



MIECZYSLAW ŻYŁA *, AGNIESZKA DUDZIŃSKA **, JANUSZ CYGANKIEWICZ ***

THE INFLUENCE OF DISINTEGRATION OF HARD COAL VARIETIES OF DIFFERENT METAMORPHISM GRADE ON THE AMOUNT OF SORBED ETHANE**WPLYW ROZDROBNIENIA ODMIAN WĘGLA KAMIENNEGO O RÓŻNYM STOPNIU METAMORFIZMU NA ILOŚCI SORBOWANEGO ETANU**

Ethane constitutes an explosive gas. It most often accompanies methane realizing during exploitation and mining works. In this paper the results of ethane sorption have been discussed on three grain classes of six selected hard coal samples collected from active Polish coalmines. On the basis of obtained results, it has been stated that the tested hard coals prove differentiated sorption power with reference to ethane. The extreme amount of ethane is sorbed by low carbonized hard coal from “Jaworzno” coalmine. This sort of coal shows great porosity, and great content of oxygen and moisture. The least amount of ethane is sorbed by hard coal from “Sośnica” coalmine. This sort of coal possesses relatively a great deal of ash contents. Together with the process of coal disintegration, the amount of sorbed ethane increases for all tested coal samples.

Between tested coals there are three medium carbonized samples collected from “Pniówek”, “Chwałowice” “Zofiówka” coalmines which are characterized by small surface values counted according to model BET from nitrogen sorption isotherms determined at the temperature of 77.5 K. The samples of these three coals prove the highest, from between tested coals, increase of ethane sorption occurring together with their disintegration.

These samples disintegrated to 0,063-0,075 mm grain class sorb ethane in the amount corresponding with the sorption quantity of low carbonized coal from “Jaworzno” coalmine in 0.5-0.7 mm grain class. It should be marked that the low carbonized samples collected from “Jaworzno” and “Wesoła” coalmines possess large specific surface and great porosity and belong to coal group of “loose” spatial structure. Regarding profusion of sorbed ethane on disintegrated medium carbonized samples from “Pniówek”, “Zofiówka”, “Chwałowice” coalmines it can be supposed that in the process of coal disintegration, breaking their “compact” structure occurs. Loosened structure of medium carbonized coals results in increasing accessibility of ethane particles to sorption centres both electron donors and electron acceptors which are present on hard coal surface. The surface sorption centre increase may result in formation a compact layer of ethane particles on coal surface. In the formed layer, not only the strengths of vertical binding of ethane

* ACADEMY OF METALURGY AND MINING, FUEL AND ENERGY DEPARTMENT, AL. A. MICKIEWICZA 30, 30-059 KRAKÓW, POLAND

** CENTRAL INSTITUTE OF MINING, MINES VENTILATION DEPARTMENT, PLAC GWARKÓW 1, 40-166 KATOWICE, POLAND; E-mail: adudzinska@gig.eu

*** CENTRAL INSTITUTE OF MINING, MINES VENTILATION DEPARTMENT, PLAC GWARKÓW 1, 40-166 KATOWICE, POLAND

particles with the coal surface appear but also the impact of horizontal strengths appears which forms a compact layer of sorbed ethane particles. The surface layer of ethane particles may lead to explosion.

Keywords: hard coal, ethan, sorption, size grade

Etan jest gazem wybuchowym. Towarzyszy on najczęściej metanowi uwalnianemu się podczas eksploatacji i robót górniczych. W pracy omówiono wyniki badań sorpcji etanu na trzech klasach ziarnowych sześciu wybranych próbek węgla kamiennych pobranych z czynnych polskich kopalń. Na podstawie uzyskanych wyników stwierdzono, że badane węgle wykazują zróżnicowane chłonności sorpcyjne w odniesieniu do etanu. Największe ilości etanu sorbuje niskouwęglony węgiel z kopalni Jaworzno o dużej porowatości oraz dużej zawartości tlenu i wilgoci, a najmniejsze ilości etanu sorbowane są przez węgiel z kopalni Sośnica o stosunkowo dużej zawartości popiołu. Wraz z procesem rozdrabniania węgla wzrasta ilość sorbowanego etanu dla wszystkich badanych próbek węglowych.

