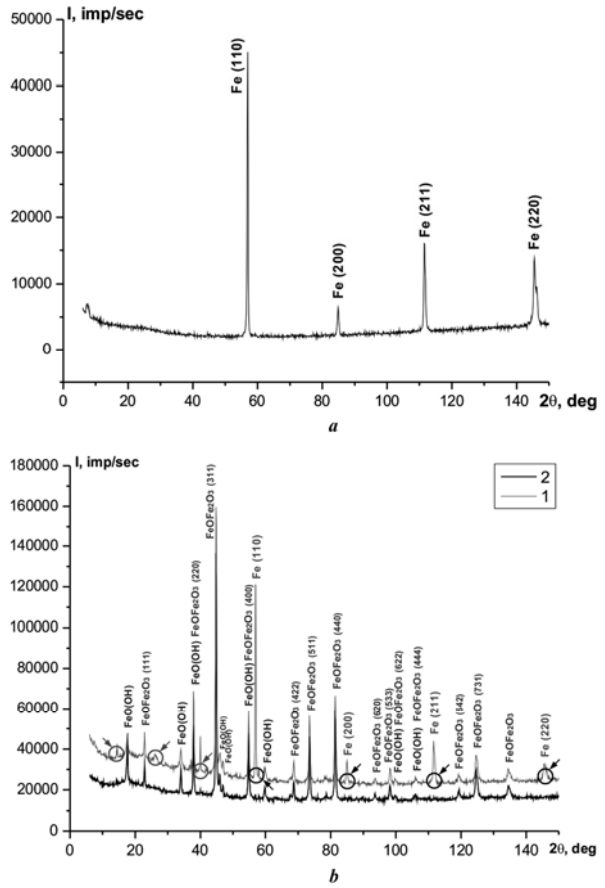

Fig.4. Diffractograms: *a* – diffractograms of the iron attachment before cavitation; *b* –powder sediment after ultra-sound cavitation (1 – 15 hours of cavitation; 2 – extra 15 hours of cavitation). Phase Fe is on the diffractogram 1 (circled), but on the diffractogram 2 phase Fe is absent and unknown reflexes are absent too (first three circles to the left). The initial mass of the iron attachment was – 44,437 g, after 30 h of ultra-sound cavitation it became – 43,751 g

RESULTS

The ratio of integral intensiveness of the reflection *HKL* α-phase (the shooting on the diffractometer with the focus according to Brag-Brentano) is connected with mass shares correlation [17]:

$$\frac{I^{\alpha}_{H_1K_1L_1}}{I^{\alpha}_{H_2K_2L_2}} = k\frac{m_1}{m_2}, \qquad (1)$$

where: $I^{\alpha}_{H_1K_1L_1}$ – the integral intensiveness of the reflection (quantity is equal to the area of the analytical reflex); k – constant for all lines of X-ray grams, which is from the calibration curve; m_1 и m_2 – mass shares of phases.

The reflexes from the surface (111) for Cu_2O and (200) for Cu were chosen as the analytical reflexes. The shooting was made under the following conditions: the wave length of radiation λ=0,154 nm, the accelerated tension 28 kV and current of 15 mA. Splits, limited the size of X-ray radiation, were 0,5×4×0,25 mm. The shooting was made in step by step regime: angles $2\theta = 35^0$-37^0 with the step of $0{,}05^0$ and the time of exposition of 3 s for Cu_2O and angles $2\theta = 49^0$-51^0 with the step of $0{,}05^0$ and the time of exposition of 3 s for Cu. The obtained diffractograms of the analytical reflexes are shown on the fig.5*a,b* [18-20].

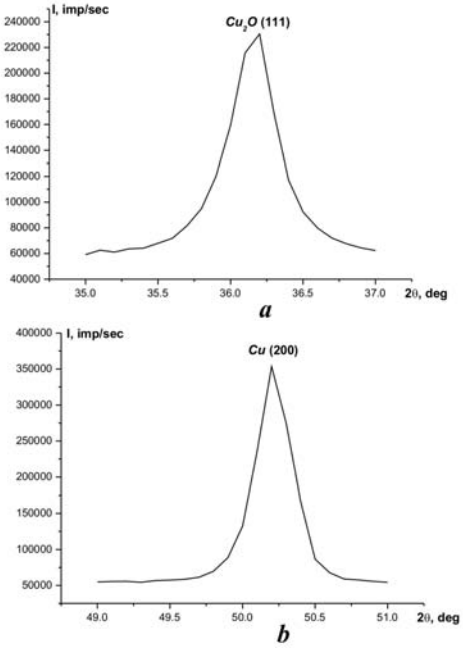

Fig.5. Diffractograms of the analytical reflexes of the powder sediment after 20 hours of ultra-sound cavitation: *a* – Cu_2O (111); *b* – Cu (200)

The results of made calculations have shown that the powder sediment, obtained after 20 h of ultra-sound cavitation, contains: 46,1% Cu_2O and 53,9% Cu, but after extra 20 h of cavitation: 40,8% Cu_2O and 59,2% Cu.

The analysis of defects on widening the lines of diffractograms in the attachment before the cavitational influence and in the products of erosion was carried out further.

It was determined that dispersion and micro tension had the following significances:

- for the copper attachment the dispersion $D = 0{,}12$ μm, micro tension $e = \Delta d/d = 0$;
- for the copper in the sediment the dispersion $D = 0{,}17$ μm, micro tension $e = \Delta d/d = 1{,}5\times10^{-4}$.

These significances show that dispersion, which under the mechanic influence must decrease, in fact increases.

The qualitative X-ray phase analysis of the products of the cavitational erosion was carried out with the help of applied programs IDENT4, XPowder Demo.

The results of the X-ray phase analysis of the products of the cavitational destruction pointed out the existence of the phases: Fe, $FeOFe_2O_3$, FeO (OH), and also the unknown phases.

The quantitative X-ray phase analysis of the powder sediment was made with the calculative method.

The ratio of integral intensiveness of the reflection HKL α-phase is connected with mass correlation (1). k - constant for all lines of X-ray grams, in our case was found with the calculative way as it was impossible to create the sample for the method of calibration curve; m_1 и m_2 - mass shares of phases.

The calculation of integral intensiveness of the reflection for finding the constant k was made according to the formula [15]:

$$I^{\alpha}_{HKL} = k \cdot P\left(\vartheta^{\alpha}_{HKL}\right) \cdot \left(F^2_{HKL}\right) \cdot \frac{1}{2\mu} \cdot p^{\alpha}_{HKL} \cdot \frac{\upsilon_{\alpha}}{\left(V^2_{я}\right)^{\alpha}},$$

where: k – constant for all lines of X-ray grams; $P(\vartheta)$ – angle factor; F_{HKL} – structural factor (taking into consideration the heat multiplier); p_{HKL} – multiplier of repetition; $V^{\alpha}_{я}$ – the volume of a simple cell of α-phase; υ_{α} – volume share of α-phase; μ – coefficient of the linear weakening of the sample.

The results of made calculations have shown that the powder sediment, obtained after 15 h of ultra-sound cavitation, consists of: 3% Fe, 92% $FeOFe_2O_3$ and 5% of unknown phases and FeO (OH).

The qualitative X-ray phase analysis for the powder sediment after extra 15 h of ultra-sound cavitation has pointed out that there are only reflexes of $FeOFe_2O_3$ and FeO (OH) on the diffractogram, but the reflexes of Fe and unknown reflexes are absent.

CONCLUSIONS

All mentioned above allow us to suggest that the main mechanism of the surface destruction under the ultra-sound cavitation is the chemical influence on the metals surface of the cavitational environment.

The distilled water had been replaced by the white spirit for checking up the chemical nature of the surface destruction, but after 20 hours of cavitation the visible signs of erosion on the surface of attachment were not founded.

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РЕНТГЕНОСТРУКТУРНЫЕ ИССЛЕДОВАНИЯ ПРОДУКТОВ КАВИТАЦИОННОЙ ЭРОЗИИ МЕТАЛЛОВ

Владимир Громенко, Сергей Кривоносов, Алексей Снижко

Аннотация. Представлены результаты качественного и количественного рентгенофазового анализа продуктов кавитационной эрозии поверхности металлов. Полученные данные позволяют предположить, что основной причиной кавитационной эрозии поверхности металлов в воде является химическое воздействие кавитирующей среды.

Ключевые слова: кавитация, эрозия, дифрактограмма, порошкообразный осадок.

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INFLUENCE OF AERODYNAMIC CHARACTERISTICS ON THE HEAT EXCHANGING IN THE COOLING SYSTEM

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S u m m a r y . The adequate mathematical model of diesel locomotive cooling device is offered. The solution of this model is received by numerical method of calculation. The optimization criterion and the method of accounting the influence of aerodynamics on heat exchange process are offered.

K e y w o r d s : diesel locomotive, cooling system, heat exchanger, air flow, energy index, Prandtl criteria.

INTRODUCTION

Trouble-free and efficient operation of the locomotive is impossible without reliable and cost effective heat carrier's cooling system. In the most advanced diesel engines by about 40% of the heat introduced with the fuel is converted into useful work, and the rest of the heat lost in exhaust gases for heating components and overcome the friction forces. Suffice it to say for example that the temperature of the lower piston diesel 10 D 100 at some points reaches 450 °C [3]. The temperature of the individual dots cylinder diesel engines covers 5 D 49 is only 50 - 100 °C below it.

If you do not take special measures, the hot gases come into contact with parts quickly overheat, their mechanical strength is reduced, the film lubrication between them will burn out. Dry friction is greatly impeding the movement of the wearing pieces and cause damage to work surfaces. To avoid this, the normal thermal state of the components of diesel supported by a special cooling system. There is an easy way of cooling. It's heat dissipation into the environment of the surfaces themselves parts. That's how small capacity diesel engines do using air cooling. But for the powerful diesel engine this solution is unacceptable, since the sizes of surface of heated parts are negligible in comparison with the amount of heat that needs to deviate them to work properly. And to increase those dimensions directly in a diesel engine can not be due to the limited size of the locomotive [10].

THE FORMULATION OF THE TASK

Heat exchanger-cooler in locomotives designed to remove heat from the cooling, diesel oil, oil of hydraulic transmission, and dissipation of heat into the surroundings. Heat exchanging between the cooling medium (water and oil, diesel oil of hydraulic transmission) and the surrounding air is in the water-and water-oil cooler sections, representing a tubular structure with a transverse outer edges-plates. The fan is directly behind the front sections or water cooler. The tubes and plates are washed by the air that fan suck in. The rate of air passing through the section, up to 8 - 10 m/s [4]. The higher air velocity that goes through the sections, the more efficient the heat is transferred. The amount of heat given out sections depends on water temperature. To reduce the size of diesel refrigerator, the temperature of water that cools diesel increases to 80-95 °C, and closed cooling systems to 105-110 °C. Water supply to the sections and carried back to the diesel pumps.

This system provides heat transfer up to 12% of the total amount released by diesel engine, with a relatively small amount of water. Water systems in locomotives differ in the number of paths of circulation. They may be open or closed. In modern diesel engines, which provide oil cooling

engine and charge air with water, as a rule, apply double-circuit system. Usually, the water system used in locomotives open - they are connected with the atmosphere. The water temperature in such systems should not exceed 90-95 °C. Closed systems are not connected with the atmosphere, the water in them is under surplus pressure and their temperature is about 100-120 °C [1] (high temperature cooling). Thus, water systems cooling include pumps for circulating water piping with fittings, devices for cooling water (radiator), fan, control and protection devices.

From the viewpoint of the cooling device's airflow aerodynamics in the mine it is important how rectifying apparatus, sections of the radiator and fan are relatively situated. On this basis the cooling device can be classified in order of placement of these units along the stream [7]. In existing designs of mine cooling devices are most often used the following scheme:

1. Louver apparatus - the radiator - the camera - the fan (2TE10L locomotive and its upgraded versions).

2. Louver apparatus - camera - the radiator - the camera - the fan (ТЭ109, ТЭП150 locomotives). To the same section of the classification can be attributed some of mine cooling devices locomotive with hydraulic transmission, such as ТГ16).

3. Louver apparatus - the radiator - the camera - the fan - the camera – the radiator (this mixed layout of blocks used in some foreign locomotives, such as "Century" (USA)).

This aerodynamic classification allows us to generalize the approach to modeling the flow of air inside the mine cooling device due to the possibility of setting up such boundary conditions.

As mentioned above, the cooling system should, on the one hand, provide optimal thermal conditions of the locomotive engine, on the other hand - to consume a minimum of energy to drive the fan. An important role in meeting these requirements has the aerodynamics of the shaft running cooler [5]. Its configuration defines the hydraulic resistance and, consequently, the consumption of the fan power. The velocity field defines the intensity of heat exchange between the cooling air and the cooling. To solve this problem, use mathematical simulation approach.

THE DECISION OF THE TASK

The object of mathematical simulations the mine of cooling device. Calculating the air flow without relative velocity of the incoming air is fully justified application; simplified two-dimensional model is allowed, as length of the radiator is several times greater than its height [17]. Besides, as the majority of constructions are symmetric, calculation scheme can be simplified and it is possible to consider only half of given cross section. This method has been used in our work.

A mathematical model of the process is a differential equation in partial derivatives. The exact solution of this equation, in general, does not exist. Therefore, to obtain the values of the velocities in the plane of the radiator have to resort to numerical methods for integrating differential equations. Among the numerical methods of finite element method is by far the most versatile method for numerical calculation of the fields. It is especially good for its flexibility, ease of programming, as well as those that it is well suited for the interpretation of physics of the phenomenon [12]. This method for solving air flow path in the air ventilation system was implemented in the application package MATLAB.

Executed calculations on "HydroGasDynamics" chair of Volodymyr Dahl East Ukrainian National University of aerodynamic characteristics of flowing part of ventilation system showed good conformity with experimental data. This allows recommending the methods of finite elements for researches of air flow in flowing part of ventilation constructions of different types.

Obtained adequate mathematical model used to study the characteristics of the locomotive system cooling in order to minimize hydraulic losses and increase the heat transfer coefficient. Hydraulic resistance of the mine is chosen in the capacity of optimization criterion. From Bernoulli's equation for the flow of real fluid, it follows that the decrease of pressure losses in the refrigerator, at equal power of fan that is installed at the end of the mine, the flow rate, washing radiator, will increase; therefore, will increase the value of *Re* [16]. The higher the value of *Re* is, the higher the heat transfer coefficient, and the quantity of hydraulic losses in the chamber cooling device is directly proportional to the coefficient of hydraulic resistance. Thus, this parameter determines the efficiency of the cooling system as a whole.

Optimization of the existing design flow of the locomotive, which is observed the formation of circulation zones, implemented in the following way:

Construction for the design scheme of the current lines are not solving the Navier-Stokes equations [15], and Laplace's equation, thus obtaining the model of the flow inside the computational domain an ideal fluid;

Then change the geometry of the existing structure so that the walls of the flow path cross-sectional repeated some of the current lines, obtained by integrating the Laplace equation.

The calculations have shown that it can reduce the pressure loss in the mine by 4% while maintaining air flow.

The cooling device as described above, are one of the complex and large-sized units. They consume up to 75% of the power consumed for own needs of locomotives. The development of rational design of cooling systems associated with the solution of complex problems of heat transfer, reducing aerodynamic drag, size and weight of large elements of the systems; to improve their layout in the back of the locomotive, to prevent ingress of the exhaust gases of diesel.

The literature presents methods to improve efficiency and reduce the size of the cooling device by changing the design of the radiator, the optimal choice of fans, as well as the layout of the nodes in the mine of locomotive cooling device. However, insufficiently sanctified remains the question of the influence of aerodynamic flow of the mine cooling device whose design determines the velocity distribution of cooling air at the inlet of the radiator, affects the heat exchange process.

Design calculations of heat transfer process are reduced to the simultaneous solution of the equation of heat balance:

$$Q = G_1 \Delta i_1 = G_2 \Delta i_2$$

and the equation of heat transfer:

$$Q = \alpha \Delta t F,$$

where: Q - the amount of heat transferred from one heat carrier to another;

G_1, G_2 - cooling flow rate sending and the receiving heat, $\Delta i_1, \Delta i_2$ – enthalpy change heat transfer fluids, α – the average heat transfer coefficient, Δt – the average temperature pressure, F – the calculated surface of the radiator.

The main task in this case is to determine the average heat transfer coefficient. Radiators used in the locomotive, may be carried to the recuperative heat exchanger type, in which the transfer of heat from one fluid to another through a separating wall [2]. In this case, the heat transfer coefficient is determined by the Nuselt criterion:

$$Nu = \frac{\alpha l}{\lambda},$$

where: α - the coefficient of heat transfer; l - the typical geometric size; λ - the coefficient of thermal conductivity the cooling.

For different constructions of radiators coefficients that determine addiction are different, but the common feature most of the formulas is that the calculation of the number of criterion is the average value of the radiator at the front speed. This leads to the fact that the formulas derived for a specific type of radiator can give inaccurate results in case of changing flow conditions and changes in the velocity profile at the front of the radiator.

Dependences $Nu = f(Re)$ [1] are known for a number of different types of radiators at the different modes of liquid flow. In general, it is possible to present them in the form presented below, separating an aerodynamic component:

$$Nu = m \cdot Re^n,$$

where: $n = 0.45..0.84$.

The coefficient of m is the function of Prandtl criteria for liquid and gas, at the frictional-gravity mode the Grasgoff criteria is included [13].

Calculation in these dependences is carried out by average on front of radiator velocity. In general case it can result in the error of determination of coefficient of heat transfer.

Velocity distributing of cooling air on front of radiator can be executed on the basis of equations of mathematical model solution, showed above [4]. Then Nuselt criterion taking into account distributing of velocity

$$Nu_{d.s.} = \frac{\int_F Nu_i dF}{F}.$$

The relation of criterion value $Nu_{d.s}$ to his value, calculated at average velocity $Nu_{c.c}$, characterizes the calculation error of heat transfer coefficient.

Main influence on its value renders the index of degree of Reynolds number. We will show it on the example of calculation of heat transfer coefficient of TEP -150 diesel engines. Velocity distribution of cooling air on radiator inlet, got as a result of calculations and confirmed by experimental data is shown on fig. 1.

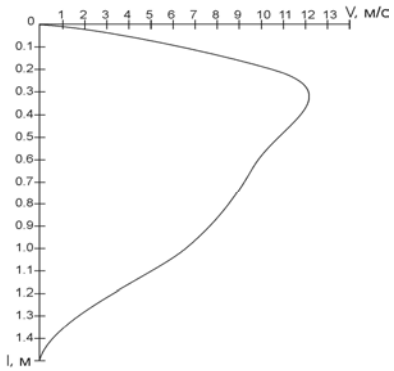

Fig. 1. Results of calculation and measuring of flow rate on front lateral jalousies of cooling chamber of ТЭП-150 diesel engine

The dependence of correction coefficient value k from the index of degree n is resulted on the fig. 2.

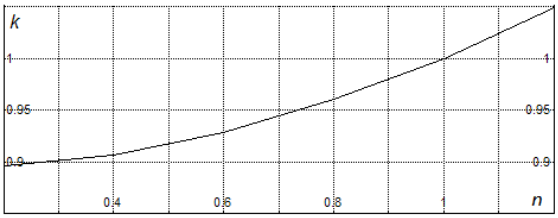

Fig.2. Dependence of correction coefficient k on parameter n

It is necessary to take into account correction coefficient to get $Nu_{o.c}$ value, calculated taking into account velocity distributing on radiator front

$$Nu_{d.s} = k \cdot Nu_{c.c} .$$

Thus, absence of account at the calculation of thermodynamics characteristics of mine of cooling device of velocity distributing results deflections of calculations from experimental data up to 10%.

Comparing estimation of efficiency of different charts of the cooling systems model and specific indexes, and also results of the unfolded technical and economical calculations are used.

To the number of actual parameters belong: quantity of heat, dissipated by cooling system; capacity, expended on functioning of the cooling system; gross weight of devices; expense of nonferrous materials; value of heat conveying surface of radiators; average annual expense of ferrous and nonferrous materials on cooling system repair; amount of heat exchangers (sections), repaired and changed during a year (average information), et cetera [22].

So-called specific indexes (energy, volumetric and gravimetric) got wide enough distribution at compounding cooling system in whole and, in particular case compounding separate heat exchangers [11]. Energy index

$$k_N = \frac{Q}{N\overline{\Delta t}} = \frac{kF}{N},$$

where: Q is quantity of heat, transferrable in heat exchanger; N is power, expended on heat exchanger functioning; $\overline{\Delta t}$ is average difference of temperatures between the cooled and cooling liquids within the limits of the whole heat exchanger: ; k is coefficient of heat transfer; F is a calculation surface of heat transfer.

The index k_N is quantity of heat transferring in heat exchanger during one hour at $\overline{\Delta t} = 1°C$, being on unit of power, expended on heat exchanger functioning. Volumetric index

$$k_V = \frac{Q}{V\overline{\Delta t}} = \frac{kF}{V},$$

where: V is volume, occupied by heat exchanger.

Gravimetric index

$$k_G = \frac{Q}{G\overline{\Delta t}} = \frac{kF}{G},$$

where: G is heat exchanger mass.

For comparison of radiators (or sections) is used the index of thermal tension of front area

$$k_{F_{fp}} = \frac{kF}{F_{fp}},$$

where: F_{fp} is frontal surface of radiator (or sections).

Specific indexes are more general comparing with full scale, because they allow conducting technical comparison of separate heat exchangers with different forms of surfaces, different values of conveying heat et cetera

Optimum heat exchanger, and the more so the optimum cooling system can not be chosen only on the basis of specific technical parameters, because they do not reflect many operating and economical factors. As basic technical and economical index, with sufficient plenitude of the characterizing the system cooling, accept the sum of the annual resulted charges, taken to heat dissipative ability of the system or to the measuring device of vehicular work [6]. The specific resulted annual charges in general case are

$$E'_P = \frac{1}{U}\left(E_H K + C\right)$$

where: E_H is normative coefficient of efficiency; K are capital costs on cooling device manufacturing; C are annual expenses on exploitation, depending on diesel engine cooling system; U – annual expenses parameter.

CONCLUSIONS

There are enough works devoted the calculation of running expenses and methods of comparative estimation of efficiency of the cooling systems [9], [10]. However all existing methods are based on the value of heat transfer coefficient α, at determination of which influence on the process of heat exchange of velocity distribution is not taken into account on the section of radiator, that reduces exactness of the calculations of efficiency and economy of the cooling systems.

In the presented work the main attention is paid on perfection of aerodynamic characteristics of flowing part of cooling device, their connections with the process of heat exchange on the basis of mathematical simulation of gas flow. The method of accounting the influence of aerodynamics on heat exchange process is offered.

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ВЛИЯНИЕ АЭРОДИНАМИЧЕСКИХ ХАРАКТЕРИСТИК ПОТОКА НА ТЕПЛООБМЕН В СИСТЕМЕ ОХЛАЖДЕНИЯ

Елизавета Гусенцова

Аннотация. Предложена адекватная математическая модель охлаждающего устройства тепловоза. Решение данной модели получено численным методом. Предложен критерий оптимизации и методика учета влияния аэродинамик на процесс теплообмена.

Ключевые слова: локомотив, охлаждающая система, теплообменник, течение воздуха, энергетический показатель, критерий Прандтля.

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THEORETICAL ASPECTS AND PRACTICAL RECOMMENDATIONS FOR USE OF METHODS OF BINDING MATERIALS MODIFICATION AND MECHANICAL TREATMENT TO SOLVE TECHNOLOGICAL AND ECOLOGICAL PRODUCTION PROBLEMS

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S u m m a r y : active application of new progressive methods of binding materials treatment allows to solve ecological alongside with pure technological and economic problems. Mechanical activation and modification, as the most effective representatives of such methods, lead to substantial increase of binders quality. The use of such methods allows to control structure formation processes while forming polymeric matrix of a binder. It may become an effective regulator for expansion of volumes of ecologically safe binding materials usage due to displacement of ecologically hazardous synthetic resins and oil materials which are the source of harmful discharge in technological processes where binding materials are used.

K e y w o r d s : fuel briguette, binding materials, technical lingo-sulphanates, power value.

INTRODUCTION

The necessity in innovative renovation of production, urged forward by the crises in economy, has led to the search and realization of such technical decisions which can minimize consumption of expensive and scare raw materials saving required level of qualities and characteristics of produced goods. Alike decisions in the sphere of technology using binding materials may be methods of their mechanical treatment and modification. Contradiction between requirements for stability and constant increase of production quality and incompatibility with these modern state of manufacturing which manifests itself in aspects of moral and physical state of functioning technological processes, is the essence of the problem under investigation. Provision of required quality indices of products obtained while using binding materials is impossible without transition to new ecologically pure types of materials which in their turn requires revising of methods of their treatment and technologies of their use. Decision of the problem is in search of perspective ways, investigation of their realization possibilities with their subsequent formalization in introduction of specific technical decision in production [Svinoroev, Kostrub, Klimova 2010; Zhizhkina, Budagyants, Gutko, 2010].

The aim of the given paper was a complex investigation of possible usage of progressive methods of binding materials treatment which consist in their mechanical activation and modification for provision of standard level of final product quality indices at decrease of its cost and general increase of level of production ecology. To substitute presently used costly and ecologically dangerous oil materials and synthetic resins, it is advisable to use lignosulphonate binding materials (LST) as recycling products of vegetable origin, which are ecologically pure, non-scare and relatively cheap [Feingold 1993]. To provide necessary technological level of LST characteristics and their correction methods of modification and mechanical treatment have been used. It assumes firstly the search and theoretical justification of possibilities of use of LST mechanical treatment and modification as instruments, aimed at increase of their binding ability and stabilization of their characteristics, and secondly, analysis of variants of possible technical decisions and development of recommendations to

their specific use in different technological processes. At this, lingocontaining materials themselves were looked at as potentially new raw material for development of principally new binding compositions with predetermined characteristics and methods of their treatment (modification and mechanical treatment) as instruments for regulation and provision of required level of quality indices [Svinoroev 2009; Svinoroev Yu., Kostrub V., Klimova O., 2010].

OBJECTS AND PROBLEMS

Many productions are based on technological processes using of binding materials. Here belongs foundry production (manufacturing of moulds and rods), woodworking (production of wood particle and fiber boards), metallurgical production (granulation of different loose materials) and others. Due to their specific use many binding materials are firstly, the reason of defects in products, and secondly, the source of environmental ejections which causes the necessity of decision not only economic but ecological problems as well. Expenses on decision of such like problems occupies special place in finished products cost structure. In this connection problem of development and creation of binding materials having rather low cost and safe for people and environment becomes very actual. All lignocontaining materials may be referred to such materials. These are products of vegetable raw materials recycling first of all recycling of wood into cellulose. Typical representative of such materials are technical lignosulphonates (LST). They have a complex of positive characteristics are not sufficiently used in industry because they do not possess sufficient binding ability and unstable characteristics. Thus, the most efficient binding materials, synthetic resins for one, specific binding ability equals 0,5 -1,2 МПа per one per cent of a binder in mixture while LST as only 0,03 – 0,09 МПа, which does not meet the requirements technological requirements, and characteristics specified in quality certificate may essentially differ from stated. Thus, absence in this group of materials having necessary technological level of strength characteristics combined with instable characteristics significantly limits the sphere of their application. At the same time conducted theoretical and experimental investigations showed that methods of modification and mechanical treatment may considerably change binding ability of compositions with LST (from 0,03 up to 0,5 МПа/% binder in a mixture), and this allows to consider real possibility of production technological processes modernization, in particular a substitution of mentioned oil and risen binders with more ecologically pure and less expensive lignosulphonate ones [Svinoroev 2005; Feingold, 1993; Boldin, Davydov, Zhukovskiy., 2006]. However, the application of such like binders cause the necessity of change in technology itself by the use of a complex of technological operations connected with realization of modification and mechanical treatment.

The essence of LST modification is in purposeful introduction into composition of material special complex action substances allowing to increase their binding ability due to processes of polymerization. In the process of drying, introduced modifier initiates formation of three-dimensional polymer screen providing high integral strength characteristics on the filler surface [Svinoroev 2005; Golozin, Svinoroev 1997; Ravich B.M. , 1975].

Mechanical treatment or mechanical activation consists in processing of liquid polymer systems using disintegrating units. It leads to activation of binder’s components, dispersion of its separate stages , their architectural modification at nano-structural level, increase of treated material reaction ability, appearance of active centres in their structure, LST in our case. It shows itself in more active interaction of treated in this way binding material with filler. In a complex, such interactions (modification and mechanical treatment) cause increase of characteristics stability and improvement of some technological indices (binding ability, viscosity , wettability etc.).

Such approach to solution of the problem of binding materials is attractive because under definite mode of mechanical action material undergoes structural changes; in this case, LST molecular-mass distribution becomes average which must lead to general stabilization of characteristics. Nano-structure subdivision and change of pH medium takes place for some period of time (hysteresis effect appears) takes place. Free radicals which become potential centres of structural processes initiating in hardening, are generated because the break of chemical tires.

These methods of action, separately or in combination, may become an effective tool of processes control leading to stabilization of material characteristics and qualitative change of its integral characteristics, in particular, required strength characteristics. Such characteristics

regulator will allow to develop binding compositions with predetermined characteristics providing ecologically pure production processes.

Presented theoretical model may be technically realized due to preliminary (right after supply of the material to the enterprise) treatment consisting in combination of mechanical action methods and introduction of modifiers (PAV for one).

In this case, the essence of the LST binding ability increase task consists in determination and development of the conditions which would after hardening lead to creation of firm joint between polymerizing components of LST oligo-dimensional molecules and creation of three-dimensional polymer matrix. It is this state of polymer structure that corresponds to its maximum binding ability.

Let us define factors determining possibility of technical realization of discussed theoretical model. As material binding abilities are determined by the strength of model mixture (standard "models-eights", for foundry binders), it is necessary to conduct a full analysis of factors which may influence on this index at all stages of the process of mixture preparation and composition hardening to understand possible ways of its increase. Here belong operations of binder measuring when preparing mixture; forming and drying of finished products (moulds and rods). Taking into consideration above mentioned, increase of binding abilities may be achieved by a complex of steps comprising:

- Optimization of binder content and modes of mixture-preparation for uniform distribution of binder along mixture composition and creation of uniform films with homogeneous structure on the filler grains;
- Optimization of forming and sealing modes;
- Selection of materials, facilitating creation of longitudinal joint between oligo-dimensional chains of lingo-sulphonate acids in the process of hardening, that is LST hardeners, which would be introduced additionally or act as a part of stabilization complex;
- Choice and use of catalysts;
- Optimization of drying modes (length, temperature).

Specifying the task in the part of LST characteristics changes, it is necessary to pay special attention to importance of modification methods. The essence is in purposeful introduction of special substances influencing some characteristics into material composition. Process of lingo-containing materials structure-formation takes place in several parallel and consecutive stages. At the entry level, at the stage of linear condensation low-molecular products are formed, then the degree of joining between macro-molecules increases, longitudinal carbon-carbon bonds are created, the reversibility degree of such structural bonds decrease, they are ready to swelling but are not dissolvable in water. At the final stages of the process formation of three-dimensional polymer takes place, however, grate degree of molecule- mass composition differentiation does not allow to get a homogeneous polymer matrix. Availability of very big molecule aggregates having molecule mass equal to hundreds of millions units and aggregates equal to some thousands units in source material leads to formation of total polymer matrix of irregular structure. Such initial state predetermines creation of considerable inner tensions in construction of polymer being developed at the stage of hardening. Finalcharacteristics of such result is low strength of foundry rods and moulds. Such presentation of LST structure-formation mechanism leads to understanding of the fact that measures, taken for stabilization of LST characteristics will influence the perfection of their binding ability as well. Taking these into consideration, it is useful to use modifiers of complex action which influencing the material will perform functions of technological characteristics stabilizer and facilitated the increase of binding ability.

The other factor determining possibility to increase LST binding ability is intensification of action direction, connected with the increase of, cooperative donor-acceptor connections level, both between binder structural elements and at the edge of binder-filler division. Their criterion may be decrease of wetting corner angle in the system of binder-filler, and increase of adhesion powers level.

Homogenization of binder inner structure and decrease of wetting corner angle should influence the change of the film structure at the filler surface and optimization of binder distribution along mixture composition which in its turn leads to the increase of strength characteristics.

Mechanical treatment leads to homogenization, leveling of binder poly-molecule composition and increase of environment acidity which facilitates initiating of the structure-formation processes by creation of a cooperative donor-acceptor connections. Homogenization,

averaging of sizes and masses of a binder molecule aggregates structure, as a result of mechanical treatment will lead to stabilization of characteristics and increase of binding ability of the system in general. Tools of regulation and control of structure-formation processes may be methods of LST mechanical activation and modification.

Thus described measures (modification as a means of longitudinal bonds provision and mechanical treatment as a way to homogenization of LST nano-structures) may facilitate perfection of LST characteristics: increase of binding ability and general stabilization of characteristics.

Proposed offers for mechanism of control of lingo-sulphonate structure formation processes and ways of their characteristics perfection require theoretical analysis of their realization methods.

Lets have a look at some aspects of their application.

Activation of materials is performed by application of high energetic exposure. Value of mechanical loading field may vary within 350 – 700g

Technical device realizing the described process is disintegrator. This device belongs to machines of impact action and consists of a frame, two electric motors connected with intermediate bearing unit shaft by means of clutch and belt transmission are erected on the frame. At the shaft ends rotors, equipped with special discs having a row of pobedit tips framed into a working chamber mounted on the frame, are fastened. The transit of treated material along the system of canals through rotating in opposite directions at high speed rotor discs provides its activation. Activation degree is controlled by the speed of discs rotation.

Mechanism of activation in disintegrator lies in transmission of a number of powerful impulses of mechanical energy to treated material with short intervals between alternating impacts which leads to accumulation in activated material a certain volume of energy capable to cause chemical, physical and technological changes in its characteristics. Energy accumulated in material in such a way changes its characteristics.

The character of influence of mechanical activation on LST has a complex character that is why to simplify analysis, it is useful to suggest that such influence will consist of two component parts: immediate influence on oligo-metric lingo-solphonate chains and on solvent –water. As it was stated before, LST presents a water solution of lingo-sulphonate acids containing 48-60% of solvent –water. That is why, it is necessary take into consideration both the change of lingo-sulphonate structural formations state and changes of solvent state.

Treatment of water in disintegrator is known to cause the changes in its nano-and – additive structures which leads to changes in physical and chemical characteristics,in particular wetting heat increases, pH rises, density and rigidity lowers.

Mechanism of LST activation is insufficiently studied but knowing the nature and making parallels with theoretical knowledge about mechanical activation of liquids one may propose:

- In disintegration destruction will be the first thing to take place, to be more precise, subdivision of LST high-molecule structural units;
- subdivision of high-molecule structural units will lead to appearance of active centres tending to structure with creation of cooperative donor-acceptor bonds;
- selection of definite modes of treatment may cause destruction of lingo-sulphonate acids oligo-metric chains chemical bonds which may initiate creation of active chemically highly reaction cetres in the form of free radicals;
- treatment will lead to change of material state parameters because destruction of really existing structure of liquid environment will take place due to sound mechanical energy action which, in its turn, may be the reason for its characteristics change;
- solvent influence should also be taken into consideration and it means that activation of additive structure of water will lea to creation of electrically active clusters or microcolloid particles which after their creation may influence on microscopic characteristics in general and act as centres of structure formation processes in hardening

From thermodynamic point of view, original liquid environment, to which belong lingo-sulphonate binders, has drop or domain structure at the edge of which low-molecule fractions, surface-active substances, and additives are localized. So called “internal pressure” defined by the domain size, stable structure configuration peculiarities, and volume of critical energy, depending on liquid origin arises as the result of above said. This pressure significantly effects the macroscopic characteristics of liquid system: wetting heat, viscosity, density, which in this case,greatly defined material binding ability (binder distribution along mixture volume, films thickness at the filler surface, adhesion, contact strength, etc.). In the process of mechanical treatment liquid domain structure destroys, it obtains

homogeneous "mono-crystal" structure. Low molecule fractions and additions are uniformly distributed along environment volume, inner pressure is minimal. Such state predetermines creation of structurally homogeneous and more strengthened matrices at hardening.

Thus, mechanical activation may theoretically be more effective tool of changing (perfection) lingo-containing materials characteristics.

Such treatment, conducted on a number of binding materials reveals definite stable and repeating mechanisms and make the following conclusions:

1. General tendency of organic foundry binders binding ability increase takes place in their disintegrative treatment, this is characteristic for such binders as LST, USK, KO, in particular.
2. LST binder mechanical and chemical activation in UDA-devices increases its binding ability up to 20%, however, at this some increase of technological sample flaking off which can be normalized varying different hardening modes or introduction of special additives, is noted.
3. The use of activated binder USK in a composition of rod mixture allowed to increase its strength up to 2,09 MPa, that is. by 1,27 times.
4. Increase of binding ability in mechanically activated organic binders is explained by their increased reaction ability due to creation of different active centres in their structure.
5. Treatment of USK binder in disintegrating device caused decrease of carbon chain length by 19%, which immediately showed itself on its molecule mass which also decreased with the increase of activation mode.
6. Plastic viscosity of mechanically activated USK binder increases with the increase of activation mode at this, multiple activation, 5-fold in particular, can increase viscosity of the given organic binder by 30%.
7. Taking into consideration low energy consumption of mechanical activation in UDA devices one should realize perspectives of its use for increase of foundry organic binders technological characteristics.
8. Thus, realization of proposed approach will allow to save costly and ecologically harmful material– organic binder content in the composition by 15 – 25% .

Obtained results may be formalized in three major variants of technical solutions (see table 1):

Table 1. Recommendations to practical application of LST modification and mechanical treatment methods aimed at obtaining of effective binding mixtures

Variant 1. For technical solution while using method of modification

№ operation	Operation aim	Operation content	Parameters of execution
1.	Preparation of source	LST heating	75 – 80°C
		Heating by modifier	45 – 50°C
		Weighing in necessary proportions	92% LST 8% NPAV
2.	Dosage	Mixing of prepared components	65 – 70°C
3.	Mixture exposition	Proceeding of mixture LST-NPAV polydisperse content homogenization process, accompanied by volume gang up of materials	65 – 70°C
4.	Supply of mixture into operation	Use as a binding material	According to order of technological process

Variant 2. For technical decision with combination of use of modification and mechanical activation methods

№ operation	Operation aim	Operation content	Parameters of execution
1.	Preparation of source materials and equipment	LST heating Preparation, adjusting operation parameters of disintegration unit	40°C
2.	Disintegration treatment	LST feed into disintegration unit , execution of process of mechanical treatment, formation of active centres in LST structure	At temperature equal to 25 – 30°C and rotation frequency 12000 rev/min
Operations 3, 4, 5, 6 in accordance with Variant 1			

Variant 3. For technical decision using mechanical treatment

№ operation	Operation aim	Operation content	Parameters of execution
1.	Preparation of source materials and equipment	LST heating Preparation, adjusting operation parameters of disintegration unit	40°C
2.	Disintegration treatment	LST feed into disintegration unit , execution of process of mechanical treatment, formation of active centres in LST structure	At temperature equal to 25 – 30°C and rotation frequency 12000 rev/min
3.	Feed of composition for use	Use as a binder	Use within 24 hours since the moment of treatment in accordance with order

Variants of technical solutions given in the table may be implemented in different production processes where binding materials are used in one or another way. It is useful, due to abovementioned reasons (ecological purity and cost), to pay special attention to binding compositions obtained on the basis of lingo-sulphonate materials. Proposed variants allow quickly and without any significant expenses realize variant 1 recommendations in real production. At the same time, variants 2 and 3 need additional spending on buying disintegrative devices, recovery of which may vary from one to three years depending on production volumes and foundry specifics, as well as types of binding materials used in the given technological process.

CONCLUSIONS

It was proved that theoretical application of binding materials treatment progressive methods is based on possibility to control processes of lingo-sulphonate binders structure formation are aimed at their characteristics perfection, in particular, perfection of their binding ability and specific strength. The essence and content of these methods is in possibility of a binder selected structural changes for provision of its predetermined strength characteristics. At this, modification solves the problem of brining components, providing lateral joining of lingo-sulphonate materials oligo-metric chains into the binder composition and mechanical activation provides creation of active centres initiating and facilitating this process.

Thus, methods of mechanical activation and modification may be tools for structure formation processes control. Provision of ecological technologies is obtained by the use of ecologically clean source materials, all lingo-sulphonate materials belong to this group, LST for one.

Presented practical recommendations may be used in technological processes of foundry rods production where convective drying hardening is used. In particular, for technology of heating radiators rods production as well as in cast shaping [Boldin, Davydov, Zhukovskiy 2006].

Combination of modification and mechanical activation methods (see Table variant 2) may be used in technology of production rods of funnel foe cast-iron pressure pipes manufactured according to heated equipment (in the hot cases). In this case active centres created in a binder (LST) due to their mechanical treatment will become initiating active centres of three-dimensional net polymer formation process, which provide foundry rod high strength characteristics [Golozin, Svinoroev 1997].

The use of binders, LST in particular, modification and mechanical treatment methods will allow to improve ecological environment at the enterprise and in the spheres of their functioning due to full or partial elimination of potential sources of harmful ejections (resin and oil binders) from the technological cycle and decrease resource consumption due to decrease of volumes of binding materials application by 15 – 25%.

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ТЕОРЕТИЧЕСКИЕ АСПЕКТЫ И ПРАКТИЧЕСКИЕ РЕКОМЕНДАЦИИ ИСПОЛЬЗОВАНИЯ МЕТОДОВ МОДИФИЦИРОВАНИЯ И МЕХАНООБРАБОТКИ СВЯЗУЮЩИХ МАТЕРИАЛОВ ДЛЯ РЕШЕНИЯ ТЕХНОЛОГИЧЕСКИХ И ЭКОЛОГИЧЕСКИХ ПРОБЛЕМ ПРОИЗВОДСТВА

Юрий Гутько, Юрий Свинороев, Владимир Коструб

Аннотация. Активное применение новых прогрессивных методов обработки связующих материалов позволяет наряду с решением чисто технологических и экономических проблем, решать и экологические. Механоактивация и модифицирование, как наиболее эффективные представители таких методов, приводят к существенному повышению качества связующих материалов. Их использование позволяет управлять процессами структурообразования при формировании полимерной матрицы связующего. Это может стать действенным регулятором для расширения объемов применения экологически безопасных связующих материалов за счет вытеснения экологически опасных синтетических смол и масляных материалов, являющихся источником вредных выбросов в технологических процессах, где применяются связующие материалы.

Ключевые слова. Топливный брикет, связующие материалы, технические лигносульфонаты, энергетическая ценность.

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PERFECTION OF METHODS OF DETERMINATION OF TYPE OF DEFECT AT THE ULTRASONIC CONTROL OF ELEMENTS OF ROLLING STOCK OF RAILWAYS

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S u m m a r y. In the article a method allowing to promote authenticity of methods of determination of type of defect at diagnosing of elements of carriage part of rolling stock of railways by an ultrasonic impulsive echo-method is developed.

K e y w o r d s : rolling stock of railways, acoustic methods of nondestructive control, ultrasonic control, ultrasonic fault detector, piezoelectric transformer, ultrasonic impulsive echo-method.

INTRODUCTION

In the last decades speed-up development of industry is accompanied by the steady rise of intensity of exploitation of railway transport. The increase of intensity of vehicular process intensifies the problem of providing of safety of motion on the ferrous road. On safety of motion the state of rail way, clear work of the system of automation, signaling and communications, has influence, quality of rolling stock (RS) carrying out a vehicular process.

One of the most responsible systems RS, from which safety of motion on the ferrous road depends above all things, there is carriage part. The indexes of quality of elements of the carriage part RS are mortgaged at planning, will be realized at making and show up in exploitation. For providing of quality of elements of the carriage part RS at making the complex of measures of the technical diagnosing is conducted.

In the complex of measures of the technical diagnosing the great number of control operations is included, including ultrasonic nondestructive control of elements of the carriage part RS on absence of internal defects [2-19].

OBJECTS AND PROBLEMS

For the rise of authenticity and informing of results of ultrasonic control with the purpose of receipt of more than complete information about the diagnostic signs of describing the technical state of object of diagnosing new methods of receipt of information about parameters are developed discovered as a result of ultrasonic control defects.

In work [20] by an author the method of determination of type (by a volume or flat) of found out the ultrasonic control of elements of carriage part of the RS railways of defect as a result is developed. A method is based on measuring of peak description of echo-signal from a defect on two frequencies – a 2,5 and 5,0 Mega Cycle per a second, determination of coefficient, presenting from itself a difference between peak descriptions of echo-signals on two frequencies and comparison of this coefficient with the scope values expected on got in work analytical dependences for a flat and by a volume defect.

In work [1] by authors by an experimental-analytical way the method of determination of angle of slope of flat defect to the surface of input of ultrasonic wave and computation of coefficient of adjustment of sensitiveness of ultrasonic apparatus for the rise of authenticity of ultrasonic control of elements of carriage part of the RS railways was developed, with the purpose of non-

admission in exploitation of elements of carriage part with defects. A method is based on measuring of peak description of echo-signal from a defect at the use of direct piezoelectric transformer and sloping transformer of longitudinal waves with the corner of input 18^0 and further computation on the analytical dependences got in work, angle of slope of defect and coefficient of adjustment of sensitiveness of ultrasonic apparatus.

Conducts the analysis of the higher presented works it is possible to come to conclusion, that criteria, on which a point by a volume defect is determined can walk up to the point flat defect inclined to the surface of input of ultrasonic wave.

Development of method of determination is the purpose of the given work, whether there is the defect discovered as a result of ultrasonic control by an echo-method in the element of the carriage part RS by a volume or flat, located parallel to the surface of input of ultrasonic wave, or flat, inclined to the surface of input of ultrasonic wave.

RESULTS OF EXPERIMENTAL RESEARCH

A method consisting of the following is offered:

- at the discovery by the direct transformer of echo-signal from a point defect in the controlled good, the search of maximum of peak description of echo-signal from this defect at the use of the combined transformer P131-2,5-0i18-VO-04 (fig. 1) of included on 18^0 is carried out (fig. 2-4, position of the *I* transformer);
- by a next stage the search of maximum of peak description of echo-signal from a defect at the location of the transformer P131-2,5-0i18-VO-04 opposite primary position is carried out (fig. 2-4, position of the *II* transformer);
- in the case when peak description of echo-signal from a defect in position of the *I* and *II* transformer are approximately identical (fig. 2, 3), a defect is either by a volume, or flat, located parallel to the surface of input of ultrasonic wave. Determination of type of defect is carried out by a method offered in work [20] with the use of the software product NDTRT-3;
- in the case when peak description of echo-signal from a defect in position of the *I* and *II* transformer echo-signals are different are located on a different depth (fig. 4), a defect is flat and is located under a corner to the surface of input of ultrasonic wave. The angle of slope of defect and coefficients of adjustment of sensitiveness of ultrasonic apparatus are determined by a method offered in work [1] with the use of the software product NDTRT-2.

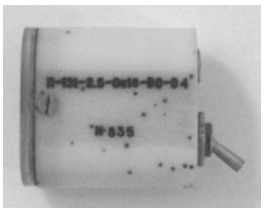

Fig. 1. Combined transformer P131-2,5-0i18-VO-04

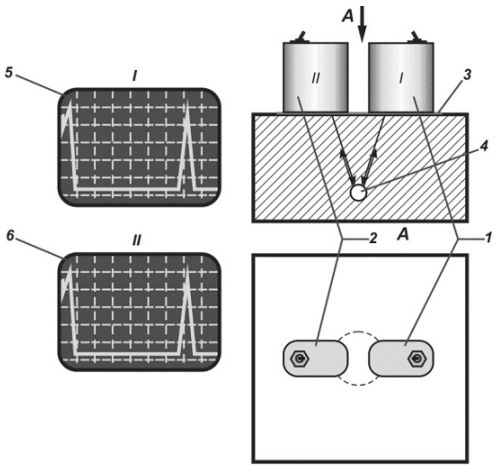

Fig. 2. Layout chart of transformer and types of echo-signal of reflected from a by a volume defect: 1 – location of transformer in the position *I*; 2 – location of transformer in the position *II*; 3 – contact liquid; 4 – model of defect; 5 – type of echo-signal from a defect at position of the transformer *I*; 6 – type of echo-signal from a defect at position of the transformer *II*

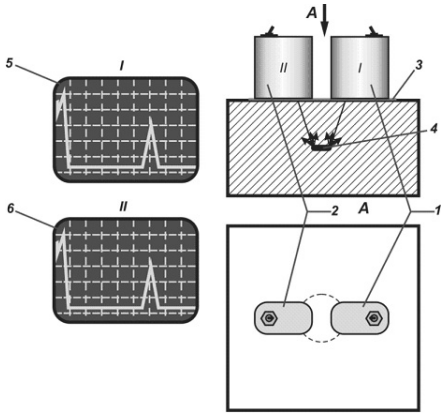

Fig. 3. Layout chart of transformer and types of echo-signal of reflected from the flat defect located parallel to the surface of input of ultrasonic wave

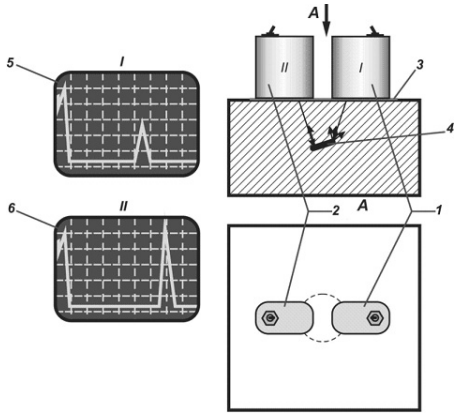

Fig. 4. Layout chart of transformer and types of echo-signal of reflected from the flat defect of located under a corner to the surface of input of ultrasonic wave

CONCLUSIONS

The analysis of methods of determination of type of defect at diagnosing of elements of carriage part of the RS railways showed an ultrasonic echo-method, that at determination of type of found out the ultrasonic control of defect as a result criteria on which a by a volume defect is determined can walk up to the flat defect located under a corner to the surface of input of ultrasonic wave.

The method of determination was developed in this connection, whether there is the defect discovered as a result of ultrasonic control by an echo-method in the element of the carriage part RS by a volume or flat, located parallel to the surface of input of ultrasonic wave, or flat, inclined to the surface of input of ultrasonic wave.

The developed method is inculcated in PJSC «Luganskteplovoz» in the process of diagnosing of elements of carriage part of hauling by the RS ultrasonic impulsive echo-method.

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СОВЕРШЕНСТВОВАНИЕ МЕТОДОВ ОПРЕДЕЛЕНИЯ ТИПА ДЕФЕКТА ПРИ УЛЬТРАЗВУКОВОМ КОНТРОЛЕ ЭЛЕМЕНТОВ ПОДВИЖНОГО СОСТАВА ЖЕЛЕЗНЫХ ДОРОГ

Андрей Киреев, Ирина Кириченко

Аннотация. В статье разработан метод, позволяющий повысить достоверность методов определения типа дефекта при диагностировании элементов экипажной части подвижного состава железных дорог ультразвуковым импульсным эхо-методом

Ключевые слова: подвижной состав железных дорог; акустический метод неразрушающего контроля; ультразвуковой контроль; ультразвуковой дефектоскоп; пьезоэлектрический преобразователь; ультразвуковой импульсный эхо-метод.

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PIEZO ACTUATORS INJECTOR OF COMMON RAIL FUEL INJECTION SYSTEM

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S u m m a r y . The problem of determination of expedience of the use of piezoelectric sensors in piezo actuators, connected with the scheme of DD-TR, is considered. The transitional characteristics and amplitude of output signal also is determinate.
K e y w o r d s : common rail, piezoelectric valve, piezo actuator, piezoelectric sensor, piezoelectric transformer, domain-dissipative.

INTRODUCTION

Diesel engines with Common rail fuel injection system are most modern. This type of diesel engines is used not only in trucks but also in passenger cars because it has great advantages among other diesel engines. Reduction of noise of working engine, reduction of amount of harmful substance, thrown out to the atmosphere, power increase are the main advantages of diesel engines with Common rail fuel injection system. By its dynamic characteristics diesel engines with Common rail fuel injection system became common to petrol engines. The difference of Common rail fuel injection system is in big injection pressure (over 1000 bar). Structurally differs by the presence of general distribution pipe, situated in a direct adjacency to the injectors, in which the fuel is under constraint over 1000 bars. The injection of fuel in the cylinders of engine is carried out through the electric guided injectors [7, 8, 25].

Application of two types of injectors is possible in the systems of injection of Common Rail: with an electromagnetic valve and with a piezoelectric valve. The advantage of injectors with a piezoelectric valve is a speed and accuracy of injection. The lacks of injectors with a piezoelectric valve is a high price, lack of possibility of control of moving of valve in the process of exploitation. Injectors with an electromagnetic valve allow to conduct control of moving of valve on the size of resistance of spool inductance, however they possess large inertia, that influences on impairment of accuracy of injection [7, 9, 28].

For realization of possibility of control of moving of valve of piezo injectors in the process of exploitation it is suggested to use piezo actuator working as on reverse so on direct piezoelectric effect [1, 2, 5, 9].

The system of injection of Common Rail with piezo injectors, allowing to produce control of moving of valve of injectors, works as follows (fig. 1). Fuel, being in a tank 1, through a pumping pump 2 is given by fuel pipe through an electromagnetic valve 4 to the high pressure pump 3. The high pressure pump gives a fuel into general distribution pipe 5. Thus, the main function of high pressure pump is the maintenance of pressure of fuel to general distribution pipe.

Fuel, being in the distribution pipe, through electric controllable piezo injectors 6 is given to the engine cylinders 7. The signal from a pressure fuel sensor 15, set in general distribution pipe, and sensor of position of crankshaft enters to the electronic control unit (ECU) 16 [11, 15, 21, 25].

Electronic control unit of the injection of fuel consists of input amplifier 8, analog-digital converter 9, controller 10, digital-analog converter 11 and output amplifier 12.

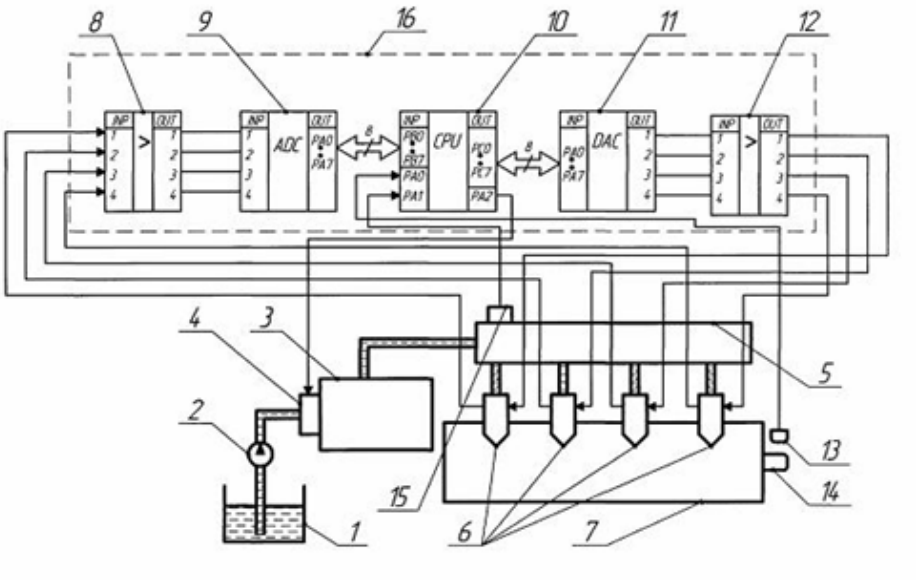

Fig. 1. Common rail fuel injection system

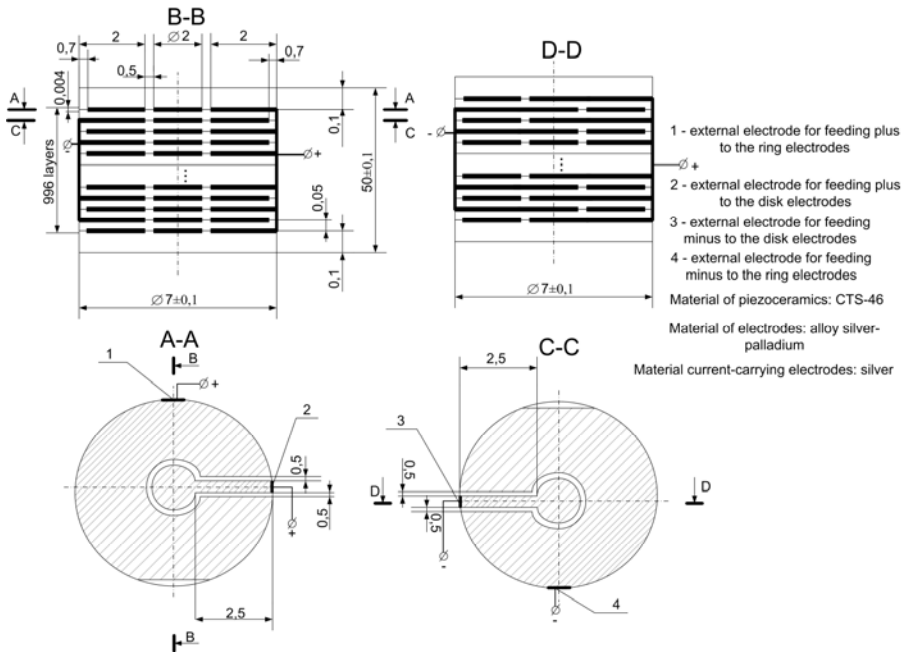

Fig. 2. Piezo actuators injector

The process of injection of fuel control is realized through an electric signal amplitude of $U_{inp} = 110$, given to input electrodes 1, 4 of piezo actuators of injector (fig. 2). While giving the electric voltage the change of sizes of piezo actuators injector and moving of nozzle valve occurs. After a voltage removing piezo injector returns its sizes to the initial ones. For diminishing of time of return of piezo actuator to the initial sizes a reinforcing spring is provided with effort of bridle of the order of 5 kgf.

Control of moving of piezo actuators injector is realized by a signal, which is weighted from the output terminal of piezo actuator 2, 3 (fig.2). Proceeding from the phenomenon of reverse piezo sensor, the formation of signal occurs while moving of piezo actuators injector, herewith on output electrodes 2, 3 a charge occurs, the size of which is proportional to the size of moving of piezo actuators injector ΔX [3, 4, 5, 12, 22]. Thus, control the size of moving of piezo actuators injector ΔX is realized with the amplitude of signal is measured from the output terminal of piezo actuator [1, 2, 15, 17].

THE ANALYSIS OF PUBLICATIONS AND MATERIALS

Piezo actuator consists of 996 piezoelectric sensors, which electrodes are parallel connected between it selves. On the fig. 3 one piezoelectric sensor of piezo actuator is schematically represented.

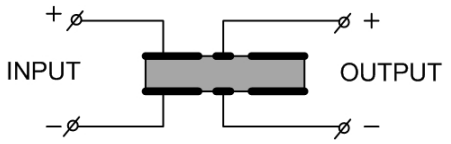

Fig. 3. Piezoelectric sensor of piezo actuator

The most approximate analogue of piezoelectric sensor of piezo actuator is a piezoelectric transformer [3, 4, 5, 24]. A piezoelectric transformer is the piezoelectric sensor with two systems of electrodes – input and output, to one of which the source of electric vibrations (for example, generator) is connected, and to the second - electric demand (for example, measuring device). On a construction and mutual location of electrodes piezoelectric sensor of piezo actuator is analogical to a disk piezoelectric transformer. The basic parameter of piezoelectric transformers is a coefficient of transformation of K [3, 4, 5, 23]. When using piezoelectric sensors in piezo actuators this coefficient is also the most important, so far as it influences on accuracy of determination of size of moving of piezo actuator ΔX. The less is the coefficient of transformation K, the more precisely possible is to define the size of moving of piezoelectric sensor of ΔX.

The coefficient of transformation is determined by the formula:

$$K=Uinp\backslash Uout, \qquad (1)$$

where: *Uinp* is the amplitude of electric signal, weighted from input electrodes, *Uout* is amplitude of electric signal, taken from output electrodes.

At excitation of piezoelectric transformer on the radial mode of vibrations the stream of energy through a cylindrical surface remains unchanging for any radius and, consequently, the concentration of energy takes place in the center of a disk there. If to install the generator section of transformer in the center of the disk, the increase of coefficient of transformation occurs due to the concentration of energy. The reduction of thickness of piezoelectric transformer causes the increase of coefficient of transformation.

A mutual location and size of electrodes also influences on the size of coefficient of transformation, thus, the more is the correlation of areas of input and output electrodes of S_{inp}/S_{out}, the less is the coefficient of transformation and more is the moving of Piezoelectric sensor. Thus, to achieve the maximal moving and realization of opportunity of control of moving feature the construction of piezo actuator must provide the presence of input, output electrodes, and the area of input electrodes must be as big as possible, and the area of output electrodes must be as small as possible.

Piezoelement, is represented on a fig. 3, by its method of location of electrodes on the surface and connecting is the analogue of traditional piezoelectric transformer (Tr). The traditional transformer are called piezoelectric transformers, at which the angle of α between the vector of input and output vectors of the electric field and vector of polarization is equal to zero. Piezoelectric transformer at which the angle $0 < \alpha \leq 90^{o}$ is domain-dissipative (DD-DD) (fig. 4) [3, 4, 5, 11, 13, 14].

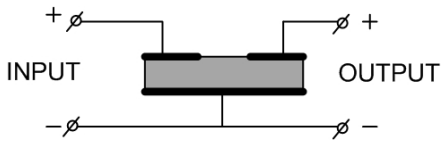

Fig. 4. Piezoelectric sensor connected with the scheme of DD-DD

When powering the input electrodes of piezoelectric sensor of signal is represented on a fig. 5, transitional characteristic of piezoelectric sensor, connected with the scheme of TR-TR (fig. 3), is represented in fig. 5. Transitional description of piezoelectric sensor, connected with the scheme of DD-DD (fig.4), is represented on a fig. 6.

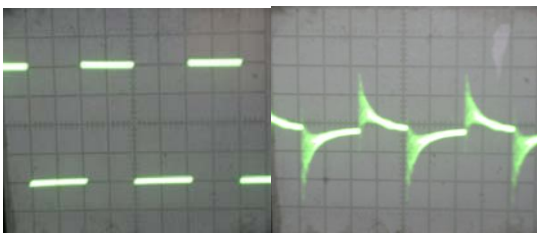

Fig. 5. The input signal and transitional characteristic of piezoelectric sensor, connected with the scheme of TR-TR

The advantage of piezoelectric sensors, connected with the scheme of DD-DD possessing

properties of differentiating element is a presence of linear characteristic in wider range, than traditional piezoelectric sensors have. The disadvantage of such piezoelectric sensors is the unsteady moving of piezoelectric sensor in relation to the axis of rotation. As a size of moving of ΔX depends on correlation of input and output electrodes, so the placement of electrodes on the surface of piezoelectric sensor by such method reduces the size of moving of piezoelectric sensor, that is the substantial disadvantage.

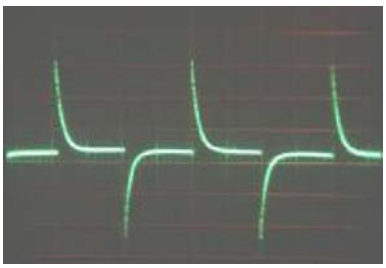

Fig. 6. The transitional characteristic of piezoelectric sensor, connected with the scheme of DD-DD

The advantage of piezoelectric sensors, connected with the scheme of TR-TR, is the steady moving of Piezoelectric sensor along the axis of rotation and large size of moving. The disadvantage is the presence of not linear characteristic [3, 4, 5, 21, 22, 24].

For the reliable functioning of piezo actuator piezo ceramic materials, from which piezoelectric sensors of piezo actuator are made, must have the followings parameters:

-high value of piezo modulus *d33*;

-to have high temperature stability in a range from -60 to +70;

-to have high strength.

The most suitable materials for making piezoelectric sensors of piezo actuator are: CTS-46 and CTBS-8.

PROBLEM STATEMENT AND RESEARCH

Two variants of connecting, considered before (Fig.3, 4), are basic, and every scheme has its advantages and disadvantages. For generation of piezo actuator, which fulfils the requirements of the large moving, availability of control function and characteristics linearity the use of fair quantities of combinations of basic variants of schemes is possible. Their main requirements are characteristics linearity in a wide range and as less as possible value of angle between the vector of input and output vectors of the electric field and vector of polarization.

The main task of experimental research is determination of transitional characteristic of piezoelectric sensor made by the combined scheme of DD-TR (fig.7), and also determination of expedience of the use of such piezoelectric sensors in piezo actuators.

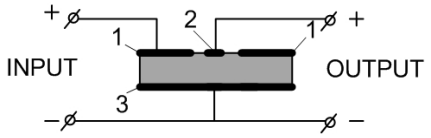

Fig. 7. Piezoelectric sensor connected with the scheme of DD-TR

Taking into account that all piezoelectric sensors of piezo actuator are equal, and the moving rate of piezo actuator is determined with a formula:

$$X_{\Sigma} = \Delta X \times n, \qquad (2)$$

where: X_{Σ} is a moving rate of piezo actuators, X_{Σ} is a moving rate of one piezoelectric sensor of piezo actuator, n - is the amount of piezo elements in piezo actuator, for determination of characteristics of piezoelectric sensor, made by the combined scheme of DD-TR, it is enough to conduct an experiment with one piezo actuator.

Moving of piezo actuator is realized under the action of electric voltage, attached to the electrodes 1, 3. Simultaneously the signal, which amplitude is proportional to the moving rate, is measured from electrodes 2, 3.

MAIN PART

For conduction of experimental researches piezo element is connected according to the scheme, represented on a fig. 8. As a device of voltage the generator G5-54 is used. The signal, taken down from output electrodes, is measured with the help of the oscillograph of S1-65A.

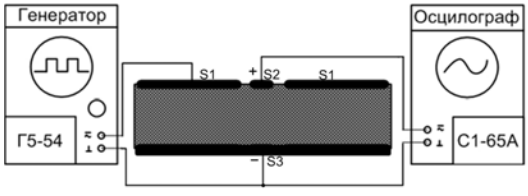

Fig. 8. The scheme of piezoelectric sensor is connected

On the input electrodes of piezoelectric sensor electric voltage with amplitudes 20, 30, 40, 50 volts is given by turns.

Table 1. Parameter of piezo sensor

Material	Diameter D, mm	Height L, mm	$S1$, mm^2	$S2$, mm^2	$S3$, mm^2
CTBS-8	30	2	678	24	706

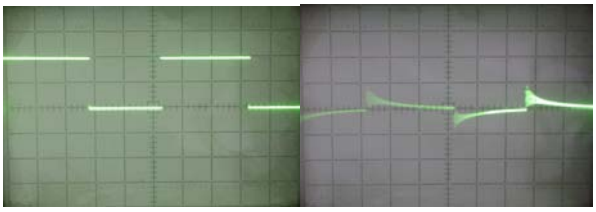

Fig. 9. The form of input electric voltage by amplitudes 20 volts and transitional characteristics

CONCLUSIONS

Information about the size of output voltage of piezoelectric sensor, connected by the scheme of TR-TR, are represented in the table 2 and taken from [6, 7, 8, 11, 26]. On diagrams, represented in fig.10-13, and measuring results, represented in the table 2, it is possible to make a conclusion, that the use of piezo elements in piezo actuator, made according to the combined scheme of DD-TR, allows to control moving with smaller distortions without the considerable diminishing of amplitude of output signal.

The increase of measuring accuracy is conditioned by the fact that at the increase of angle α between the vector of polarization and vector of voltage of the electric field of output signal there is the degeneration of vibration properties of transformer into an aperiodic differencing circuit. When increasing of angle α also sensitiveness is increased and the working range of frequencies broadens is extended.

Table 2. **The size of output voltage of piezoelectric sensor**

Inp.voltage	20	30	40	50
DD-TR. Out. voltage	8	14	18	22
TR -TR. Out. voltage	10	17	21	25

The outlook of further researches is determination by influence of parameters of environment, electromagnetic radiations on amplitude of output signal and moving rate of piezo actuator.

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ПЬЕЗОАКТУАТОР ФОРСУНКИ СИСТЕМЫ ВПРЫСКА COMMON RAIL

Ирина Кириченко, Александр Стрелец, Николай Кошевой

Аннтотация. В статье рассматриваются вопросы целесообразности применения в пьезоэлектрических актуаторах пьезоэлементов, выполненных по схеме ДД-ТР. Определена переходная характеристика и амплитуда выходного сигнала.

Ключевые слова. Common Rail, пьезоэлектрический клапан, пьезоэлектрический актуатор, пьезоэлемент, пьезоэлектрический трансформатор, доменно-диссипативная схема.

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GRAPHIC PRESENTATION OF RESULTS OF CALCULATIONS BY CALCULABLE COMPLEX «MIRELA +»

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S u m m a r y . The analysis of visualization in the system of the automated planning of constructions is resulted in the article. The new going is offered near realization of algorithms of visualization of results of calculations within the framework of complex «MIRELA +».
K e y w o r d s : finite element methods, visualization.

INTRODUCTION

In a modern engineer, aircraft building, on the stage of planning of details and elements of constructions, and also for the design of different processes and phenomena the FINITE element method is used. It also is successfully used in mechanics, biomechanics. Engineers use the specialized packages, which allow not only to boundary problems but also build geometrical models, create a calculable grid, and do an analysis of the got calculation data.

A finite element method (FEM) is a widespread numeral method, which is used many researchers and engineers for the calculations of processes and phenomena which take place in a technological process. A numeral design can replace a model experiment often, when last inaccessible as a result of absence of experimental base and facilities for his realization.

Application of FEM is realized in the large number of the programs (CAD/CAM products, computer-aided designs) of home and imported production. It is world-wide complexes of ANSYS, AutoCAD, COMPASS and other, that well showed oneself not only abroad but also on Ukraine. For today FEM is inalienable part of engineering analysis and developments. Important property of these methods is authenticity, possibility of the use in a computer design with the large enough stake of confidence in their reliability.

Experience of application of MCE shows for the decision of engineering and scientific tasks, that the phase of analysis of numeral results of calculation on working hours and duration often substantially excels the first two stages of decision of task - preparation of basic data and calculation of task on computer. All modern programmatic systems of decision of tasks of mechanics of FEM contain the special modules that automation the process of analysis of results. The most effective method of such analysis is graphic presentation of the got numerical values.

PROBLEMS AND RESULTS

An aim of work is an analysis of algorithm of visualization of numeral results of calculation by means of construction of a semitone or variegated images with the use of illumination of three-dimensional objects.

To solve the problem of deforming, damping and dissipative warming of elastic construction the many works is devoted [1-12]

There is plenty enough of different variations of visualization of results of calculation. Among most widespread is a construction of different two-dimensional and three-dimensional charts, lines. However the most effective method of visual presentation and perception of distribution of numerical size after some two-dimensional or three-dimensional calculation area is an image of a semitone or variegated picture, where every tint or

color is answered by the well-known range of numerical values.

Visualization of conclusion of numeral decision it is related to two basic problems:

- by the presence of large array of numeral information, that must be prospected on authenticity, exactness and adequacy of maintenance of task;
- by the necessity of synthesis of additional information - standard results of finite element analysis(for example, after the got key moving it is necessary to find the key values of components of tensors of deformation and tension).

In most cases the visible surface of geometrical area that is prospected by the method of eventual elements shows a soba eventual totality of flat non-intersection geometrical figures of simply-shaped (mostly triangles or quadrangles) (fig. 1). To Tom, the image of finite-element object is usually taken to visualization in space the determined amount of flat geometrical figures - verges of eventual element.

In general case the problem of visualization of results of numeral calculations of tasks of mechanics is taken the FEM to the decision of two followings tasks:

- a construction of mathematical vehicle of planning of three-dimensional geometrical area is on the plane;
- Painting out of projection by colors or tints, proper distributing on the initial geometrical area of visualized function.

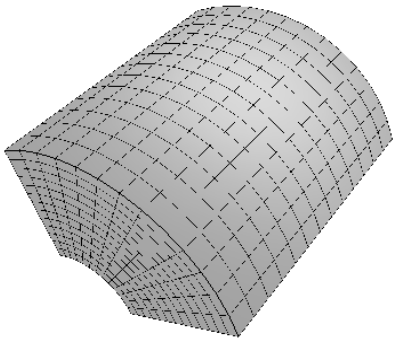


Fig.1. Surface of object as totality of non-intersection quadrangles

The idea of algorithm of visualization of a semitone image consists in the construction of spatial surface of S for tabular the set value of its co-ordinates (x_i, y_i, U_i), where (x_i, y_i) are co-ordinates of key points of area, U_i is point value of researching function, and n is an amount of key points of geometrical area, which form it framework model.

In the case of linear approximation S will show by itself a surface, formed intersecting in space (x, y, U) of m planes, and projection of S on the plane of $z = 0$ will coincide with the probed area [1]. Thus every plane is simply characterized by a corner, formed by it with the plane of $z = 0$ (fig. 2).

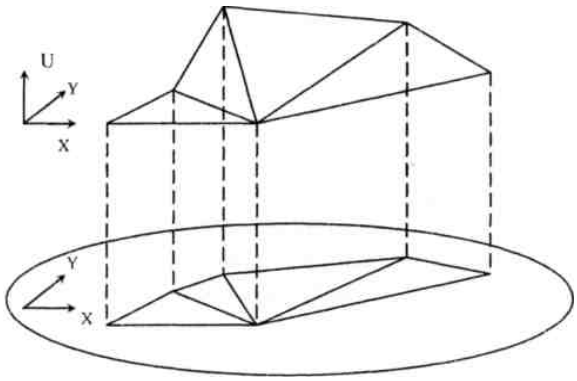


Fig. 2. Chart of construction of surface of results of S

One of the possible going near the visual analysis of function of U there is consideration of auxiliary function $F^{(S)}(e)$, $(e = \overline{1,n})$, that puts in accordance to every formative the surface of S a plane e angle of its slope to the plane of z=0.

If to put every value of function $F^{(S)}(e)$ in accordance any color and to paint out every eventual element this color, got image will allow to judge about distributing of values of function of U on all calculation area. In practice in place of function $F^{(S)}(e)$ examine the following function:

$$\overline{F}^{(S)} = F^{(S)} - \min_{e} F^{(S)}. \qquad (1)$$

This allows to analyses the relative change of size of U on the set area.

Other going near the analysis of surface of S is a construction of real function

$$P^{(S)}(u) = \frac{G \cdot \left(u - \min\limits_{S} u\right)}{\max\limits_{S} u - \min\limits_{S} u}, \qquad (2)$$

where: G is some numerical amplification factor.

In general case G is the beforehand set function which acts part «strengthening», that it is needed for adjusting of areas of monotony of function of P on the area of its values. If to put every value of P in accordance any color and to paint out them all areas of the probed area, for which a value of P is identical, the got image also

will allow to judge about distributing of analyses parameter on the set area.

An alternative algorithm of construction of a semitone picture of distributing of some function of U is on a three-cornered area. Let the range of visualization of numerical values of function of U be disposed on an interval from $U_{\min}$ to $U_{\max}$ and amount of gradations of colors (half-tones), necessary for visualization of three-cornered area, n is evened. Then the range of values of U, which are painted out on a picture one color, will look like $[U_i;U_{i+1}]$, where

$$U_i = U_{\min} + ih, \quad h = \frac{U_{\max} - U_{\min}}{n-1}.$$

Therefore number of color which answers some value, it is possible to define after a formula:

$$j = \operatorname{int} \frac{U^* - U_{\min}}{h}. \qquad (3)$$

Let it is necessary to build a semitone image for a triangle $P_1P_2P_3$ with key values - $U^{P1}U^{P2}U^{P3}$. And here U^{P1} is a maximal key value on a triangle, and U^{P2} – minimum. Obviously, that m_{12} – an amount of gradations of image on a side P_1P_2 will be maximal, here $m_{12} = m_{13} + m_{32}$, where

$$\begin{aligned} m_{12} &= \operatorname{int} \frac{U^{P_1} - U_{\min}}{h} - \operatorname{int} \frac{U^{P_2} - U_{\min}}{h}, \\ m_{13} &= \operatorname{int} \frac{U^{P_1} - U_{\min}}{h} - \operatorname{int} \frac{U^{P_3} - U_{\min}}{h}, \\ m_{32} &= \operatorname{int} \frac{U^{P_3} - U_{\min}}{h} - \operatorname{int} \frac{U^{P_2} - U_{\min}}{h}. \end{aligned} \qquad (4)$$

In this case the image of triangle is taken to the image of aggregate from m_{12} quadrangles and triangles, color each of which answers his number in an image scale.

On fig. 3 the example of such lying out of triangle on image areas ($m_{12} = 4$, $m_{13} = 3$, $m_{32} = 1$) is resulted. Easily to see that the set of image grounds consists of two triangles and two quadrangles (shaded area), here color each such area answers the number of his index.

The example of work of a semitone algorithm is represented on fig. 4.

During visualization of semitone images for the increase of evidentness it is often needed to destroy alongside from object imager scale which gives information about accordance of color or tint of some range of the probed function (fig. 5).

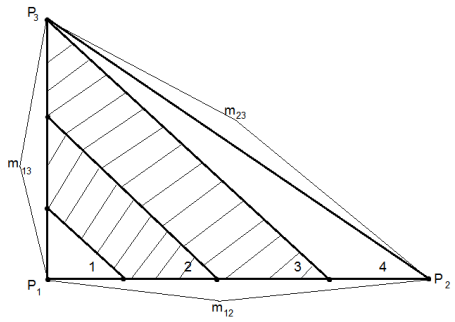


Fig. 3. An example of breaking up of triangle is on image areas

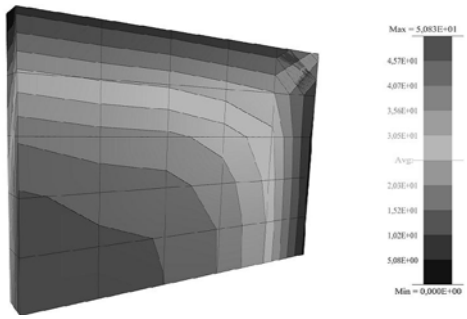
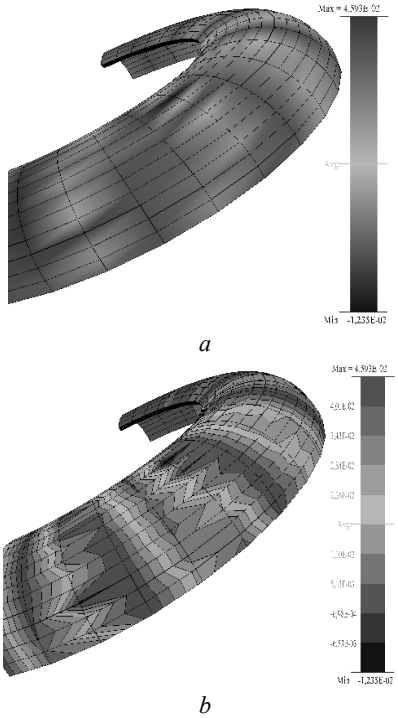


Fig. 4. Distributing of tensions for the areas of surface of flag



a

b

Fig. 5. A distribution of displacements of shall construction (visualization of object with animage scale):a – Semitone image, b – Coloured image

Other going near the construction of gray-scale pictures a construction and visualization of a semitone picture, corresponding distribution of

gradient can serve on the prospected surface of object [13-16].

The alternative going near visualization of results of calculation is a change of geometry of area in accordance with distributing of effects of illumination of spatial object. It gives an opportunity to see the features of form of surface of object. That allows getting additional information about distribution of analyzable parameter.

For the image of the lighted up stage in computer graphic arts the models of diffuse and mirror reflection of object of light are more frequent all used from set one or a few point sources of illumination [14, 15].

The diffuse reflection of light of point source from ideal diffuser is determined the law of Lambert, in obedience to which light, that falls, dispersed in all sides with identical intensity. Luminosity of point is proportional its area, to visible from a source in this case, and described next correlation:

$$I_r = I_p P_d \cos\varphi, \qquad (5)$$

where: I_r – intensity of the reflected light, I_p – intensity of point source, $P_d \in [0;1]$ – coefficient of diffuse reflection, dependency upon properties of material of beating back object and color of source of illumination, $\varphi \in [0; \pi/2]$ – corner, formed direction of light and normal of surface.

For the increase of reality of perception of picture in computer graphic arts also taken into account the presence of dissipated light which is described by the coefficient of dispersion:

$$I = I_r \cdot P_r + I_p \cdot P_d \cdot \cos\varphi, \qquad (6)$$

where: I_r – is intensity of the dissipated light, $P_r \in [0,1]$ – is a coefficient of diffuse reflection of the dissipated light.

The design of fading of light with distance from a source is described the following formula:

$$I = \frac{I_r \cdot P_r + I_p \cdot P_d \cdot \cos\varphi}{d + K}, \qquad (7)$$

where: d is distance from the center of projection to object, K is an arbitrary constant which sets the measure of fading of light

At the use of the parallel planning the account of distance is provided by that the nearest to the observer object is illuminated with maximal intensity, and all are located farther - with less. Thus, as distance of d, distance is used to the nearest to the point supervision of object.

It is removed from an ideal mirror light evidently only in case that a corner form directions of supervision and reflection equals a zero. For non-perfect reflected surfaces the model of Fong is used:

$$I_s = I_p \cdot W(\lambda, \varphi) \cdot \cos^n \alpha, \qquad (8)$$

where: $W(\lambda, \varphi)$ – is a curve of reflection which dependency upon a wave-length of light of source λ and angle of incidence φ, $a \in [-\pi/2; \pi/2]$ – is a corner between directions of supervision and reflection, is an index of measure that sets the decrease of intensity at the change of corner.

For simplicity in practice usually $W(\lambda, \varphi)$ replace some constant of K_s, neat so that the built picture was subjectively perceived realistically.

The total model of illumination used in computer graphics looks like:

$$I = I_r \cdot P_r + \frac{I_p}{d + K} \cdot \left(P_d \cdot \cos\varphi + W(\lambda, \varphi) \cdot \cos^n \alpha\right) \qquad (9)$$

or $$I = I_r \cdot P_r + \frac{I_p}{d + K} \cdot \left(P_d \cdot \cos\varphi + K_s \cdot \cos^n \alpha\right). \qquad (10)$$

At the use of the rationed vectors straight falling of L, normals of N, reflections of R and supervision of V, the model of illumination for one source is described thus:

$$I = I_r \cdot P_r + \frac{I_p}{d + K} \cdot \left(P_d \cdot L \cdot N + K_s \cdot (R \cdot V)^n\right). \qquad (11)$$

During visualization of flat polygon figure (for example, verges of finite element) if a source of light is on endlessness, then $L \cdot N$ equals a constant, and $R \cdot V$ changes within the limits of this figure. Thus visualization of the lighted up certainly-element object requires the point constructions of character that results in the necessity of the use of original algorithm of Z- of buffer. Possibilities of modern computers with the use of modern graphic standards of OpenGL or DirectX the lighted up objects allow effectively to visualize.

To give form of surface in such libraries it is necessary to determine a normal vector. In this case as components of these vectors it is possible to use the corresponding components of vector of moving, deformations or tension. If to the coordinates of knots to add the properly rationed values of the investigated function and represent the got corrugated surface of object lighted up by the lateral source of light, then the got picture also

will allow to judge about distribution of the investigated numerical size for areas.

On fig. 6 the lighted up image over of difficult object is brought [17, 18].

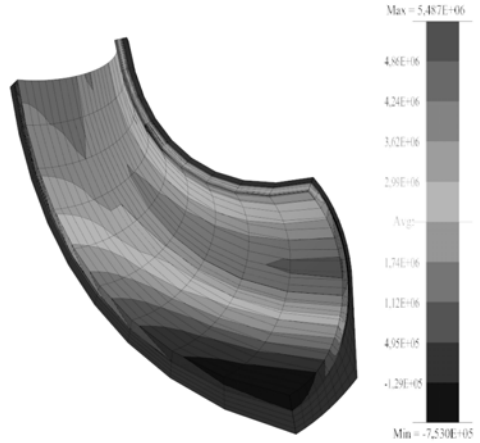


Fig. 6. Colour distribution of σ_{yy}

CONCLUSIONS

On the basis of the considered approach the method of half-tone visualization of results of calculation of the tensely-deformed and thermal state of constructions is offered on the basis of calculable complex "MIRELA+".

The offered method allows presenting transferring, tensions and temperature to the knots and centers of finite elements as moiré stripes, isolines or surfaces on volume or in the set sections.

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ГРАФИЧЕСКОЕ ПРЕДСТАВЛЕНИЕ РЕЗУЛЬТАТОВ РАСЧЕТОВ В ВЫЧИСЛИТЕЛЬНОМ КОМПЛЕКСЕ «МІРЕЛА +»

Юрий Козуб, Галина Козуб

Аннтотация. Рассмотрен анализ процедур визуализации в системах автоматизированного проектирования. Предложен новый поход для реализации алгоритмов графического представления результатов расчета в рамках вычислительного комплекса «МІРЕЛА +».

Ключевые слова: метод конечных элементов, визуализация.

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THE CASCADE PRESSURE EXCHANGE REACTIVE ROTETION DISK ENGINE CREATION REASONS

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S u m m a r y . The theoretical reasons of creation the reactive rotation disc engine on cascade pressure exchanger base (ERR CEP) have been stated. The particularities of ERR CEP working process in collation with wave disc engine on wave pressure exchanger base have been considered. It is in particular shown that cascade pressure exchange principles use allows vastly to increase the pressure of preliminary compression of charge and also to reduce the loss of expanding products of combustion in useful work turning moment of engine.

K e y w o r d s : cascade pressure exchanger, wave pressure exchanger, reactive stream, mass-exchange, disc engine of reactive rotation.

INTRODUCTION

Now the need for supernumerary and simple internal combustion engines on a design, working at different types of hydro-carbonic fuel, including natural gas (methane) with low cleaning degree increases.

The pistons ICE which have gained the greatest distribution practically have settled a reserve of considerable improvement of specific power and fuel profitability. Besides, existence of a large number of the precision details, difficult systems and units causes high cost of their production and service.

In heat power machines, reforming heat in mechanical work the main part of internal work make up compression of a gaseous body in an installation cycle. Charge compression by means of a mechanical ouster (the piston or shovels of driving wheel) thermodynamic is irrational and interfaced to complication of engine design. The use wave or cascade pressure exchangers in the capacity of main or additional air charge compressor unit is a new direction of multipurpose heat machines development. In pressure exchangers direct transformation extending gases energy to compressed air located energy in the course of direct contact between compressing and compressed environments is carried out.

THE ANALYSIS OF PUBLICATIONS

The first successful attempt of application of a wave exchanger (WPE) as the first step of compression was carried out by Claud Seippel from the Brown Bovery company in Switzerland on the locomotive gas-turbine engine (GTE). In the early sixties in the Ruston-Hornsby company under the direction of Rhone Pearson the wave rotor turbine (WRT) in which disk rotor spiral-shape channels at the same time was created and tested served as combustion chambers for an air and kerosene mix. At the beginning of the 2000th years a row of known research centers such as NASA, Rolls-Royce, Indiana University, Purdue University Indianapolis, the company ABB, Michigan State University have renewed interest to integration of WPE of a various configuration in mini- and microGTE [Akbari P. A, Nalim M.R., Muller N., 2006., Akbari, P., Muller, N., 2003, Benini E., Toffolo A., Lazzaretto A., 2003., Rogers C., 2003., Welch G. E., 2000, Krajniuk A.I., Storcheous J.V., 2000, Wilson, J. and Paxson, D. E., 1993, Zauner, E., Chyou, Y. P., Walraven, F. and Althaus, R., 1993].

It is necessary to note, however, that the appreciable effect of integration of WPE in a working cycle of GTE is reached only if efficiency

processes of compression and expansion of working bodies in wave exchanger excess efficiency these processes in installation turbo-compressor part. Besides, use of WPE as the top step («Top stage») doesn't eliminate, and in some cases aggravates the main lack of the gas-turbine engine – unsatisfactory efficiency on transitional and partial modes. Strongly pronounced of exchange processes wave nature in WPE determinate sensitivity of its consumption characteristics to thermodynamic parameters of working environments in gas-distributing ports and rotor frequency rotation. The deviation of an operating mode of GTE from settlement conditions leads to destruction of waves interaction adjusted picture with gas-distributing ports and to sharp decrease its efficiency. But even on a settlement mode the inevitable energy dissipation in the course of formation and interaction of strong shock waves in a rotor limits efficiency the best samples of WPE values 0,59… 0,63 [Krajniuk A.I., Storcheous J.V., 2000].

In 2005 scientists of Michigan university under the direction of N. Muller started development of the new disk engine on the WPE basis. Unconditional advantage of the wave disk engine (WDE) in relation to known heat engines is compactness and simplicity. Authors of the project argue that the demoversion of the motor which will be constructed according to conditions of APRA-E provided by agency (A Department of Energy of the USA) a grant in $2,5 million will has efficiency not lower than 30%. At the same time realization of high profitability, within WDE declared by designers is represented very not a simple task. Along with noted features of wave processes restrictive factors of a working cycle of WDE are: low extent of preliminary compression of a fresh charge (allegedly less than 2,5); considerable losses of flooding of jet streams in a type of high (above-critical) differences of pressure in jet nozzles; not full exploitation of a radial component of jet streams speed.

Research objective is increase of efficiency of the disk engine by application of a cascade exchange by pressure.

THE THEORETICAL PRECONDITIONS OF CREATION OF THE DISK ENGINE OF JET ROTATION ON THE BASIS OF A CASCADE EXCHANGER OF PRESSURE

Considerable races of indicators improvement of heat machines of different purpose it can be reached by cascade pressure exchange application for compression of air-gas environments in installation working cycle. Such compression realize the cascade pressure exchangers (CPE) representing itself a new generation of pressure exchangers with mainly static nature of direct interaction of compressing and compressed environments. The working cycle of CPE differs with high efficiency (to 85 … 87 %) and tolerance to removal of an operational mode from settlement conditions. The CPE power efficiency realizes in considerable excess of a consumption of compressed air of rather compressing environment, subjects more than the temperature of the last is higher. This property of «consumption multiplication» opens creation prospect on CPE base of essentially new devices of heat-reforming multipurpose machines: thermal compressors and gas generators [Krajniuk, A.I., 2009.], gas-turbine engines [Krajniuk, A.I., 2010, Krajniuk, A.I., Krajniuk A.A, Bryantsev M.A, 2011.], supercharge systems of high-forced engines [Krajniuk, A.I., Alexeev S.V., Krajniuk, A. A., 2009, Krajniuk, A.I., Alexeev S.V., Kovtoon A.S., 2011], air refrigerators [Krajniuk, A.I., Bryantsev M.A., 2010, Krajniuk, A.I., Bryantsev M.A., Krajniuk, A. A., 2010, Krajniuk, A.I., 2011].

In biggest degree the cascade pressure exchanger potential can be realized in a working cycle of the jet rotation disk engine (JRE CPE) (fig.).

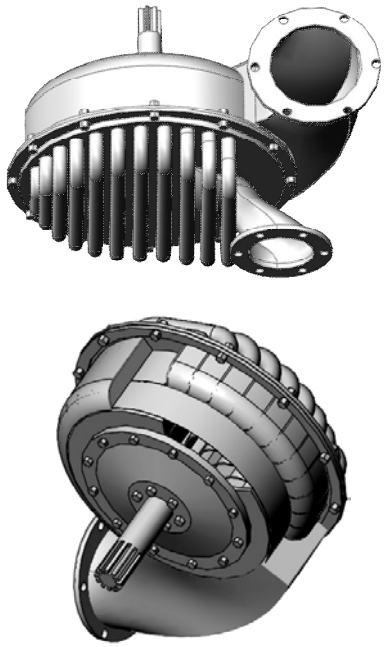

Fig. The common appearance of cascade pressure exchange disk engine

The main idea of use the CPE as the base unit of the engine consists in efficiency increase possibility transformations hot gases energy to located work of a compressed charge and reduces in losses of extending products energy transformation of combustion to useful work of a torque of engine. Theoretical reasons of the noted base on the following features of a working cycle of JRE CPE:

1. The main compression of a fresh charge is realized at the expense of recuperative use of energy of extending gases in the process of cascade mass-exchanger between adjacent cells of sites of compression and expansion. This process provides possibility of essential charge compression preliminary degree increase that promotes to increase cycle thermal efficiency.

2. In the engine on CPE base the expiration of the most part of jet streams is carried out not in the atmosphere, as in WDE, and to mass-exchange canals of a stator. Decrease in differences of pressure in jet nozzles to under-critical level is accompanied by reduction of losses of flooding of a stream. Thus the residual energy of the jet stream which has not been transformed to work, isn't lost quite as it is useful used in the form of a flow substance in mass-exchange channels, promoting additional increase of preliminary compression of a charge without increase in quantity of the brought warmth.

3. Thanks to that fuel - the air mix at the end of compression process concentrates in local volume from an ignition source, partially mixes up with hot gases and it is warmed up by walls of cells, favorable conditions for timely combustion of poor fuels, including, natural methane with low extent of cleaning are created.

Despite complexity of gas-dynamic processes of a working cycle, the design of the engine is simple and laconic, as contains only two mobile interfaced details. Absence of discretely operated bodies of a gas-distribution, ouster and systems of cooling causes reliability and simplicity of operation of an exchanger. According to results of settlement researches the specific capacity of JRE CPE makes from 3 to 4,8 kW/kg. Great values in the specified range correspond to engines of bigger dimension.

CONCLUSIONS

Low cost of manufacturing and reliability in a combination to small dimensions and weight cause to anticipate interest to disk engines of jet rotation the CPE from producers of modern power independent equipment and, first of all, aircraft, armored machinery, means of small-scale mechanization, motorcycles and racing cars.

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ПРЕДПОСЫЛКИ СОЗДАНИЯ ДИСКОВОГО ДВИГАТЕЛЯ РЕАКТИВНОГО ВРАЩЕНИЯ КАСКАДНОГО ОБМЕНА ДАВЛЕНИЕМ

Александр Крайнюк, Александр Данилейченко

Аннотация. изложены теоретические предпосылки создания дискового двигателя реактивного вращения на базе каскадного обменника давления (ДРВ КОД). Рассмотрены особенности рабочего процесса ДРВ КОД в сопоставлении с волновым дисковым двигателем на базе волнового обменника давления. В частности показано, что использование принципов каскадного обмена давлением позволяет значительно увеличить давление предварительного сжатия заряда, а также снизить потери расширяющихся продуктов сгорания в полезную работу крутящего момента двигателя.

Ключевые слова: каскадный обменник давления, волновой обменник давления, реактивная струя, массообмен, дисковый двигатель реактивного вращения.

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STEERABILITY AND STABILITY OF AUTOMOBILE NON-LINEAR MODEL

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S u m m a r i .The problem of the automobile course stability is considered. The change of the car steerability based on the analysis of non-linear bicycl model is analyzed. Generalized dependence determining “the steerability curve” is obtained. Conditions which caused the loss of stability with increasing speed while moving within the constant radius circle regarding the bifurcation set are analyzed.
K e y w o r d s : car, stability, model, slip, bifurcation set.

INTRODUCTION

The increased interest of researchers to study the dynamics of vehicles in recent years can be explained by increasing the number and growth rate of their movements, the increase in total traffic, the constant upgrading of vehicles, active introduction of automatic control elements in the various components of the car. This determines the need to improve the reliability and safety, requires an assessment of the impact of all the improvements introduced in the behavior of the car under different design solutions and traffic situations.

Studies of the dynamics of modern road transport differ considerably, not only from the classical, goes back to N. Zhukovsky [1], I.V. Rocard [2] and others, but also the methods of twenty - thirty years ago. [3] Development of computer technology allows us to consider vehicles with many degrees of freedom [4, 5]. Methods of computer algebra can write in an analytical form of the equation of motion, in terms of the vast specialist performs the conversion "by hand." The combination of these methods with the numerical analysis performed on high-speed computers to determine the movement in a variety of conditions.

At the same time, growth in the number of publications indicates a large number of intractable problems. Among them - the determination of the dependence of various dynamic properties of the system, such as stability and handling, or the nature of these properties on the loss of certain parameters of the problem; nonlabour-intensive and reliable identification of numerous regular and physical parameters of the problem and the study of the "sensitivity" of the mathematical model to a "depth modeling " in particular, the number and choice of degrees of freedom is not only necessary, but also sufficient for an adequate description of certain motions. Studies [6] showed that a reasonable reduction of the number of degrees of freedom is accompanied by significant savings in time and resources, has no significant effect on a number of important practical motion parameters. This points to the need for the most complete study of the properties of the simplest models and increase the number of degrees of freedom only when necessary.

As work on the dynamics of the most approaching the ideal choice for the complexity of the model, you can specify the work H. Troger [7 - 9], Lobas L.G., Sakhno V.P., Soltus A.P. [10 - 18]. In these works for the simplest models of plane

equations of motion are written, developed a process of elimination reactions, studied the stability conditions linear motion systems, depending on the speed of movement, are the main mechanisms of instability associated with the birth of the pendulum and "serpentiform" movements, found a weak "sensitivity" of the results research to model the behavior of the driver's choice.

Based on the simulations, a numerical study of stationary motions under the influence of various stationary disturbing factors: constant cross wind, the side slope of the road, move in a circle. The first approximation built various sections in the space of parameters of the stability regions. Proved that nonequilibrium systems inherent bifurcation. Reaching the stage of bifurcation lost stability and control. Alternation of stability and instability - a common phenomenon in the evolution of any open system, and the process is irreversible. After passing the bifurcation probability of returning the system to its original state is very small.

Active car safety is largely depended on its steerability. Automobile accidents largely result from the loss of steerability [19]. The major part of accidents are caused by skidding and fixed trajectory deviation while maneuvering. Therefore, the preservation of qualities of automobile dynamic systems is of great importance for solving practical tasks. Our paper deals with investigating the automobile models with understeering and oversteering. Necessary and sufficient conditions for car steerability change are analyzed.

SETTING UP THE PROBLEM

The model with Rockar's flexible wheels has the following form [2, 20]:

$$R = \frac{V}{\omega^*} = \frac{k_1 \cdot k_2 \cdot l^2 - m \cdot V^2 \cdot (k_1 \cdot a - k_2 \cdot b)}{k_1 \cdot k_2 \cdot l \cdot \theta}, \quad (1)$$

where: V – longitudinal speed constituent of the of the automobile mass center;

ω^* – angle velocity of the automobile relative to the vertical axis;

k_1, k_2 – coefficients of slipping resistance;

l – wheelbase of the automobile;

m – mass of the automobile;

a, b – distance from the mass center to the front and rear axles of the automobile ($a+b=l$);

θ – rotational angle of steering wheels.

The form (1) is valid at small angles θ and determines the trajectory radius of the point on the longitudinal axle of the automobile (fig. 1). The speed of the point numerically coincides with the longitudinal constituent V of the mass center.

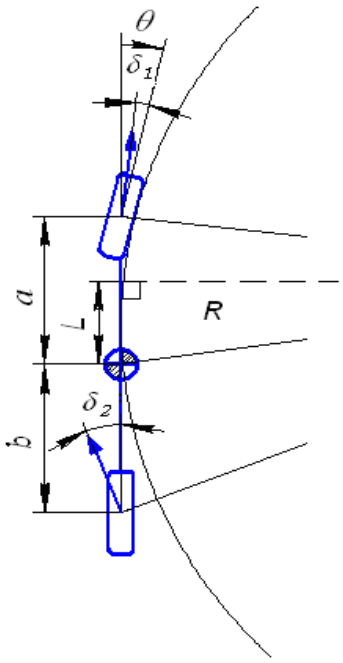

Fig. 1. Parameters determining the position of the automobile at fixed turn (Rockar's flexible wheels): the turn centre and relative position of the automobile

The position of the automobile is determined by the trajectory radius R and distance L (from indicated point to the centre of the automobile mass).

$$R = \frac{V}{\omega^*} = \frac{l}{\theta} \cdot \left(1 - \frac{V^2}{V_{кр}^2}\right),$$

$$L = \left|\frac{u^*}{\omega^*}\right| = \left|\frac{b \cdot l \cdot k_2 - a \cdot m \cdot V^2}{l \cdot k_2}\right|. \quad (2)$$

Motion within the constant radius R at various velocity results from the form (1), obtained by the solution relative to θ

$$\theta = \frac{l \cdot \left(1 - V^2 / V_{kp}^2\right)}{R} = \frac{l}{R} + \frac{\overline{k}_2 - \overline{k}_1}{\overline{k}_1 \cdot \overline{k}_2} \cdot \frac{a_y}{g}. \quad (3)$$

Followed by the equation (3), the gradient of the understeering [21] in the case of non-linear slipping hypothesis is defined by

$$K_{us} = \frac{\overline{k}_2 - \overline{k}_1}{\overline{k}_1 \overline{k}_2}.$$

THE INVESTIGATION OF A NONLINEAR AUTOMOBILE STEERABILITY MODEL

For a linear automobile model with flexible Rocker's wheels the steerability (1 – understeer, 2 – neutral, 3 – oversteer) is known to be determined by the relation of the dimensionless coefficients of slipping resistance for front and rear axles: 1 - $\bar{k}_2 > \bar{k}_1$; 2 - $\bar{k}_2 = \bar{k}_1$; 3 - $\bar{k}_2 < \bar{k}_1$.

At automobile's moving within radius R ith various velocity V (longitudinal velocity constituent of the mass center) Ackerman's angle should remain constant

$$l / R = \theta + \delta_2 - \delta_1. \qquad (4)$$

Therefore, the turn angle of steering wheels is determined by

$$\theta = l / R + (\delta_1 - \delta_2). \qquad (5)$$

The geometric approach to the finding of the second constituent in the form (5) is given below.

A number of equations determining the set of stationary regimes for a bicycle model of the automobile can be changed by the following equation [11]

$$\bar{Y}(\delta_2 - \delta_1) = \frac{V^2}{g \cdot l}(\theta + \delta_2 - \delta_1), \qquad (6)$$

where: $\bar{Y} = \bar{Y}(\delta_2 - \delta_1)$ – a stationary curve determined by dimensionless dependences of slipping forces for axles (fig. 2)

$$\bar{Y} = \bar{Y}_1(\delta_1) = \bar{Y}_2(\delta_2). \qquad (7)$$

Sloping angle tangent of the mobile straight line is proportional to the square of the longitudinal velocity constituent of the automobile mass center $\frac{V^2}{g \cdot l}$, turn angle of steering wheels θ determines the parallel displacement of a straight line.

Points of intersection of a straight line and a stationary curve correspond to stationary regimes of the model (ordinate of the point of intersection Y determines the specific side acceleration of the mass center s for a corresponding stationary regime, its abscissa – the difference between slipping angles on the axis $(\delta_2 - \delta_1)$.

With current value of Y the difference $(\delta_2 - \delta_1)$ is determined by the function $G(Y)$, converse to the function $Y(\delta_2 - \delta_1)$.

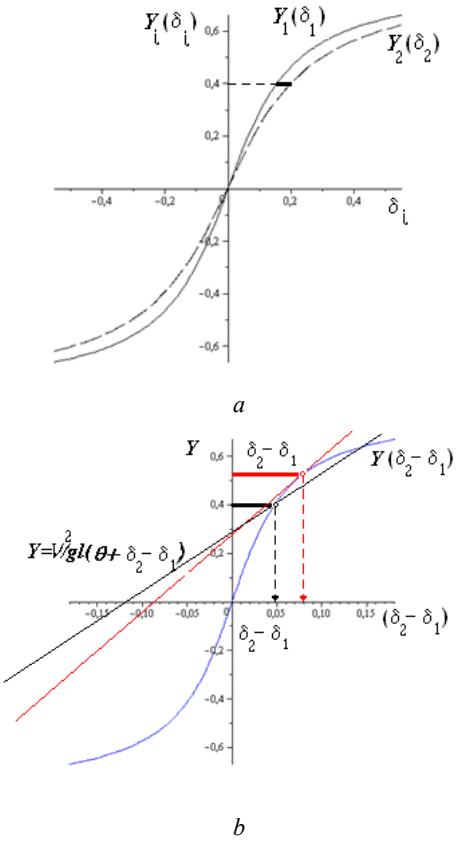

Fig. 2. Drawing a stationary curve $\bar{Y} = \bar{Y}(\delta_2 - \delta_1)$: a - diagrams of slipping forces for front and rear axles, as functions of slipping angles; b - multiple roots of the equation (6)

Initial dependences are $Y_1 = Y_1(\delta_1)$, $Y_2 = Y_2(\delta_2)$.

Having accepted these dependences for δ_i, we have $\delta_1 = F_1(Y)$, $\delta_2 = F_2(Y)$, $(\delta_2 - \delta_1) = G(Y) = F_2(Y) - F_1(Y)$.

For drawing the curve $G(Y)$ (fig. 3) diagrams of slipping angles dependences δ_1, δ_2 for front and rear axles are initial ones, as functions of slipping forces Y.

Having determined the function $G(Y)$, we have θ by the equation (5):

$$\theta = l / R + \delta_1 - \delta_2 = l / R - G(Y). \qquad (8)$$

In the case of the linear slipping hypothesis ($\delta_2 - \delta_1 = (\frac{\bar{k}_2 - \bar{k}_1}{\bar{k}_1 \bar{k}_2}) \cdot Y$) we have the earlier determined equation [22]

$$\theta = l / R + (\frac{\bar{k}_2 - \bar{k}_1}{\bar{k}_1 \bar{k}_2}) a_y / g. \qquad (9)$$

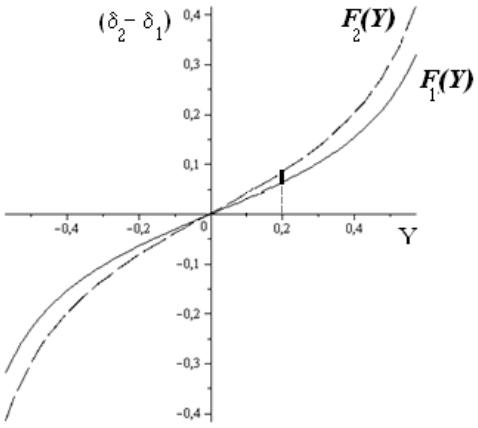

Fig. 3. The curve $G(Y)$

The change car steerability occurring sometimes in our life [22] (fig. 4) cannot be explained by the linear slipping hypothesis.

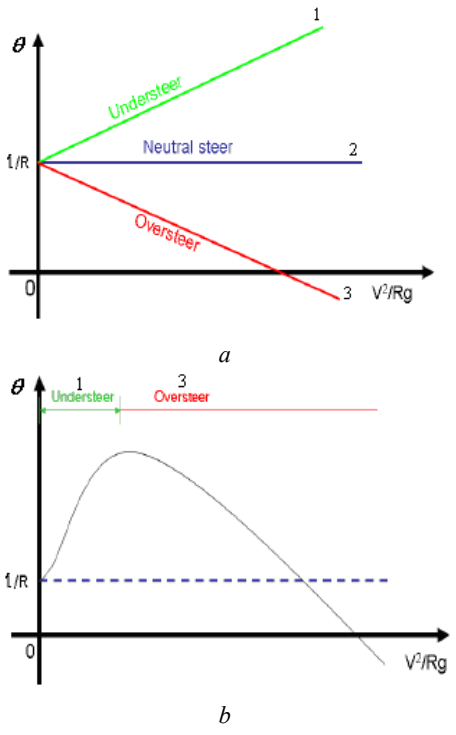

Fig. 4. Dependence of controllability: *a* - diagram of the steerability corresponding to the linear slipping hypothesis; *b* - virtual alteration of the automobile steerability

In our paper we try to explain such impossibility by the analysis of the non-linear bicycle model regarding nonlinearity of sideways slipping forces (monotone dependences with the function of saturation $\overline{Y}_i(\delta_i) = \overline{k}_i\delta_i(1+\overline{k}_i^2\delta_i^2/\varphi_i^2)^{-1/2}$ are regarded).

Analytical conditions for change car steerability are provided for indicated dependences determining slipping forces: $\varphi_1 > \varphi_2$ is necessary and adequate (inadequate turn – excessive turn) to the model with understeering $\overline{k}_2 > \overline{k}_1$; $\varphi_1 < \varphi_2$ is necessary and adequate (excessive turn – inadequate turn) to the model with oversteering. Both cases are realized by the specific sideway acceleration value determined by

$$V^2/Rg = \varphi_1\varphi_2\sqrt{\frac{(\overline{k}_1)^{2/3} - (\overline{k}_2)^{2/3}}{\varphi_2^2(\overline{k}_1)^{2/3} - \varphi_1^2(\overline{k}_2)^{2/3}}}. \quad (10)$$

We are going to draw the diagram of the steerability for definite numeric values (for oversteering).

The distance between the front and rear axles is

$$l = 5 \text{ m}.$$

Dimensionless coefficients of slipping resistance:

$$\overline{k}_1 = 3{,}300;\ \overline{k}_2 = 2{,}526.$$

The critical velocity for linear motion is

$$V_{kp} = \sqrt{9{,}8 \cdot l \cdot \overline{k}_1 \cdot \overline{k}_2 \big/ (\overline{k}_1 - \overline{k}_2)} = 22{,}98 \text{ m/s}.$$

The influence of the changeable clutch coefficient variation for the front axle in the sideway direction $\varphi_1 = \{0.8, 0.75, 0.7\}$ (clutch coefficient for the rear axle in the sideway direction is $\varphi_2 = 0.8$) on the diagram of the steerability (R = 30,5 m) in the case of the non-linear slipping hypothesis is illustrated.

We enlist below the values of specific sideway acceleration causing the change of the car steerability based on the analytical form (10):

for $\varphi_1 = 0{,}75$ we have $\overline{Y} = 0{,}59$, $V = 13{,}28$ m/s;

for $\varphi_1 = 0{,}7$ - $\overline{Y} = 0{,}47$, $V = 11{,}88$ m/s.

Stationary circular motion regimes ($R = 30{,}5$ m) with increasing longitudinal velocity of the mass center is realized. The loss of stability takes place at $V = 13.03$ m/s [23] (fig. 6); unstable circularregimes correspond to the dotted lines of diagram.

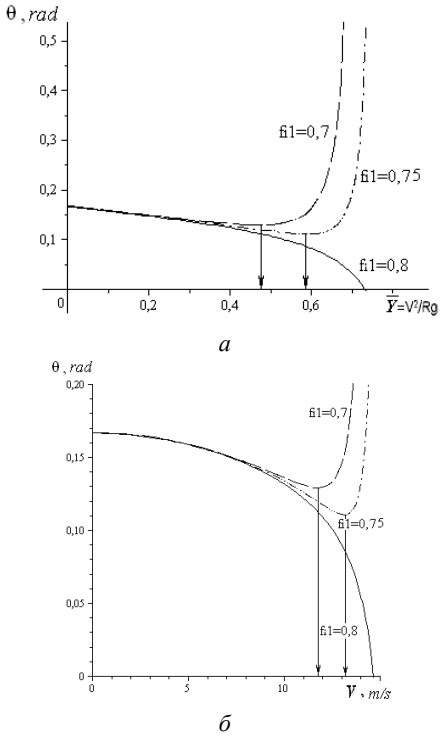

Fig. 5. Diagrams of the steerability for the non-linear slipping hypothesis with various changeable clutch coefficients in the sideway direction for the front axle: *a*- dependence $\theta = \theta(a_y / g)$; *b* - dependence $\theta = \theta(V)$

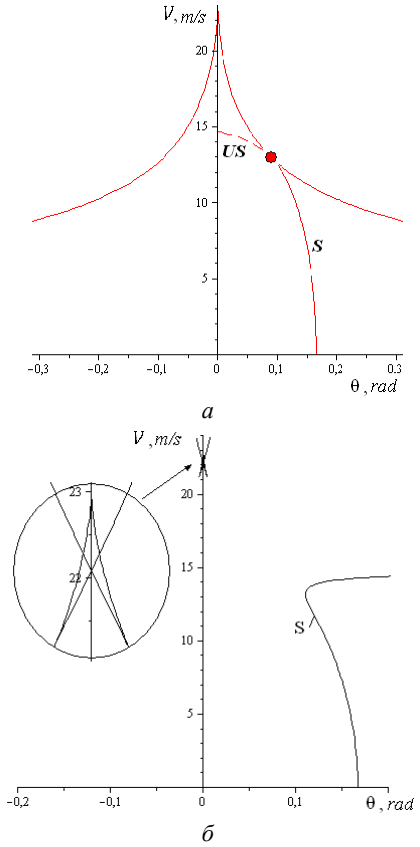

Fig. 6. Diagrams of the stability within the plain of the model controlling values: a - $\varphi_1 = 0.8$; *b*- $\varphi_1 = 0.75$

Next, we consider a dependence of the type $\overline{Y}_i(\delta_i) = \gamma_i \delta_i \cdot (1 + (|\delta_i| - \beta_i)^2 / \beta_i^2)^{-1/2}$, which guarantee the nonmonotonicity of slipping forces (unlike monotone dependences at considerable slipping angle the function has descending sections). Parameters γ_i and β_i are due to keeping geometrical characteristics of the monotone dependences, $\overline{Y}_i(\delta_i) = \overline{k}_i \delta_i (1 + \overline{k}_i^2 \delta_i^2 / \varphi_i^2)^{-1/2}$, enabling the constancy of the critical velocity for rectilinear motion, coordination of maximum values of dimensionless slipping forces: $\gamma_i = \overline{k}_i \cdot \sqrt{2}$, $\beta_i = \varphi_i / (2 \cdot \overline{k}_i)$.

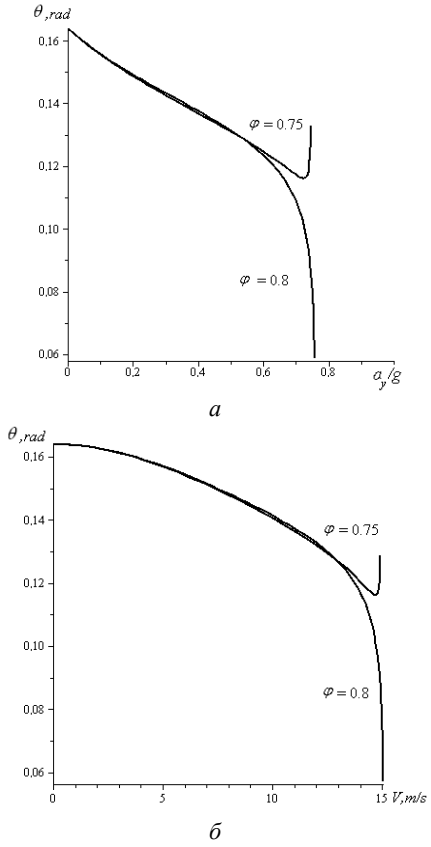

Fig. 7. Diagrams of the steering for the non-linear slipping hypothesis with changeable clutch coefficients variation in the sideway direction for the front axle: *a* - dependence $\theta = \theta(a_y / g)$; *b* - dependence $\theta = \theta(V)$

The influence of the changeable clutch coefficient variation for the front axle in the sideway direction $\varphi_1 = \{0{,}8; 0{,}75\}$ (clutch coefficient for the rear axle in the sideway direction is $\varphi_2 = 0{,}8$) on the steering diagram (R = 30,5 m) in the case of the non-linear slipping hypothesis is illustrated.

We enlist below the values of specific sideway acceleration causing the change of the car

steerability: for $\varphi_1 = 0{,}75$ we have $\overline{Y} = 0{,}72$, $V = 14{,}7$ m/s.

Stationary circular motion regimes ($R = 30{,}5$ m) with increasing longitudinal velocity of the centre of mass being realized, the loss of stability takes place at $V = 14{,}38$ m/s (fig. 8); unstable circularregimes correspond to the dotted lines of diagram.

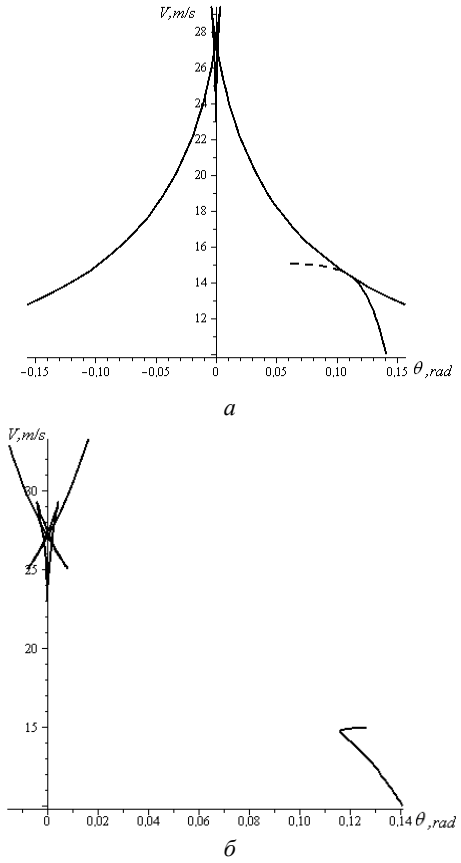

Fig. 8. Diagrams of the stability within the plain of a model of controlling values of a model: a - $\varphi_1 = 0{,}8$; *b* - $\varphi_1 = 0{,}75$

CONCLUSIONS

Analytical regimes for the change of the car model steerability of the automobile are obtained. Diagrams of the steering for the non-linear slipping hypothesis for changeable cutch coefficient variations in the sideway direction on the front axle are given.

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УПРАВЛЯЕМОСТЬ И УСТОЙЧИВОСТЬ НЕЛИНЕЙНОЙ МОДЕЛИ АВТОМОБИЛЯ

Александр Кравченко, Владимир Вербицкий, Валерий Хребет, Наталья Вельмагина

Аннотация. Рассматриваются проблемы курсовой устойчивости движения автомобиля. В работе анализируется смена свойств управляемости на основе анализа нелинейной велосипедной модели, которая учитывает нелинейность сил бокового увода. Получена обобщенная зависимость, определяющая «кривую управляемости». Проанализированы условия потери устойчивости для случая движения с возрастающей скоростью по окружности постоянного радиуса на основе построения бифуркационного множества.
Ключевые слова: автомобиль, устойчивость, модель, боковой увод, бифуркационное множество.

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INFORMATION SECURITY COMPANY IN A DOS (DDOS) ATTACK

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Summary. The article to contain results of the researches, allowing to raise level of protection of the automated and intellectual information systems enterprises (AIS). The article discusses the use of discrete procedures to detect threats DoS (DDoS) attacks for information resources.
Key words: information security, threat detection, discrete process.

INTRODUCTION

The influence of information automation systems pervades many aspects of everyday life in most parts of the world. In the shape of factory and process control systems they enable high productivity in industrial production, transport systems they provide the backbone of technical civilization [Slobodyaneuk M. 2010]. One of the foremost transport businesses security concerns is the protection of critical information, both within their internal financial infrastructures and from external elements. Up to now, most of these systems are isolated, but for the last couple of years, due to market pressures and novel technology capabilities, a new trend has been rising to interconnect automation systems to achieve faster reaction times. Initially, such interconnections were based on obscure, specialized, and proprietary communication means and protocols. Now more and more open and standardized Internet technologies are used for that purpose. Studies show that most cyber-attacks occur inside organizations, instigated by personnel with valid access to the system. This work describes the design, implementation, and testing of a security system that enhances the capability of transport businesses to protect information within the boundary of their networks.

The sophistication and effectiveness of cyber attacks have steadily advanced. These attacks often take advantage of flaws in software code, use exploits that can circumvent signature-based tools that commonly identify and prevent known threats, and social engineering techniques designed to trick the unsuspecting user into divulging sensitive information or propagating attacks. These attacks are becoming increasingly automated with the use of botnets - compromised computers that can be remotely controlled by attackers to automatically launch attacks. Bots (short for robots) have become a key automation tool to speed the infection of vulnerable systems [Ahmad D. 2005, Chi S.-D. 2001, Gorodetski V. 2002, Knight J. 2002, Templeton S. 2000, Xiang Y. 2004].

RESEARCH OBJECT

Mission-critical information systems (MCIS) are understood as the electronic communication development objects, by means of which collection, processing, storage and transmission of information are performed with the purpose to ensure the handling processes. Their exceedance of allowable values may lead to the malfunction or their endamagement. Managing critical applications and infrastructures, or operating critical solutions, requires a secure and safe but flexible service to meet the specific business needs. The CIOs of enterprise should implement management controls to verify that system owners reporting, particularly on mission-critical systems,

are developing system contingency plans. Similarly, the Component CIOs should implement controls to ensure that system owners are conducting recurring tests of the systems plans.

RESULTS OF RESEARCH

The Distributed Denial of Service (DDoS) attacks against major Internet sites in 2009-2011 years highlighted the urgent need for improving the security of networks and systems connected to the Internet. According to statistics for 2011 [11], 89% of DDoS traffic was generated in 23 countries. The distribution of DDoS sources was fairly evenly spread among those countries, with each accounting for 3-5% of all DDoS traffic. Most attacks came from the US and Indonesia with each country accounting for 5% of all DDoS traffic. The US's leading position is down to the large number of computers in the country. Last year, US law enforcement authorities waged a successful anti-botnet campaign which led to the closure of a number of botnets. It is quite possible that cybercriminals will try to restore the lost botnet capacities and the number of DDoS attacks will increase. Meanwhile, the large number of infected computers in Indonesia means it also ranks highly in the DDoS traffic rating. In 2011, almost every second machine (48%) on the Indonesian segment of Kaspersky Security Network, Kaspersky Lab's globally-distributed threat monitoring network, was subjected to a local malware infection attempt. Such a high percentage of blocked local infection attempts is the result of a large number of unprotected computers being used to spread malware. Those countries responsible for less than 3% of all DDoS traffic included countries with high levels of computerization and IT security (Japan, Hong Kong, Singapore) as well as countries where the number of computers per person is significantly lower and antivirus protection is far from perfect (India, Vietnam, Oman, Egypt, the Philippines, etc.).

The decision of questions of complex maintenance of security and stability of functioning of the automated systems (AS) in the conditions of unauthorized access (UNA), including, influences of computer attacks, demands the system analysis and synthesis of possible variants of construction of means of counteraction UNA means. At complex formation it is necessary to co-ordinate and inter connect functions and parameters of the EXPERT, protection frames of the information from UNA, anti-virus means, gateway screens, the communication equipment, the general and special software and perspective means of counteraction to computer attacks.

In the aftermath of the DDoS attacks, security experts identified network intrusion detection as one of several technologies that can lead to improved network security. While intrusion detection processes alone cannot prevent or defend against security attacks, they can serve as a valuable source of information for security administrators about the types of activity attackers may be using against them. Network intrusion detection (NID) is the process of identifying network activity that can lead to the compromise of a security policy [Smirniy M., Lahno V., Petrov A., 2009].

Two primary forms of network intrusion detection systems (NIDS) exist: misuse detection and anomaly detection. Misuse detection relies on matching known patterns of hostile activity against databases of past attacks. Although they can be quite effective at identifying known attacks and their variants, misuse detection systems are generally unable to identify new security attacks and also require ongoing threat database updates in order to remain effective. Anomaly-based NID identifies malicious activity by applying statistical measures or artificial intelligence to compare current activity against historical knowledge of network utilization. Common problems with anomaly-based systems are that they often require extensive training data for artificial learning algorithms, and that expert systems quickly become overwhelmed with the number of rules required to identify all potential network threats Chowdhury M., 2004].

The Fuzzy Intrusion Recognition Engine (FIRE) is an anomaly-based intrusion detection system (IDS) that uses fuzzy systems to identify malicious network activity. The system combines simple network traffic metrics with fuzzy rules to determine the likelihood of specific or general network attacks. FIRE relies on fuzzy network traffic profiles as inputs to its rule sets. Although FIRE is not exclusively a network-based detection system, we will focus on network profiling for this paper. The FIRE goals are:

- To demonstrate how fuzzy systems can be used as an intrusion detection method.
- To identify which data sources that are the best inputs to the fuzzy intrusion detection system.
- To determine the best methods for representing network input data.

• To show how the system can be scaled to distributed intrusion detection involving multiple hosts and/or networks.

The first stage of modeling fuzzy knowledge bases consisting of the formation of expert information for the object model by constructing a knowledge base. This is the traditional fuzzy systems and does not guarantee the match and model desired result. The second stage required for tuning of fuzzy models through its learning from experimental data. Training model is the selection of parameters of membership functions by minimizing the difference between the experimental and theoretical data.

The data mining process effectively reduces the size of the data that needs to be retained for future comparisons. The NDP prepares counts and other statistical measures from the mined data and stores them to disk. Since FIRE is an anomaly detection system, the measures are chosen such that anomalies in network data can be ascertained easily. Typical summaries include [Lahno V., A. Petrov A., 2009]:

1. The number of total packets observed in the data collection interval.

2. The number of unique sdp's observed in the interval.

3. The number of sdp's that are new in this data collection interval.

4. The number of sdp's that are new in the longerterm data retention interval (i.e. have never been seen before).

5. The number of well-known ports used in an interval.

6. The variance of the count of packets seen against the sdp's.

7. The number of sdp's that include foreign hosts (hosts outside the local network domain).

8. The number of successfully established TCP connections in a time interval.

Analytical model of membership function of variable ϕ (ϕ - controlled input variables) to an arbitrary fuzzy term T can be expressed as

$$\mu^{T}(\phi)=\frac{1}{1+\left(\dfrac{\phi-\alpha}{\beta}\right)^{2}}, \qquad (1)$$

where: α - coordinate of the maximum function; β - the coefficient functions.

Function of the controlled parameter ϕ_i fuzzy set of values conducive to the realization of the j-th option, describe the function (S-Q)-type:

$$\mu_j(\phi_i)=\begin{cases} S\left(\dfrac{\phi_i-\overset{0\,j}{\phi_i}}{\varsigma_{ij}}\right), \phi_i \le \overset{0\,j}{\phi_i}, \\ Q\left(\dfrac{\phi_i-\overset{0\,j}{\phi_i}}{\xi_{ij}}\right), \phi_i > \overset{0\,j}{\phi_i}, \end{cases} \qquad (2)$$

where: S and Q arbitrary functions that do not grow on the set of positive real numbers, $\varsigma>0$, $\xi>0$ (Options ς and ξ are respectively the left and right fuzziness coefficients);

Membership function in terms of (S-Q) correlation functions will be described

$$\mu(\phi)=\begin{cases} \dfrac{1}{1+\left(\dfrac{\alpha-\phi}{\beta}\right)^{2}}, & \phi \le \alpha, \\ \dfrac{1}{1+\left(\dfrac{\phi-\alpha}{\beta}\right)^{2}}, & \phi > \alpha. \end{cases} \qquad (3)$$

FIRE consists of the three types of components: network data collector (NDC), network data processor (NDP), Fuzzy Threat Analyzer (FTA). The network data collector (NDC) is a promiscuous network data sniffer and recorder. It reads raw network packets off the wire and stores them on disk. The next component, the network data processor (NDP), summarizes and tabulates the raw packet data in carefully selected categories. In a sense, an NDP performs a kind of data mining on the collected packets. The NDP merges these summaries and tables with past data and stores them on disk. Next, the NDP compares the current data with the historical mined data to create values that reflect how the new data differs from what was observed in the past. These values are "fuzzified" to produce the fuzzy inputs needed by the Fuzzy Threat Analyzer (FTA). The resulting fuzzy inputs from the NDPs are called "fuzzy alerts" because they represent an alert condition to a degree.

Example list of factors that affect the productivity of information systems under the threat of DDoS attacks, presented in the form of linguistic variables, for which the selected set and universal terms. According constructed fuzzy knowledge base, representing a set of fuzzy rules "IF-THEN" that define the relationship between input and output variables. For fuzzy knowledge bases composed logical equation.

$$\mu^{d_j}(D) = \bigvee_{p=1}^{h_j}\left[\mu^{y_3^{jp}}(y_3) \wedge \mu^{y_4^{jp}}(y_4) \wedge \ldots \wedge \mu^{\phi_z^{jp}}(\phi_z)\right],$$
$$p = \overline{1, h_j}, j = \overline{1, U} \quad (4)$$

Once the NDP completes the data mining phase, it produces fuzzy sets based on past input data. FIRE uses the historical and statistical data for each element of matrix (5) [Lahno V., A. Petrov A., 2011]. We have arbitrarily chosen five fuzzy sets for each data element: *low*, *medium-low*, *medium, medium-high*, and *high* (table 1). By standardizing the number of sets, we can apply the same fuzzy rules against the data from each NDP, regardless of the differences in the local input domain.

$$H = \begin{pmatrix} \phi_{11} & \phi_{12} & \ldots & \phi_{1i} & \ldots & \phi_{1n} \\ \phi_{21} & \phi_{22} & \ldots & \phi_{2i} & \ldots & \phi_{2n} \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ \phi_{l1} & \phi_{l2} & \ldots & \phi_{li} & \ldots & \phi_{ln} \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ \phi_{N1} & \phi_{N2} & \ldots & \phi_{Ni} & \ldots & \phi_{Nn} \end{pmatrix}. \quad (5)$$

In a common intrusion scenario, an attacker conducts a port scan of a network, sending packets to several well-known ports (FTP, HTTP, etc.) looking for systems that might be running those services. The presence of those services on a system gives a hint as to what vulnerabilities the attacker might try to exploit to penetrate the system. Additionally, the attacker may use scanners that can accurately identify the operating system on the target machine by examining the response of the TCP stack to carefully crafted TCP control messages. Knowledge of the services running and the host operating system is extremely valuable to the attacker because it helps to narrow the types of vulnerabilities the attacker can exploit on the systems. Port and operating system detection scanning may be a strong indicator that a more serious attack may be occurring in the future.

With the fuzzy input sets defined, the security administrator can then construct the rules of the fuzzy system. Fuzzy rules are written using common sense experiences by the security administrator. The rules designer seeks to define rules that cover as much of the input space as possible Using tools such as the Matlab Fuzzy Toolbox, the designer can check the input rule space to ensure that the fuzzy rules cover the input space and that all output responses are defined, figure 1.

Table 1. Factors affecting the productivity of information systems for DDoS and DoS attacks

A partial state variable of the information system and Network	**Universum**	Terms for linguistic assessment
ϕ_1 – indicator of current risks [10]	[0,1], arbitrary units (A.U.).	*low*, *medium-low*, *medium, medium-high*, and *high*
ϕ_2 – acceptable level of risk information	[0,1], A.U.	-
ϕ_3 – intensity of flow rate (requests) coming to servers	[10,6000], frame / s	-
ϕ_4 – nominal capacity of the environment data	[10,100], Mbit / s	-
ϕ_5 – number of attempts to access to environmental data generated by an attacker to view	$[0, N_a]$	-
ϕ_6 – the service transaction	[0,001-0,01], s	-
ϕ_7 – IP pcket length	[1 -65529], byte	-
ϕ_8 – large number of IP packets with the type of attack Ping of Death	[0,1], A.U.	-
ϕ_9 – number of http-requests to the object of attack	[0,1], A.U.	-
ϕ_{10} – presence of TCP packets	[0,1], A.U.	-
ϕ_{11} – presence of UDP packets	[0,1], A.U.	-
ϕ_{12} – presence of ICMP packets	[0,1], A.U.	-
ϕ_{13} – availability of SQL injection	[0,1], A.U.	-
ϕ_{14} - interval between frames	[10-100], bit	-
…		-
ϕ_z - other factors		-

This algorithm was implemented in Delphi. Fig. 2 shows a general view of the application. We have implemented the graphs attack in a combination of Prolog and Delphi, fig. 2. Experimental results show that our logical attack graph tool is very efficient and can handle networks with thousands of machines.

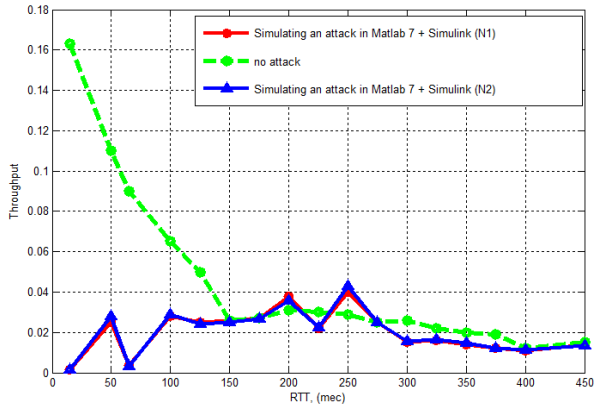

Fig 1. Dos Inter-burst Period

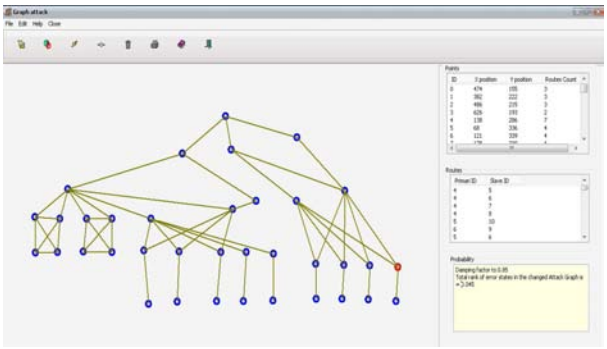

Fig. 2. Comparison in Delphi Network Attack Graphs

We show screenshots of a few examples of Network Attack Graphs. States in the graph have been ranked according to the ranking algorithm based on PageRank. We set the damping factor to 0.85. For each error state, the intensity of color is proportional to the relative rank of that state in the Attack Graph. The security metric based on the total rank of error states is a quantitative guide for comparing Attack Graphs. A system administrator could fix a particular security property, make changes to his network configuration and compare the Attack Graphs obtained using this security metric. Thus, he can determine the relative utility of different security measures. He could also fix the system model and observe changes in the ranks of the Attack Graph based on varying the security property from a weak to a strong one.

CONCLUSIONS

Hence, the applicability of the autonomous and profound research of the issues of designing new mathematical models for the estimation of the automated data processing systems (ADPS) security is conditioned by the following factors:

- obviousness and operativeness of making multialternative solutions on the ADPS security;
- presence of possibilities to check the semantic relations and ADPS compatibility, data protection facilities and attack countering;
- variety of forms and methods of detailed evaluation of attack graphs (scenarios) on ADPS and countering to them;
- imbedded facilities of the a priori processing of subject and object «roles» in the future processes of ADPS functioning under attacks.

However the practical utilization of the offered mathematical attack models requires solution of the issues of designing the sophisticated mathematical software for prevention of attack scenarios, and also developing the science-intensive program-, information - and communication facilities.

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ИНФОРМАЦИОННАЯ БЕЗОПАСНОСТЬ КОМПАНИИ ПРИ DOS (DDOS) АТАКЕ

Валерий Лахно

Аннотация. Статья содержит результаты исследований, позволяющие повысить уровень защиты автоматизированных и интеллектуальных информационных систем предприятий и компаний. В статье предложена модель системы поддержки принятия решений в случае выявления DoS (DDoS) атаки для варианта нечеткой входной информации.

Ключевые слова: информационная безопасность, атака типа отказ в обслуживании, система поддержки принятия решений.

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DATABASE OF HAZARDOUS SUBSTANCES PROPERTIES

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S u m m a r y. The paper presents the structure of the database and methods for determining the necessary parameters of the properties of substances used for modeling the consequences of accidents at high-risk enterprises. The formulas for the approximation functions of thermophysical parameters and methods for obtaining the coefficients for them, as well as the formulas and methods for obtaining the coefficients for the specific characteristics of the dangers of flammable, toxic substances.

K e y w o r d s : database, properties of hazardous substances, fires, poisoning, explosions, thermal parameters.

INTRODUCTION

In evaluating the quantitative indicators of potential hazards of industrial facilities, the technology which treated hazardous substances or dangerous processes are present, by means of mathematical modeling, are used as input data, some thermophysical properties of substances and their specific parameters. Most often, these processes are modeled as explosions, fires, the spread of toxic pollutants in the atmosphere and, consequently, the impact on people, materials and equipment of the thermal radiation of shock-wave loading, toxic load, obtained by inhalation [Granovsky E. 1999, Lyfar V. 2000]. Need a database of operational and technical characteristics of equipment, technologies, substances and materials for information technology to manage technological risk. When filling the database, you must have a reliable method of obtaining quantitative factors and the appropriate fields and tables, as well as methods for determining the reliability of equipment in operation for which do the assessment of risk.

RESEARCH OBJECT

This article presents the structure of the input data required for modeling of hazardous industrial processes, methods for obtaining the coefficients of the properties of substances and properties of the operating and technical facilities and equipment.

RESULTS OF RESEARCH

Database of hazards must include the following tables:

Breakthrough (breaking properties of the metal), containing the name of the material density and tensile strength;

Construction (design, structure) that contains the name that uniquely characterizes an object undergoing shock-wave loads, the limit values of the shock wave for various degrees of damage;

Elements (substances), containing indices and ratios properties of hazardous substances (for details see below);

Inflammability (combustible materials), containing the name of the material and the factors that determine the ignition when exposed to thermal radiation;

SurfaceBase (the underlying surface), containing the name, material density, specific heat and thermal conductivity of the soil;

Auxiliary tables and connection requests.

The main properties of the dangerous properties of substances table «Elements».

Table «Materials» must contain field:

- lngCASNumberID – integer CAS number;
- Name - CAS name, English (LANG-09,SUBLANG-01) name of the substance in English. It is possible to add fields that contain names in other languages

Table «Property» must contain field:

- lngCASNumberID – CAS number, synchronized with the table «Materials»
- intEFT – integer value, confirming or denying the identity of the substance of an explosive, flammable, toxic.
- dblMW – M - molecular weight, g / mol.
- dblCrtclTemp – K_c - the critical temperature, ^{o}K.
- dblCrtclPress – P_c - critical pressure, Pa.
- dblCrtclVol - V_c - critical volume, liter / mole.
- dblNrmlBoilingPnt - T_b - boiling temperature of liquid at normal pressure (1 atm), ^{o}K.

Several parameters are a function of temperature. The following lists the main parameters and formulas to determine them. Proposed to use the widely used formula DIPPR [6-10].

Liquid density is proposed by the following formulas:

$$\rho_{100}(T) = A + B \cdot T + C \cdot T^2 + D \cdot T^3 + E \cdot T^4 \quad (1)$$

$$\rho_{105}(T) = \frac{A}{B^{1+\left(1-\frac{T}{C}\right)^{D}}} \quad (2)$$

$$\rho 116(T) = A + B \cdot \tau(T)^{0.35} + C \cdot \tau(T)^{\frac{2}{3}} + D \cdot \tau(T) + E \cdot \tau(T)^{\frac{4}{3}}, \quad (3)$$

where: the $\tau(T) = 1 - \frac{T}{T_c}$

The viscosity of vapor:

$$\eta_{102}(T) = \frac{A \cdot T^B}{1 + \frac{C}{T} + \frac{D}{T^2}} \quad (4)$$

Saturated vapor pressure:

$$P_{101}(T) = exp\left(A + \frac{B}{T} + C \cdot ln(T) + D \cdot T^E\right) \quad (5)$$

The heat capacity of liquid:

$$c_{p100}(T) = A + B \cdot T + C \cdot T^2 + D \cdot T^3 + E \cdot T^4 \quad (6)$$

$$c_{p114}(T) = \frac{A^2}{\tau} + B - 2 \cdot A \cdot C \cdot \tau - A \cdot D \cdot \tau^2 - \left(\frac{C^2 \cdot \tau^3}{3} + \frac{C \cdot D \cdot \tau^4}{2} + \frac{D^2 \cdot \tau^5}{5}\right) \quad (7)$$

The specific heat of gas:

$$c_{p107}(T) = A + B \cdot \left[\frac{C/T}{sinh(C/T)}\right]^2 + D \cdot \left[\frac{E/T}{cosh(E/T)}\right]^2 \quad (8)$$

The evaporation heat:

$$H_{106}(T) = A\left(1 - \frac{T}{Tc}\right)^{B + C\cdot\left(\frac{T}{Tc}\right) + D\cdot\left(\frac{T}{Tc}\right)^2 + E\cdot\left(\frac{T}{Tc}\right)^3} \quad (9)$$

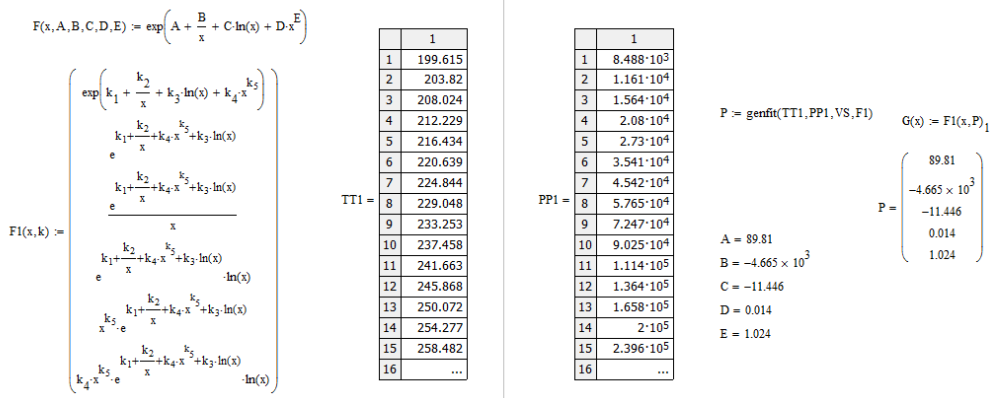
In all cases, the coefficients of the type:

dbl#Par#A – field of the coefficient A
dbl#Par#B – field of the coefficient B
dbl#Par#C – field of the coefficient C
dbl#Par#D – field of the coefficient D
dbl#Par#E – field of the coefficient E

dbl#Par#TMin - $T_{\min}$ - minimum temperature of applications, K

dbl#Par#TMax - $T_{\max}$ - minimum temperature of applications, K

For these factors we propose a method common nonlinear regression, well implemented in the environment Mathcad. For example, in fig. 1 and fig. 2 shows a method for determining the regression coefficients for the dependence of the saturated vapor pressure of ammonia on the temperature:



	1
1	199.615
2	203.82
3	208.024
4	212.229
5	216.434
6	220.639
7	224.844
8	229.048
9	233.253
10	237.458
11	241.663
12	245.868
13	250.072
14	254.277
15	258.482
16	...

	1
1	$8.488 \cdot 10^3$
2	$1.161 \cdot 10^4$
3	$1.564 \cdot 10^4$
4	$2.08 \cdot 10^4$
5	$2.73 \cdot 10^4$
6	$3.541 \cdot 10^4$
7	$4.542 \cdot 10^4$
8	$5.765 \cdot 10^4$
9	$7.247 \cdot 10^4$
10	$9.025 \cdot 10^4$
11	$1.114 \cdot 10^5$
12	$1.364 \cdot 10^5$
13	$1.658 \cdot 10^5$
14	$2 \cdot 10^5$
15	$2.396 \cdot 10^5$
16	...

Fig. 1. Obtaining regression coefficients using the function "genfit" an array of experimental data <TT1,PP1>

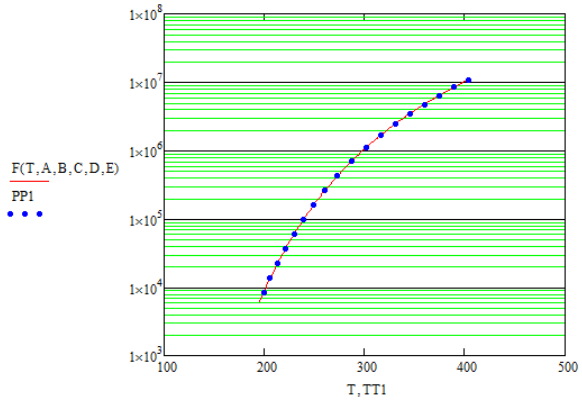


Fig. 2. The dependence of the saturated vapor pressure on temperature for ammonia obtained on the basis of regression coefficients.

For other formulas describing the properties of the elements used a similar method of nonlinear regression with the representation of the function F1 (x, k) array of derivatives with respect to the corresponding coefficients.

For determine the toxic effects of inhalation exposure to hazardous impurities at its dispersion in the atmosphere is proposed to use the probit-dependence [14,18,19,21,22]:

$$Pr = a + b\,ln(\int_{t_b}^{t_e} c(t)^n dt) \qquad (10)$$

where: the coefficients a, b, n may be obtained by this study [20] by a simple solution in the form:

$$b = \frac{2.327}{ln(SD) - ln(ST)} \qquad (11)$$

$$a = 2.673 - b * ln(ST) \qquad (12)$$

where: the SD and ST - the toxic load values obtained experimentally for a 50% response and 1% mortality, respectively.

In addition, to determine the probability of failure of equipment need to know: λ_a – the average flow rate of failures of equipment (instrument, device) $T_a = \left(\sum_{i=1}^{N} T_i\right) / N;\ \lambda_a = 1/T_a$, где T_i – actually worked time in the period i; N – number of failures that occurred during testing (periods of work). In this case: $P(t) = 1 - exp(-\lambda_a t)$ - probability of failure for the period t.

Information on the reliability of the equipment may be given in the technical documentation, scientific and technical literature, reports on the study of reliability.

When processing reliability are determined λ_a, $P(t)$, and confidence limits of reliability with confidence α=0,9.

Typically, the probability of failure within one year (8760 hours), but the period of normalization can be driven to the required uptime and other values determined by the expert.

In this summary are the performance the upper limit of probability of failure $P_u(t)$, the mean value $P(t)$ and lower limit $P_l(t)$. The range between the lower and upper bound of the probability of failure is uncertain.

Value of the confidence limits of estimates are determined using the coefficients given in tables [5] r1, r3, r0 of exponential distribution.

The coefficients r1, r3 is determined depending on the number of failures recorded during the observation period T (actual hours worked). $\lambda_u = \lambda_a / r_3$ - the frequency of the upper confidence interval. $\lambda_l = \lambda_a / r_1$ - the frequency of the lower confidence interval.

If during the period of observation is not found a single failure, that is determined only by the upper value $\lambda_u = \lambda_a / r_0$. For these values are determined by the probability of failure. It is recommended to collect operational data on equipment during the period of operation. Collection of operational information is held on a particular company-specific installation and is to find data on the actual operating time of a particular unit of this type of equipment and number of failures during the observation period. Sources of information on the production of: the repair journal, journal of submission (admission) in the repair of equipment (of repair); report to the head of department or responsible for the equipment, the test report on reliability, passport of equipment.

CONCLUSIONS

The database describe of the structure is designed and can be used for the creation and operation of the base in the field of information technology risk management of man-made objects

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БАЗА ДАННЫХ ОПАСНЫХ СВОЙСТВ ВЕЩЕСТВ

Владимир Лыфарь

Аннотация. В статье предлагается структура базы данных и методы определения необходимых параметров свойств веществ, используемых для моделирования последствий аварий на предприятиях повышенной опасности. Предложены формулы для аппроксимации функций теплофизических параметров и методы получения коэффициентов для них, а также формулы и методы получения коэффициентов для специфических характеристик опасности горючих, токсичных веществ.

Ключевые слова: база данных, свойства опасных веществ, пожары, отравления, взрывы, теплофизические параметры.

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INVESTIGATION OF THE INFLUENCE OF CATASTROPHES ON HUMAN VITAL ACTIVITY

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S u m m a r y. The analysis of the sources of catastrophes taking place on the Earth and influencing human vital activity has been done in this article.
K e y w o r d s: human vital activity, source, catastrophe, magnetic fields.

INTRODUCTION

The transformation of modern civilization, in which the motive forces are represented by technologies and plenty of people, has reached its technological limit. According to the estimations of the experts, specializing in the field of safety of human vital activity people live beyond their means. Annually we consume a great amount of hydrocarbons for the creation of which nature required more than 2 mln. years. Some years ago the boundary, when people began to extract more than 1/3 of the total quantity of oil on the shelf and from ocean depths, was overcome. Brazilian and American companies started sea drilling at a depth of 2,5 km.

Scientific thought of the XXI century hasn't solved the problem of producing the required quantity of cheap pure energy and its effective accumulation yet. The obvious illustration of present world crisis is the rise of prices for oil from 7 up to 140 dollars per barrel in the period of 2005-2012 years. Just the same situation arouse in the production of food-stuffs in the economic development of many developed countries, the global problems of civilization became sharp.

At present it became evident that the former path of mankind development is not acceptable. Mankind development has always been accompanied by global problems. For example, one of them is the hyperbolic increase of population (the number of people on the Planet ran to more than 7mlrd.inhabitants up to the period of 01.03.2012).

Mankind and science faced a very complicated choice: the condition of resources, biosphere make civilization renew or radically change a whole set of life-sustaining technologies (energetics, production of food-stuffs, transport infrastructure, society governing, etc.) in a short period of time (15 – 20 years).

In the 20-th century there happened an earthquake which took away more than 1 mln. lives. The disastrous earthquake in the Indian Ocean resulted in tsunami that took away more than 300,000 lives.

The analysis of the history of the XX century catastrophes reveals the fact that gigantic natural calamities and shattering technogenic catastrophes had usually had their forerunners – disasters of the same type developing in accordance with similar scenario, but of much smaller scale. The countries which could appreciate their meaning and significance and also take all the necessary measures, avoided tragic events.

RESEARCH OBJECT

The analysis of the factors, leading to catastrophes and influencing human vital activity.

RESULTS OF EXPERIMENTAL RESEARCH

There always exist the sources of the origin of all natural catastrophes, connected with prolonged accumulation and sudden release of energy. Taking into account the results of the studies of scientific works and researches [Leibacher G. 1985, Mezherin V.A. 2004, Turchin A.V. 2010, Grigoriev A.A. 1991, Sheidegger A.E. 1981, Alexeyev N.A. 1988, Budyko M.I. 1986, Stephen J. 2005] the authors of this article believe, that there are a lot of various factors which can lead to the emergence of global natural cataclysms on the Earth. At present these factors may be classified as:

- falling asteroids that are able to cause eruptions of volcanoes, global technogenic accidents, catastrophes or at worst – perdition of the whole biological mass;
- sun flashes;
- reversal replacement of the Earth magnetic poles;
- gamma-splashes from distant outer space.

Falling asteroids and comets is being considered as one of the possible causes of modern civilization extinction in the works [Mezherin V.A. 2004, Turchin A.V. 2010].

Fallen asteroid, that provoked dinosaurs' dying out, was up to 10 km in diameter [Turchin A.V. 2010].

At present the supposed collision of asteroid Apofis with the Earth in 2029 is evaluated as probability equal to 0,001 and, most of all, can't destroy mankind [Turchin A.V. 2010].

The size of asteroid is about 400 m, supposed energy of explosion is up to 800 megatons, probable place of falling is the Pacific Ocean and Mexico [Turchin A.V. 2010]. Nevertheless, asteroid would bring to tzunami, equal to Indonesian one in 2004 (only 1% of earthquake energy turns into tzunami, and earthquake energy is evaluated as equal to 30 gigatons) throughout the Pacific Ocean. Such energy could lead to considerable demolitions.

As a guide, it may be considered, that the destruction zone in the course of asteroid's falling is increasing proportional to the root of the 4-th power of explosion force, and each ton of mass produces about 100 tons of trotyl energy equivalent, depending on the speed of the collision - typically a few tons of kilometers per second. The stony asteroid with the volume of $1km^3$ will emit energy of 300 gigatons. Taking into consideration the fact that the destruction radius is decreasing in proportion to the fourth power of destruction force, it's possible to suppose that it will be 230km, but it will make up 1300km for asteroid with 10 km destruction radius. The real meaning of the diameter of asteroid capable of destroying all living beings on the Planet, has been calculated by Pustynsky and makes up 60 km [Turchin A.V. 2010].

The scenario of intensive Earth bombardment by a great number of splinters is more dangerous. These splinters can appear:

- as a result of some cosmic body disintergration, splitting a comet into a stream of splinters (Tungus meteorite might have been one of the fragments of Enke comet);
- as a result of collision of a large asteroid or a comet with the Moon [Turchin A.V. 2010].

Many comets consist of splinter clusters which can fall to thousands of pieces in the atmosphere even at the initial stage.

Dinosaurs were not the undoings by asteroid blow against the Earth. Very likely, it happened due to the subsequent effect – «asteroid winter» during asteroid collision at a distance of 400 mln.km from the Earth [Turchin A.V. 2010].

Falling cosmic bodies onto the Earth, and also into a thin section of the earth crust or into the lid of a volcano's magmatic caldron may provoke eruptions of supervolcanoes, the total number of which runs nearly to 60. Iron rocks, formed and melt in the time of falling iron asteroid, may play the role of «Stivenson's probe» - that is, to fuse the earth crust robe resulting in forming canal in the entrails of the earth. It is fraught with tremendous volcano's activity. Falling large asteroid will provoke a world earthquake, in the first place being dangerous for modern technogenic civilization by developing secondary destructive factors.

Throughout the whole historic way of its development society itself created conditions for the emergence of global technogenic accidents and catastrophes in the form of the consequences of nuclear weapon tests and space exploration; numerous transport and industrial accidents in the Indian city of Bhopal; Chernobyl tragedy; the accident having been taken place at the nuclear power station Fukusima-1, that have already resulted in global biosphere crisis.

The collision of cosmic bodies with the Earth may lead to the emergence of electromagnetic impulse, comparing with the same one during the atomic bomb explosion owing to the fast plasma motion. It'll result in an enormous chemical pollution of the whole atmosphere (the latter being a powerful factor of influences'

diffusion) even if by means of nitric oxides, which, in their turn, lead to forming rains out from a nitric acid; atmosphere dust obstruction, thus creating conditions for nuclear winter.

The probability of volcano's catastrophe, comparing with asteroid one, according to different estimations, is from 5 to 20 times greater at the same energy level. Volcano's activity, beginning from 2010 year is increasing intensively at a fast rate.

Sun flashes and increasing Sun shining have an influence not only on all biological objects on the Earth, but also on changing its climate. Granular structure called granulation, is characteristic for Sun's surface. It is constantly changing. This fact is indicative of gas circulation, comprising tens of thousands kilometers in depth and becomes apparent on considerable surface sections (active fields). Sun – spots, the emergence of which correlates with Sun activity, are connected with active fields [Mezherin V.A. 2004].

At present the process of burning down hydrogen is taking place in the Sun's central part. There exist suggestions,that the Sun shining, non-stability of its burning and accumulation of helium will be increasing in the course of this process [Leibacher G. 1985]. Modelling calculations, which have been carried out, [Mezherin V.A. 2004, Turchin A.V. 2010] show, that practically nothing will be changed in the nearest 5 mlrd. years. The Sun will be gradually moving along its path, its shining will be constantly growing, the temperature on its surface will firstly increase a bit, and then it'll be slowly going down. But all these changes won't be great. In order to break off the existence of all living beings on the Earth, it is quite enough for the Sun to be warmed up more than by 10% in the period of 100 years. It might have increased the temperature on the Earth by 10 – 20 degrees without any greenhouse effect. At present the sun is on the ascending secular trend of its activity, delivering about 1000 gigatons (10^{22} joules) of luminous energy to the Earth in the period of 24 hours, which isn't dangerous for all living beings on the Earth.

From time to time monstrous - sized whirlwinds, analogous on their scale to the eruptions of supervolcanoes on the Earth, are generated on the Sun, throwing out enormous quantities of substances and energy (fig. 1). In the XIX century there happened a flash 5 times as strong as the most powerful flashes of the XX century. In 1972 a flash with the emission of luminous energy, equal to $2 \cdot 10^{15}$ tons, was registered. At the same time there happened throwing out the cloud with the mass of more than 1mln.tons which exceeded the Earth in its size. The cloud escaped the entrails of the Sun at a speed of about 1000 km/sec [Mezherin V.A. 2004]. In 1989 the part of throwing out Sun radiation came to the Earth which, in its turn, resulted in the breach of operation of energy supply systems - the Province of Quebec in Canada was disconnected within 7 seconds.

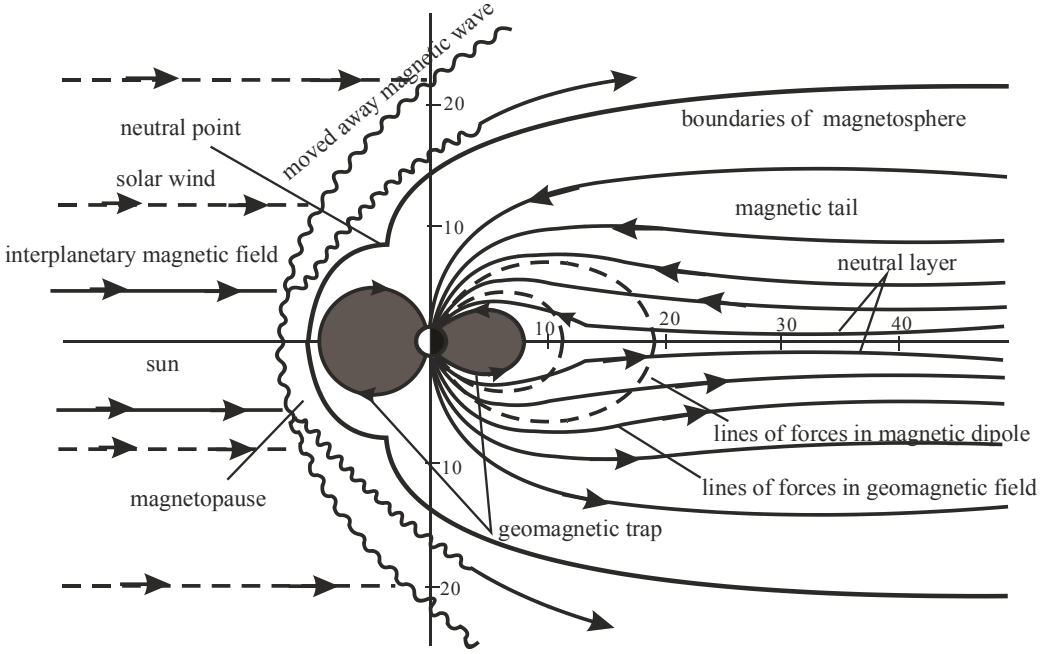

Fig.1. The Earth's magnetosphere in meridional section

Physical characteristics of the Sun, the processes, taking place in the period of its activity, cause great changes in the whole physical and organic world of our Planet, call forth magnetic storms and affect condition of a practically healthy person. The first person's reactions to magnetic perturbations become already apparent in 8 – 10 minutes after the beginning of the storm [Turchin A.V. 2010, Gordiyenko V.A. 2006].

The stream of charged particles is constantly flying from the Sun to the Earth or, as it is said, «solar wind is blowing» (fig. 2). . Flying up to the Earth, the particles interact with the Earth magnetic field. The lines of forces of geomagnetic field change in form under the pressure of flying particles, sag, as if elastic steel strips in the form of the geomagnetic field lines of forces would sag under the pressure of real wind. From the Sun's part magnetic field turns out to be squeezed, from the night part, a train, consisting of stretched lines of forces, is formed. The length of the train is 80 times as large as the radius of the Earth. Lines of forces, forming the train, are vibrating. A person perceives these vibrations as a part of short – periodic variations of the Earth magnetic field. A great number of particles, especially the fastest ones, are caught by the lines of forces, that is, the particles start moving along the lines of forces from one magnetic pole to another. The layers, in which a lot of particles, flown from the Sun assemble, are formed above the Earth. These layers enclose the Earth from new streams of solar particles, shield it from sun radiation.

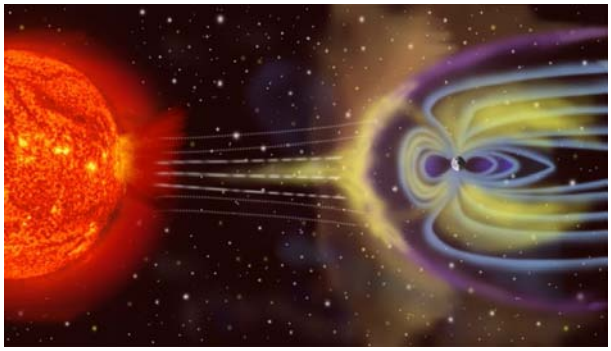

Fig. 2. Diagram of solar wind interaction with the Earth's magnetosphere

Most of people don't respond to a quiet geomagnetic situation, but they respond to magnetic storms in the same manner and on a mass scale (up to 75% of population of the globe) [Leibacher G. 1985, Gordiyenko V.A. 2006]. Each manifestation of Sun activity results in about 2 thousand of deaths in industrially developed countries [Turchin A.V. 2010]. The most negative influence of magnetic storms becomes apparent on the Earth poles and in ecologically contaminated zones.

The storms have 11 – year cyclic recurrence (coinciding with the cyclic recurrence of Sun activity) [Mezherin V.A. 2004].

Magnetic perturbations, comprising the Earth, are accompanied by the intensification of polar lights intensity, change of the height and density of ionized layers, resulting in reversal changing Earth magnetic field.

Earth magnetic poles don't coincide with geographical ones. Nowadays, the South magnetic pole of the Earth is situated close by northern borders of Canada, between the Islands Melwill and Devon, at the point with co – ordinates of latitude 77^0 North and longitude 102^0 West. North magnetic pole is situated close by the southern geographical pole at the Antarctica's end, at the point with co – ordinates of latitude 66^0 South and longitude 140^0 East [Grigoriyev V.M. 1973]. Earth magnetic poles aren't situated at the diametrically opposite points of the globe, the magnetic axis doesn't only coincide with the axis of the earth's revolution, but also doesn't pass through its centre (fig.3). The magnitude of geomagnetic field at the poles is about 2 times as large as at the equator, it being known, that the magnitude of geomagnetic field at the North Pole is a bit larger than at the South Pole [Leibacher G. 1985].

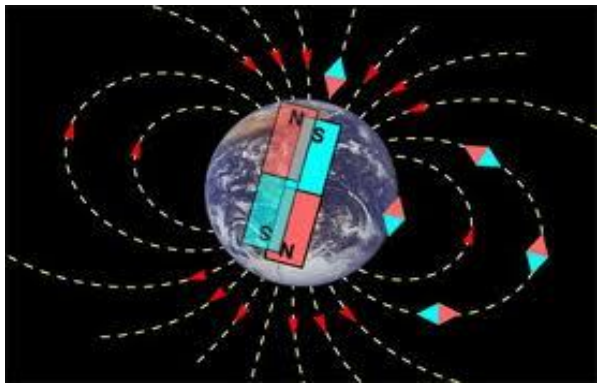

Fig. 3. The replacement of the Earth magnetic poles

Magnetic field inversion in itself won't lead to people's dying out, because reversal poles' replacement repeatedly occurred in the past without appreciable harm. The simultaneous combination of three unfavourable factors – the incidence of the Earth magnetic pole (poles may appear at the equator) to zero, the ozone layer exhaustion and gigantic sun flash, the coronary throwing out of which will be directed to the Earth,

may result in the intensive radiation affection of all biological objects on the Earth or the complete destruction of all electronic systems just as it took place in the Province of Quebec in Canada in 1989 [Vladimirskiy B.M. 1971, Kuznetsov A.M. 1994, Tornuyev U.V. 1980, Isayev L.K. 1997, Holodov U.A. 1975].

Gamma – splashes (short intensive streams of gamma – radiation, coming in the form of narrow fascicles from outer space) – *distant, near and soft* might have caused ozone layer destruction and even atmosphere ionization [Vladimirskiy B.M. 1971]. Evaluating risk of the influence of near gamma – flashes, Boris Stern supposes, that gamma – splash in Our Galaxy takes place once in a million years on the average. The gamma –splash of such hypernew star as *WR* 104, situated at about 7000 light years from the Earth, which axis is turned almost in the direction of our Planet, may cause ozone layer destruction on the half of the Earth. It is very likely that gamma – splash happened to be one of the causes of Ordovick's dying out 443 mln. years ago, resulted in the death of 60% species of living beings. In authors' opinon, [Gordiyenko V.A. 2006, V. Maletkin, L. Maletkina, O. Druz 2010] gamma – splashes have a considerable influence on the Earth's biosphere approximately every five million years [Mezherin V.A. 2004].

Soft gamma – splashes are connected with catastrophic processes on special neutron stars – magnitars. So, on the 27th of August 1998, a flash on the magnitar, situated at a distance of 20,000 light years, led to the immediate reducing the height of the Earth's ionosphere by 30 km [Turchin A.V. 2010].

Even *a distant gamma – splash* or another highly – energetic cosmic event may be dangerous by the Earth's radiation affection both by means of direct emanation, which is blocked, to a considerable extent, by the atmosphere, and due to the formation of radioactive atoms in the atmosphere. Gamma – emanation leads to atmosphere nitrogen oxidation resulted in the formation of an opaque poisonous gas – nitrogen dioxide. The latter may block sunlight in atmosphere upper layers and lead to a new glacial epoch.

The danger of any gamma – splash lies in its suddenness. It begins without any warning from invisible sources, spreads at a velocity of light, can hit only one Earth's hemisphere, because it lasts not more than one minute.

The sources, having been examined in this article and capable of provoking cataclysms on the Earth, exert influence on the objects of animate and inanimate nature through their interaction with the bodies and objects surrounding them.

CONCLUSIONS

1. The most probable sources capable of provoking nature cataclysms and technogenic accidents, are the following:
   - large – scale mishaps and anthropogenic activity of a person;
   - collisions of cosmic bodies with a diameter of 10 km and more;
   - sun flashes and increasing the shining;
   - gamma – splashes (intensive streams of gamma – emanation, coming from distant outer space);
   - processes in the Earth's nucleus that are unknown in science.
2. The moment of the beginning person's stressful reaction to magnetic storms may be shifted for various terms concerning the beginning and depends upon an individual man.
3. Further investigations of the influence of magnetic storms on safety of human vital activity are necessary for surviving of humanity on the planet Earth while prognosing Sun's activity in the period of 2011…2015 years.

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ИССЛЕДОВАНИЕ ВЛИЯНИЯ КАТАСТРОФ НА ЖИЗНЕДЕЯТЕЛЬНОСТЬ ЧЕЛОВЕКА

Валерий Малеткин, Олег Друзь,
Людмила Малеткина

Аннотация. В данной статье проведен анализ источников катастроф, происходящих на планете и их влияние на жизнедеятельность человека.
Ключевые слова: жизнедеятельность человека, источник, катастрофа, магнитные поля.

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THE CALCULATION METHOD OF SMALL-SIZED COMPOSITE ENCLOSURES IN CAD/CAE SYSTEMS

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S u m m a r y. This article is about the possibility of calculating of the small enclosures made of composite materials in CAD/CAE systems. The initial data for calculating consists of the fiber and matrix elastic constants and the fiber volume content in the composite. The stress-strain state has been obtained. The enclosure was loaded with the internal pressure.

K e y w o r d s: composite, heterogeneous model, homogeneous model, physico-mechanical properties, stress tensor, transversally isotropic body.

INTRODUCTION

New materials gain large scales in a world where science and technology develop rapidly. They are used in various fields. It concerns space and aircraft. Composite materials can be attributed to this. They are more durable to the traditional construction materials and alloys. Thus, there is a need for analysis of structures and their components made of composite materials in the CAD / CAE systems [3-10, 19-21].

Most of strength calculations use homogeneous (isotropic) materials. Their properties are independent of their spatial position in a coordinate system. The another approach is required for calculating of the CM [14-17].

The purpose of the article is to develop a calculation methods of small enclosures made of composite materials (CM). This can be performed with the help of a modern CAD / CAE systems (particularly in the software package ANSYS).

OBJECTS AND PROBLEMS

The heterogeneous model is one of the major models made of composite materials, which are used for durability and design analysis of structures [1, 2].

The heterogeneous composite model is based on the notion of isotropic material as the reinforcing fibers with their idealized interaction fig. 1. They can be ordered or randomly placed in the isotropic matrix. The fibers are usually parallel to each other.

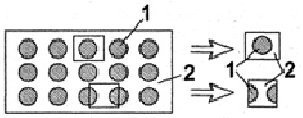

Fig. 1. The heterogeneous composite model: 1 - fiber, 2 - matrix

Thus, the physical and mechanical properties of the matrix and the fibers and their volume fraction in the CM are needed to know for the calculation of monolayer element of the unidirectional CM.

The elastic constants of the matrix and fibers are generally initially known while the manufacturing of the products made from CM. Their volume content in the CM is also known. It is necessary to move from the elastic constants of the composite elements to the composite constants for calculating the CM in CAD / CAE systems [11-13, 18].

The elastic constants are calculated by a certain law for the unidirectional composite. It depends on the direction of fibers. Relatively speaking, the direction along fiber is for1, and across the fiber is for 2. The along-the-fibers elastic modulus is calculated by the formula [1]:

$$E_1 = E_B \cdot \Theta + E_M \cdot (1-\Theta), \quad (1)$$

where: $E_в$– elastic modulus of the fibers;

Θ– fiber volume content;

$E_м$– elastic modulus of the matrix.

The across-the-fibers elastic modulus is calculated by the formula:

$$E_2 = \frac{E_B \cdot E_M \left[E_B \cdot \Theta + E_M \cdot (1-\Theta)\right]}{\left[E_B \cdot \Theta + E_M \cdot (1-\Theta)\right] \cdot \left[E_M \cdot \Theta + E_B \cdot (1-\Theta)\right] - \Theta \cdot (1-\Theta) \cdot \left(E_B \cdot \mu_M - E_M \cdot \mu_B\right)^2}. \quad (2)$$

The along-the-fibers Poisson's ratio of the composite is calculated by the formula:

$$\mu_{12} = \mu_B \cdot \Theta + \mu_M \cdot (1-\Theta), \quad (3)$$

where:$\mu_в$ – Poisson's ratio of the fiber;

$\mu_м$ – Poisson's ratio of the matrix.

The across-the-fibers Poisson's ratio of the composite is calculated by the formula:

$$\mu_{21} = \frac{E_B \cdot E_M \cdot \left[\mu_B \cdot \Theta + \mu_M \cdot (1-\Theta)\right]}{\left[E_B \cdot \Theta + E_M \cdot (1-\Theta)\right] \cdot \left[E_M \cdot \Theta + E_B \cdot (1-\Theta)\right] - \Theta \cdot (1-\Theta) \cdot \left(E_B \cdot \mu_M - E_M \cdot \mu_B\right)^2}. \quad (4)$$

The shear modulus in the plane of isotropy depends on the elastic modulus and Poisson's ratio. It is found by the formula [1-5]:

$$G_{ij} = \frac{E_i}{2 \cdot (1+\mu_{ij})}, \quad (5)$$

where:E_i– i-direction elastic modulus;

μ_{ij} – j-direction Poisson's ratios while loading in the direction of " i ".

The shear modulus in the any plane perpendicular to the plane of isotropy is taken as the average of the shear modulus is calculated on the basis of equality of shear deformation and shear modulus calculated on the basis of equality of shear stresses is found by the formula [1]:

$$G_{12} = \frac{G_{12}^{Д} + G_{12}^{Н}}{2}, \quad (6)$$

where: $G_{12}^{Д}$ – shear modulus of equality of shear deformation;

$G_{12}^{Н}$– shear modulus of equality of shear stresses;

$$G_{12}^{Д} = G_B \cdot \Theta + G_M \cdot (1-\Theta), \quad (7)$$

$$G_{12}^{Н} = \frac{G_B \cdot G_M}{G_M \cdot \Theta + G_B \cdot (1-\Theta)}, \quad (8)$$

where: $G_в$– shear modulus of the the fiber;

$G_м$– shear modulus of the the matrix.

In turn, shear moduli of fiber and matrix can be calculated by the formula:

$$G_B = \frac{E_B}{2 \cdot (1+\mu_B)}, \quad (9)$$

$$G_M = \frac{E_M}{2 \cdot (1+\mu_M)}. \quad (10)$$

Thus, we know the elastic moduli and Poisson's ratios of the fiber and the matrix, as well as the fiber volume content in the CM. Now we can calculate the the elastic constants of the whole layer.

Poisson's ratio can have 3 different values when the transversely isotropic body is loaded. It depends on the loading direction relative to the axis of symmetry. The axis of symmetry in this case is the axis Z, and the plane of isotropy is the XY plane. The loading deformations are shown in fig. 2.

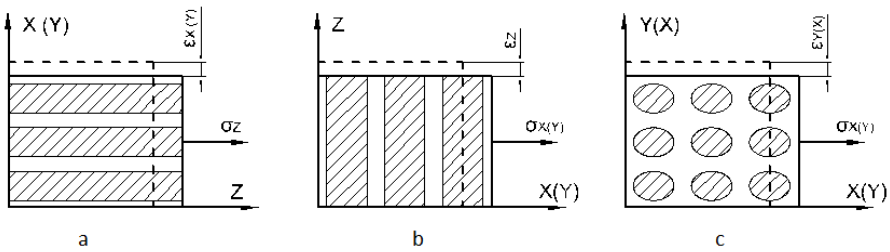

Fig. 2. Deformation of the layer at the normal stress: a - lateral deflection at the longitudinal loading; b - longitudinal deflection at the lateral loading; c - deflection at the lateral loading

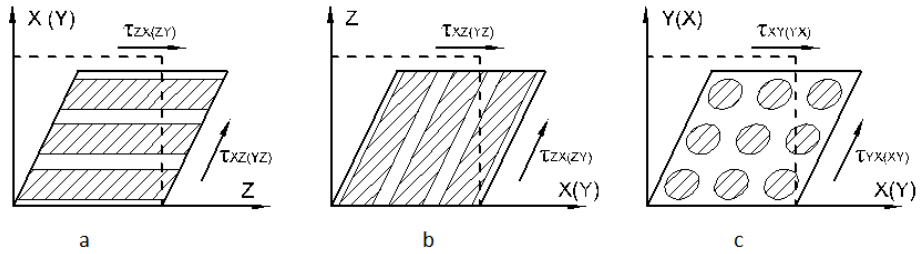

Fig. 3. Deformation of the layer for the tangential stresses: a, b - shear strain in the plane perpendicular to the plane of isotropy; c - shear strain in the plane of isotropy

Let's accept conditionally the Poisson's ratio in the plane of isotropy as "0". The shear modulus G_{xy} in this case is found by the formula (5).

Initial data of elastic constants CM components are summarized in table 1.

Table 1. The elastic constants of the CM components

Physical quantity	Designation	Value
Elastic modulus of the fibers, MPa	$E_в$	90000
Poisson's ratio of the fiber	$\mu_в$	0,28
shear modulus of the the fiber, MPa	$G_в$	35156
Elastic modulus of the matrix, MPa	$E_м$	4000
Poisson's ratio of the matrix	$\mu_м$	0,3
shear modulus of the the matrix, MPa	$G_м$	1538
fiber volume content	Θ	0,6

The data were obtained after the calculations. Table of elastic constants defined in the CAD/CAE systems is made. Tables 2 and 3 are constructed for the longitudinal and circular layer.

Table 2. The elastic constants of the longitudinal layer

Physical quantity	Designation	Rated value	Value
Modulus of elasticity, MPa	E_x	E_2	10138
	E_y		10138
	E_z	E_1	55600
Poisson's Ratio	μ_{xy}	–	0
	μ_{yz}	μ_{21}	0,053
	μ_{xz}		0,053
Shear modulus, MPa	G_{xy}	G_{xy}	5069
	G_{yz}	G_{12}	12659
	G_{xz}		12659

Table 3. The elastic constants of the circular layer

Physical quantity	Designation	Rated value	Value
Modulus of elasticity, MPa	E_x	E_2	10138
	E_y	E_1	55600
	E_z	E_2	10138
Poisson's Ratio	μ_{xy}	μ_{21}	0,053
	μ_{yz}	μ_{12}	0,288
	μ_{xz}	–	0
Shear modulus, MPa	G_{xy}	G_{12}	12659
	G_{yz}		12659
	G_{xz}	G_{xy}	5069

Test calculation is performed on the "balloon" product. The balloon is calculated in the CAD / CAE system using the finite element method.

The balloon was loaded by the internal pressure P = 10 MPa with a given elastic constants of the longitudinal layer (table 2) and a given elastic constants of the circular layer (table 3). The quantity of the deformation has been increased in 100 times for clarity. Results of calculation of the balloon with the longitudinal layer are shown in fig. 4 and with the circular layer are shown in fig. 5. Tension evaluation is MPa.

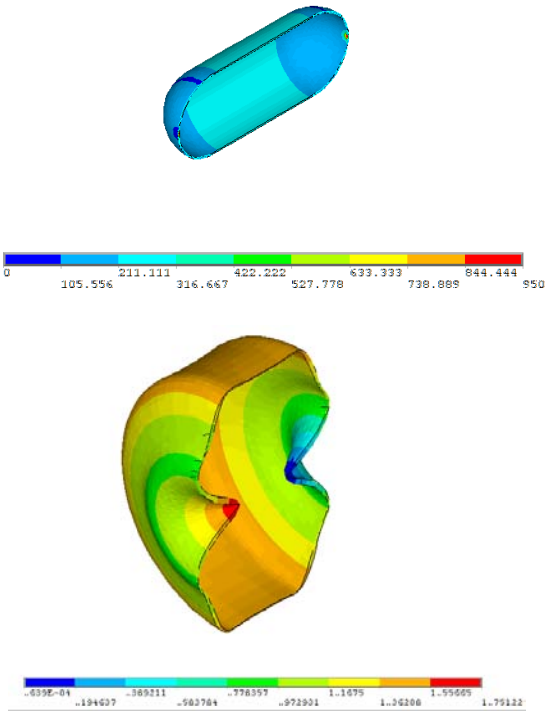

Fig. 4. Equivalent stresses in the longitudinal layer of the balloon

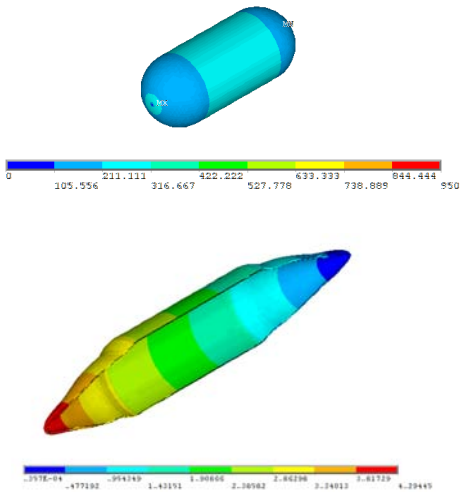

Fig. 5. Equivalent stresses in the circular layer of the balloon

CONCLUSIONS

The test calculation was performed on the "balloon" product. The calculation has shown that the method of calculation of construction elements made of composite materials in the CAD/CAE systems is suitable for modeling of the force aircraft elements. This is applicable for pipes, SPRM body, transport and launch container (TLC) based on the polymer composite.

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МЕТОДИКА РАСЧЕТА МАЛОГАБАРИТНЫХ КОРПУСОВ ИЗ КОМПОЗИЦИОННЫХ МАТЕРИАЛОВ В CAD/CAE СИСТЕМАХ

Игорь Малков, Геннадий Сыровой,
Игорь Непран, Сергей Кашкаров

Аннотация. В статье рассмотренна возможность расчета элементов конструкции из композитных материалов в CAD/CAE системах, исходными данными для расчета которых являются упругие константы волокна и матрицы, а так же объемное содержание волокна в композите. Полученно напряженно-деформированное состояние простых элементов, нагруженных внутренним давлением и сжимающей силой.

Ключевые слова: композит, гетерогенная модель, физико-механические свойства, тензор напряжений, трансверсально-изотропное тело.

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GROUNDING OF THE FREQUENCY RANGE CHOICE IN THE SYSTEM OF MONITORING OF THE OPERATION RELIABILITY OF THE TECHNICAL SYSTEMS

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S u m m a r y . There grounded the frequency range choice in the system of the operation reliability of the technical systems based on the application of probabilistic – statistical method.
K e y w o r d s : monitoring, dispersion ellipse, cluster.

PROBLEM DEFINITION

In connection with great period of technical system operation and increasing of refusals connected with formation of operation defects in metal in the form of corrosion and erosion wear, dispersion and cracks, application of traditional discrete methods of inspection becomes ineffective because of great labour intensity, inopportuneness and locality of the given ways of investigation [Gnedenko B.V., Belyaev Yu.K., Soloview A.D., 1965]. A radical way of ensuring necessary level of operation reliability of the structures is application of the system of continuous tracking (monitoring) technical state in the process of operation on the base of acoustics-emission method, various methods of unfailed check and methods of experimental evaluation of tensile deformed state.

ANALYSIS OF THE PROBLEM

A wide introduction of the technical diagnostics is one of the most important factors of the effectiveness increase of the machine and technological equipment, decrease of the expanses required for these repair and operation [Thursdays V.A., 2003]. The system of the technical diagnostics acquire a great role in connection with the increase of reliability of the rolling stock, the system optimization of its plan preventive repair or repair due to its actual state of the object [Reshetov D.N., 1988]. It should be noted that the damage because of frequent repair of the units and sets connected with redundant labour intensity of disassembly and assembly work is so great that one of the most paramount problems is the problem of transfer from scheduled – preventive system to the operation according to the results of systematic vibro-acoustic diagnostics of the rolling stock equipment [Pakhomov E.A., 1985].

A new technology of operation aims at removing sudden break-downs, ensuring reliability of the equipment and economy of financial and material resources [Ostreikovskaya V.A., 2005]. The parameters of the diagnostic signal are the source of the technical state information in the given technology [Marchenko D., Vetrov A., 2003]. The changes of the properties of the signal are correlated with the changes of the technical state caused by the degradation of the units, change of geometrical sizes of the parts, wear. One of the most informed diagnostic features are the parameters of vibro-acoustic emission (VAE), Generated in the process of the mechanism work [Klyuyev V.V,. 2003].

The motions of the parts, units and sets of any machine are not random. They are performed along definite paths with definite speeds specified by existing kinematic links existing between the parts. In the ideal case the position and speed of any part are determined by position and speed of the drive member. Luck a mechanism is called

ideal [Ivanova V.S., 1979]. Different defects of manufacture are shown in violation of designed links between the parts. Their motion differs from the specified one and it may be explained as emergence of additional degrees of freedom of the parts [Barenblatt G.I., 2003]. Motion of the parts in the kinematic chain of the machine by parasitic degrees of freedom rohich occur while wearing and other faults are accompanied by their collision and due to it elastic waves are spread in the body of the mechanism.

Many published investigations devoted to acoustic phenomena in the machines are directed to the search of the ways of reduction of general level of radiated noise power [Gnedenko B.V., Belyaev Yu.K., Soloview A.D., 1965, Gadasin V.A., Ushakov I.A., 1975, Bortsova A.T., 1983, Barzilovich E.Yu., Kashtanov V.A., 1971]. As for VAE the noise is used here as an information carries of the technical state of the equipment one of the advantages of VAE consists in the fact that the phenomena which break down the mechanism serve as a source of the diagnostic signal, that is, while vibro-acoustic diagnostics we obtain the information of the technical state of the machine [Baldin K.V., 2004].

Main reasons of the setting up the systems of diagnostic monitoring at the railway transport are the following: absence of access and difficult access to the object. High speeds of the growth of the operation defects in the structure; catastrophic consequences caused by the object break down [Ayzinbud S.Y., 1990].

The problem of providing maximum lifetime, «delay» of the system ageing, prolongation of their operation period under the conditions of resource restriction (financial possibilities, manpower resources, etc.) [Dodonov A.G,. 1988, Golubenko A., 2008], becomes one of the urgent problems for the scientists, economists and technical specialists of different countries. The consequences of the refusal rise, faults or defects in these system can bring even tragic consequences: global catastrophes, defeat of surroundings, human sacrifices, Great financial and material losses [Khaitun S.D., 1996]. The investigations in this direction are not possible without a system approach, taking into account various problems and their solution which can bring to improvement of the system state, guarantee some reliability and prolongation of its operation period with due regard for economical criteria and restrictions [Koks D.R., Smith V.Z.,1967].

Apparatus – programme complexes required for collection and measuring information processing on the basic of personal computers are necessary as a base means of measurement while monitoring [Nagovitsyn V.S., 2004, Pakhomov E.A., 1974]. These complexes give a high accuracy and operativeness of measurement, give wide possibilities while processing and keeping the results, multi-functionality, high mobility, rather low cost (in comparison with total cost of substituted devices).

The results of application of the continuous monitoring can be useful while grounding optimal volumes of repair-restore work which ensure the given prolongation of service life of analyzed systems [Terentyev V.F., 2003]. The analysis of the system reliability based on the dynamics of its operation gives the possibility to determine the present – day state of the system and to predict future of the system [Panin V.E., 1985].

But under these investigations the question arises whether this system is under control. Prediction of the further state of the system can be possible only in the case of positive reply regarding controllability.

THE PURPOSE OF INVESTIGATION

Development of the universal algorithm of identification of the working state of the system for accident (failure, break-down) or normal condition, algorithm of the system check by controllability and creation of automatic system of monitoring – scientific problems the solution of which allows to increase work ability and reliability of the system, decrease material expanses by timely substitution of defective units of the system.

These are no sudden refusals. One can foresee crash only in the case if the behavior of the system changes are known when it transfers from the normal regime of the operation into emergency. It is possible to identify the system due to approach to this or that state. Energy dissipation in the open non-linear system takes place inside some frequency spectrum.

Interval $[a, b]$ with minimum distance $(b-a)$, which contains p-% radiation level (for instance, $p = 95\%$) called p-window $[a, b]$. Inside this frequency range the energy distributions for given frequencies correspond to the state of normal work. Assemblage of the centers of gravities of frequency diagram form clusters specified for normal and emergency regimes of the work of the system.

The analysis of the statistic structure of the cluster allows to find two-dimensional laws inside any cluster, to form a decisive rule of identification of belonging of the investigated system to either regime.

RESULTS OF INVESTIGATION

To form clusters for «normal» and «emergency» work of the system there considered the vector of observation $\bar{x}(t) = \{x_1(t), x_2(t)\}$, which is subordinated to the two-dimensional law:

$$\varphi(x) = \frac{1}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} \exp[-\frac{1}{2(1-\rho^2)}((\frac{x_1-m_1}{\sigma_1})^2 - 2\rho(\frac{x_1-m_1}{\sigma_1})(\frac{x_2-m_2}{\sigma_2}) + (\frac{x_2-m_2}{\sigma_2})^2)],$$

where: m_1, m_2 – mean value expectation, and σ_1 и σ_2 – dispersion.

It is known that the density of the normal law of distribution keeps normal values on the ellipses:

$$\lambda^2 = \frac{1}{2(1-\rho^2)}((\frac{x_1-m_1}{\sigma_1})^2 - 2\rho(\frac{x_1-m_1}{\sigma_1}) \times \times (\frac{x_2-m_2}{\sigma_2}) + (\frac{x_2-m_2}{\sigma_2})^2),$$

where: λ^2 – ellipses of probability. It was proved that the probability of hit of the vector $\bar{\xi}$ of such a ellipse is equal to $P = 1 - e^{-\frac{\lambda^2}{2}}$.

The centers of two clusters are found as the centers of two ellipses. The point of tangency is found from the system solution of two equations of the second order.

The system determining the point of the tangency of the ellipses is the following:

$$\begin{cases} \frac{1}{(1-r^2)}\left(\left(\frac{x_0-a}{S_1}\right)^2 - 2r\left(\frac{x_0-a}{S_1}\right)\left(\frac{y_0-b}{S_2}\right)^2\right) = \frac{1}{(1-\rho^2)} \times \\ \times\left(\left(\frac{x_0-\alpha}{\sigma_1}\right)^2 - 2\rho\left(\frac{x_0-\alpha}{\sigma_1}\right)\left(\frac{y_0-\beta}{\sigma_1}\right) + \left(\frac{y_0-\beta}{\sigma_2}\right)^2\right); \\ \frac{\sigma_2}{\sigma_1}\frac{\rho\sigma_1(y_0-\beta)-\sigma_2(x_0-\alpha)}{\sigma_1(y_0-\beta)-\rho\sigma_2(x_0-\alpha)} = \frac{S_2}{S_1}\frac{rS_1(y_0-b)-S_2(x_0-a)}{S_1(y_0-b)-rS_2(x_0-a)}, \end{cases}$$

or

$$\begin{cases} 0 = F_1(x, y); \\ 0 = F_2(x, y). \end{cases}$$

The solution of the system determines the point (x_0, y_0).

The equation of the general tangent to the ellipses is written in this way:

$$F(x, y) = y - y_0 - k(x - x_0).$$

This function is the criteria while checking the belonging of the current point to either cluster.

If

$$F(x, y) \cdot F(a, b) > 0, F(x, y) \cdot F(\alpha, \beta) < 0,$$

then $M \in K_1$ (where K_1 – the first cluster).

If

$$F(x, y) \cdot F(a, b) < 0, F(x, y) \cdot F(\alpha, \beta) > 0,$$

then $M \in K_2$ (where K_2 – the second cluster).

The value of the boundaries of the window defines the band where the system (acoustic, electromagnetic) «sounds».

CONCLUSIONS

There grounded a methodologic approach to the choice of frequency range and creation of the data bank of normal and emergence regimes of the system operation. Organization of the data renewal allows to solve scientific and practical problem of diagnostics of the technical state in the regime of real time.

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ОБОСНОВАНИЕ ВЫБОРА ЧАСТОТНОГО ДИАПАЗОНА В СИСТЕМЕ КОНТРОЛЯ ОПЕРАТИВНОЙ НАДЕЖНОСТИ ТЕХНИЧЕСКИХ СИСТЕМ

Дмитрий Марченко

Аннотация. Обоснован выбор частотного диапазона в системе оперативной надежности технических систем, основанный на приложении вероятностно-статистического метода.

Ключевые слова: мониторинг, эллипс рассеяния, кластер.

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PREDICTION OF QUALITY OF SEWING DEPARTMENT UNDER UNSTEADY OPERATING MODE CHANGE

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S u m m a r y . The articles describes mathematical model of quality dynamics in garments industry and garments merchandising. As a result, the major identified ways and means of production to working with vibrating equipment with conditions to achieve the greatest level of quality. The algorithm of dynamic programming to achieve the minimum loss of quality in the case of work in several areas. The obtained optimal distribution of vibration during operation in the organization of work with different number of plots
K e y w o r d s : quality, garments industry, dynamic programming, vibrating equipment.

INTRODUCTION

Quality of sewing goods varies according to the needs of society which is constantly changing and growing. The level duality clothing items valued complex indices. Hygienic quality index apparel products allows hygroscopic, heat insulation, air permeability, water resistance, etc. The quality of garments is dependent on the quality of fabric, quality of modeling, design, technology, tailoring. Quality control of garments performed by comparing the product with standard samples.

The standards and specifications with the technical requirements for products. For example, the requirements for the production of clothing are: treatment of the edges of parts, the use of gasket materials, paving edge processing pockets requirements lining to the bottom hem and sleeves products, the use of supers. Garments should have a beautiful appearance, good save fashioned, to be comfortable and practical to wear.

Quality control of finished products are completed by the department of technical control in accordance with the requirements[1,2] which contains the methods of quality control and identified the features that characterize the quality of the product. For quality inspection the inspector workstation is equipped with a set of dummies, bracket shelves, model-a model and an assembly diagram, specifications on the model, a set of technical standards, a set of measuring tools and accessories, stationery stamp to mark the defect in the product on the adaptation .

Noted on the form and location of the defect on the adaptation of the product is returned to the workplace where admitted fault. Grade products are installed in accordance with the requirements of [3,4], which set out the requirements for the quality of products.

Size, appearance of products and technology approved to meet the technical requirements for the model. Control of linear measurements performed roulette type RH with a limit value 0 - 2000 mm and scale factor - 1 mm. Control size of the product in accordance with the data of the design documentation for the model, for each site according to the dimension table products in finished form. Maximum deviations from the nominal size in the product and are located symmetrically in the finished product are as follows: for the main seams ± 1 - 2 mm, length 10 mm ± back to back width of ± 5 mm, the width of a shelf zone ± 5 mm, the width shelves at the armhole ± 10mm, the width sleeves ± 5mm for length sleeves ± 10 mm, the width of the collar to ± 5 mm, length 10 mm ± collar and so on.

Errors in control mainly observed due to errors of measurement errors on the dummy landing articles and errors of the manikins, pliable

material, inaccuracies cut parts and assemblies, negligence or other controller.

Existing techniques estimate the errors can detect the degree of influence of each of the reasons for the emergence percentage of defective products, but these methods do not take into account the uncertainty of manufacturing and production control in the relationship.

OBJECTS AND PROBLEMS

Our main goal is achieve maximum quality during operation. Note for the production of a single product to perform many operations, each of which can be determined by their own speed, including the speed of the machine, which undoubtedly affects the vibration characteristics. Thus, the implementation of long straight seams provides typically the maximum speed of the machine under the maximum level of vibration. Performing warped seams, short transactions running on low speed, according common vibration will be reduced.

RESEARCH ANALYSIS

A single operator machine can perform operations that are defined by different vibration equipment. Pose the problem of determining the distribution patterns of vibration over time, which determines the maximum final product quality.

In a number of works [5-7] discussed the determination of quality garments, in particular the question of exposure sewing equipment quality. But still not solved the real development of recommendations for the production process to ensure maximum quality.

Purpose is to solve variational problems determining the program of work on sewing equipment with vibration for maximum quality.

Grade finished garments will be set in accordance with standards of quality. Grade determined in accordance with the requirements of the standard and consumer properties of products: appearance, landing on the shape, size, and in accordance with the requirements of the construction, the range and quality of materials, technical documentation on the product and approved samples.

Note that the manner specified in [8] defined quality obtained at the end of work. Define T - total time, t - current time, R - the maximum permissible level of vibrations, r - current vibration. We introduce the dimensionless time and dimensionless vibration.

$$\tau = \frac{t}{T}. \tag{1}$$

$$x = \frac{r}{R}. \tag{2}$$

We consider a change rate as from time to time and vibration

$$Y = B + A \cdot e^{-a \cdot x^b \tau^c} + D \cdot (1 - \tau). \tag{3}$$

Where D term associated with general fatigue employee regardless of level of vibration. We identify it with the condition $A + B + D = 1$, c - coefficient changes as the time under vibration. Although each level of vibration, this ratio can be separate, experience shows that the variation was not very large.

For its location experiment definition quality early work, inside and end were held.

Evaluation of the quality finished products produced by 40-point scale. The presence of defects reduces the appearance evaluation of quality clothing by subtracting points from the baseline value reduction estimates. If the sample has the ideal product quality landing, it has maximum score point scale - 40 points and belongs to the I grade. Based on the 30% aqueous (for products I grade) or 50% aqueous (for products II grade) level of positive answers experts that the defect is visually prominent, set points differentiated by grades according to the level of defect. Thus, for a variety of products I found 38-40 points for a variety of products II - 32-37 points.

Distribution of marks obtained at the beginning of the day when using equipment with vibration working surface given in [8]. We can prove that this distribution is close to normal.

Define quality for mid-day to mid-level vibrations when the fair is a normal distribution (table 1).

Table 1. Distribution points as the middle of the day

0	1	2	3	4	5	6	7	8	9
35.954	36.315	36.676	37.037	37.398	37.759	38.12	38.481	38.841	39.202
4	10	10	16	18	17	6	11	6	2

Constructing a histogram distribution of quality in the middle of the day (fig. 1) we can conclude its proximity to the normal distribution.

Value grade products is determined using the integral

$W = \int_{37}^{40} p(x)dx = 0,686.$ indicating that 68.6% of production goes to first grade.

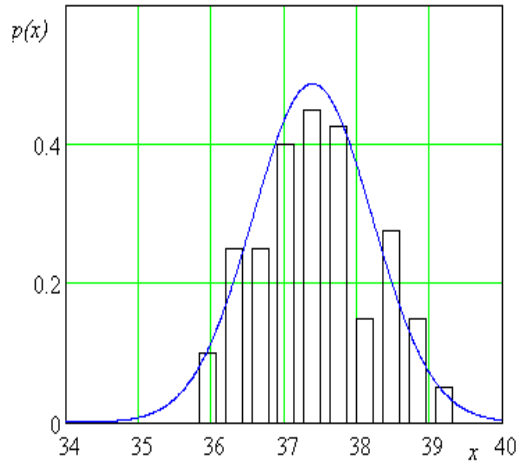

Fig. 1. Histogram distribution points as the middle of the day

To find the coefficient c go

$$Y_c = A + B_e^{-aX^b 0,5^c}. \quad (4)$$

Where have

$$c = \log_{0,5}\left[\frac{\ln\left(\frac{Y_c - A}{b}\right)}{-aX^b}\right] = \frac{\ln\left[\frac{\ln\left(\frac{Y_c - A}{b}\right)}{-aX^b}\right]}{\ln 0,5}. \quad (5)$$

For the parameters found c=1,28

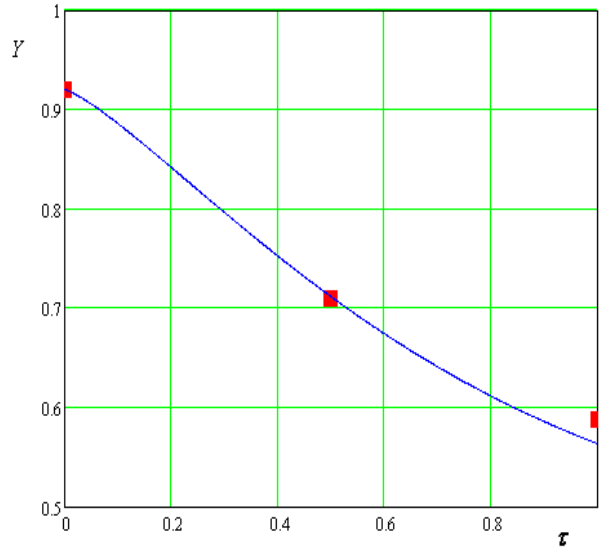

Fig.2. Reduction of time as the average level of vibration

Then compatible relationship quality on time and the vibrations will look (fig. 2)

$$Y = 0.45 + 0.57 \cdot e^{-2.291 \cdot x^{1,66} \cdot \tau^{1,28}}. \quad (6)$$

In the case of variable vibration is very difficult to construct an experiment which would consider all possible patterns of vibration. We introduce the hypothesis of legal compliance changes as mainly an expression of the increment. For this we find the differential input function.

$$dY = -a \cdot A \cdot e^{-a \cdot x^b \cdot \tau^c} \cdot \left[b \cdot x^{b-1} \cdot \tau \cdot \frac{dx}{d\tau} + c \cdot x^b \cdot \tau^{c-1} \right] d\tau. \quad (7)$$

Recall that we are dealing with a specific amount of time and vibration, which varies from 0 to 1. It may be noted that the differential at any values have negative nature, that is, it shows reduced quality in some time under the influence of vibration, given their change in time.

The general decrease in quality.

$$H = \int_0^1 a \cdot A \cdot e^{-a \cdot x^b \cdot \tau^c} \cdot \left[b \cdot x^{b-1} \cdot \tau \cdot \frac{dx}{d\tau} + c \cdot x^b \cdot \tau^{c-1} \right] d\tau. \quad (8)$$

It rejected the sign "minus" because we are not dealing with quality, and reduced quality. Then the overall quality can be defined as

$$Y = B + A - H. \quad (9)$$

Posing the problem of finding the vibration function changes over time, which provided the lowest level of quality products during working hours. We introduce restrictions during work should be used every possible level of vibration. We will offer some features change vibrations that match the condition.

The real work in garment production presents a number of time periods during which implemented a separate operation. As already mentioned, a separate operation provides fairly certain level of vibration. Try to improve the quality of change operations in a systematic way, which determines the average level of vibration during operation.

Reduced quality in this interval can be defined as

$$\Delta H = \left\{ e^{-a(i \cdot \Delta x)^b \left[(j+1) \cdot \Delta \tau \right]^c} - e^{-a(i \cdot \Delta x)^b \left[j \cdot \Delta \tau \right]^c} \right\}. \quad (10)$$

The overall decrease in quality over time can be determined amount

$$H = \sum_{j=1}^{n-1} \left\{ e^{-a(i\cdot\Delta x)^b[(j+1)\cdot\Delta\tau]^c} - e^{-a(i\cdot\Delta x)^b[j\cdot\Delta\tau]^c} \right\}. \quad (11)$$

The problem in this case can be formulated as follows.

There is a table that defines the decline in the quality of products at different ratios of time and vibration. We must find a way to change vibrations in time to the total drop in quality would be minimal (table 2).

Table 2. Changing the level of vibration equipment

	1	2	...	j	...	n-1	n
1	$\Delta H_{1,1}$	$\Delta H_{1,2}$	...	$\Delta H_{1,j}$	...	$\Delta H_{1,n-1}$	$\Delta H_{1,n}$
2	$\Delta H_{2,1}$	$\Delta H_{2,2}$	...	$\Delta H_{2,j}$	...	$\Delta H_{2,n-1}$	$\Delta H_{2,n}$
...	...	...	...	...	...	...	...
i	$\Delta H_{i,1}$	$\Delta H_{i,2}$	...	$\Delta H_{i,j}$	...	$\Delta H_{i,n-1}$	$\Delta H_{i,n}$
...	...	...	...	...	...	...	...
n-1	$\Delta H_{n-1,1}$	$\Delta H_{n-1,2}$	...	$\Delta H_{n-1,j}$	...	$\Delta H_{n-1,n-1}$	$\Delta H_{n-1,n}$
n	$\Delta H_{n,1}$	$\Delta H_{n,2}$	...	$\Delta H_{n,j}$	...	$\Delta H_{n,n-1}$	$\Delta H_{n,n}$

Adds a condition to each section met once. Then the formal task is to find the number of vibrations depends and depending on the number of vibrations j in condition that the sum of (11) become minimum.

To determine this dependence algorithm multi movement, the essence of which can be defined as follows. First movement begins with the first column of the table, which is determined by the minimum value. For the second column is the minimum value of the sum of the first of the second, for the third - the second to the third, and so on. After the first movement to place first column put the second and the process repeats for him. Process of movement tripled, exposing each column forward.

The results, among other things, to determine the best mode in terms of the number of operations performed.

CONCLUSIONS

As a result, the major identified ways and means of production to working with vibrating equipment with conditions to achieve the greatest level of quality.

These results include the following:

• The stated variation problem of determining the shortest vibration function changes during the work to achieve the greatest level of quality;

• The algorithm of dynamic programming to achieve the minimum loss of quality in the case of work in several areas. The obtained optimal distribution of vibration during operation in the organization of work with different number of plots;

• Defined the most efficient in terms of quality of sites throughout the day;

The novelty of the results is as follows

• The first posed and solved the optimal combination of quality and vibration at work;

• Installed new facts necessary for workflow based on increasing quality;

• Engineering and intuitive representation of the dependence of reduction in quality of the production process received theoretical confirmation.

The practical significance of the results is made in this

• Opportunities to organize the production process with minimal quality;

• Ability to select the mode of equipment with different levels of vibration while maintaining quality;

• Obtaining control methods defect production and the costs of examinations and stage production.

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ПРОГНОЗИРОВАНИЕ КАЧЕСТВА ПРОДУКЦИИ НА ШВЕЙНОМ ПРЕДПРИЯТИИ В НЕСТАЦИОНАРНЫХ РЕЖИМАХ РАБОТЫ

Ольга Мокшина, Николай Рябчиков

Аннотация. В статье описывается математическая модель динамики качества в швейной промышленности и квалиметрии одежды. В результате показаны основные пути и средства производства одежды при работе с вибрирующим оборудованием при условиями для достижения наивысшего уровня качества. Разработан алгоритм динамического программирования для достижения минимальной потери качества в случае работы в нескольких областях. Получено оптимальное распределение вибрации во время работы и организации работы с различным количеством участков.

Ключевые слова: качество, легкая промышленность, динамическое программирование, вибрационное оборудование.

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CALCULATION OF CALIBRATION FORCE OF GEAR TEETH BY EXPANDING WITH CONE-SHAPED PUNCH

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S u m m a r y. The technology of producing gear-wheels by stamping with division of operations of rough and finishing forming is examined. A solution for stress and deforming force of calibration of gear teeth in a stamp with cone-shaped punch is found.
K e y w o r d s: gear-wheels, calibration, stamping, deforming effort, tensions.

INTRODUCTION

Stamping tooth gear-wheels is an effective technology, which allows to decrease the consumption of metal and power, labour-intensive characteristics, and to increase operating abilities of items. [15]

RESEACH OBJECT

The research introduces the technology of producing tooth-wheels with division of operations of rough forming and finishing forming. In this case the level of final deformation is low, deformation occurs in cold conditions and a finishing operation is calibration, i.e. high precision of teeth geometrical dimensions is reached. The rough work-piece for calibration can be a half-way product with not completely shaped teeth, made either by cold, hot or warm stamping, or of powder metal by pressing and sintering. [18]

Calibration is performed in a special stamp. The rough work-piece for calibration is made in the shape to enter the cavity of calibration stamp with a gap which allows free entrance. Its surface and the stamp surface are covered with technological lubricant (for example, machine grease with molybdenum disulfide). The deformation level at the operation of calibration, calculated according to the change of a tooth depth, does not exceed 5…10%, that allows to provide 8-9 level of precision of tooth wheel dimensions and roughness R_a=0,32. [17-20]

REZULTS OF EXPERIMENTAL RESEARCH

In the technology under investigation the calibration operation is exercised according to the scheme of deformation of teeth with radial flow of metal, performed with a cone-shaped punch, which expands the center bore of a tooth gear and makes the metal flow in a radial direction. While developing the technological process and tooling, it is necessary to distinguish operating stress in a stamp and the level of max. deforming force at the final stage of calibration which corresponds the complete formation of teeth. [9,10]

The design model of calibration of gear teeth with radial flow of metal is shown in fig.1. The amount of metal under deformation is presented consisting of two areas. In Area I there is metal flow in a tooth, Area II constitutes a ring with a conical bore situated under internal (on the side of a punch) and external (on the side of a tooth) pressure. To develop calculating formulas we apply the method of simultaneous solution of equilibrium and plasticity equations.

Due to the fact that the length of a tooth is rather more than its depth, the flow of metal in the direction of the length is negligibly small. So, without making a raw error, we can take that in Area I metal is situated in conditions of flat deformation.

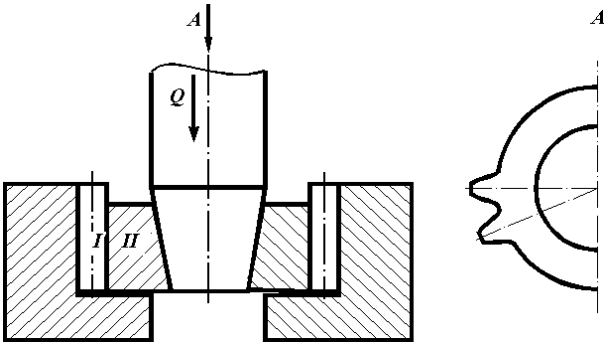

Fig. 1. The scheme of calibration of gear teeth with radial flow of metal

For the analysis we divide the space of Area I to the finite number m of elementary units, changing their curved configuration to linear wedge one (fig.2).

The size of blocks h_j, h_{j+1}, α_j is calculated using the equations of the lines of gearing for their given number m.

The stress in the deformed metal while entering the tooth hole is calculated using the approximate equations of equilibrium and plasticity that for the flat plastic flow of wedge elementary units in polar coordinates r and ρ is as follows [1]

$$\frac{d\sigma_r}{dh_r} + \frac{(\sigma_r - \sigma_\varphi)}{h_r} + \frac{2\tau_k}{\alpha h_r} = 0, \qquad (1)$$

where: $\tau_k = \mu 2k$ - value of shear stress on a contact surface;

$k = \sigma_s / \sqrt{3}$ - constant plasticity,

μ - coefficient of contact friction.

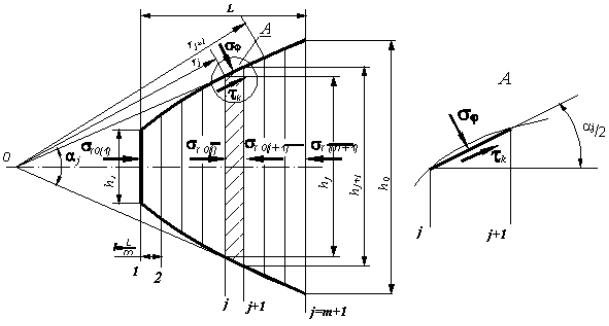

Fig. 2. Calculating scheme for Area I with dividing it to the finite number of elementary units

Integrating the equation (1) with definition of the constant of integration from the condition that on the left edge of elementary wedge unit with $h_r = h_j$, normal stresses are $\sigma_r = \sigma_{r0(j)}$, we have

$$\sigma_{rj} = -2k(1 + \frac{2\mu}{\alpha}) ln \frac{h_r}{h_j} + \sigma_{r0(j)}, \qquad (2)$$

where: j- section size.

Calculation of the normal stress on the boundary of Area I and Area II $\sigma_{r(m+1)}$ using the formula (2) is performed by numerical method in sequence, starting with the second section from the left boundary of Area I. In this connection, for the free flow of metal in a tooth hole we take the value $\sigma_{r0(1)} = 0$, and for the final stage, when the formation of angles is performed - $\sigma_{r0(1)} = 4k$.

Strengthening of metal while forming the teeth is calculated by taking the average values of the constants of plasticity in elementary units

$$k_{cp} = \frac{k_j + k_{j+1}}{2},$$

$$k_j = \frac{1}{\sqrt{3}} \left[\sigma_{s0} + A \left(\frac{h_0 - h_j}{h_0} \cdot 100 \right)^n \right], \qquad (3)$$

where: σ_{s0}, A, n - initial flow stress and coefficients of linear approximation of strengthening curve [2].

Area II is a ring, limited with radial surface passing through the bottom line of teeth and the cone-shape surface of punch. At the final stage of calibration the length of circular fiber in Area II hardly changes because the flow of metal in the hole under the tooth is negligible. Hence, we can take it that at the final stage of calibration in the sections of circular Area II flat deformed condition takes place.

In Area II of stress we find from simultaneous solution of differential equilibrium and plasticity equations. Usage of shear stress law allows to get a closed solution, when the arbitrary functions in coordinates r and θ are got from the plasticity equations with the following calculation of integration constant from conditions of equation of stresses at the boundary of Area I and Area II.

$$\sigma_\theta = 2k \left(\frac{2\mu}{\beta} + \sqrt{1 - 4\mu^2} \right) ln \frac{r}{r_a} + \sigma_{r(m+1)}, \qquad (4)$$

$$\sigma_r = -2k \left[\left(\frac{2\mu}{\beta} + \sqrt{1 - 4\mu^2} \right) ln \frac{r}{r_a} - \sqrt{1 - \frac{4\mu_\theta}{\beta}} \right] + \sigma_{r(m+1)}.$$

The value of axial deforming force transmitting through the punch we can find by

taking the value of the projections of all forces on a vertical axis.

$$Q = \iint\limits_{s} |\sigma_s| \sin\beta dS + \iint\limits_{s} |\tau_k| \cos\beta dS \ . \qquad (5)$$

The final formula for the stress of gear tooth calibration is as follows

$$Q = 2\pi d_c \left[\left(\frac{2\mu}{\beta} + \sqrt{1-4\mu^2} \right) \left(2{,}3 b_2 \ln \frac{b_2}{b_1} - b_2 + b_1 \right) + \mu H + \frac{\sigma_{r(m+1)}}{2k} (b_2 - b_1) \right] \qquad (6)$$

Calculation of the stresses on the boundary of Area I and Area II is performed by a numerical method, here the accuracy depends on the number of divisions *m*.

Experimental proof of the solution received for strengthening the calibration of a tooth-gear of a starter's reduction unit was performed, the work-piece for it was a half-way product, made of iron powder and sintered. The experiment proved a good fit of design data, deviation rate is 15%. [21]

CONCLUSIONS

The analysis of stressed-deformed conditions during calibration of gear teeth with radial flow of metal is carried out. By means of simultaneous solution of differential equilibrium and plasticity equations we got the formula for deforming force, necessary for calibration of teeth by cone-shaped punch.

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РАСЧЕТ УСИЛИЯ КАЛИБРОВКИ ЗУБЬЕВ ШЕСТЕРНИ РАЗДАЧЕЙ КОНИЧЕСКИМ ПУАНСОНОМ

Марина Морнева, Владимир Гаврыш, Наталия Кузьменко

Аннотация. Рассматривается технология изготовления зубчатых колес штамповкой с разделением операций предварительного и окончательного формообразования. Получено решение для напряжений и деформирующего усилия операции калибровки зубьев шестерни в штампе коническим пуансоном.

Ключевые слова: зубчатые колеса, калибровка, штамповка, деформирующее усилие, напряжения.

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THE MATHEMATICAL MODEL OF THE TRACTION FORCE COEFFICIENT OF THE CONVEYOR ON AN AIR CUSHION WITH SLOPING ROUND CHANNELS

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Summary. Using the methods of ideal liquid aerodynamics and the theory of machines on an air cushion, the mathematical model of the traction force coefficient of the conveyor on an air cushion with sloping round channels is obtained. Compare the results of the modelling and the experimental research of the traction force coefficient of the conveyor on an air cushion with sloping round channels is carried out.

Key words: conveyor, air cushion, traction force

INTRODUCTION

Conveyors on an air cushion with sloping round channels (fig. 1) are a special type of industrial transport, which can be used for:

- transportation of products in the assembling process;
- transportation of loads in warehouses and logistics centres;
- transportation of products through the heating, baking, drying ovens and cooling chambers.

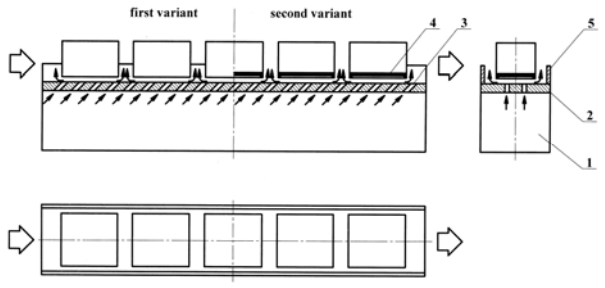

Fig.1. Conveyor on an air cushion with sloping channels: 1 - air receiver; 2 - nozzle; 3 - channel; 4 - pallet; 5 - guide

Despite the existence of such advantages as: the simplicity of construction, high reliability, quiet operation, safety of operation in an explosive environment, the possibility of combining the process of transportation and the thermal processing of loads, wide application of conveyors on an air cushion with sloping round channels do not have. One of the reasons of this fact is the lack of study of these conveyors, in particular their traction qualities, the main indicator of which is the traction force coefficient.

ANALYSIS OF THE PUBLICATIONS. THE AIM AND TASKS OF RESEARCH

Conveyors on an air cushion studied in the scientific works of Bitukov V., Kolodezhnov V. [Bitukov 1979; Bitukov, Kolodezhnov 1979], Khanzhonkov V. [Khanzhonkov 1975, 1981], Pang M. [Pang, Zhang, Ni 2005], Rabochiy G., Redko A., Turushin V. [Redko, Turushin 1997; Turushin, Rabochiy 1978; Rabochiy, Turushin 1983; Turushin, Redko 1997], Song R. [Song, Ni, Zheng, 2006] and other scientists. However, conveyors with sloping channels in these works are not considered.

The scientific works of Lu J., Huang G., Li S. [Lu, Huang 2008; Lu, Huang, Li 2009], Yun L., Bliault A. [Yun, Bliault 2000], Zalewski W. [Zalewski 2003], Zhou J., Guo J., Tang W., Zhang S. [Zhou, Guo, Tang, Zhang 2009; Zhou, Tang, Zhang 2009] are devoted to research of aircraft and ships with support devices on an air cushion. But, taking into account the principle differences

between the conveyors and aircraft or ships, use the results of these works to determine the characteristics of the conveyors on an air cushion is not possible.

In work of Złoto T. and Nagorka A. [Zloto, Nagorka 2007] the results of investigation of the pressure distribution of oil film in the variable height gap between the valve plate and cylinder block in the axial piston pump are presented. However, due to the fact that the air and oil have different physical properties, the results of this work may not be used in the study of conveyors on an air cushion.

In work of Dreszer K.A., Pawlowski T., Zagajski P. [Dreszer, Pawlowski, Zagajski 2007] the process of grain relocation with screw conveyors is investigated. Conveyors on an air cushion in these works are not studied.

Taking the above into account, the aim of this article is to obtain a mathematical model of the traction force coefficient of the conveyor on an air cushion with sloping round channels. To achieve this aim it is necessary to solve the following tasks:

- mathematical modelling of the traction force coefficient of the conveyor on an air cushion with sloping round channels;
- experimental checking of the results of the mathematical modelling.

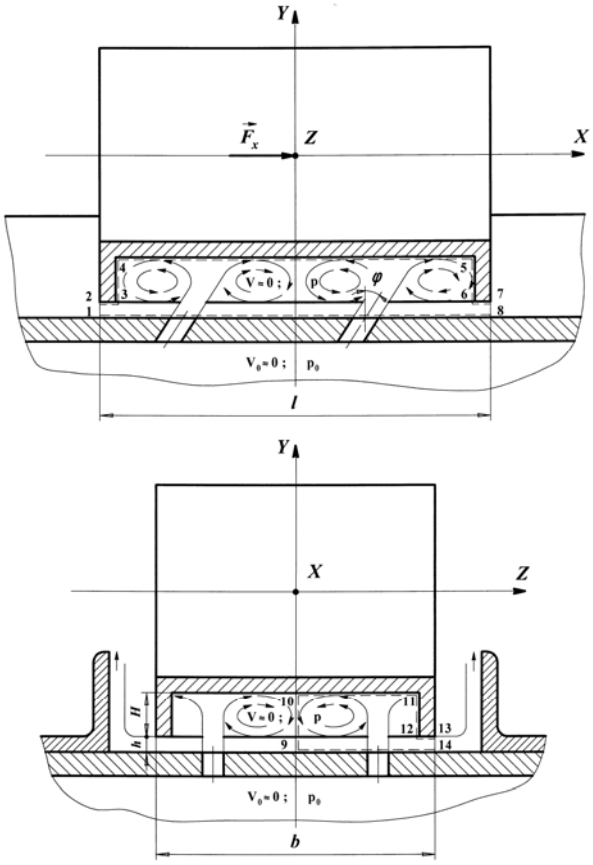

Fig. 2. Calculation scheme of the conveyor on an air cushion with sloping round channels

THE DECISION OF THE RESEARCH TASKS

The traction force, which acts on the load, transported by conveyor on an air cushion with sloping round channels, can be determined with the help of the law of conservation of momentum for the volume of the liquid, limited control contour 1-2-3-4-5-6-7-8-1 (fig. 2). Using the theory of machines on an air cushion [Khanzhonkov 1972], in the projection on the X-axis have:

$$F_x = \rho V_{1a}^2 S_1 n_1 \sin\varphi\,, \qquad (1)$$

where: ρ - the air density; V_{1a} - the average velocity of the air in the channel outlets; S_1 - the cross-sectional area of the channel; n_1 - the number of channels situated under the load; φ - the slope angle of channels to the vertical line.

On the basis of the Bernoulli equation for the flow in the channel outlet can be found:

$$p_{1a} + \frac{\rho V_{1a}^2}{2} = p + \frac{\rho V_1^2}{2}\,,$$

where: p_{1a} - the average pressure in the channel outlets; p - the pressure in an air cushion; V_1 - the speed of the airflow around the edge of the channel outlet.

Accepting

$$V_{1a} = \alpha_1 V_1\,, \qquad (2)$$

where: α_1 - coefficient, which takes into account the uneven distribution of speed in the channel outlet; can be obtained:

$$p_{1a} = p + \left(1 - \alpha_1^2\right)\frac{\rho V_1^2}{2}\,. \qquad (3)$$

Substituting the expressions (2) and (3) in equation (1) and accepting

$$S_1 n_1 = \overline{S}_1 S\,, \qquad (4)$$

will have:

$$F_x = \rho\alpha_1^2 V_1^2 \bar{S}_1 S \sin\varphi\,, \qquad (5)$$

where: $\bar{S}_1$ - the relative area of channels; S - the area of the support surface of the load.

Using the Bernoulli equation, for the part of the flow from the receiver to the channel outlet can be found:

$$p_0 = p + \frac{\rho V_1^2}{2}. \qquad (6)$$

where: p_0 - the air pressure in the receiver.

The pressure in the air cushion can be determined with the help of the law of conservation of momentum for the volume of the liquid, limited control contour 9-10-11-12-13-14-9 (fig. 2). In the projection on the Z-axis have:

$$\rho V_2^2 hl = p(H+h)l - pHl\,,$$

whence it follows:

$$p = \rho V_2^2\,,$$

where : V_2 - the speed of the air, coming out from under the load; h - the thickness of the air cushion; H - the depth of the cavity on the side of the support surface of the load. Then the expression (6) will have the form:

$$p_0 = \rho V_2^2 + \frac{\rho V_1^2}{2}. \qquad (7)$$

The construction of the conveyor gives grounds to assert that

$$V_1 S_1 n_1 = V_2 S_2 = V_2 \Pi h\,,$$

where: S_2 - the area of the output slit; Π - the perimeter of the load; whence, taking into account the expression (4) and designated $\bar{S}_2 = \frac{\Pi h}{\bar{S}_1 S}$,

$$V_2 = \frac{V_1}{\bar{S}_2}\,,$$

where: $\bar{S}_2$ - the relative area of the output slit.

In view of the foregoing, equation (7) can be represented as:

$$p_0 = \left(\frac{2 + \bar{S}_2^2}{\bar{S}_2^2}\right)\frac{\rho V_1^2}{2}. \qquad (8)$$

Generally, the traction force can be determined as follows:

$$F_x = c_x p_0 S\,, \qquad (9)$$

where: c_x - the traction force coefficient. Substituting the expression (5) and (8) in the relationship (9) and solving the resulting equation on c_x, find a formula of the traction force coefficient:

$$c_x = \frac{2\alpha_1^2 \bar{S}_1 \bar{S}_2^2 \sin\varphi}{2 + \bar{S}_2^2}. \qquad (10)$$

In accordance with the [Turushin, Pronin 2007]

$$\alpha_1 \approx 4\frac{H+h}{d}\left[1 - 2\frac{H+h}{d}\left(1 - e^{-0{,}5\frac{d}{H+h}}\right)\right], \qquad (11)$$

where: d - the diameter of the channels. Substituting the expression (11) to equation (10), and also considering that

$$\bar{S}_2 = \frac{\Pi h}{\bar{S}_1 S} = \frac{2(b+l)h}{\bar{S}_1 bl}\,,$$

where: b - width of load; l - length of load; will have:

$$c_x = \frac{64\frac{(H+h)^2}{d^2}\left[1 - 2\frac{H+h}{d}\left(1 - e^{-0{,}5\frac{d}{H+h}}\right)\right]^2}{1 + 2\frac{(b+l)^2}{\bar{S}_1^2 b^2 l^2}h^2} \times \frac{(b+l)^2}{\bar{S}_1 b^2 l^2}h^2 \sin\varphi\,. \qquad (12)$$

Expression (12) is a mathematical model of the traction force coefficient of the conveyor on an air cushion with sloping round channels.

The results of the modelling and experimental research of the traction force coefficient of the conveyor on an air cushion with sloping round channels [Turushin, Pronin 2006] are presented in fig. 3-6 (the modelling results are shown as a dotted line, the results of the experiment are shown a solid line). As you can see, the differences between the modelled and experimental values of the traction force coefficient is in the range of 0.9 - 14 % , which indicates a satisfactory accuracy of the obtained model.

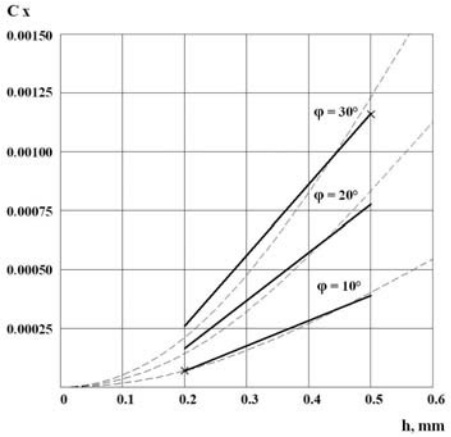

Fig. 3. The modelled and experimental values of the traction force coefficient when $d = 4$ mm, $\overline{S}_1 = 1$ %, $H = 1$ mm

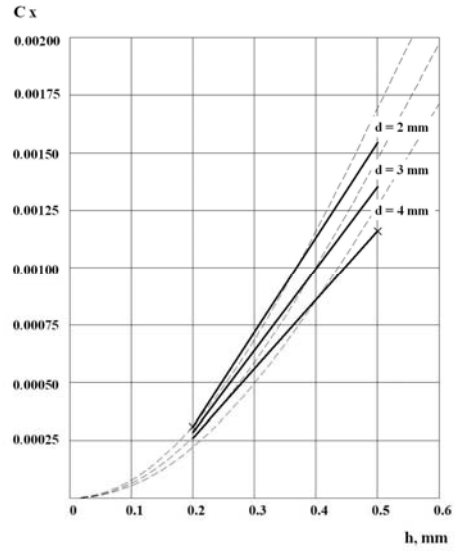

Fig. 4. The modelled and experimental values of the traction force coefficient when $\varphi = 30^\circ$, $\overline{S}_1 = 1$ %, $H = 1$ mm

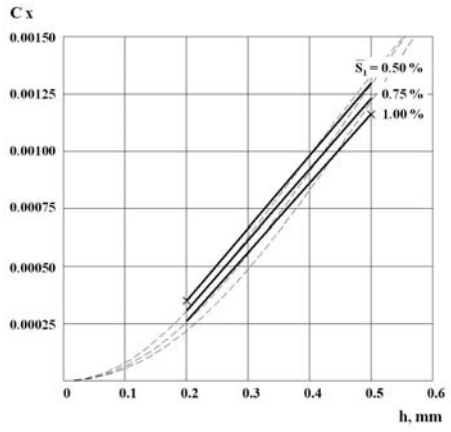

Fig. 5. The modelled and experimental values of the traction force coefficient when $\varphi = 30^\circ$, $d = 4$ mm, $H = 1$ mm

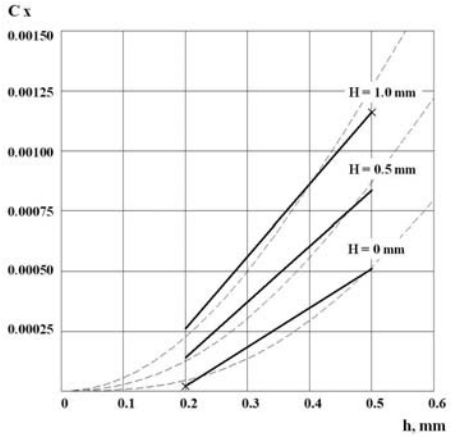

Fig. 6. The modelled and experimental values of the traction force coefficient when $\varphi = 30^\circ$, $d = 4$ mm, $\overline{S}_1 = 1$ %

CONCLUSIONS

1. The mathematical model of the traction force coefficient of the conveyor on an air cushion with sloping round channels is obtained. The model takes into account the character of the velocity distribution in the channel outlets, as well as the possible presence of the load box-shaped support surface, which ensures the high accuracy of the model and its universality in relation to the configuration of a load support surface.
2. The obtained mathematical model of the traction force coefficient of the conveyor on an air cushion with sloping round channels adequately displays the data of the experiment. The modelling results differ from the results of the experiment for not more than 14 %.

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МАТЕМАТИЧЕСКАЯ МОДЕЛЬ КОЭФФИЦИЕНТА ТЯГОВОЙ СИЛЫ КОНВЕЙЕРА НА ВОЗДУШНОЙ ПОДУШКЕ С НАКЛОННЫМИ КРУГЛЫМИ КАНАЛАМИ

Максим Пронин

Аннотация. Используя методы аэродинамики идеальной жидкости и положения теории аппаратов на воздушной подушке, получена математическая модель коэффициента тяговой силы конвейера на воздушной подушке с наклонными круглыми каналами. Проведено сравнение результатов моделирования и экспериментального исследования коэффициента тяговой силы конвейера на воздушной подушке с наклонными круглыми каналами.

Ключевые слова: конвейер, воздушная подушка, тяговая сила

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METHOD AND MODELS OF BLOCK-RANK ANALYSIS OF THE VALUE FACTORS AS INDICATORS OF ECONOMIC SECURITY AND EFFICIENCY OF THE MANAGEMENT OF THE INTANGIBLE COMPONENT OF THE VALUE OF THE SCIENCE-BASED PROJECT-ORIENTED ENTERPRISES

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S u m m a r y . The new approach to the determination of the economic security of the science-based project - oriented enterprises is considered. It is based on determination of management efficiency of the intangible component of their value. The rates of height of factors of value are used as indicators of the management efficiency estimation. They reflect the state, positive and negative influence, and purposeful betterment of objects of intellectual property and resulting index.
K e y w o r d s . Project oriented enterprises, economic security, value, intangible component, management efficiency.

INTRODUCTION

In modern terms of the global economic system evolution the different paradigms of passing to new strategies of development are examined. One of them has the name informatively-innovative [Buz'ko, Efremov 2010]. The other one's named as knowledge paradigm that underlining a difference between knowledge and information [Rach, Rossoshanska, Medvedeva 2011; Stepanova 2012].

But for today it's already became acknowledged axiomatic statement that an intellectual creative capital of the person is a main economic source. "The time has came when development of this source became not only an absolute necessity but the requirement of life-support of existence of human and the whole civilization" [Ghorelov, Krablova 2012].

To convert the knowledge into the material product of wide consumption (commodity) the new forms of activity organization of enterprises are needed. Statistics shows that such form is the science-based project-oriented enterprise [Beresovsky 2011].

The projects as instruments of putting the innovations into business are the basis of their activity. Thus, as a criterion of "science-based" is not the character of activity organization but the laws of nature. The application of those laws determines descriptions of the receiving products in technological processes (technological modes) [Rossoshanska 2012]. For them "ability of human capital with high-frequency to generate rational ideas and provide the maximal rate of their implementation becomes the source of competitive advantage, steady development, and providing of economic security" [Atoyan, Lopuhin 2010].

Thus, the point of the choice of indicators that would characterize a presence of competitive advantage and economic security at the enterprise performed as informative sources of the enterprise management and approve the administrative decisions remains arguing and open.

ANALYSIS OF THE PUBLICATIONS

The one may distinguish two groups of indicators that describe fundamentally different approaches from the point of the time measuring. The first one accents attention on a short-term prospect that is related to the competition for a consumer market that provides economic viability of enterprises. It corresponds to the "accounting

standard" of thinking when indicators of average profit, return on a capital are used. In other words, such indicators are analytical derivatives from the financial reporting [Teplova 2004]. The other one examines the health of enterprise from the point of the strategic planning. The main indicator of that is a gradual increase of the total value of the business. It corresponds to the "financial standard" of thinking when the modified indicators are also used from the financial reporting, but with the significant corrections. Except that, not the absolute indicators but their rates of height are examined for the reflection of dynamics of process of value creation [Shyshkin 2009; Shyshkin 2011]. Recently the approach oriented to the value of enterprise was considered most perspective [Shyshkin 2009; Eleneva 2011].

However neither accounting nor financial indexes that were used at the marked approaches are unable to represent reasons of creation of additional value. Therefore the "value based standard" that binds the health of the enterprise with the investing capital in development of human potential and R&D projects and programs comes on to replace financial standard of thinking. Its basic postulate is proclaimed in the paper [Karlsson, Wangerud, Axelsson, Sveiby, Annell, Vikstrom 1991]: "People and not capital that generate profit".

Theoretical bases of the management of the enterprise value has been become the object of research for many authors: [Drucker 1974], [Drury 2001], [Modigliani, Miller 1958], [Stewart, Bennet 1999], [Gryasnova, Fedotova 2003], [Oleyko 2002], [Shyshkin 2009], [Shnayder 2012].

But the decision in economic safe value based management of science-based project-oriented enterprises with an application of the value approach has not been found till now.

THE GOAL AND TASKS OF RESEARCH

Management is feasible only when corresponding indicators and methods of working of these indicators will be found. Therefore a research aim is to search of the approach to the construction of model and its components, that would give an opportunity, first of all, to estimate the state of economic security of the science-based project-oriented enterprises (SBPOE) and to accept rational decisions in the value management of their intangible component that is more significant for them than tangible one.

THE MAIN RESULTS AND THEIR ANALYSIS

Any enterprise as well as a human exists when it moves, i.e. perform an activity as an active integrity. Therefore the possibility of providing the continuous activity becomes a criterion of economic security of the enterprise [Rossoshanska, Rach 2012].

For the SBPOE the performance of such activity will be a permanent growth of the intangible component of the value. In this context under the economic security of the SBPOE one should understand employees' sufficiency of own methods and means in order to provide the continuous process of the motion at direction of creation and implementation of new knowledge: the objects of intellectual property, especially those which would provide the growth of the value of the SBPOE.

The creators of the intellectual property objects are employees of the SBPOE, competent persons. It is competent person who is able to make it in terms that constantly changing and practically never repeating [Rossoshanska 2011]. And it is impossible to attain, if they will not be able to "join in the permanent self-training for all their life" [Ramazanov, Kalinenko, Rakova 2011]. A competence is an ability of the employee as a person within the frames of business processes for that he is responsible on the basis of present knowledge and the one that generated by him to design and realize the continuous activity of other employees in the direction of improvement and development the business processes in the conditions of spatio-temporal availability of methods and facilities [Rossoshanska 2012].

The effective growth of the value of the SBPOE will take place with the condition if the growth rates of the most "essential objects" will pass ahead the growth rates of other objects of intellectual property. Exactly this condition can be considered as the aim of value-based management of the intangible component of the SBPOE. From this point the objects of intellectual property on the criterion of importance is suggested to classify as following [Lyashenko 2010]: objects for competitive advantages (CA); objects for innovative activity (IA); objects for service activities (SA); non-traditional for the field of enterprise activity objects (NT). Any of the intellectual property objects are the potential sources of appreciation of market value of the enterprise. But the offered scale gives an opportunity to define the most essential objects and give them a rank.

As an author of the paper [Shyshkin 2009] marked the "economic process of the value creation does not exist out of the time". Therefore only the "dynamic criterion of the decision making model allows to form a structure that provides the optimal trajectory of development of economic process of the value creation". Such criterion mustn't set the concrete values of parameters that should be attained. It determines correlations of indicators. It is the providing of relations that gives the desirable growth of the market value of SBPOE and testifies to its economic security. And understanding of the "desirable growth" i.e. economic security is set subjectively, for example, by the committee of directors of the SBPOE, and is examined as the ideal state in relation to which the transient states of enterprise are measured. It's fully responds to the statement that "we are the source of any and every dangers ourselves, and the idea about the prescribed outside dangers is the essence of the converted form of psychological origin" [Rats, Sleptsov, Kopulov 1995].

The conducted researches of the essence of objects of intellectual property proved that regardless of the belonging to any of the marked group (CA, IA, SA or NT), it is possible to distinguish four blocks of indicators, essence of which represents: the condition of objects (C); the purposeful actions under their betterment (B); their positive (A^+) and negative (A^-) reverse actions on the value of the SBPOE.

Except that, to four objects it should be added another one, the additional element that is represents economic essence of value added from the use of objects in total, and that is why can be named as a "resulting" element. For the SBPOE such resulting element can be VIC - Value of Intangible Component that described in [Lyashenko 2012]. It is also possible to distinguish for him marked four blocks of indicators.

The pointed groups of objects, the blocks of indicators, and additional resulting element give an opportunity to build the matrix of correlation of indicators. It is built by the same rules that matrix with the use of EVA has been built [Shyshkin 2009] but taking into account its block configuration (fig. 1).

In this matrix a condition is executed that for the groups of objects VIC > CA > IA > SA > NT. In addition, within the limits of every group a condition is also executed: $A^+ > B > C > A^-$. If a comparison of indicator in a line with an indicator in a column will perform that the growth rate of the first one passes ahead the growth rate of the second one then the crossing point must be filled in "1". In opposite case is "-1".

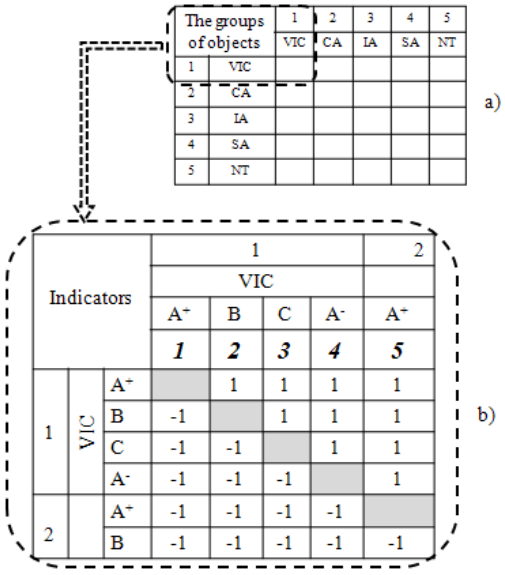

Fig. 1. The matrix of the correlation of indicators
a – the block structure;
b – example of the VIC group structure.

The base matrix that represents requirements, for example, from the committee of directors of the SBPOE in the top part from a diagonal must have only "1", and in lower, as a result of its symmetry, only "-1". The sequence of indicators in a matrix determines their ranks (a fat italic on the fig. 1 b). And a rank is used as an indicator for comparison in future. In the actual matrix of indicators "1" and "-1" are filled in depending on actual correlation of indicators that was compared.

The basis of further calculation is made by the matrix of deviations. It has the same dimension as the matrices of correlations of indicators. In it every cell filled in with "0" if the actual grade of indicator on a line did not change in relation to an indicator on a column, and "1", if it actually is. In every line a sum of "1" calculates. Then all sums are summarized to the sum of distinguished from base model correlations of indicators in comparing to actually attained model. On the basis of this sum and amount of indicators the Kendall's tau coefficient is calculated in the matrix. It performs as the integrated indicator of the state of the economic security and characterizes it as the phenomenon that is perceived from outside. In addition, it's examined as an indicator of the estimation of value-based management efficiency of the SBPOE's intangible component. Its comparing to the tabular value gives an opportunity to draw conclusion whether the hypothesis of independences of two selections that are presented in base and actual matrices is cast aside or not [Lopach, Chubenko, Babych 2002].

In this case it gives an opportunity to set the following: data of the matrices closely related between each other or not. With the presence of such relation it is possible to assert that regarding the deviation of actual correlations between the growth rates of indicators from base ones due to intangible component of the value the market value and present state of economic security of SBPOE increases. So, it is possible to consider satisfactory state of the enterprise in total.

The absence of the relations, first of all, testifies that employees showed not enough competence in creating the objects of intellectual property, and/or the created objects are not used in SBPOE to the extent that was planned from the beginning, and/or the received effect does not corresponds to that one planned. Thus, the economic security of SBPOE changes its motion from the state of the safety in direction of the danger [Rossoshanska, Rach 2012]. And the management of the value of the intangible component can be characterized as unsatisfactory.

The offered structure of the matrix contains 20 indicators. It's expediently to present every block of indicators not by one, but by two indicators. That gives an opportunity to enter another additional essence classification of indicators in the future. In that case, the amount of indicators increases to 40. And it considerably complicates the search of ways of change the direction of motion of economic security from dangerous to safe.

For the decision of this point the new approach to the analysis of the matrix of deviations is offered. It's based on principles of system-integral approach [Rach, Rossoshanska, Medvedeva 2010].

From the matrix of rejections as primary integrity (further on – i-matrix) separate blocks are distinguished after the amount of the objects' groups (fig. 2).

Indicators		VIC			
		A^+	B	C	A^-
VIC	A^+		0	1	0
	B	0		1	1
	C	1	1		0
	A^-	0	1	0	

Indicators		CA			
		A^+	B	C	A^-
CA	A^+		1	0	0
	B	1		1	1
	C	0	1		0
	A^-	0	1	0	

Indicators		IA			
		A^+	B	C	A^-
IA	A^+		0	0	0
	B	0		1	1
	C	0	1		0
	A^-	0	1	0	

Indicators		SA			
		A^+	B	C	A^-
SA	A^+		0	1	0
	B	0		0	1
	C	1	0		0
	A^-	0	1	0	

Indicators		NT			
		A^+	B	C	A^-
NT	A^+		0	1	0
	B	0		1	1
	C	1	1		1
	A^-	0	1	1	

Fig. 2. The matrices of the deviations for the groups of the objects

Kendall's tau coefficient is calculating for each of them. Then the most dangerous groups are found out on the basis of analysis of those calculations. Exactly in these groups in actual matrices there will be considerable divergences of correlations in comparing to the base matrix.

Then from the i-matrix are examined in pairs the groups of objects, and for them the matrices of deviation (fig. 3) are distinguished. For each of such matrix the Kendall's tau coefficients are also calculating.

Indicators		VIC				CA			
		A^+	B	C	A^-	A^+	B	C	A^-
VIC	A^+		0	1	0	1	1	0	0
	B	0		1	1	1	0	1	1
	C	1	1		0	0	1	0	0
	A^-	0	1	0		0	1	0	1
CA	A^+	1	1	0	0		0	1	0
	B	1	0	1	1	0		1	0
	C	0	1	0	0	1	1		1
	A^-	0	1	0	1	0	0	1	

Fig. 3. Example of the matrix of the deviations for two groups: VIC and CA

In the same way the combinations of three and four groups of objects are examined. Depending on values for every separate group of Kendall's tau coefficient, it is necessary to pick up the combinations that will give a maximum of information for the search of the most effective ways of motion in direction of economic safe state.

There is the matrix with different combinations of groups of objects and value for their Kendall's tau coefficient on the fig. 4. The calculation of coefficients for combinations of "CA-IA", "IA-SA" does not give new information because for every separate group of the block tau equaled a zero. There is also not much additional information in other combinations where the involved groups were with a zero value for the tau ("VIC-CA", "VIC-IA", "VIC-SA", "VIC-CA-IA", "VIC-CA-IA-SA").

	.07	.07	.07	.28	.37	.00	.00	.07	.29	.07	.03	.02	.20
VIC									.29				
CA									.00				
IA									.00				
SA									.00				
NT									.14				

Fig. 4. The value of the Kendall's tau coefficient for the different combination for the groups of the objects

From the point of getting an additional information it's useful to calculate the coefficients for the different combinations of indexes for different groups that belong to one block (condition of the objects (C); the purposeful actions on their betterment (B); their positive (A^+) and negative (A^-) reverse action. There is an example of matrix of the deviations that was made for the indexes of betterment on the fig. 5.

BETTERMENT

K=		0,3333		VIC		CA		IA		SA		NT		The sum of the lines
				B		B		B		B		B		
				1	2	3	4	5	6	7	8	9	10	
				B_1	B_2	B_1	B_2	B_1	B_2	B_1	B_2	B_1	B_2	
VIC	B	1	B_1		0	1	1	1	1	1	1	0	0	6
		2	B_2	0		1	1	1	1	1	1	1	1	8
CA	B	3	B_1	1	1		1	1	1	1	1	0	0	7
		4	B_2	1	1	1		1	1	1	1	0	0	7
IA	B	5	B_1	1	1	1	1		1	1	1	0	0	7
		6	B_2	1	1	1	1	1		1	1	0	0	7
SA	B	7	B_1	1	1	1	1	1	1		1	0	0	7
		8	B_2	1	1	1	1	1	1	1		0	0	7
NT	B	9	B_1	0	1	0	0	0	0	0	0		1	2
		0	B_2	0	1	0	0	0	0	0	0	1		2
The sum of the columns				6	8	7	7	7	7	7	7	2	2	60

Fig. 5. The Kendall's tau coefficient calculation for the indicators of betterment for all groups of the objects

By means of such combinations in a test example it was found out that the indicators of the condition and betterment had greater values (0,38 and 0,33) in relation to the indicators of positive action (0,13). From the position of motion in direction of economic safe state first of all it points on a necessity of activations of development of objects of intellectual property for the competitive advantages, and their putting into operation.

CONCLUSIONS

The analysis of the existent approaches to the management has proved that the "accounting" and "financial" standards of thinking were not effective in an era of the knowledge economy. They didn't take into account the main feature of such economy, when people but not capital that generate profit. Therefore, it's proven that the "valued standard" of thinking is needed for the science-based project-oriented enterprises. It's effective in the era of knowledge economy. Thus, the determination to the definition "economic security of the science-based project-oriented enterprises" had been given from this point of view. It was described as an ability of enterprise to increase its market value due to its intangible component.

The classification of the indicators for intellectual property objects was worked out on the base of the earlier classification of intellectual property objects on the criterion of importance that has been offered by one of the authors of this article. Essence of the last one has represented the condition of the objects; the purposeful actions on their betterment; their positive and negative reverse activity on the science-based project-oriented enterprises. Combination of the classifiers gave an opportunity to work out the model of construction of the indicators' correlation matrix that represents the terms of effective value based management of the science-based project-oriented enterprises.

The new method of block-rank analysis of activity results of the science-based project-oriented enterprises were worked out from the point of their economic security that had been based on the analysis of the Kendall's tau coefficient for the groups of objects of intellectual property and indexes of their height rates that characterized their use in the process of activity of enterprise calculated for different combinations of the groups.

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МЕТОД И МОДЕЛИ БЛОЧНО-РАНГОВОГО АНАЛИЗА ФАКТОРОВ СТОИМОСТИ КАК ИНДИКАТОРОВ ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ И ЭФФЕКТИВНОСТИ УПРАВЛЕНИЯ НЕМАТЕРИАЛЬНЫМ КОМПОНЕНТОМ СТОИМОСТИ НАУКОЁМКИХ ПРОЕКТНО-ОРИЕНТИРОВАННЫХ ПРЕДПРИЯТИЙ

Ольга Россошанская, Наталья Ляшенко

Аннотация. Рассмотрен новый подход к определению экономической безопасности наукоемких проектно-ориентированных предприятий, основанный на определении эффективности управления нематериальным компонентом их стоимости. В качестве индикаторов оценки эффективности управления использованы темпы роста факторов стоимости, которые отражают состояние, позитивное и негативное влияние, а также целенаправленные действия по улучшению объектов интеллектуальной собственности и результирующего показателя.

Ключевые слова. Проектно-ориентированные предприятия, экономическая безопасность, стоимость, нематериальный компонент, эффективность управления.

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INFORMATION TECHNOLOGIES IN UKRAINE: PROBLEMS AND OBSTACLES

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S u m m a r y . In the article the problems and obstacles of developing information technologies of society in Ukraine are explored. The positive and negative consequences of influencing are certain and usage of the information technologies in the life of Ukrainian people. The concretes examples are considered.
K e y w o r d s : an informative technologies, the Internet, a market, a network.

INTRODUCTION

The prospects of developing informative society in Ukraine are limited by unrealized human potential. Ukraine is unable to develop the personal computer of own production, although in times of Soviet USSR she had similar ambitions. So far, there is only not unfounded impression, that Ukrainian nation is the passive user of the innovative technologies created by other nations, and does not offer to the world their own ones. Consequently, our society can not be categorized as smart society, in which indicates about the technologically determined social transformations, and related with transition from wide application of knowledge's to the mass using of information, from which by an automatic way in the necessary time and in the necessary place almost it is possible to «extract» the necessary knowledge's. At the same time, according to the UNO data, after the index of development human potential in Ukraine, it takes the 69 site from 170 countries (in 2010). Sharp property stratification, which generates the problems of poverty, absence of social elevators and etc., is a considerable brake on the way of human potential realization in Ukraine. This is necessary to consider, that during last years in Ukraine does not growing up the potential of human development but lost it, yielding to this index not only to the developed western countries, but also to neighboring Russia and Byelorussia. In addition, this comparative high index is represents that Ukrainian high indexes in education are not hopeless yet.

OBJECTS AND PROBLEMS

The problems of developing information technologies were engaged and researched by scientists from different countries, such as Artur Boguta (Lublin University Technology) [2], Brusilovsky P. and Miller P. [3], Cherednichenco V.S. [4], Galanter E. [5], Goldberg I. [6], Horoshco V.O. [7], Marcin Buczaj, AndrzejS umorek (Department Computer and Electrical Engineering Lublin University Technology) [11], Nawrocki W. [12], Petykiewicz P. [14], Sowa J. F. [16], Tlaczala W. [17] and they are asserts that every country has technological, public and another development information technologies features. Therefore the article purpose is researching of the problems and obstacles of development information technologies in Ukraine.

RESULTS AND DISCUSSION

On a background the prospects of introduction information technologies in Ukraine with the purpose of human society degree is becoming obvious foolishness of human behaviour, which are enough through an edge at

the level of fictitious formed, bureaucratic corrupted and incompetence, removal of competent people conscious or irresponsible from the management, get up self-evident.

Except for that, it is necessary to consider with threats, that rising up in the case, if people intellect does not answer to the machines wit and when it is necessary to expect the usage of leader information technologies not for the welfare, but for the total control of the human conduct and even its modifications in the desired direction. Without regard to all external signs of progress, on the whole Ukraine there are negative tendencies of development domestic informative sphere. During last year's Ukraine is worsened positions in the various international rating, that certify its electronic consciousness causes.

In particular, according to the rating of developing information and communication technologies they were published in the World Economic Forum by experts in April 2011. Ukraine among occupied the appraised from 138 countries only the 90th place, considerably yielding to such neighbours as Russia (77 position) and Kazakhstan (67 position). But Sweden, Singapore and Finland are headed this list. The given rating is exactly important because he coincides with rating of network development, that is specifies on that, as far as this country or another country in the world is ready to use information technologies in the real life [9].

In the estimations participants of the II Ukrainian Forum of management by the Internet (Kiev, September 2011) were more optimistic, according to them the market of information technologies in Ukraine is on the verge of revolutionary jump, after which stormy extensive growth will begin.

Nearly from 6 million to 17 million Ukrainians are using the Internet. From year to year the quality of Internet gets better – the traffic, a capacity and fast-acting of which appraisal will growing to 2015 year as 48 times. Already today, from data of measuring company Pando Networks, Ukraine is a member of the first ten countries with the highest speed of developing information technologies.

Ukraine has the real achievements in the market of program outsourcing, under which it is necessary to understand the usage of the own benefit in stranger resources, no keys of selection from the production links process, low profitable and transmission to their specialized companies, grant of the resources to other companies, that are occupied with similar business, but high results were not attained yet.

In the case with program outsourcing the question is shared participation of the Ukrainian performers in creation of the stranger finished product. Indeed, quite a bit software popular product in the world contain a peace of Ukrainian national intelligent, and the specific carriers of various intelligence companies information are arrange real headhunting. There are 55-60 % domestic outsourcings products on export, as piracy incident to Ukrainian market is revolved by modest necessities in the software products of internal producer. Ukrainian informative market has peculiar high degree of shade which is characterized by low index of tax collection and accordingly by low level of budgetary charges for it development.

Ukraine takes the 15 seat in the world rating of software producers. There are about thousand companies, witch are engaged in the information and communication technologies developing. From official data, about 25-30 thousands Ukrainian specialists are occupying here, although, out of doubt, in actual fact the number is bigger.

In the world export of outsourcing products the annual part of Ukraine received almost $ 1 billion in 2010, but according to analytical agency Gartner the Indian export in 2010 was estimated in $ 34 billion, Chinese - $ 28 billion, and Russia -$ 2,65 billion.

The global market of information export technologies is estimated by experts in $ 90 billion and in 2013 year it can grow up to $ 120 billion. There was a question in 2004, if Ukraine could be on the outsourcing field as a player without Russia .She has already became in 2006 an independent player in this sphere. Characteristically, if an outsourcing company were concentrated in large town, presently this direction develops in regions actively [8].

According to data of power, the industry is shortage of specialist: in Ukraine (2010) a 14,4 thousand of specialists was officially counted **,** that for the state with the considerable scientific and educational resource of their preparation extraordinarily had. At the same time in one of appearances chairman of the state agency about the questions of science, innovation and informatization of Ukraine cited such digits: 60-70 % domestic market of a particular branch is found in shade and 9 from 10 Ukrainian program works in the external market.

In such situation of warning impact to skilled specialist in a border or in the shadow sector of

national economy in natural way is to become one of foreground jobs of state informative policy, the state needs: to provide development of feedback processes by the assistance to entrepreneurial activity at information technologies, flexible reaction on the newest tendencies of its development and on external influences of this development; to create Ukrainian silicon valleys for deserving legal employment of Ukrainian specialists, the expansion of corridor their possibilities through the increase of government businesses, start to specialized projects in the field of information technologies, introduction of the grants system and etc.

Because of the high changing dynamics in industry, it is necessary to carry out the noting state policy of modern stimulation market not on the wave of enthusiasm, but according to the prognoses in relation with perspective directions of his development and cycle of the next preparation wave for specialists (4-5 years). Except for that, the relatively limited budgetary resources will be efficiently to combination alternative sources of financing in – the facilities of the international funds, foreign investors, informative companies, witch can be motivate by locally, and more global.

Determining the degree of processes influencing in informatization on the Ukrainian life and society (Ukrainian citizens), it is not impossible to mark an annoying fact with episodic statistical information and shortage of sizeable sociological researches.

Over that, until now there is no synonymous understanding, that measuring of exceptionally mechanical indexes degree of the newest information technologies introduction (although there are considerable complications) in no way passes the real picture of influencing these technologies on the everyday Ukrainian life and Ukrainians, which are in a great extent is measured by the volumes of the concrete services using , for which informative and communicative technologies are only a methods, instead the goal**.** Measuring of the Internet amount is the example of a similar inadequate approach - users in Ukraine. Their number is given out for enormous achievement in the field of informatization. Pursuant to data of sociology Institute 54,7 % -is not until now using the computers in Ukraine. However is comparative with the indexes of eight-year remoteness it is possible to mark substantial growth of well-informed amount – the untrained persons were 79, 8 %. But such as positive dynamics is deceitful, because it is arrived at exceptionally due to demographic changes. Including the rising generation of young Ukrainians (which practically is 100% using computers), an index in actual fact changed: it was corrected by growth number of young people and departure of senior generation. That can mean only: actual absence of state policy from bringing to the new informative and communication technologies of senior Ukrainian citizens generations. Basic discussion around the index of amount in the Internet - users in Ukraine takes place in relation to the choice of concrete methodology of research, which affects an eventual index. At the same time the practical absence of reliable statistics in relation could be ascertain, how exactly the Ukraine citizens use the Internet and select tendencies growing key of common users amount.

The sociology Institute researches, even in 2008-2009 crisis years are demand on the Internet - services did not diminish, but grew up ,the estimation point of view is the explored features question about the Internet for our citizens and it is the considerably major parameter of network value , than another general tendency of growing users [5].

In general case the statistical information about the generalized directions of the using technologies by the citizens (entertainments, news, work, intercourse, etc.) even these forms of activity is practically absent. In this question exactly the reality allows to draw conclusion about that, if the information technologies are influenced on the society life, if they continue to execute a background function.

Statistical data from the economic sphere is an expulsion, which give an opportunity to assert that Ukrainians in separate directions of vital functions indeed begin to use information technologies for facilitation of the existence or acceleration of the certain real processes.

If a few years ago the shops were really exotic things purchases in the Internet , at least time in more than 10 million of Ukrainian people bought commodities or services in virtual shops, etc. Over that, the shops allows to satisfy the most unusual sectors of human mode exactly in the Internet sector.

Banking is actively developing market in the Internet - it has about 22% Ukrainian users of the Internet network, and it has about 3-3, 5 million people(although about 99 % of users are done less than by 5 operations on a month, it answers to the utilitarian using of the system especially - payment of accounts after vital and utilities economy, addition to the mobile telephones and etc.). The

«Touchpoll» company researches are 11 % plan to begin using such system in the near future, and potentially already in 2012 common amount of system users in the Internet – banking can be multiplied to 15-17 million. Needs to mark that not great extent have enough high rates of capture by our citizens , given technology are stipulated by the factor of information lack with existence of such favor: only 46 % from the common number of the Ukrainian network users of the Internet are know about existence of the Internet favor - banking.

The system of express-paying is developing on the same basis, that has also allows to pay the accounts. Such companies signed the special agreements, according to which they get possibility to give a chance to pay the basic types of accounts to the users. At the same time it has already sets the question of destroying in a high-quality new level in providing safety of personal information, as a subject of the condition low knowledge of Ukrainian citizens with principles of the Internet network safety, they could be a prey of criminals.

The pay terminal market in Ukraine is growing up (QIWI, 24nonStop, City-Pay), that allows to fill up quickly the accounts of mobile telephones, electronic pay systems, to pay for vital and utilities economy services and etc. The information of this market all time are corrected, however, for example, during 5 years the functioning system QIWI is total appeal to made 3,2 billion of grn., and the amount of transactions is a 105,7 million [15].

The possibilities of the Internet are actively used for various favourable actions or attempts of citizen's self-actualization - modern communicative possibilities of social networks are allowed to the citizens.

Technology of the remote bank service, which access to the accounts and operations with them is allowed at any time and from any computer, that has an access to the Internet network. To the prime examples of similar actions it is possible to deliver action of the wireless Kiss FM radio station, which proposed on the Aukro.ua personal things, souvenirs and unique suggestions of disc- jockeys. The facilities begun to work on the account of separation for child's oncology in the National institute of cancer became investigation of conducting action. Similar actions with the using of Internet network possibilities - it is that new reality, in which Ukrainian citizens are exist and which is substantially changes the parameters of their vital functions.

On this background, you can see modest successes of the state in the real (instead of model) informatization in the activity and facilitation of co-operations between government and citizens. It is possible to select a few reasons of such state (except for the chronic shortage of facilities on similar initiatives and absence of desire leaders in separate state institutions to carry out such transformations).

Most projects which are realized today, practically do not relate to the necessities of man reality, daily routine (at least - the Ukrainian citizen). For example, the sites of public authorities are actively include electronic waiting rooms or enabled possibilities for electronic appeal from the side of citizen. At the same time, even in the real life an amount of appeals (statements, queries and etc.) from public is not so big, and when they used this one, it is realized by traditional paper and pen.

The low efficiency of the law introduction is accepted in 2010 «About access to public information», which created proper legal support for the electronic management and other forms of developing informative society of modern type in Ukraine, testifies about actuality of this problem. However, as sociologists found out, most Ukrainians either do not know this acceptance law, or disbelieve in its efficiency. Only 3 percents of citizens took the right of advantage to send the informative query to governments. 52 % Ukrainian people are don't known that in Ukraine the law about access to public information is accepted, the main – people don't believe in possibility of this law to do power more transparent and less corrupted. One in five considers that this law is able to have certain positive influence. Only 36,5 % are heard something about it, but do not know exactly, and only 11 % are acquainted with this law.

According to the questioning there is most of those, who did not hear about existence of this law, in south regions - 64 %, and in Crimea - 88 % [10].

The state increasingly focuses on the internal processes of public information management (Back-office), paying less attention to the externally oriented processes. So, annually to the various « informational and analytically systems» in public authorities of all levels are given considerable facilities (at that such systems are often created on different types of platforms, that complicates their concerted work between them).

Informatization of the state specific areas could bring to a real counteraction over the corruptions on places, in what not often interested

experimental and underpaid paid workers of state institutions.

In general, the surplus theoretical problems of introduction electronic management should be noted, that results in tightening of practical steps and preparation of official records on the removed subject of general meaningfulness problem, while most of materials which prepares in foreign countries by the researchers on the theme of alteration of e- government, it is devoted to consideration of concrete projects, instead of generalized philosophical reflections in behalf of that or other model of co-operations.

Without regard to the noted failing and miscalculations, the Ukrainian state undertakes some enough successful steps on a way to the real application of information technologies for citizens are more meaningful for the life spheres.

In the beginning of 2011 year the Ukraine Ministry of internal affairs and inter-regional center of delivery passport documents that is engaged in preparation and delivery of foreign passports allowed to carry out online registration to the Center reception.

The pilot projects are begins in Ternopol from an electronic record to the doctor and conduct of electronic illnesses histories (a project is started jointly with a Danish company «WebAdvancers» without the investment of facilities from the side of the state).

However more meaningful achievements of the state, which at the same time cause most agitations from the side of public, connected with the sphere of education.

During the last ten years in Ukraine it was succeeded to create normative-legal foundation for development the sector of e-education. Already in the beginning of 2010 year the row of documents which regulate development and informative application was accepted information and communicative technologies in education: 4 decrees from President of Ukraine; 2 edicts from Verkhovna Rada of Ukraine; 16 edict from Cabinet of Ministers of Ukraine; 2 orders of education and science Department, youth and sports of Ukraine.

At the same time it is possible to consider this data only partly reliable. Even the brief survey of higher sites educational establishments (which usually are the key elements of the e-education systems) testifies to that majority from them plays the advertising and representative function and have a small differs from publicity booklets. In the real educational process in higher educational establishments modern information technologies are used, extremely unsystematic and episodically. In the best case it is presentation systems, or in the high institutes it is television space bridge with the personalities.

Last years the usage of informative and prospecting system «Competition» is an informative breach at higher level educational establishments, that is appointed to inform operatively university entrants about the receipt of statements on the entry the higher educational establishments of the III-IV levels accreditation for gaining the educational-qualifying level of bachelor, specialist, master's degree of medical and veterinary-medical directions after directions of preparation (by specialties). Access to the system «Competition» is carried out to the address (http:// vstup.info). The system functions in the global informative composition in subsystem and local subsystems of conduct the account statements receipt entering higher educational establishments. At the same time the idea of experiment and his motion to got the row of critical remarks from the side of experts, politicians, representatives of public organizations.

Considerably more active information technologies are includes in the domestic schools, more intensive is carried out such introduction. In September 2010 the general scheme of the Ministry education and science, youth and sport of Ukraine and the Institute of innovative technologies and education and maintenance «Shodennic.ua» started, whose goal is to create a unified educational network for all participants in the educational process. In 2011 an educational platform, on which «Shodennic.ua» works on, became the laureate of bonus World Summit Award in a category the «Electronic teaching and education» (E-Learning & Education). During a year more than 3000 schools (with 20 000 from the common amount of middle educational establishments) or about 100000 users were connected to this project. At the same time the detailed statistical data from the system are absent, consequently it is heavy to set in the level of penetration such system (in rural locality). Now it is possible to establish an providing role of such system which allows parents to control teaching of their children in more district way, presence in a class, to get on mobile telephones important information about visitation, teaching successes and etc [13].

On the way of conversion to given project into the life the low level of modern penetration can become a hindrance information technologies in rural districts, that it is related foremost to the lack of infrastructure development. For the

decision of given problem a national project is begun the «Opened world» by which is foreseen creation of national network informative and communication on the basis of technology 4G, that will be used above all things for the necessities of school education. During 2011 year to this project 800 Ukrainian schools are connected.

All these projects are the reflection of the culture dominant real state in society of a new type: no book-texts cultures, but the computer – screen cultures. Young people are reads little and even stops to write with a hand or do elementary calculations. Instead young people looks over quite a bit pictures, collects quite a bit texts on a keyboard, quickly considers on a calculator, that properly it is not appraised and it is not taken into account in the Ukrainian educational system.

The Ukrainian teaching must not renounce the traditional pictures of pupils literacy. But the attention must be paid on a new literacy generated by the epoch of information and communicative revolution and literacy informative-technological, as an ability to work with the informative devices but not with the expenditure purpose of own time, and with the purpose of spiritual and professional self-perfection. The same is touches upon mastering by the bases of pupils screen culture. That the Ukrainian young people very intensively use modern information technologies and the Internet network, in particular is led by sociological researches. As a result of questioning, nearly 80 % of students are daily (constantly) used the Internet (chats, forums, social networks). Over that – exactly playing computer games and pastime in the Internet – it is the second popularity form of spending free time.

These data are correlated with the data of Sociology NAN Institute of Ukraine up to the 20 anniversary of Ukraine independence, after which in 2011 about 20 % Ukrainian citizens link the leisure exactly to the computer (in 1994 such was only 4,7 %). The XXI century became in Ukraine the time of swift computerizing and Internet development. In 2002 nearly 80 % were not able and never used a computer, constantly only 4 % used computers at work. In 2010 remained only 55 %, other either work with a computer (15 %) constantly, sometimes uses computers (30 %). Needs to mark that the number of those, who in general does not plan to buy a computer, remains practically permanent – at the level of 29,9 %.

It is possible to mark, that an amount and general formed of the Internet network using is stipulated exceptionally by appearance of new «young» users, while more seniors remain out of informatization processes. In such situation the material state of different population layers is instrumental.

As a result of questioning domestic young people, they do not feel strongly limited in a material plan - only 2,7 % marked that they critically have not the facilities (on feed), while to 70 % mark that considerable material confusions are not felt. Fully obviously, that such numbers substantially select young people from senior generation which are appurtenant to certain forces task and create a «digital precipice» between these groups [18].

All marked is stipulates priority of the using by students Internet resources for studying or searching information and only up to half of users usage it for communication (56,6 %). The level of penetration the same social networks in Ukraine (for example - Facebook) remains very insignificant in percents, and in attitude toward the common amount of users in network: at common their amount in 15 million only 1,4 million are users of Facebook, that is one of the lowest indexes in Europe. It is true, that there are some more powerful projects «Odnoklassniki» or «VKontakte». It is confirmed by the results of researching company InMind, according to which the domestic audience of social medias in digestive to 2011 year made 81 % active users for an average index in 61 %.

This level of immersion young people in the Internet and virtual space now allows to speak about the formation of new trends in the behavior of users that were not typical for Ukraine 4-6 years ago. So, already the mentioned number of swift growth amount of the Internet network users, reduced not only to positives, but also to the negative swift forming groups of people, which have dependence on the Internet.

According to the Institute of Social and Political Psychology of the national Academy of Pedagogical Sciences in Ukraine among the Ukrainian users of the Internet are considered dependent from 2 % to 6 %, absolute majority among which are students. In the group of teenagers with a high level of education , men's is the most dependence part on the Internet , this statistician is almost in three times exceeds women part. Almost the same indexes were exposed by specialists, which set that every fifteenth person (6,54 %) which has an experience of working in the Internet have a dependence on this already in juvenile age. Dependence is one of the Internet consequences even although compared with alcohol and drug addiction, this dependence less

harmful to human health, but its consequences have negative social and psychological color . In this sense the influence of this illness on the human relationships with the environment is the most substantial: it is complicate the relations between parents and children, in the married couple, between friends. So increasingly this disease appears during the trials of divorce, from labour disputes and even in relation to the criminal offenses (there is not single one cases of grave crimes like murders in Ukraine). Characterizing the theme of social networks, needs to mark that the Ukrainian sphere of social medias is differs even from the media sphere of Ukrainian neighbours .In general, it is characterized by a certain social lethargy and dominance content entertainment. Local (class, school, institute group and etc.) associations, which is forming the structure of a new society type .

The considerable public activity is not characteristic for the Ukrainian segment of social networks, as for example in Russia, where especially the Internet activity of the «Dark blue buckets» is reduced to the row of scandals and forced actions from the side of public authorities in relation to the movement members. Itself activity (number of users)it is not substance in social networks without her exit in real life . There were no social and political meaningful actions in Ukraine – up to nowadays there are any announced actions in social networks witch are collected the certain amount of admirers in a network, however in «practical» (street) part of action almost nobody come out. This once again, that it is difficult to consider social networks as a source of meaningful public transformations: they are the method of such transformations, but not enough reliable, because can help to spread that exists (deep protest), it is doubtful whether they could «to generate» him. Except this, it have been already mentioned the satisfaction of Ukrainian young people with own material position .This position makes out of them not very reliable revolutionary. The real "revolutionary" class in Ukraine is only the elderly people or groups of people witch suffer from budget diminution on social needs. But, according to the sociological researches, only 3 % over 60 years people have an access to the Internet and probably a little part is able to use it, and to use social networks. It secure obvious failures in the attempts of domestic politicians to use social networks in the advancement of own image or attempts to activate (to unite) their admirers by using similar projects. The most of such projects are created under the elections, after witch they remain with minimum support of founder, or a founder in general loses interest in them, that leads of the domain sealing(how it happened with a project the «Ideal country») [1].

At the same time, the social networks can turn into the important method of self-expression youth. The world indexes of amount growing and format usage of social networks in Ukraine (according to a data of international media agency Universal McCann): using of social networks: there are 81 % regular users ,when the typical index is 61 %; nearly 30 % of Ukrainian audience (and approximately the same percent in the world) using the mobile devices for staying out the Internet ; it is set up, that Ukrainian users are actively employment of services Web 2.0, though in global scale the mobile Internet becomes a «new engine» of social media; its popularity in Ukraine have also responsible for indexes (accordingly – 63 % and 65 %); blogger users – in Ukraine and in the world – are mainly young people (to 75 % users in age 16–34 years). The Ukrainian government begins to use these tendencies in the process of adjusting effective external communication channels and effective strategic communications. In 2010–2011 the personal pages of public servants, mayors of cities, governmental mass-media were created.

This pages were created not to adhere to a residual principle (must be so), but most of them are fully supported (not personally, but special representatives). The telecommunication renewal is accompanies the disintegration of «universalism» structures and disintegration of society.

At the same time the integration of lowest level associations is increases: the local identities is the dominant local model of identities ,it is called «new tribalism» according to the Herbert theorists type («pedigree sociality»).

As a «screen culture» is produce to weakening of logical generalization culture is certain ideologizing. The rational unique for whole society, the ideology either is done impossible quite, or considerably primitiveness up to the level of «comics». Accordingly to the ideologically motivated idea about the universal determinism orientation of social development is perceptions changing of its uncertainty and multivariate. Educational cultural identity is basis on the new social hierarchy's formation and social groups. Exactly the main social conflicts are basis in this sphere, as indicated in particular, the situation of the cartoon crisis in Western Europe.

CONCLUSIONS

Currently, it can be concluded that growing telecommunication human capabilities is providing with the foundations for the new virtual teamwork and for the extinction most traditional forms of collectivism, that losing their intermediary, symbolic functions. Trends to dominance in society information technologies did not pass and in the Ukrainian society, which is a significant challenge for all creative forces, politicians, social and educational workers.

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ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ В УКРАИНЕ: ПРОБЛЕМЫ И ПРЕПЯТСТВИЯ

Ксения Серебряк

Аннотация. В статье исследованы проблемы и препятствия развития информационных технологий в обществе Украины. Определенны позитивные и негативные последствия влияния использования информационных технологий на жизнь украинцев. Рассмотрены конкретные примеры.

Ключевые слова: информационные технологии, Интернет, рынок, сеть.

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THE DEVELOPMENT OF MEANS FOR DUST CLEANINGAS AN IMPORTANT DIRECTION FOR AIR IMPROVEMENT IN THE FOUNDRY

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S u m m a r y . The objective of the study is the analysis of cleaning means for dust, molding mixtures and sand in areas of foundries. The aim is to develop a technology for cleaning thin and compacted layers of dust, loose materials.
K e y w o r d s : Foundry, hazards, means of cleaning, tools, dust.

INTRODUCTION

In the foundry working conditions are characterized by a number of factors that exceed the maximum allowable concentrations and have harmful effects on the human body [Shinkareva 2011, Kasyanov 2011]. These include dust, noise, vibration, heat, toxic gases and other. Studies showed [Shinkareva 2010, Pertsev 2003, Rabenda 2001, Kundiev 2001] that the dust in foundries is the prevailing hazard.

Dust control is an important hygienic and socio-economic problem. Dust incapacitate equipment, reduces the quality of products, reduce the lighting of industrial facilities and what is more, can cause occupational respiratory diseases.

PUBLICATIONS ANALYSIS

The appearing of dust in foundries happens while sowing, grinding, mixing of moulding and core sand, forming, core knockout and castings finishing. Additional sources of dust appearing are transportation, loading and unloading of bulk materials, equipment vibration, ventilation, spillage of sand and molding mixtures. The significant role in this process plays the depreciation of industrial funds, breach of technical exploitation and ill-timed, defective equipment repair [Speransky 1995, Ivanov 1990]. Due to the fact that it is hard to eliminate or improve the most of dust sources in foundries, it is necessary to remove the dust after its formation.

The analysis of cleaning technologies was conducted due to the literature sources [Shinkareva 2010, Shinkareva 2011], as well as in such foundries as HC "Luganskteplovoz" and Lugansk Foundry and Mechanical Plant. The causes of secondary dust appearing are cleaning brooms, brushes, air blasting.

PURPOSE AND RISING OF THE TASK OF RESEARCHES

The objective of the study is the analysis of cleaning means for dust, molding mixtures and sand in areas of foundries. The aim is to develop a technology for cleaning thin and compacted layers of dust, loose materials.

BASIC DIVISION

The conducted analysis of dust cleaning technologies in foundries showed that existing cleaning methods are ineffective, and some of them lead to the secondary dust formation. It was found out that the most effective means of cleaning are central vacuum systems. They do not require a lot of staff to work and significantly reduce the secondary dust appearing [Krasovitsky 2008,

Dobrosotsky 2005, Mankov 2008, Trachtenberg 1997, Supakov 1978, Sobolev 2005]. For these systems the technical problem is imperfection of developed dust cleaning equipment (dust cleaning nozzles and dust collectors). Existing dust cleaning nozzles (collector, rack, ejector, etc.) are bulky and have low productivity.

To solve this problem, i.e., cleaning of large spills of moulding mixtures, sand and caked dust was developed an useful model of dust cleaning ejector nozzle – the patent of Ukraine number 44275 from 25.09.2009, the bulletin № 18 [Shinkareva, Gedrovich, Nosko, Shinkarev 2009]. The dust cleaning ejector nozzle which is shown on fig. 1 contains a frame 1 of cylindrical shape with 'n' holes of 'D' diameter, located at the angle φ º (from 10 º to 45 º), which depends from the amount and properties of dust around a circle at a distance x from the lower edge; the bounding wall 2 in the form of bars, absorbing pipe 3, the lower butt end of which is placed on the lower butt end of frame 1 at some distance, the hub 4 with operational thread through which the absorbing pipe 3 goes and in which it moves and fixes with the help of clamp 5, stiffness ribs 6, with the help of which the hub 4 is fixed on the inner side of the nozzle frame 1.

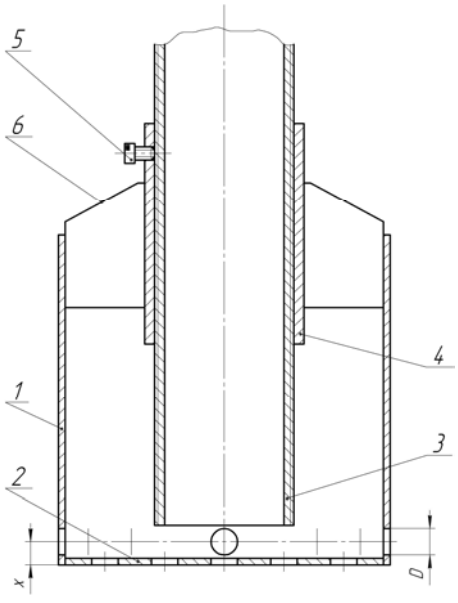

Fig 1. Dust cleaning ejector nozzle

This ejector nozzle is simple and easy to use, it provides high-quality cleaning of caked loose pile stuff. While cleaning thin layers of dust on the uneven surface the use of the ejector nozzle will be ineffective.

For cleaning dust on the uneven surfaces was offered an useful model of dust cleaning nozzle – the patent of Ukraine number 53997 from 25.10.2010, the bulletin № 20 [Shinkareva, Gedrovich, Shinkarev 2010]. Pyloprybyralna nozzle is shown on fig. 2 contains the trapezoid body 1, a larger base of which is rigidly fixed tube 2 of plugs 3 and 4 holes on the top edge of the bottom slot 5. On fig. 3 (the cut A-A of fig. 2) are shown the lower slit 5, also given the lower edge 6 and upper edge 7 with directed durable material. It is shown that the lower edge 6 of the lower slit 5 is placed on the vertical axis of symmetry plane of the tube 2 crosscut and the upper edge 7 of the lower slit 5 is placed on an inclined axis at an angle α to the vertical axis of symmetry plane of the tube 2 crosscut, upper absorbing pipe 8 of the tube 2 is combined with absorbing pipe 9 of trapezoidal frame 1 and also shown connection sleeve 10 of dust cleaning nozzles which is connected with hub 11 of the dust cleaning system with the help of operation thread.

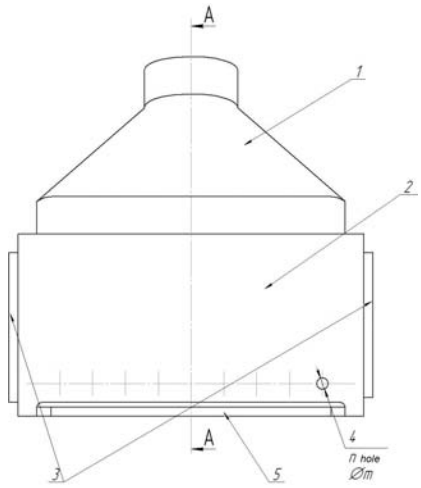

Fig.2. Dust cleaning nozzle

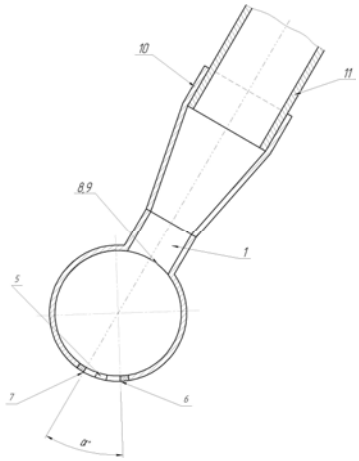

Fig. 3. The cut **A-A** of fig.2

This utility model was awarded with the silver medal of the International Salon of Inventions and New Technologies "New time". Dust cleaning nozzle can be used for devices of vacuum cleaning in construction, metallurgy and other industries. On the top and bottom of the absorbed slit was transmitted the alloying metal (e.g. chrome-tungsten or chrome-molybdenum steel with a hardness of 52-60 HRC), which improved the durability and increased the life time. On the tube above the top edge of the bottom slit were made holes - it increased the productivity of nozzle during the working on uneven surfaces, surfaces with a thin layer of dust, and cleaning the dust with abrasive impurities. But the use of this dust cleaning nozzle on the uneven ground with caked loose material is not efficient enough

For cleaning the caked dust on the uneven surface is proposed an useful model of dust cleaning nozzle – the patent of Ukraine number 55659 from 27.12.2010, the bulletin № 21 [Shinkareva, Gedrovich, Shinkarev 2010]. Dust cleaning nozzle which is shown in fig. 4, fig. 5 – type A of dust cleaning nozzle. Dust cleaning nozzle contains a trapezoidal frame 1, where the less part of it is interface between connection sleeve 2, and the hub 3 of dust cleaning system by operational thread, the larger part of trapezoidal frame 1 is provided with a pointed scraper 4, which is performed as a frame with partitions into which woven wire lattice with square meshes 5 is inserted. The larger part of frame 1 has an absorbing pipe 6.

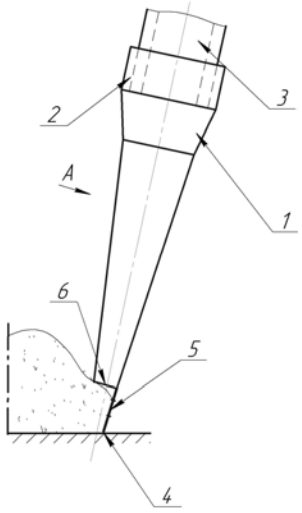

Fig. 4. Dust cleaning nozzle

The advantage of this model is that sharp scraper is designed as a framework with partitions, in which is inserted a grid with square cells. This increases the service time due to the possibility of changing the framework grid in scraper in case of clogging or tear and wear.

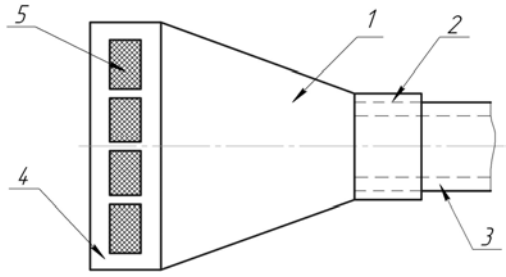

Fig. 5. Type **A** fig. 4

The connection of socket of designed dust cleaning nozzles with tap of dust cleaning system was made with a running screw, which allowed quick nozzle changes during the doing up process.

CONCLUSIONS

1. Proposed designs of nozzles are simple.
2. Nozzles are easy to use.
3. Increased life time.
4. Suggested cleaning means increase the speed and quality of cleaning, also if it's necessary, allow a quick change of nozzles.

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РАЗРАБОТКА СРЕДСТВ ДЛЯ УБОРКИ ПЫЛИ КАК ВАЖНЕЙШЕЕ НАПРАВЛЕНИЕ УЛУЧШЕНИЯ ВОЗДУШНОЙ СРЕДЫ В ЛИТЕЙНЫХ ЦЕХАХ

Татьяна Шинкарева, Анатолий Гедрович

Анотация. Задачей исследования является анализ средств уборки пыли, формовочной смеси и песка в помещениях литейных цехов. Целью работы является разработка технических средств уборки тонких слоев пыли, а также слежавшихся слоев сыпучих материалов.
Ключевые слова: литейное производство, вредные факторы, средства уборки, насадки, пыль.

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THEORETICAL BASIS OF AUTOMOBILE FREIGHT SYSTEM WITH CHANGEABLE TRAILERS

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Summary. In the article the theoretical basis for calculating the productivity of the vehicle and determination of the rational distance whileorganizing the cargo transportation with the change of trailers is offered.
Key words: car, semitrailer, cargo transportation, cost, distance

INTRODUCTION

A very important role in the performance of road freight traffic plays the organization of the rolling stock movement, execution of the loading and unloading work, which can take up to 40% of the car haul time [1]. There is a well-known method of trucks shipments with removable semitrailers, which can significantly reduce the time of loading and unloading. For example, the automobile with the trailer arrives to the point of loading, and instead of loading it, its empty trailer is changed to the loaded one before [1,2]. The downtime of the vehicle reduces as the replacement of the trailer takes 20 - 40 minutes instead of 40 - 90 downtime for loading. However, the organization of the shuttle transportation needs more trailers, therefore, the analysis of a car performance, cost accountingand rational transportation distance is needed.

RESEARCH OBJECT

Automobile transportation with removable trailers helps to reduce the downtime of the vehicle. The is a task to calculate the increase of the vehicle performance and to determine maximum sustainable transportation distance.

RESULTS OF THE TEORETICAL RESEARCHES

The analysis of the automobile performance is made by hourly productivity [3].

$$W_Q = \frac{q \cdot \gamma \cdot V \cdot \beta}{l + t_1 \cdot V \cdot \beta}, \quad (1)$$

where: q - capacity of vehicle, t;
γ - static coefficient of load-lift capacity;
V - technical vehicle speed, km/h;
β - ratio of run;
l - transportation distance, km;
t_1 - time for loading and unloading, hours.

The resulting dependence of the change of performance (fig. 1) leads to the following conclusions:

- increase in hourly productivity of the vehicle when using the removable trailers is 30 - 130% depending on the load-lift capacity and distance of transportation;
- the effect increases with increasing of the load-lift capacity and decreasing of the distance of transportation.

To quantify the changes in performance the formula can be used:

$$\Delta W_Q = \frac{q \cdot \gamma \cdot (t_1 - t_3)}{(t_2 + t_1) \cdot (t_2 + t_3)}, \quad (2)$$

where: t_2 –the time of trailers movement, h;
t_3 - time of trailer's replacement, h.

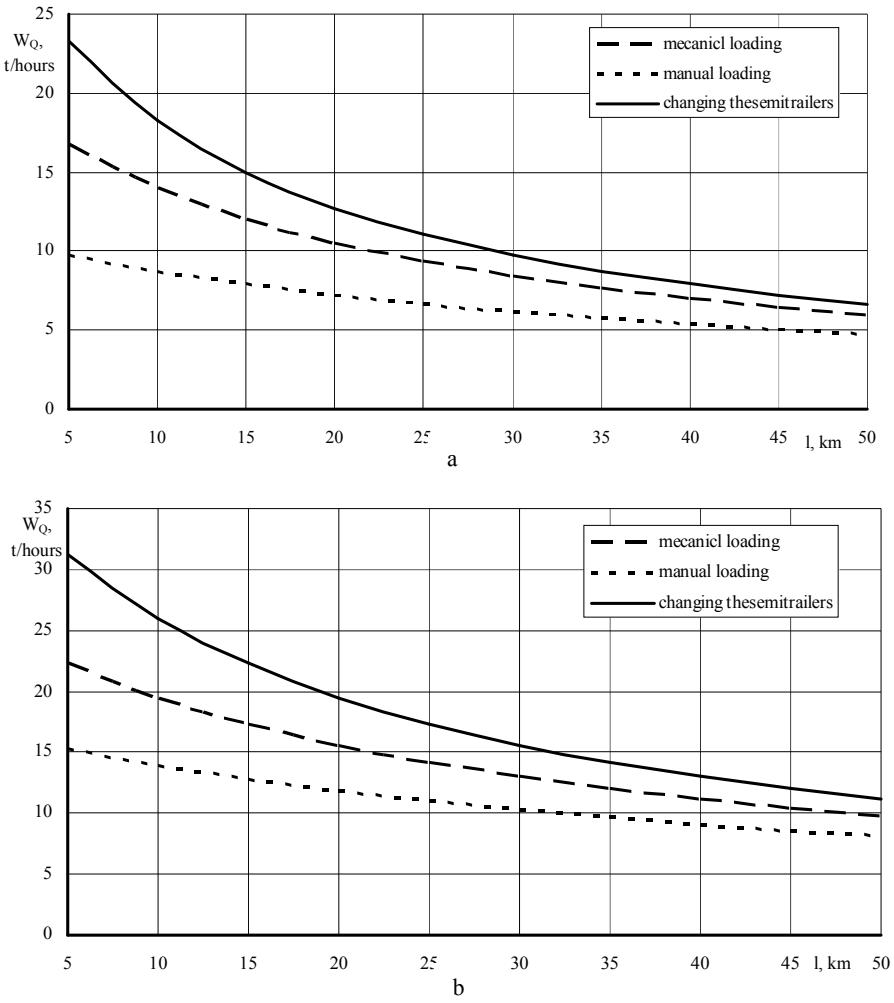

Fig.1. Hourly production of a road-train: a – lifting capacity of 14 tones; b – lifting capacity of 26 tones

It should be noted that when increasing the distance of transportation,the time of loading, unloading in the total time of circulation is reduced and thus decreases the effect of its reducing. So it makes sense to limit the maximum distance at which it's appropriate to use the changeable trailers.

The rational distance can be determined from the condition of providing a positive economic effect. The economic effects of reducing vehicle downtime must be greater than the cost for additional trailers. For reimbursement the costs for trailers it is needed to perform N transportations it means that the next condition must be fulfilled:

$$\Delta t_1 \cdot S_t \cdot n \geq K \,, \tag{3}$$

where: Δt_1 - downtime for loading and unloading a vehicle, h;

S_t - one hour of downtime cost, c.u. / h;

K - the cost of trailers, c.u.

Then, taking into consideration (3), we obtain:

$$n \geq \frac{K}{\Delta t_1 \cdot S_t}. \tag{4}$$

The required number of transportations is determined by the amount of labor-time of the vehicle for which the capital investments should be recouped. Fund of tractor's working time:

$$T = t_y \cdot D \cdot t_w \cdot n_w \,, \tag{5}$$

where: t_y - the term of the cost recovery for trailers, years;

D - the number of working days per year, days;

t_w - the transition time, h;

n_w - number of shifts.

The number of transportations is defined as the ratio of the total working time to time of one transportation. Considering that a single transportation time is the amount of time of movement and time of replacing the trailer, we get:

$$n = \frac{T}{t_2 + t_3}. \tag{6}$$

Then, considering (6) и (4):

$$\frac{T}{t_2 + t_3} \geq \frac{K}{\Delta t_1 \cdot S_t},$$

or

$$t_2 + t_3 \leq \frac{T \cdot \Delta t_1 \cdot S_t}{K}. \quad (7)$$

Since the movement time is determined by the distance of transportation and vehicle speed, the next formula can be written for the maximum sustainable distance of the transportation:

$$l \leq \left(\frac{T \cdot \Delta t_1 \cdot S_t}{K} - t_3 \right) \cdot V \quad (8)$$

SONCLUTIONS

Basing on the structural analysis of the prime cost and terms of the organization and performance of cargo traffic with a change of trailers the following conclusions are made:

- when using removable trailer car's performance increases;
- degree of increase in productivity increases with decreasing of transportation distance;
- the area of effective application of changeable trailers system is limited to maximum distance;
- the technique of determining the maximum transport distance is proposed.

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ТЕОРЕТИЧЕСКИЕ ОСНОВЫ СИСТЕМЫ АВТОМОБИЛЬНЫХ ПЕРЕВОЗОК СО СМЕННЫМИ ПРИЦЕПАМИ

Максим Слободянюк, Михаил Грибиниченко

Аннотация. Предложены теоретические основы расчета производительности автомобиля и определения рационального расстояния перевозки при организации грузовых перевозок со сменой прицепов.

Ключевые слова: автомобиль, полуприцеп, грузовые перевозки, себестоимость, расстояние

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DEVELOPMENT OF TRANSIT AND SOCIO - ECONOMICAL POTENTIAL OF EASTERN UKRAINE ON THE EXAMPLE OF LUGANSK REGION

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S u m m a r y . This article considers the questions of creating the Euro-region on the example of Lugansk region, Ukraine. International, inter-regional cooperation is an important component in the development of foreign economic relations of Ukraine. Reforming of social - economic relationships in Ukraine, structural rearrangement of all mechanisms of society vital functions creates the background for the acceleration of territorial development of every region, first of all at the expense of beneficial geographical position and technological accessibility of transport - logistic service.
K e y w o r d s : traffic flows, transportation, transit, storage systems, transit potential, transport - logistical sphere.

INTRODUCTION

The transformation of the former USSR republic into the independent states is the reason of the actualization of the border problem. On the one hand, a state border is an attribute of an independent state. On the other hand, the borders of the new states are mixed. One part of them is a former Soviet Union's state border and the other part is in fact, the administrative border between former republics. The first is an old border which has a long history and tradition, the second part is only being formed.

As it is said in the Program of economic reforms for 2010 - 2014 years "Wealthy society, competitive economics, effective state", transit potential of the country is not being used in full: for example the cargo traffic between Europe and the Russian Federation through Belarus is 5 times higher than through Ukraine [Nechaev 2011].

If in 2007 which is characterized by the highest figures achieved for the last ten years, the general volume of the transit cargo was almost 387 mln. tones, in 2011 this index was only 151.2 mln. tones - it is 2.5 times less. In spite of the fact that in the complex program of the statement of Ukraine as a transit state for the period of 2002 – 2015 the achievement of transit cargo traffic on the territory of the country in the value of 300 million tons, (it is 1.5 times more than the present time value) was foreseen. [Slobodyanyuk 2011], indicators of characterizing the traffic volume shown in figure 1.

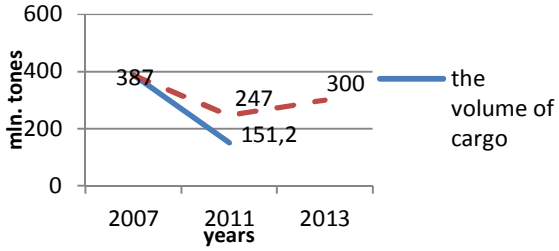

Fig. 1. Indicators characterizing actual and projected volume of transit traffic of Ukraine

In this connection nowadays the problem of the development of mechanisms which improve the quality of the transit communication, logistics infrastructure and transit cargo traffic becomes actual and the usage of which can create the real preconditions for increasing the transit traffic to unachieved 300 mln. of tones, improving the social - economic situation of the border territories and the economy of Ukraine in general.

OBJECTS AND PROBLEMS

The analysis of the traffic flow distribution in regions demands for creation of effective storage facility systems. Though the traffic flows inside the net of distribution must be organized according to the logistic principles and the transport communication must have an alternative.

The system of storage facilities distributed in the area must be coordinated by controlled transport connections in a way which allows telling about transport- storage systems. Only in this way the capacity of the warehouses will be used efficiently, and the whole system will be capable to transform the input streams into the output ones, which means to absorb and smooth the eruption of flows.

Rational flow management in the net of the distribution demands to create automatic management systems which use optimization models. In transportation, especially railway one, a developed information environment, which forms the basis for the effective management is created.

The basic partners of Ukraine in 2011 remained the same. On the first place in freight turnover was Russia where the trade "levelling" took place. The import of Russian goods to Ukraine increased to 2.2%, the export increased to 37.3%. Germany took the second place in freight turnover. China was on the third place (in trade with China a levelling of balance took place because of the increase in Ukrainian exports to the Chinese Republic in 2011, comparing with 2010 it was 59.7%,when the China's goods import to Ukraine grew only on 0,2). The fourth in cargo volume with Ukraine on the basis of 2011 was Belarus, the imported goods from which increased for account of oil products, agricultural machines, mechanical machines. Also, Ukraine increased the export of raw materials and metallurgical products to Poland, which was on the fifth place [Slobodyanyuk 2012].

In figure 2 the structure of freight turnover with countries partners is shown.

As the State Statistics Committee of Ukraine says, in January 2011the import of goods from the Russian Federation was 51.3% of total import volume that makes up the highest figure among the CIS countries.

The export of Ukrainian goods to the Russian Federation in January made up 25.7% of the whole value of export, totally among the CIS countries - 33,7%. In comparison with January 2010 export to Russia increased to 82.3% and achieved almost 1,187 billion dollars.

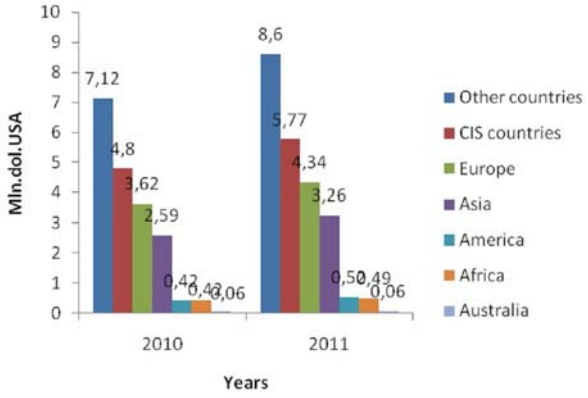

Fig. 2. Geographic structure of traffic of goods in Ukraine in 2010-2011

Reformation of the social - economic relationships in Ukraine, structural rearrangement of all mechanisms of vital functions of society creates the background for the acceleration of territorial development of every region first of all at the expense of beneficial geographical position and technological accessibility of transport - logistic service.

The positivity of formation and functioning of the Euroregion "Donbass" (further “Euroregion”, depends a lot on condition of transport – logistic system of the incoming definite border territories – Lugansk region, Donetsk region (Ukraine) and Rostov region (the Russian Federation)) [Nechaev 2010].

During the creation of the Euro region "Donbass", the development of trade - economic contacts, creation of common enterprises in the border territories and the simplification of crossing the border for the citizens of Rostov, Belgorod, Voronezh and Lugansk regions are supposed. Lugansk region has the longest border in Ukraine – it is about 800 km with Russian Federation [13].

In eastern Ukrainian regions powerful industrial complexes are concentrated. To increase the volume of the export activity the transport system in different fields which is capable to provide the development of transport - transit traffic volume is needed. The motorway Europe - Asia crosses the territories of Zaporozhye, Donetsk and Lugansk regions.

Bilateral export-import relations between Russia and Ukraine are the highest in volume and more diversified in nomenclature in all post soviet area. They show the specifics and contradictions of trade and economic - political relations between new independent states in the best way. The basic volume of the transport - transit interrelations falls

on the city of Lugansk and Lugansk region, which is proved by statistics about cargo transit for the period of 2000 - 2011 years, which is shown in the table 1.

Table 1. Cargo transit in Lugansk region according to different kinds of transport for the period of 2000-2011

Years / modes of transport	2000	2005	2008	2009	2010	2011
Transport in general	2590,6	3855,0	4907,2	4407,8	5073,3	5413,8
Railway transport	1703,1	2157,5	2592,6	2218,5	2367,0	2347,7
Automobile transport	887,5	1697,5	2314,6	2189,3	2706,3	3066,1

Positive tendencies in cargo transit by the railway transport of general use are observed in the way of the diagrams in figure 3.

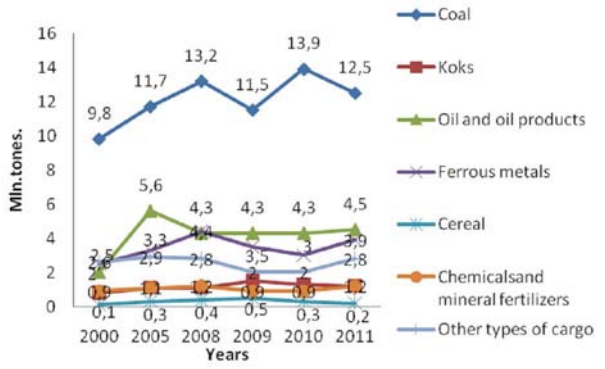

Fig. 3. Graphics of cargo transit by the means of railway of the general use in Lugansk region for the period of 200-2011, mln of tones

The tendencies in cargo transit by motor transport shows the data which is shown in table 2.

Table 2. The data of cargo transit by motor transport of common use in Lugansk region for the period of 2000 – 2011

Years	2000	2005	2008	2009	2010	2011
Total mln.t.	26,1	31,8	27,4	24,7	24,3	26,3

Volumes of cargo transportation in the Lugansk region motor and railway transport shown in figure 4.

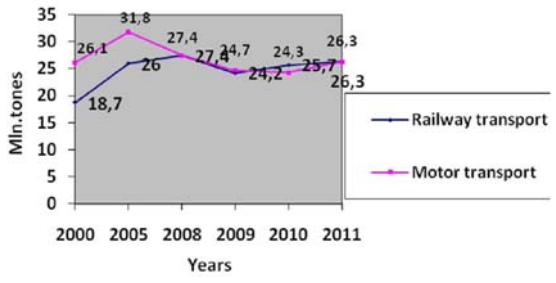

Fig.4. The dynamics of cargo transit in Lugansk region by motor and railway transport for the period of 2000 – 2011yares

For the period of 2008-2011 GC "Sverdlovskantratsit", is one of the major flows making enterprises in the Eastern part of Ukraine. Its volume is shown in table 3.

Table 3. The volume of readymade products in different years in "Sverdlovatratsit"

Year	2008	2009	2010	2011
Coal production, thousand tons	6109,72	5817,64	6375,95	6559,03
Finished products, thousand tons	3694,3	3624.6	3872,9	3913,4

To model the structure of transport system of border area of Eastern Ukraine, in consideration of rather high index numbers of transport flows which are formed at the local level and make up flows of transport corridors is necessary:

• to learn the conditions and prospects of the development of modern transport communications and logistic infrastructure of Sverdlovsk region;

•to develop and correct the process of Sverdlovsk, Chervonopartizansk cities planning and other territories of the region having the aim to optimize the location and industrial-technical objects, including the objects which are close to the border infrastructure and implementing the functions of effective goods promotion in the ITC Europe-Asia – Europe system;

• to learn the opportunities of using the custom regimes in the conditions of Ukrainian-Russian border area and partly in the region of Sverdlovsk city. The regimes are defined by the customs code of Ukraine: reimport, reexport, temporary import (export), and "special custom zone", the regime which is used in free economical zones, goods reprocessing in the custom's territory and out of it and others;

• while planning and realization of the complexes of organizational, scientific and technical events, it is important to use methodology of non commercial partnership of authorities, business and science. This approach is called to provide the system implementation in every day practice the cutting edge technologies, new technique, making non standard, first of all financial decisions. It will assist the intensive development of the partners because of the development of their competitive abilities and getting extra profit and organizing more perspective science – technical design development, consulting maintenance investment prepositions, programmes and projects;

• in the period of changes in Ukrainian economy, the economic activity of most of its parties is impossible without the realization of the functions of cargo storage and transportation, although the organization of this function is often on the low level. It leads to the significant financial losses of the mentioned parties and the decrease of the logistics client service and structural departments of the enterprises.

As the processes connected with the activity of warehouses and different types of cargo motor transport, present the main part of cumulative expenses in the network commodity distribution, so the efficiently organized objects of logistic infrastructure (storehouses, transport), and also their integrative interaction allows to optimize the expenses of the logistic system, therefore to reduce the final cost of the product. In this part the optimization the management of warehouses and transport creates the economic effect for the managing party.

CONCLUSIONS

Considering the fact that the shortest cargo transit directions are going across Ukraine because of its geographical position and also because of developed transport net, and non-freezing ports, there are potential opportunities to increase the volume of international cargo transit.

The available transport flows which get round Ukraine in favor of more beneficial conditions of crossing the border and the execution of cargo documents. The winners are those who have active transit policy which is directed to the development of the infrastructure transit power, modernization of movable staff, the ordering of the procedure of cargo movement across the borders and the implementation of the modern technologies of cargo transit and information support.

The usage of terminal store-house complexes allows to manage the technologies of cargo transit efficiently and more effectively. As at these objects the transformation of economic flow by the changes in characteristics of the accepted and dispatched cargo according to the size, composition and the other characteristics having a goal to send the cargo further with the help of motor transport.

The effective organization of object logistics interaction of logistic structure consists of terminal storehouse complexes and motor, railway transport creates strategic benefits of three kinds - economic, servicing and technological.

It is necessary nowadays to work out the methodological base to build and to develop effective transport storehouse system in the region of distribution of cargo flows that surely allows provide the cargo movement with a minimum expenses and necessary transport - storehouse service for product consumers.

Thereby the effective organization of the logistic structure objects' interaction that consists of terminal storehouse complexes and motor, railway transport creates strategic benefits of three kinds - economic, servicing and technological.

There is a necessity to work out the methodological base of building the effective transport storehouse system in the regions of cargo flows distribution that will allow to provide the processes of the cargo movement with a minimum expenses and the necessary transport - storehouse service for product consumers.

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РАЗВИТИЕ ТРАНЗИТНОГО И СОЦИАЛЬНО – ЭКОНОМИЧЕСКОГО ПОТЕНЦИАЛА ВОСТОЧНОЙ УКРАИНЫ НА ПРИМЕРЕ ЛУГАНСКОЙ ОБЛАСТИ

Максим Слободянюк, Елена Лапаева

Аннотация. В данной статье рассматриваются вопросы создания Еврорегиона на примере Луганской области, Украины. Международное, межрегиональное сотрудничество является важной составляющей в развитии внешнеэкономических связей Украины. Реформирование социально – экономических отношений в Украине, структурная перестройка всех механизмов жизнедеятельности общества создает предпосылки для ускорения территориального развития каждого из регионов прежде всего за счет выгодности географического расположения и технологической доступности транспортно – логистических услуг.

Ключевые слова: транспортные потоки, транзит, складские системы, транзитный потенциал, транспортно – логистическая сфера.

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THERMOELASTIC CONTACT PROBLEM FOR THE ELASTIC HALF-SPACE

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Summary. In this work the connected thermoelastic contact problem for an elastic half-space to which some area heat radiant is brought is considered. Applying a method of integral transformations of Fourier to system of the differential equations of thermoelasticity and a heat conduction equation, the problem is reduced to system of two two-dimensional integral equations for definition of thermoelastic normal voltages and temperature distribution.
Keywords: elastic half-space, thermoelasticity, integral transformations, thermoelastic contact problems

INTRODUCTION

Thermoelasticity is a new area of mechanics developing during the last years. It investigates interaction of a field of strains and a field of temperature and, thus, binds on the basis of thermodynamics of irreversible processes two separate earlier independent disciplines - the theory of elasticity and the thermal conduction theory. The equations and thermoelasticity problems are the further improvement of relations and problems of the classical theory of elasticity.

The basic publications on the problem are given in works [1-22] which contain the review of the basic scientific outcomes devoted to a solution of static, dynamic and thermoelastic problems for elastic and viscoelastic skew fields.

OBJECT AND PROBLEMS

The purpose of the offered work is research of a thermoelastic contact problem for an elastic half-space (fig. 1), definition of normal contact voltages and a field of temperature in the field of contact. As far as it is known to authors the similar problem was not considered earlier.

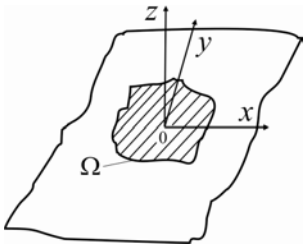

Fig.1. The rated scheme

Problem statement. The connected problem of thermoelasticity for a half-space to which some area Ω heat radiant is brought is considered.

Mathematically the problem is formulated in the form of three differential equations of thermoelasticity and a heat conduction equation [1,3,5]

$$(\lambda+\mu)\frac{\partial\theta}{\partial x}+\mu\Delta u=\gamma\frac{\partial T}{\partial x},$$
$$(\lambda+\mu)\frac{\partial\theta}{\partial y}+\mu\Delta v=\gamma\frac{\partial T}{\partial y},$$
$$(\lambda+\mu)\frac{\partial\theta}{\partial z}+\mu\Delta w=\gamma\frac{\partial T}{\partial z}, \qquad (1)$$
$$\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}+\frac{\partial T}{\partial z^2}=0.$$

In the absence of mass forces with boundary conditions $\sigma_{zz}(x,y,o)=q(x,y)$,
$w(x,y,o)=f(x,y),\ (x,y)\in\Omega$,
$T(x,y,o)=\varphi(x,y)$,
$\sigma_{xz}(x,y,o)=\sigma_{yz}(x,y,o)=\sigma_{zz}(x,y,o)=0$,

$$\psi = \frac{\partial T}{\partial Z} - \chi_o T = 0, \quad (x,y) \notin \Omega. \qquad (2)$$

Here $\theta = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}$,

$\Delta = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ - a relative modification of volume and a three-dimensional differential operator of Laplace, $u(x,y,z)$, $v(x,y,z)$ and $w(x,y,z)$ - projections of a vector of elastic transition to axes x, y, z, accordingly, $T(x,y,z)$ - temperature, $\gamma = (3\lambda + 2\mu)\cdot\alpha_t = 3K\alpha_t$,

$K = \lambda + \frac{2}{3}\mu$, $\alpha_t = \frac{\gamma}{3K}$, μ - the module of shift of a material of an elastic half-space, $(\lambda + \mu) = \mu(1-2\nu)^{-1}$, ν - factor of Poisson.

Applying to system of the differential equations (1) two-dimensional transformation of Fourier [13], we will receive system of two two-dimensional integral equations of the first sort concerning normal thermoelastic voltages $\sigma_{zz} = q(x,y)$ and distributions of temperature $T(x,y)$

$$\int\int_{\Omega} k_{12}(\xi - x, \eta - y) q(\xi,\eta) d\xi d\eta + \int\int_{\Omega} k_{22}(\xi - x, \eta -$$

$$- y) S(\xi,\eta) d\xi d\eta == 4\pi^2 \mu f(x,y), (x,y) \in \Omega,$$

$$\int\int_{\Omega} k_{21}(\xi - x, \eta - y) S(\xi,\eta) d\xi d\eta = 4\pi^2 \varphi(x,y),$$

$$(x,y) \in \Omega,$$

$$k_{12}(x,y) = \int_{-\infty}^{\infty}\int K_{12}(\alpha,\beta) e^{i(\alpha x + \beta y)} d\alpha d\beta, \qquad (3)$$

$$k_{22}(x,y) = \int_{-\infty}^{\infty}\int K_{22}(\alpha,\beta) e^{i(\alpha x + \beta y)} d\alpha d\beta,$$

$$k_{21}(x,y) = \int_{-\infty}^{\infty}\int K_{21}(\alpha,\beta) e^{i(\alpha x + \beta y)} d\alpha d\beta,$$

$$K_{12}(\alpha,\beta) = (1-2\nu)(\lambda+\chi)\{2\lambda_1[\chi(1-2\nu) - \lambda_1]\}^{-1}$$

,

$$K_{22}(\alpha,\beta) = (1-2\nu)[2\lambda_1(1-\nu) + (\lambda_1 + \chi)(2\nu\gamma - \beta_o)] \times$$

$$\times \{2\lambda_1(\lambda_1 - \chi_o)[\chi(1-\nu) - \lambda_1]\}^{-1},$$

$$K_{21}(\alpha,\beta) = (\lambda_1 - \chi_o)^{-1}, \ \lambda_1(\alpha^2 + \beta^2)^{1/2},$$

$$\chi = (3 - 4\nu).$$

The strict conclusion of system of two-dimensional integral equations of the connected thermoelastic contact problem which kernels depend on a difference of arguments is shown.

CONCLUSIONS

From the received system of two two-dimensional integral equations to which the task has been reduced normal contact voltages and a temperature field on half-space boundary have been defined.

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ТЕРМОУПРУГАЯ КОНТАКТНАЯ ЗАДАЧА ДЛЯ УПРУГОГО ПОЛУПРОСТРАНСТВА

Валерий Старченко, Вячеслав Буряк

Аннотация. В работе рассматривается связанная термоупругая контактная задача для упругого полупространства, к некоторой области которого подводится источник тепла. Применяя метод интегральных преобразований Фурье к системе дифференциальных уравнений термоупругости и уравнению теплопроводности, задача сводится к системе двух двумерных интегральных уравнений для определения термоупругих нормальных напряжений и распределения температуры.
Ключевые слова: упругое полупространство, термоупругость, интегральные преобразования, термоупругие контактные задачи.

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RESEARCH OF INFLUENCE OF BRAKE DEVICE ON DYNAMIC PROPERTIES OF ELECTRO-PNEUMATIC VALVE

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S u m m a r y : The results of mathematical simulation of dynamic processes of opening and closing electro-pneumatic valve and optimization of geometrical parameters of brake device are presented.

K e y w o r d s : jet actuating devices, electro-pneumatic valve, brake device, dynamic properties, mathematical model, numerical experiment.

INTRODUCTION

One of the most perspective directions of solution the problem of the reliability increasing and operation life of control system by the powerful streams of liquids and gases is the use of jet executive devices (JED) as a regulative and locking valve. Especially it is actual for industries with extreme operating conditions – coal, chemical, power, transport, agriculture etc., where the classic devices of the mechanical operating fail much more quickly comparing with normal operating conditions [2, 4, 6, 7, 9, 17, 18]. It is caused by more intensive wear of movable parts of regulative organs.

Researches that conducted in V.Dahl EUNU, allowed to create the row of the systems with jet executive devices on the basis of vortex regulative device [14, 15]. Experience of their operation showed that increasing working characteristics of interface unit has considerable reserve. In modern control system the most simple and reliable electro-pneumatic transformers are electro-pneumatic valves (EPV) with cylindrical core (fig. 1).

They successfully work as a part of the pneumatic drives of jigging machines on the coal-concentrating factories of Ukraine, Russia and other countries.

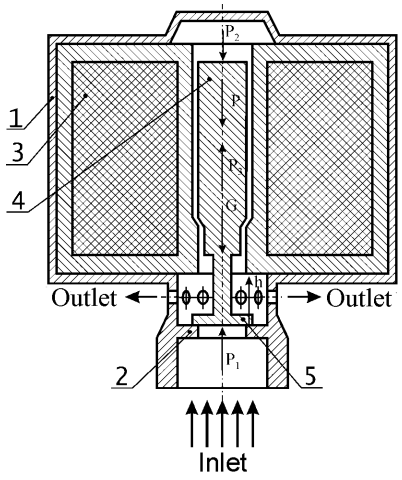

Fig. 1. Structural chart of electro-pneumatic valve 1 – housing; 2 – saddle; 3 – electromagnet; 4 – core; 5 – core locking part

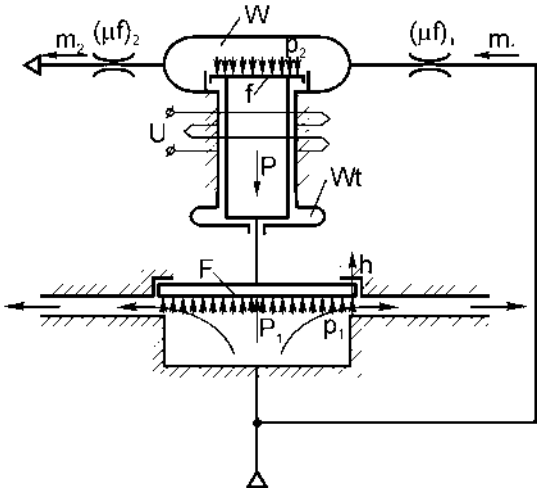

Fig. 2. Calculation chart of EPV with unloading and core braking

The researches that directed on modernization of the valves of such a type [16] showed, that using the discharging device along with the substantial increase of their carrying capacity and improvement of fast-acting, to the rev-up of landing on the saddle of locking organ, i.e. to the increase of the shock loadings. To decline this negative effect we offer the construction of EPV with a damping device.

RESEARCH OBJECT

A calculation chart and mathematical model of electro-pneumatic valve with unloading and core braking at the end of motion is presented below [10-13].

$$\begin{cases} \dfrac{dh}{dt} = V; \\ M\dfrac{dV}{dt} = P - P_1 + p_2 f - k_d V + Mg - P_t; \\ P = f(i,h); \\ P_1 = \int\limits_F p_1 df; \\ P_t = p_t \cdot f_t; \\ \dfrac{dLi}{dt} + R \cdot i = U(t); \\ \dfrac{W_0 + f(h_{\max} - h)}{kRT_{01}} \dfrac{dp_2}{dt} + \dfrac{p_2}{RT_{01}} f \cdot V = m_1 - m_2; \\ \dfrac{W_{0t} + f_t h}{kRT_{01}} \dfrac{dp_t}{dt} + \dfrac{p_t}{RT_{01}} f_t \cdot V = 0; \\ m_1 = (\mu f)_1 p_n \sqrt{\dfrac{2k}{(k-1)RT_{01}} \left[\left(\dfrac{p_2}{p_n}\right)^{\frac{2}{k}} - \left(\dfrac{p_2}{p_n}\right)^{\frac{k+1}{k}} \right]}; \\ m_2 = (\mu f)_2 p_2 \sqrt{\dfrac{2k}{(k-1)RT_{01}} \left[\left(\dfrac{p_{атм}}{p_2}\right)^{\frac{2}{k}} - \left(\dfrac{p_{атм}}{p_2}\right)^{\frac{k+1}{k}} \right]}; \end{cases}$$

where: h is core's displacement; V is speed of core; t is time; M is the reduced mass of movable parts; P is electromagnetic force; P_1 is aerodynamic force; P_t is braking force; p_n is feeding pressure; p_a is atmospheric pressure; p_2 is pressure in unloading cavity; p_t is pressure of braking; F is area of locking organ; f is area of core; f_t is braking area; k_d is damping coefficient; L, R is inductance and active resistance of solenoid coil; U, i is tension and current in solenoid coil; W_0, W_{0t} are dead volumes of unloading and braking chambers; m_1, m_2 are mass charges of the unloading system; $(\mu f)_1$, $(\mu f)_2$ are effective areas of filling and upcast tracks of unloader; k is adiabatic index; R is gas permanent; T_{01} is braking temperature.

The decision of mathematical model equations was realized by the Runge-Kutt method of the forth order of exactness in the application package for engineering's and scientific calculations with the opened source code Freemat® at the followings terms:

- Initial conditions: $t = 0$; $h = 0$; $V = 0$; $p_t = p_a$ $i = 0.2\,A$; $p_2 = p_a$; $U = 24\,V$.
- Boundary conditions: $0 \le h \le h_{\max}$.
- Assumptions:

1. The thermodynamics process is adiabatic.
2. $T_{01} = const$.

RESULTS OF RESEARCH

To establish the approximating dependence of speed of valve's closing V from the parameters of brake device (relative length $\bar{h}_t = h_t / h_{\max}$ and relative «dead» volume of brake chamber $\overline{W}_t = W_t / F_t h_{\max}$) the two factor numerical experiment was planned by the Boks-Wilson method [1, 3, 8]. The matrix of factors encoding and planning matrix is resulted below.

Table 1. Factors encoding

	-1.41	-1	0	1	1.41
$\bar{h}_t$	0.1	0.23	0.55	0.87	1
$\overline{W}_t$	2.149	2.463	3.224	3.985	4.299

Table 2. Planning matrix

Experience №	X_1	X_2	Y
1	-1	-1	0.49
2	-1	1	0.516
3	1	-1	0.394
4	1	1	0.46
5	-1.41	0	0.533
6	1.41	0	0.434
7	0	-1.41	0.404
8	0	1.41	0.484
9	0	0	0.458

The results of experiment were processed on least-squares method and resulted on fig. 3 as a surface of response.

Equation of regression for speed (in meters per second) of valve closing at confidence

probability $\alpha = 0,95$ and square Pirson's correlation coefficient can be presented in a kind [1]:

$$V = 0.4580 - 0.0366 \cdot X_1 + 0.0257 \cdot X_2 + 0.0131 \cdot X_1^2 - 0.0067 \cdot X_2^2 + 0.0100 \cdot X_1 \cdot X_2$$

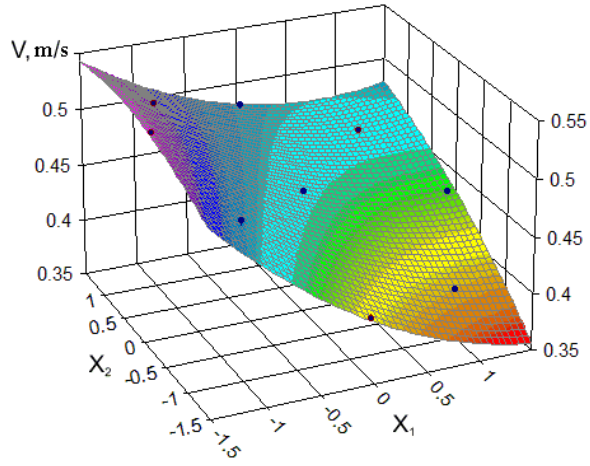

Fig. 3. Surface of response of speed of valve closing

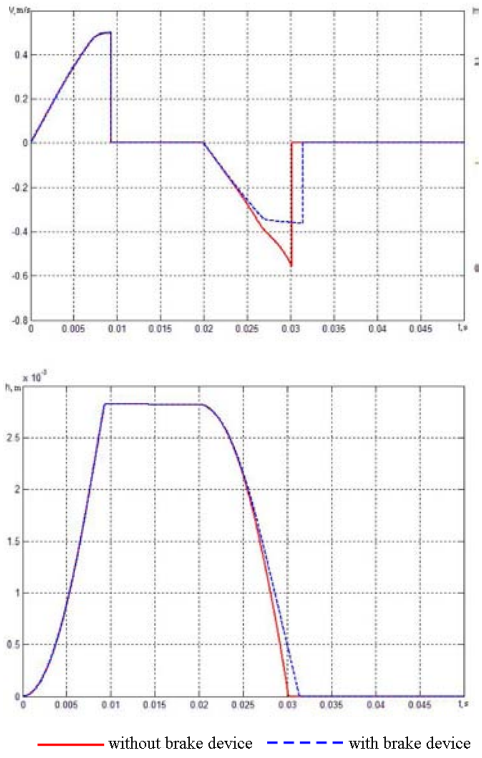

Fig. 4. Transient processes in electro-pneumatic valve

The value of global minimum, found by standard method (i.e. equality of the first derivatives to zero) showed that it lays out of limits of the investigated area. Therefore minimum time of transient process was on the border of the investigated area.

$$V_{\min} = 0.4580 - 0.0366 \cdot 1.41 + 0.0257 \cdot (-1.41) + 0.0131 \cdot 1.41^2 - 0.0067 \cdot (-1.41)^2 + \\ + 0.0100 \cdot 1.41 \cdot (-1.41) = 0.363\,(m/s).$$

To determine the influence of brake device on the fast-acting of EPV the calculation of transient processes for two variants (with a brake device and without it) was realized. The analysis of charts (fig. 4) showed that using the brake device practically did not influence on the EPV fast-acting (decrease does not exceed 4% here). The use of brake device allows to decrease speed of mandrel at the end of motion in 1,5 time.

CONCLUSIONS

1. The developed mathematical model of working process of electro-pneumatic valve adequately describes the dynamic processes of core displacement jointly with a locking device as poppet valve. The model is based on equations of dynamic equilibrium of the system «core – locking organ», equations of indissolubility, equations of gas charges at a subsonic flow in the elements of valve flowing part, equations of the working environment state and equations of electric processes with initial and boundary conditions.

2. Using the brake device allowed to reduce core's speed at the end of motion in 1.5 time, i.e. to reduce the impact force of valve at a saddle more than twice.

3. The brake device does not reduce the fast-acting of electro-pneumatic valve much. The increase of transient process time does not exceed 4% .

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ИССЛЕДОВАНИЕ ВЛИЯНИЯ ТОРМОЗНОГО УСТРОЙСТВА НА ДИНАМИЧЕСКИЕ ХАРАКТЕРИСТИКИ ЭЛЕКТРОПНЕВМАТИЧЕСКОГО КЛАПАНА

Дмитрий Семин, Ярослав Мальцев, Марина Мальцева

Аннотация. Приведены результаты математического моделирования динамических процессов при открытии и закрытии электропневматического клапана и оптимизация геометрических параметров тормозного устройства.

Ключевые слова: струйное исполнительное устройство, электропневматический клапан, тормозное устройство, динамические характеристики, математическая модель, численный эксперимент.

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STRUCTURAL SYNTHESIS OF PIPELINE TRANSPORTATION OF INDUSTRIAL ENTERPRISES

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Summary. In the article the impact of the structure of pipeline transportation systems on the efficiency of their operation is examined. It is shown that, depending on the assumed structure, transport systems can be characterized by different performance characteristics. It is established that the structure of the system influences the development of the aging process and decrease system performance. Recommendations on the choice of the structure of systems that can be used at the design stage are given.
Keym words: system, the pipeline, transportation, structure.

INTRODUCTION

Piping systems of industrial enterprises provide the ability to process flow of the technological processes and can be operated over a long period of time. Maintaining of their efficiency requires to conduct operations associated with repairing and maintenance. The need to disable the linear elements of such systems is accompanied by a reduction in their operating parameters and performance characteristics [1-5]. Therefore, the choice of rational structure of piping systems is being examined as a pressing problem, which arises at the stage of making design decisions.

ANALYSIS OF LAST RESEARCHING AND PUBLICATIONS

The possibility of reducing the efficiency of pipeline systems as a result of the gradual development of the aging process should be assessed at the design stage, and according to the results of this analysis decisions related to the choice of a particular structure should be made. A comparison of alternatives and final choice of system design is usually carried out based on the evaluation of metal consumption of the whole structure. This approach allows us to reduce the level of financial costs in the manufacture and installation of piping systems, but the expected decrease in their efficiency while in service is not taken into account [6-20].

GOAL OF RESEARCHING

The purpose of this work is a comparative analysis and the establishment of patterns of influence of restored pipe systems structures on effectiveness in operation process.

MATERIALS AND RESULRS OF RESEARCHING

In general, the problem of structural synthesis has no unique solution. This means that the final choice of structure should be based on comparative analysis of alternative options to ensure the delivery of the target product. Considered in this variants of structure may vary in the level of complexity, consumption of materials, as well as the expected values of operational parameters. Let us consider the task of structural synthesis of the pipeline system providing the delivery of the target product from the source of the seven customers, the relative position of which corresponds to the Technology section of the data presented in fig. 1. We assume that all consumers (A1, A2, ... A7) for a specified

period of time should get the target product in the same volume. For example, in relation to this scheme of mutual location of the source and the seven consumers of the product, as shown in Fig.1 we can form four different variants of structure at different levels of complexity, which are presented in table 1.

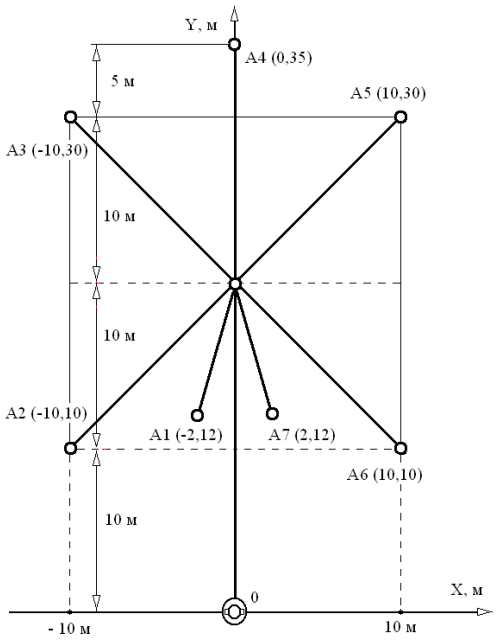


Fig. 1. The scheme of the technological area and coordinates of the consumers of the target product

To evaluate the level of a test structure should be used such characteristics as the total number of linear elements (pipes) and the number of distribution centers for the organization of traffic flow. Thus, the table. 2 shows the comparative characteristics of the analyzed structures, the structures themselves are arranged in order of increasing level of complexity. It is seen that the total length of all pipelines is minimal for the structure labeled ST4, and has a maximum value for the structure of the ST3.

The effectiveness of the renewable systems will be evaluated using the index, which is the ratio of the product volume that the system will deliver to customers within a specified period of time under the condition of reliable operation of elements of valves to the volume that the system is able to deliver over the same time, on condition of reliable operation of all structural elements [21].

In order to identify patterns of influence of renewable system structure on the efficiency of their functioning in the mode of nominal operation, it is important to consider the options presented in the table. 1.

Table 1. Alternative structures of pipeline transportation systems used in the analysis

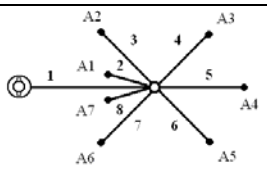
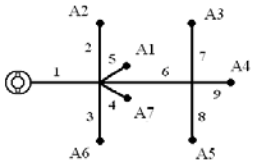
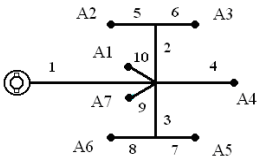
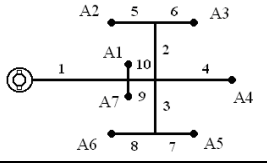
Designation of the structure	Image of the structure	Performance score of the system
ST1		$F_S = P^2$
ST2		$F_S = \frac{3P^3 + 4P^2}{7}$
Designation of the structure	Image of the structure	Performance score of the system
ST3		$F_S = \frac{4P^3 + 3P^2}{7}$
ST4		$F_S = \frac{4P^4 + P^3 + 2P^2}{7}$

Table 2. Characteristics of the analyzed variants of structure of transport systems

Structure symbol	Characteristics of the analyzed structures		
	Number of distribution centers	Number of linear elements	Total length of the pipeline, m
ST1	1	8	108,1
ST2	2	9	80,66
ST3	3	10	111,5
ST4	4	11	99,0

1. Structure with the symbol ST1

Performance score: $F_S = P_1 \cdot \sum_{i=2}^{8} P_i \varphi_i$, where:

Pi - the coefficient of readiness of the i-th pipeline, which is the probability that the line is in working order at any moment, except for scheduled periods during which its intended use is not provided;

φi - transit potential of the i - th pipeline, which is a fraction of of the product that passes through a pipeline across the sample level in case of trouble-free operation of all structural elements.

Since in our task all consumers receive per unit of time equal volumes of the product, then:

$$F_S = \frac{P_1}{7} \cdot \sum_{i=2}^{8} P_i$$

Let's assume that the coefficients of the readiness of all pipelines are identical and are characterized by the value of R. Then: $F_S(P) = P^2$.

2. Structure with a symbol ST2

Performance score for this case:

$$F_S = P_1 \cdot \{P_2\varphi_2 + P_3\varphi_3 + P_4\varphi_4 + P_5\varphi_5 + P_6\varphi_6(P_7\varphi_7 + P_8\varphi_8 + P_9\varphi_9)\}.$$

Transit potentials for the analyzed structures: $\varphi_2 = \varphi_3 = \varphi_4 = \varphi_5 = 0{,}143;\ \varphi_6 = 0{,}429;$ $\varphi_7 = \varphi_8 = \varphi_9 = 0{,}333$. Then:

$$F_S = \frac{1}{7} P_1 \cdot \{P_2 + P_3 + P_4 + P_5 + P_6 \cdot (P_7 + P_8 + P_9)\}.$$

If the coefficients of the readiness are the same for all pipelines ($P_1 = P_2 = \ldots = P_9 = P$), then:

$$F_S(P) = \frac{3P^3 + 4P^2}{7}.$$

3. Structure with the symbol ST3

Performance score for this case:

$$F_S = P_1 \cdot \{P_4\varphi_4 + P_{10}\varphi_{10} + P_9\varphi_9 + P_2\varphi_2(P_5\varphi_5 + P_6\varphi_6) + P_3\varphi_3(P_7\varphi_7 + P_8\varphi_8)\}$$

Transit potentials for the analyzed structures: $\varphi_4 = \varphi_9 = \varphi_{10} = 0{,}143;\ \varphi_2 = \varphi_3 = 0{,}286;$ $\varphi_5 = \varphi_6 = \varphi_7 = \varphi_8 = 0{,}5$.

Then:

$$F_S = \frac{1}{7} P_1 \cdot \{P_4 + P_9 + P_{10} + P_2 \cdot (P_5 + P_6) + P_3 \cdot (P_7 + P_8)\}.$$

With the same value of P-availability for all linear elements: $F_S(P) = \frac{4P^3 + 3P^2}{7}$

4. Structure with the symbol ST4

Performance score for this case:

$$F_S = P_1 \cdot \{P_{10}\varphi_{10} + P_9\varphi_9 + P_{11}\varphi_{11} \cdot [P_2\varphi_2(P_6\varphi_6 + P_5\varphi_5) + P_3\varphi_3(P_7\varphi_7 + P_8\varphi_8) + P_4\varphi_4]\}.$$

Transit potentials for the analyzed structures: $\varphi_9 = \varphi_{10} = 0{,}143;\ \varphi_2 = \varphi_3 = 0{,}4;$ $\varphi_5 = \varphi_6 = \varphi_7 = \varphi_8 = 0{,}5,\ \varphi_4 = 0{,}2;\ \varphi_{11} = 0{,}714$.

Then:

$$F_S = \frac{1}{7} P_1 \cdot \{P_4 + P_9 + P_{10} + P_2 \cdot (P_5 + P_6) + P_3 \cdot (P_7 + P_8)\}.$$

With the same value of P-availability for all linear elements: $F_S(P) = \frac{4P^4 + P^3 + 2P^2}{7}$.

Dependence of performance on the availability of a pipeline for all the analyzed variants of structure is shown in fig. 2. It is evident that a gradual decline in the readiness are the same associated with the development of the aging process is accompanied by a decrease in rate and efficiency of operation. For example, the declines of the readiness are the same of entry-level to a value leads to a decrease for the ST1 structure by about 14%, and for structures ST2, ST3 and ST4 at 17, 18 and 22%.This means that the best operational characteristics will have restored system with the structure of ST1, and the worst system with the structure ST4. Thus, the results of the analysis suggest that if the coefficients of the readiness of all pipelines are approximately equal, the best performance characteristics will have structures that are characterized by smaller number of linear elements, as well as distribution centers of traffic. Note that the structure of ST4, is characterized by a minimum length of pipe (table 2), is the worst among the analyzed variants of structure from an operational point of view, as evidenced by the dependencies presented in figure 2.

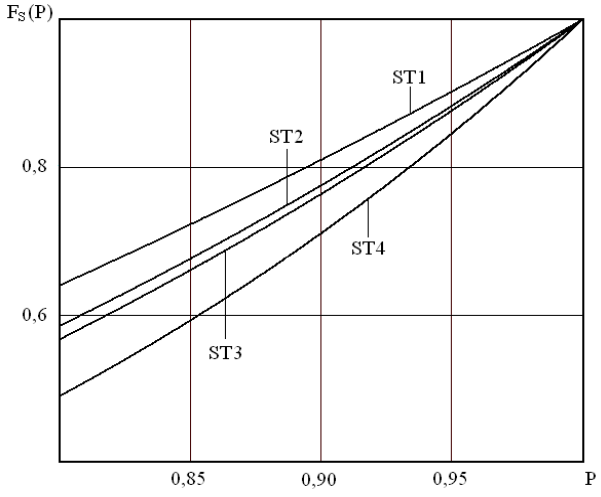


Fig. 2. The dependence of efficiency on the structure of the restored system and availability of a pipeline P

CONCLUSIONS

The regularities of the influence of the structure pipeline systems on the efficiency of their functioning are set, it allows to conclude that in the case of approximately the same values of the coefficients of the readiness of all pipelines, the best indicators are characterized by a structure with a smaller number of high-level crossings, and ensure the delivery to customers of smaller amounts of the target product at the distribution sites of higher level.

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СТРУКТУРНЫЙ СИНТЕЗ СИСТЕМ ТРУБОПРОВОДНОГО ТРАНСПОРТА ПРОМЫШЛЕННЫХ ПРЕДПРИЯТИЙ

Игорь Тарарычкин, Грегорий Нечаев, Максим Слободянюк

Аннотация. Рассмотрены вопросы влияния структуры трубопроводных транспортных систем на эффективность их функционирования. Показано, что в зависимости от принятой структуры, транспортные системы могут характеризоваться различными эксплуатационными показателями. Установлено, что структура системы оказывает влияние на развитие процессов старения и снижение эффективности функционирования систем.

Ключевые слова: системы, трубопровод, транспорт, структура.

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COMPUTER-AIDED DESIGN OF ELECTRONIC COURSES

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S u m m a r y . The article describes the software model of the system designing of the electronic courses (EC) with minimal impact of the subjective factor (CAD EC). IT uses ontologies of subject domain (SD). Ontology of subject of discipline (SDi) built on basis of SD. Ontology of subject of discipline includes descriptions of concepts, examples, laboratory works, tests. CAD EC converts reference books EC in the corresponding files of Moodle.
K e y w o r d s : architecture, ontology, subject area, integrated information technology, e-course, UML.

INTRODUCTION

Basic directions of informatization include as important component e - learning and upgrading of educational services in e-learning [1]. One of components of e-learning is EC.

Planning EC supposes forming of great numbers of concepts, their descriptions, relations, examples, laboratory works, tests with minimum influence of human factor. Construction indicated higher by hand is a labour intensive process, both at times and on an amount engaged in the process of planning of highly skilled specialists. Understanding of importance of creation of tools of support of planning process EC came practically simultaneously with the acceptance of paradigm of e - learning.

Methodology of planning of ontology of SD, corresponding SDi EC supposes forming of great numbers of concepts, relations, functions of interpretation and axioms.

It is presently known more than one hundred instrumental programmatic systems with the wide spectrum of descriptions and functional possibilities, providing absence of subjectivity of ontology of SD [8-15]. Accumulate ontology on different SD. Use of corresponding ontology at the beginning of planning EC guarantees his good quality.

RESEARCH OBJECT

The programmatic model of the system of computer-aided design electronic courses (CAD EC) design is examined in the article. CAD EC is an application instrumental complex ontological appointment (ICON - IK National Academy of Sciences of Ukraine, Kiev). CAD EC uses subsystems ICON significantly. The design used SD, that corresponds SDi EC, is used. Ontology of SD is the product of work of the original of Instrumental complex with ontological direction (ICON). The basic task of ICON is realization of the integrated information technology of the automated construction of ontology in an arbitrary subject domain. He executes an analysis and treatment of large volumes of the unstructured data, in particular linguistic corps of texts in Ukrainian and Russian language, extraction from them subject knowledge with their subsequent presentation as an ontological structure or ontology of subject domain [2, 16-18] and libraries of information (BSI). CAD EC using ontology of SD and BSI must build EC of corresponding SDi.

RESULTS OF RESEARCH

CAD builds ontology of the discipline in the automated mode from SD, including in the form of handbooks EC explanations of the notions, in the form of examples, in the form of laboratory works, in the form of tests. Informations of Library

includes (by definition) universal knowledge resources in the SD. A description of the ontology and informations of Library gives basic training material EC. Laboratory work and tests are introduced in the choice of appropriate concepts EC manually or from the available electronic libraries. On the basis of the models of adaptive control of quality can be adapted EC to the needs of the student [3].

CAD EC converts reference books EC in the corresponding files of Moodle.

The proposed model of the CAD EC performs the following functions:

1. Reading OWL file description of the ontology and output of ontology of SD on the screen.
2. Providing of the automated selection from ontology of necessary concepts for SDi of educational course.
3. At a click by a mouse on termin from ontology, for a branch is below than concept selected a red color, other tops become semilucent.
4. For a termin on which clicked, in a file writed down name, nearest connections (all contiguous termins). Name of File «Vibrannie.txt». File structure: *< name of concept></name of related concepts></ name of related concepts >… </ name of related concepts >#.
5. The reading the description of the selected concepts from the file «OPIS ONTOLOGY» and write it to a file «LEC.txt.
6. The automated supplement to the concept of the laboratory work and write it to a file «LAB.txt». (Automation provides three options:
   6.1. Import of laboratory of works from the electronic resource.
   6.2. Entering text laboratory work by hand.
   6.3. The lack of laboratory work for this concept).
7. The automated supplement to the concept of the test and write it to a file «TEST.txt». (Automation provides three options:
   7.1. Import test from the electronic resource.
   7.2. Entering text by hand.
   7.3. The lack of tests for a given concept).
8. Ensuring compliance functions for all selected 5, 6, 7 of concepts.
9. Converting files texts of laboratory work in Moodle files.
10. Converting files texts test files in Moodle.

Need to investigate how to provide the functions above.

For example, function 1 can be provided with a software module for output ontology graphically on the screen (fig. 1).

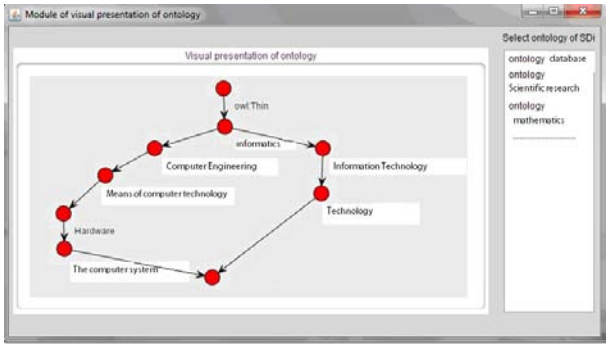

Fig. 1. Window of the module visualization ontology

To investigate the possibility of providing these functions, need to build a functional model.

For planning of functional models (functional design) of software and different sort of technologies in information it is known row of the generally accepted standard methodologies and functional simulation languages, such as IDEF, DFD, UML.

UML (Unified Modeling Language) is a language of graphic description of the objective modeling in area of software development [4]. UML is a widely used standard de facto the object-oriented visual simulation language [5, 6].

Stopped up in the language of UML potential possibilities can be used not only for the object-oriented design of the systems but also for representation of knowledges in the intellectual systems which, essentially, there are perspective difficult programmable technological complexes. Having regard to all advantages of language of UML, a functional model CAD EC was projected on his basis.

Functional model CAD EC is a set of diagrams.

We consider the diagram:

- diagram of variants of the use (fig. 2);
- diagram of activity (fig. 3).

Essence of diagram of variants consists of the following: the system that developed appears as a great number of essences or actors, that co-operate with the system by means of the so-called variants of the use. Thus an actor or acting person is name any entity, interactive with the system from outside. It can be man, program or any other system which can serve as an source affecting the designed system. In turn, the use case is used to describe the services that the system provides to the actor.

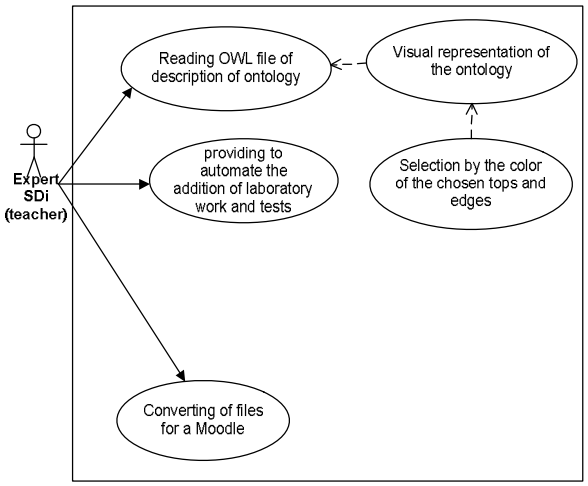

Fig. 2. Diagram of variants of the use for basic functions CAD EC

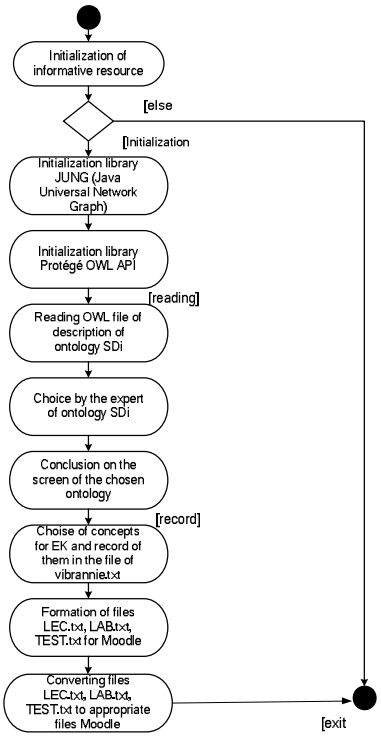

Fig. 3. UML- diagram of activity CAD EC

By the diagram of activity (fig. 3) it is possible to study a conduct CAD EC with the use of models of flow of data and stream management. The diagram of activity represents some algorithm, describing the life cycle of object the condition of which can change. Diagram of activity unlike a flow-chart, has more wide notation. For example, on it is possible to specify the states of objects.

By basic data for the system CAD EC there are OWL-files containing description of ontology of subject domain (SD). The structure of file of OWL of description of ontology following:

```
<owl:Ontology rdf:about=""/>
  <owl:Class rdf:ID="Imya top level 1 ">
    <rdfs:subClassOf>
      <owl:Class rdf:ID="Imya top level 0"/>
    </ Rdfs: subClassOf>
  </ Owl: Class>
  <owl:Class rdf:ID=" name top level 2">
    <rdfs:subClassOf rdf:resource="# name top level 1"/>
  </ Owl: Class>
  <owl:Class rdf:ID=" name top level 2">
```

A visual representation of the ontology in figure 4.

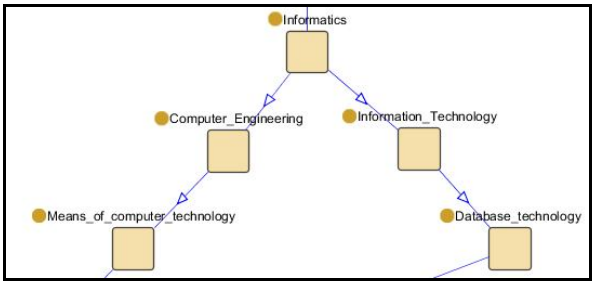

Fig. 4. Fragment ontology SD DATA BASE

Programmatic realization uses the platform of Java Swing Framework. Unlike other platforms, it not only gives the interface of development on the basis of template of MVC but also is realized on his basis. Representation is a class – heir of class Frame.

Owing to organization of model of Java [7] on interfaces, a comptroller is a set of anonymous of classes of processing of the events. As well as other platforms, Swing leaves for a programmer making of model.

CONCLUSIONS

The paper presents the software model CAD EC that uses the the original tool set ontological destination (ICON). In the automated mode is construction of the ontology discipline SDi on SD based, which includes a description of the concepts of SDi, examples, laboratory works, tests.

Library ICON are universally valid resources of knowledge in a given SDi and in this sense they are invariant under the adaptation and optimization of the of system to the target application, in particular, to adapt to the problem of automating the development of e-learning courses (EC) by the subject discipline (SDi). The proposed model perform production the universally valid of e-courses with minimal impact of the subjective

factor, with reducing of the laboriousness of the process, both in time and in quantity involved in the process of design of highly qualified specialists.

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СИСТЕМА АВТОМАТИЗИРОВАННОГО ПРОЕКТИРОВАНИЯ ЭЛЕКТРОННЫХ КУРСОВ

Юрий Тихонов, Виталий Семенков, Геннадий Могильный

Аннотация. В статье описана программная модель системы автоматизации проектирования общезначимых, с минимальным влиянием субъективного фактора электронных курсов (САПР ЭК). САПР ЭК использует онтологию предметной области (ПдО). В автоматизированном режиме из ПдО строится онтология предметной дисциплины (ПдД), включающая в виде справочников ЭК описания понятий ПдД, примеры, лабораторные работы, тесты. В конце работы САПР ЭК конвертирует справочники ЭК в соответствующие файлы Moodle.

Ключевые слова: архитектура, онтология, предметная область, интегрированная информационная технология, предметная дисциплина, электронный курс, UML.

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MODIFICATION OF CEMENT MATRIXES WITH DISPERSION OF MULTILAYER CARBON NANOTUBES

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Summary. The concrete with compact structure on the basis of Portland cement modified by the dispersion of multilayer carbon nanotubes Graphistrength™ by Arkema is investigated. The change in the structure of cement stone in the process of concrete setting and hardening when introducing carbon nanotubes into the concrete composition is observed.
Key words: carbon nanotubes, dispersion, calcium hydrosilicate, frost resistance.

INTRODUCTION

It is rational to use carbon nanodispersed systems as modifying addition when making cement concretes with perfected mechanical properties [Yakovlev 2007, Staroverov 2009, Lipanov 2009, Laukaitis 2012, Konsta-Gdoutos 2010, Konsta-Gdoutos M.S 2008, Maeva 2009, Shah 2009]. It is ascertained that inclusion carbon nanodispersed systems in composition of mineral astringent matrixes results in its structuring with forming crystalline hydrate formations of increased density and durability [Antonovič 2010, Makar 2004, Li 2007, Cwirzen 2008, Yakovlev 2011]. Also the increasing of density for 2-3 times using minuteamounts of carbon nanodispersed systems is noted.

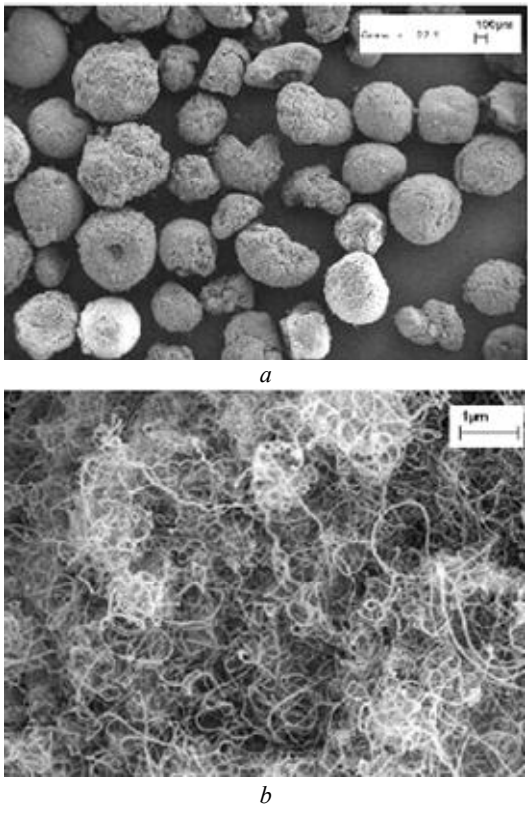
The main purpose of work is determination the possibility of modification of dense aggreate concrete's structure by multilayer carbon nanotubes Graphistrength™ made by corporate Arkema as nanodispersed addition and it's influence on modified cement matrix structure.

MATERIALS AND RESEARCH METHODS

Bars of 40x40x160 mm as samples for strength tests were produced by usual procedure. We studied the strength properties of fine-grained cement concrete «PC400-D0», quartz sand with gradation factor $M_к$ = 3,08 and heavy-weight concrete based on Portland cement «PC400-D0» with gravel of 10 mm as coarse aggregate.

We used multiarrayed carbon nanotubes Graphistrength™ , produced by Arkema as nano dispersed addition. They consist of 10-15 arrays of nanotubes, from 10 to 15 nm in diameter, from 1 to 15 μm (fig. 1b) of length anf 50-150 kg/m^3 of mass specific gravity.

In the process of dispergation of carbon nanosystems the problem of their stabilization in aqueous suspension, when storing prior to use, becomes urgent. Nanoparticles with sizes 6 – 20 nm possess high surface energy and, as a rule, they are combined into "clews" or clusters with sizes up to 400 - 900 μm (fig. 1, a). At the same time, nanoparticles are difficult do distribute onto single nanostructures in aqueous disperse medium and require special technologies for their dispergation .



a

b

Fig. 1. Multiarrayed carbon nanotubes Graphistrenght™; a – assembled representation of bars with mean particle size of 400 μm, b – 20000-times zoomed carbon nanotubes

Beams do not segregate into separate nanotubes while damp mixing, so it is necessary to provide their breaking up in the volume of mineral matrix through their preliminary dispergation in environment of surface-active substance solution in the ultrasonic unit.

A water suspension with addition of plasticiser SP-1, produced in hydrodynamic ultrasonic grinding aid agent, was used in experiments. By means of ultrasonic grinding aid agent parent particles with nanotubes were separated. Derived elements of 170 nm (fig. 2) generates stable dispersion of waterborne carbon nanotubes. To quantify the size of particles we used multy-shaped system 90 Plus/BI-MAS.

The cement matrix microstructure was studied on raster electronic microscope JSM JC 25S by JEOL.To define the cement matrix mineralogical composition the X-ray phase analysis was conducted [Shelehov 1997] on the diffractometer DRON-3 in the focusing mode by Bragg-Brentano under CuKα-radiation monochromated by the graphite crystal-monochromator.

The differential-thermal analysis was carried out on the derivatographer DIAMOND TG/DTA. The temperature elevation rate was 10 °C/min, maximum temperature during the analysis T = 760 °C.

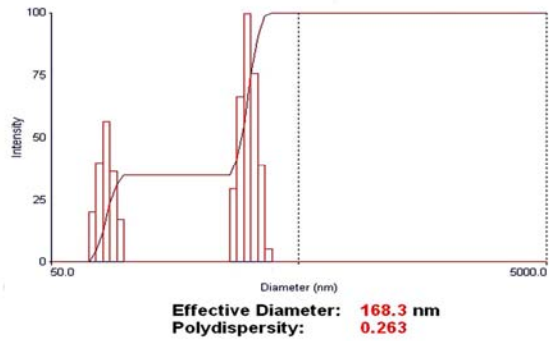
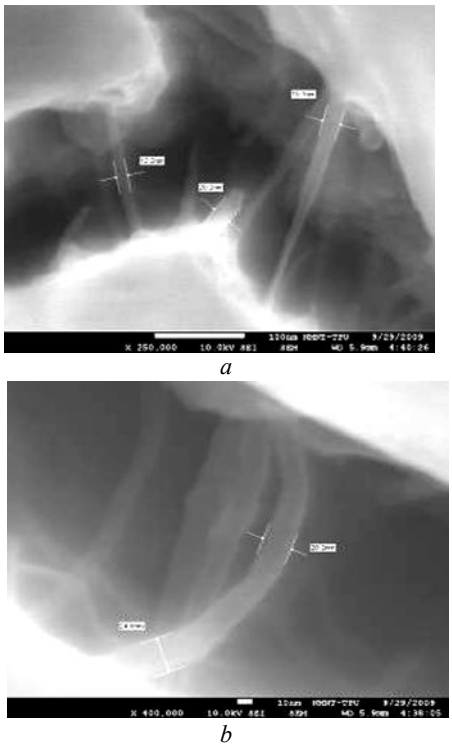


Fig. 2. Nanotubes Graphistrenght ™ particle size distribution after dispergation in hydrodynamical hypersonic grinding aid agent

RESULT AND DISCUSSION

The surface appearance of carbon nanotubes in environment of surface-active substance after dispergation in ultrasonic grinding aid agent is on the fig. 3. There are carbon nanotubes situated in splits formed in the film of surface-active matter after it's drying-out and shrinkage on the surface of carrying base.



a

b

Fig. 3. Carbon nanotubes on the film of surface-active matter after it's drying-out and shrinkage on the surface of carrying base

The X-ray phase analysis of cement matrixes demonstrated the intensification of hydration of cement materials. Thus, on reference samples the reflection lines (d_α, Å = 2.78; **2.75**; 2.70;) corresponding to cement minerals, have a greater intensity in comparison with the reflection lines in the cement matrix modified by carbon nanotubes (fig. 4). The samples with nanotubes also demonstrated higher relative content of calcium hydroxide (dα, Å = 2. 63) and decreased content of calcite in cement stone (dα, Å = 3.03) which indicates the decreased carbonization of cement stone due to higher density of its structure.

The introduction of the dispersion of carbon nanotubes results in the cement matrix structuring with the formation of dense defectless calcium hydrosilicate shell on the surface of solid phases (fig. 5b), including cement and filler particles [Yakovlev 2009, 2011], providing better adhesion with their surfaces. At the same time, due to the contacts between the structured boundary layers, the spatial casing cells are formed in the modified cement matrix structure. A large number of spot contacts provides the formation of utterly filled system in which the collective transition to the adhesion in the short-range order results in the sharp strengthening of the modified cement matrix structure due to the spatial packing formation.

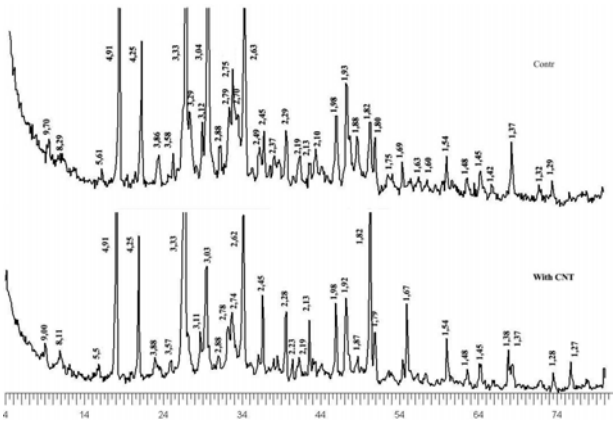
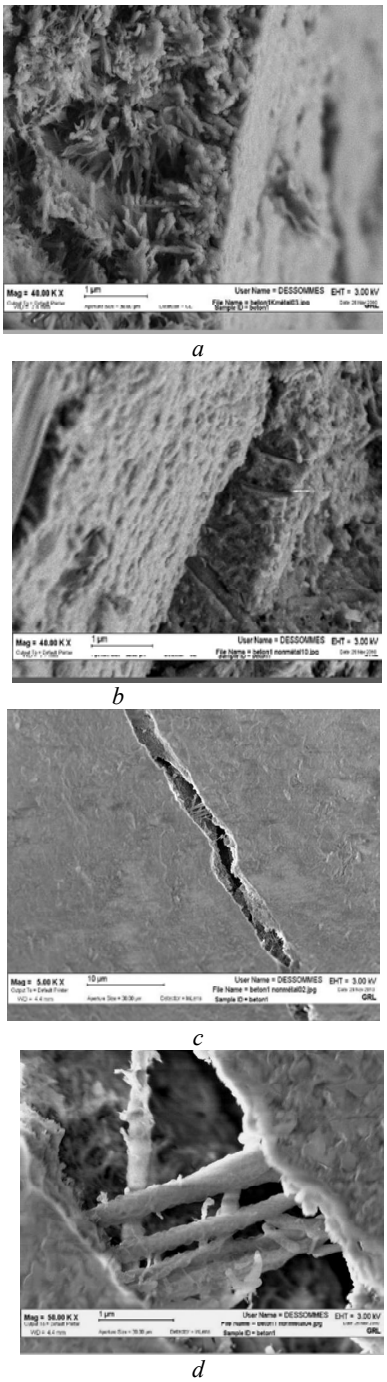


Fig. 4. X-ray spectra of cement matrixes

Calcium hydrosilicates are registered in the healing shrinkage cracks whose growth is slowed down by the reinforcing effect of carbon nanotubes (fig. 5d). The analysis of nanotubes in the cracks covered with calcium hydrosilicates demonstrated that by their sizes they are vividly exceeding the initial diameter of nanotubes which, taking into account the availability of surfactants on the nanotube surfaces, is 40 - 50 nm. In fig. 5d the diameters of new formations on the surface of nanotubes are 300 - 400 nm indicating the covering of nanotubes with the layer of calcium hydrosilicates which is also described in [Konsta-Gdoutos 2010]. At the same time, the article points out that due to the high activity of carbon nanotubes the surface is healing within the first hours of Portland cement hydration. Apparently this is connected with the fact that the introduction of nanotube dispersion intensifies the processes of Portland cement hydration which is confirmed by the X-ray phase analysis of the cement matrix in concrete modified by multilayer carbon nanotubes.



a

b

c

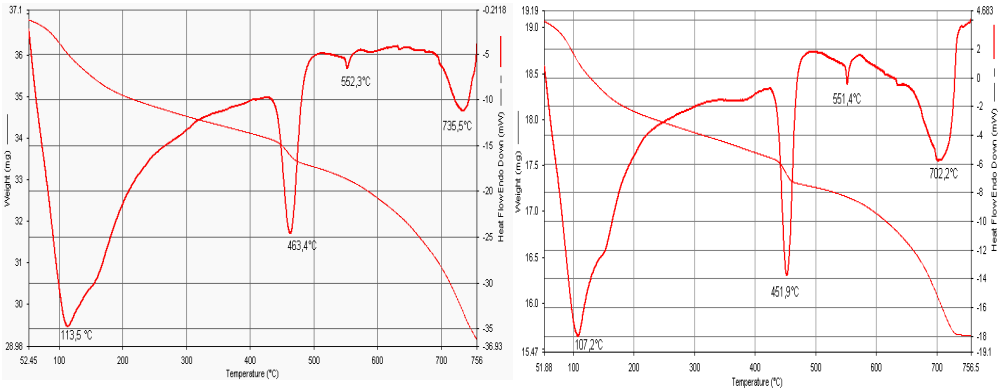
d

Fig. 5. Microstructure of cement stone: a – b, c - general view in the region of shrinkage cracks, d – carbon nanotubes coated with calcium hydrosilicate in the healing crack

The results of differential thermography prove the stepped dehydration of calcium hydrosilicates demonstrated in the form of endothermic effects in the temperature ranges 110 - 115 °C, 452 - 463 °C and 702 - 736 °C (fig. 6) but, at the same time, we observe the significant shift of endoeffects in the range of low temperatures during the modification of cement stone by carbon nanotubes. Thus, the endothermic effect in the control sample is observed at 735.5 °C (fig. 6a), in trial samples on DTA curve the endothermic effect is revealed earlier, at 702 °C (fig. 6b). Apparently, this is connected with the elevation of calcium hydrosilicate basicity formed under the influence of the dispersions of multilayer carbon nanotubes discussed in [Yakovlev 2011] based on the microanalysis of the structured layer of hydrosilicates. At the same time, the analysis of endothermic effects in calcium hydrosilicates described in [Gorshkov 1994] Gorshkov V.S. et al demonstrate that with the increase in the ratio CaO:SiO (above 1.5) the dehydration temperature shifts to the left, when this ratio decreases below 1.5, the dehydration occurs at higher temperatures. Thus, we can say that calcium hydrosilicates with higher basicity structured along the surface of the solid phase in the cement stone with the formation of dense shells are formed during the modification of cement stone by carbon nanotubes [Yakovlev 2009, Korzhenko 2012].

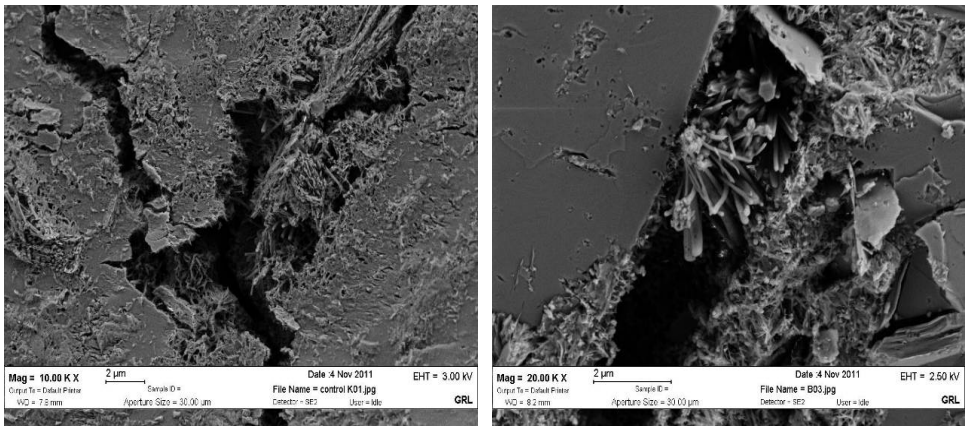
Also the change in the total loss of crystalline hydrate water during the differential-thermal analysis is noted, at the same time, due to dehydration the reference sample mass decreased by 21.9 %, the trial sample – by 19.4 %.

The availability of spatial frame based on calcium hydrosilicates with improved density predetermines its increased durability that should eventually result in improved frost resistance of the cement stone in concrete composition.



a *b*

Fig. 6. Spectra of differential-thermal analysis of the cement matrix: a – in concrete reference samples, b – in concrete cement modified by carbon nanotubes



a b

Fig. 7. Microstructure of dense cement concrete after the frost resistance test: a – reference sample with frost resistance index F200, b – trial sample of concrete with carbon nanotubes (frost resistance F300)

The cement stone dense structure predetermines the decrease of its water absorption and consequently decreases the concrete deformation during water crystallization caused by low temperature action on the concrete.

The concrete frost resistance increase is connected with the dense structure of cement stone in concrete. As it is seen in fig. 7, microcracks formed in the cement stone in the process of frost resistance test prevail in the reference sample (fig. 8a). At the same time, the cement stone structure prepared with modifying carbon nanotubes is practically not destructed since due to its high density the cement stone eliminates water access into intercrystalline area (fig. 7b).

Consequently, the growth of microcracks in the trial sample is restrained by multilayer carbon nanotubes structuring the cement matrix in the concrete with the formation of spatial frame with dense structure practically inaccessible for water. The cement stone dense structure predetermines the decrease of its water absorption and consequently decreases the concrete deformation during water crystallization caused by low temperature action on the concrete.

CONCLUSIONS

Thus we can say that when the cement stone is modified by carbon nanotubes, more high-basic calcium hydrosilicates structured along the solid phase surface are formed in the cement stone with the formation of dense shells which produce the highly durable spatial frame combining all the concrete components into the conglomerate with improved physical and technical properties, including the increased durability and frost resistance.

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МОДИФИКАЦИЯ ЦЕМЕНТНЫХ МАТРИЦ ДИСПЕРСИЕЙ МНОГОСЛОЙНЫХ УГЛЕРОДНЫХ НАНОТРУБОК

Григорий Яковлев, Григорий Первушин,
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Игорь Пудов, Александр Корженко, Ядвига Керене

Аннотация. Исследован бетон плотной структуры на основе портландцемента, модифицированный дисперсией многослойных углеродных нанотрубок Graphistrength™, производимых корпорацией «Аркема». Установлено изменение структуры цементного камня в процессе гидратации и твердения при введении углеродных нанотрубок в состав бетона.

Ключевые слова: углеродные нанотрубки, дисперсия, гидросиликат кальция, морозостойкость.

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THE RESEARCHES OF INFLUENCE OF THERMAL TREATMENT TO STRUCTURE AND PROPERTIES OF CORE OF ROLLS WITH LAYER OF HIGH ALLOYED CAST IRON

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S u m m a r y. The paper is dedicated to researches of influence of thermal treatment to quality of rolls' core. It has been established that high temperature of heating promote to changes in metal base of such material. It has been showed that such structural changes do not reduce properties' level of core of rolls.

K e y w o r d s: properties, roll, stresses' level, structure, thermal treatment

INTRODUCTION

During rolling the surface of rolls barrel is heated from rolled metal and it cooled by water or by air. Its induce appearance of temperature stresses of surfaces compression. Such thermal and inside stresses of rolls are added. Cracks appear on rolls surface as a result of stresses' values exceeding above limit of their material elasticity. The cooling of surface cause strengths stresses appearance and gradual formation of cracks grid with following crumbling of corpuscle of surface-layer. During rolling separate cracks of fatigue origin gradually rise and can lead to destruction of rolls [Tretyakov, Garber, Davletbaev 1976; Budagyants, Karssky 1983; Skoblo, Voronov, Rudyuk 1994; Budagyants, Zhizhkina, Sirota, Kondratenko, Saushkin 2000].

That is why their stability to wear and destruction is main indexes of rolls' quality. During rolling process quality of core determine stability of roll against shock and strength loading, torsional and bending moments. Chemical compositions of used alloys, crystallization speed and following types of treatment equivalently influence at formation of level their properties [Treyger, Prykhodko 1988; Zhizhkina, Budagyants, Gutko 2010; Zhizhkina 2011].

The analyses of problem of wear-resistant rise and increase of rolls' service life [Beashlik 1955; Levi, Kantenik 1967; Budagyants, Zhizhkina 2003; Budagyants, Zhizhkina, Kondratenko 2004; Zhizhkina, Budagyants, Gutko 2008; Ryabicheva, Tsirkin, Usatyuk 2010] show that next main directions of researches and developments:

- the optimization of chemical compositions of used materials and development new ones;
- the improvement of existing technology and making new processes;
- the development effective methods of thermal treatment;
- the making of new construction of rolls;
- the reconstruction of working surface;
- the improvement of exploitations conditions;
- the development reliable methods of quality control and main valuing criterions.

OBJEKT OF RESEARCH

The experience of production of bimetallic rolling rolls [Budagyants, Zhizhkina, Gutko 2009; Budagyants, Zhizhkina, Gutko,2010; Zhizhkina 2012] showed that different areas such castings

have distinctive speeds of crystallization. This lead to rise of level of inside stresses into products and to reduction of rolls' work capacity. The method of production and rolls' materials determine their appearance. As a result of gradual advancement of crystallization front rolls casting is preliminary tense product. Besides availability of nonmetallic inclusions in metal lead to local rise of stresses' level [Zhizhkina, Budagyants, Gutko 2010]. But stresses field is changed. Processes of smoothing of local distortion of bodies structure, redistribution and justification of stresses are springing up into roll. This lead to partial relaxation of stresses.

Individual facts of this are good known. For example, during long rolls presence in warehouse general level of stresses is reduced as a result of redistribution of them along the whole volume of casting. The duration such "natural olding" amount to 3-12 mouth [Budagyants, Karssky 1983]. But researches [Zhizhkina 2011] showed that during such process stresses in rolls are reduced to 25-30 % (or 50-70 MPa).

It has been established that thermal treatment is more effective method of reduce of increased level of stresses [Zhizhkina, Budagyants, Gutko 2008; Zhizhkina 2011]. Their difference from other methods consist in change of goods properties as a result certain combination of heating and cooling. Researches of peculiarities of structure formation of rolls of different types and sizes made it possible to develop special conditions. Such conditions reduce residual (casting) stresses of good and give it special properties: resistance to wear, fatigue itc. [Zhizhkina 2011]. However thermal treatment of rolling rolls is sufficiently complex process. More phases turning in metal matrix provide treatment. Such turning influence properties level.

ANALYSIS OF PUBLICATIONS IN RELATION TO RESEARCH OBJECT

In world practical experience rolling rolls are subjected to high temperatures thermal treatment. It ensures good alloys' treating, high strength and wear-resistance [Treyger, Prykhodko 1988]. Researches [Zhizhkina 2011] showed that thermal treatment of rolls for rise hardness would be reduce to crumbling and at some cases – to destruction rolls. The carrying out complementary tempering promote to redistribution of residual stresses into bimetallic rolls. However such treatment is complex process. That is why it necessary to value at quantity of residual starting austenite in matrix, its stability and to forecast formation possible products of decay during thermal treatment. Researches' results [Bolkhovitinov 1946; Bogachev 1952; Bunin, Malinochka, Taran 1969; Zhizhkina 2011] showed that such thermal treatment disturb mechanical characteristics complex of central part of roll.

However such technology's application for bimetallic rolls is problematical process, because they are produced of heterogeneous cast irons [Zhizhkina, Budagyants, Gutko 2008]. That is why during massive rolls' production multistage thermal treatment are more effective processes. Such regimes are combination of annealing and considerably strength of material [Zhizhkina 2011].

The relaxation annealing receives extensive application for massive rolls with high alloyed working layer and core of gray low alloyed cast iron. It lead to essential reduction of level residual stresses, to rise of thermal endurance, strength, wear-resistance of working layer and stickiness of core [Zhizhkina 2011]. Its recommendations temperature fluctuates at interval 200-750 ^{0}C.

It has been established that the temperature is more essential factor than time of observance. The heating to 500 ^{0}C without observation reduce residual stresses fifty one per cent. The rise of time to six hours with such heating reduces it sixty per cent. Considerable reduction of stresses (eighty per cent) is improved when temperature of annealing is higher. At that moment the choice of regime and parameters of thermal treatment are depended on changes which take place in core of rolls ingot.

That is why the aim of this paper – researches of influence of high temperature thermal treatment on structure and physical and mechanical properties of rolls' core.

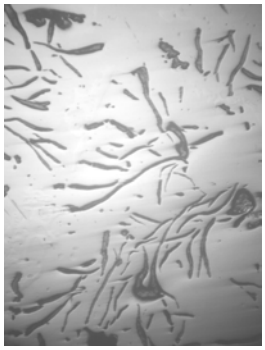
To reach this aim the following problems should be solved:

- to value influence of high temperature and speed of cooling on structure of core's material;
- to analyze change of properties of cast iron during thermal treatment.

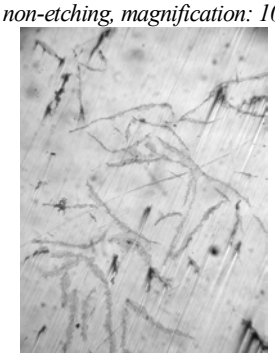
RESULTS OF RESEARCHES

Researches of influence of high temperature and time of heating on structure and properties of cores material of analyzed rolls were carried out in laboratory. Samples were taken from neck of rolls for these researches according to [Bogomolova, 1978].

It is known that the rise of temperature of thermal treatment increase carbon dissolving in austenite [Bolkhovitinov 1946; Bunin, Malinochka, Taran 1969]. It is corroborated results of one's researches of heating of cores material to temperature 920 ^{0}C (fig. 1).



a, non-etching, magnification: 100 x



b, non-etching, magnification: 100 x

Fig. 1 The influence of heating temperature (T=920 ^{0}C) on graphite inclusions' dissolving into structure of cast iron for rolls' core: a – cast sample, b – sample after thermal treatment

Under certain conditions of super cooling austenite with big quantity of carbon disintegrate without formation of excessive ferrite. As a result pearlites' structures are formed.

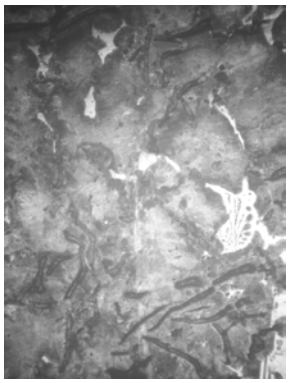
Researches of influence of high temperature of heating on phase composition of metallic matrix of core were realizated. It has been established that cast samples with more 2 % silicon are characterized by uneven and rough structure. Individual areas with big quantity of carbides or flake graphite are observed in such structure (fig. 2).

Under production conditions rolls are cooled slowly for prevention of thermal stresses and cracks' formation. That is why under laboratory conditions speed of samples' cooling was small.

Such cooling and big content of silicon in areas with excess quantity of graphite contribute to turning of austenite to ferrite (look fig. 2).

Changes are taken place in areas with excess quantity of carbides of pearlite matrix. As a result the flake pearlite turned into granular ones.

The influence of structure turning on level of properties is interested. As a result of thermal treatment formation of spherical carbides and small rise of pearlite matrix microhardness are taken place. Microhardness of carbides is not changed.



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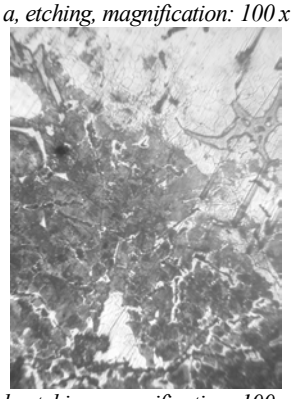

b, etching, magnification: 100 x

Fig. 2. The influence of heating temperature (T=920 ^{0}C) on phase composition of metallic matrix of rolls' core: a – cast sample, b – sample after thermal treatment

After thermal treatment the discharge of ferrite with lesser value of microhardness was taken place in most of samples. That is why general level of hardness did not change (table 1).

Thus structural dispersion and nonuniformity are increased as a result of high temperature (920 ^{0}C) treatment. The austenite disintegrated to ferrite and graphite in areas with big quantity of graphite. The flake pearlite turned into granular ones in metallic matrix near carbides' inclusions. Such nonuniformaty in structure essentially did not

influenced on general level of hardness and strength.

Table 1. The level of properties of material of core and necks of rolls with working layer of high alloyed cast iron **at cast** condition and after high temperature treatment

Properties	Condition	Sample			
		1	2	3	4
Microhardness of structure parts, HV: pearlite	cast	340,5	331,4	329,9	303,6
	after thermal treatment	363,9	321,5	375,1	358,2
carbides	cast	904,3	924,7	924,7	927
	after thermal treatment	880,6	880,6	957,4	957,4
General hardness, HB (Brinell tests)	cast	248	277	241	255
	after thermal treatment	241	285	255	262
Bending strength, MPa	cast	364	456	451,5	455
	after thermal treatment	417,3	461,5	431,4	438,4

CONCLUSIONS

Rolls casting is good with high level of inside stresses. It has been established that thermal treatment is more effective method of reduce of increased level of stresses.

Researches' result of influence of high temperature treatment on quality of rolls core showed that during heating to 920 ^{0}C changes are taken place in metallic base. The austenite disintegrates to ferrite and graphite in areas with big quantity of graphite. The flake pearlite turns into granular ones in areas with big quantity of carbides.

It has been established that such structural changes do not reduce level of properties. However such structural nonuniformity made reduce exploitations' index of rolls. That is why work continues at this direction.

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ИССЛЕДОВАНИЕ ВЛИЯНИЯ ТЕРМИЧЕСКОЙ ОБРАБОТКИ НА СТРУКТУРУ И СВОЙСТВА СЕРДЦЕВИНЫ ВАЛКОВ С РАБОЧИМ СЛОЕМ ИЗ ВЫСОКОЛЕГИРОВАННОГО ЧУГУНА

Наталья Жижкина

Аннотация. Статья посвящена исследованиям влияния термической обработки на качество сердцевины валков. Установлено, что высокая температура нагрева способствует изменениям в металлической основе такого материала. Показано, что такие структурные изменения не снижают уровень свойств.

Ключевые слова: валок, структура, свойства, термическая обработка, уровень напряжений.

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