Wśród badanych węgla znajdują się trzy próbki węgla średniouwęglonych pobrane z kopalń: Pniówek, Chwałowice, Zofiówka, które charakteryzują się małymi wartościami powierzchni wyliczonymi według modelu BET z izoterm sorpcji azotu wyznaczonych w temperaturze 77,5 K. Próbki tych trzech węgla wykazują największy, spośród badanych, przyrost ilości sorbowanego etanu zachodzący wraz z rozdrobieniem. Próbki te rozdrobnione do klasy ziarnowej 0,063-0,075 mm sorbują etan w ilości odpowiadającej wielkości sorpcji na niskouwęglonym węglu z kopalni Jaworzno będącym w klasie ziarnowej 0,5-0,7 mm. Należy zaznaczyć, że próbki węgla niskouwęglonego pobrane z kopalni Jaworzno i Wesoła mające dużą powierzchnię właściwą i dużą porowatość należą do grupy węgla o „luźnej” budowie przestrzennej. Uwzględniając duże ilości sorbowanego etanu na rozdrobnionych średniouwęglonych próbkach węgla z kopalń: Pniówek, Zofiówka, Chwałowice można przypuszczać, że w procesie rozdrabniania węgla zachodzi rozbijanie ich „zwartej” struktury. Rozluźniona struktura średniouwęglonych węgla prowadzi do zwiększenia dostępności cząsteczek etanu do centrów sorpcji zarówno elektronodonorowych jak też elektroakceptorowych obecnych na powierzchni węgla kamiennych. Powierzchniowy wzrost centrów sorpcji może prowadzić do utworzenia na powierzchni węgla zwartej warstwy cząsteczek etanu. W utworzonej warstwie występują nie tylko siły pionowego wiązania cząsteczek etanu z powierzchnią węgla, lecz również oddziaływania poziomych sił tworzących zwartą warstwę zaadsorbowanych cząsteczek etanu. Powierzchniowa warstwa cząsteczek etanu może prowadzić do wybuchu.

Słowa kluczowe: węgiel kamienny, etan, sorpcja, klasa ziarnowa

Introduction

In the last a dozen or so years, with applying a precise chromatographic analysis it has been proved the presence of measurable amounts of flammable and explosive gases in mining air such as: ethane, propane, butane, ethene, propene, butene, ethine and methane. (Cygankiewicz, 2000; Dai, 2007; Adamus et al., 2010). They constitute hydrocarbons of small amount of carbon element but of great explosive strength and also flammable. Ethane constitutes an explosive hydrocarbon which most often accompanies methane occurring in coal seams. The lower limit of ethane explosiveness amounts to 3.1% and is lower than the lower limit of methane explosiveness which amounts to 5.3%. The ethane content in mining air varies from the value of 0.0001% rank and even reaches percentage values. The local ethane accumulation may form explosion hazard. Out-of-control goaf gas outflows, including methane and ethane, to mining excavations may be particularly hazardous.

In contemporary scientific literature dedicated to sorption and desorption of earlier mentioned hydrocarbons there is not research referring to the influence of metamorphism grade of coal and its disintegration on sorption and desorption of these gases.

Coal crushes during winning, transport and processing. In coal seams a coal part may be in the crushed state during exploitation, particularly coals of greater crushing susceptibility. According to Laskowski (Laskowski, 1948) when winning was not yet so mechanized, 50% of fine coal of below 10mm graining appeared during winning. The problem of disintegration influence on sorption may be of great significance because leaving in coal particles of not desorbed gases may form explosion hazard in coalmines. The principal purpose of conducted research constitutes proving the influence of mechanical disintegration of hard coal samples on the amount of sorbed ethane.

The varies features and good sorption properties result from its complex structure and very heterogeneous surface character containing groups both electro prone as well as nucleon prone (Żyła & Krainer, 1993). The coal structure is also conspicuous by its very varied porous arrangements comprising the structure of micro and sub micro porous structure, mesoporous, micro porous and diffusion porous which possess the considerable influence on gas sorption kinetic (Bustin & Clarkson, 1998; Rodrigues & Lemos de Sousa, 2002; Sing, 2004; Krzyżanowski & Zarębska, 2007). The hard coal structure is described by many models which take into account both the arrangement of aromatic coal part, the construction of aliphatic-alicyclic structure and oxygen surface reactive groups (Ceglarska-Stefańska, 1975; Milewska-Duda, 1987). In the group of elaborated models of coal structures one can distinguish a model subgroup of small aromatic hydrocarbon condensation and models of high-polymeric arrangements containing the structure of carbocyclic and heterocyclic hydrocarbons. The heterocyclic hydrocarbons containing in their structure nitrogen or sulphur show the properties of electron donor centres.

To the group of small aromatic condensation models includes the model proposed by Given P.H. (Given, 1960). In this model one can distinguish the basic arrangement containing in aromatic concentrations carbon element within the limits of 80-90%. These small concentrations show the structure of 9,10 dihydroanthracene. In the proposed model (fig. 1) the author predicted the presence of many oxygen groups particularly of hydroxyl and alcoholic character as well as the presence of oxygen and nitrogen in heterocyclic arrangements. The model elaborated by G.R. Hill and L.B. Lyon (Hill & Lyon 1962) containing high molecular arrangements constitutes an interesting model. In this model (fig. 2) the authors presented three-dimensional arrangement of coal structure with many several-cyclic aromatic concentrations joined with one another by means of binding atoms of carbon, oxygen and sulphur. It has been regarded the presence of reactive groups and the ranges being conspicuous by their positive and negative charges being able to neutralize each other and form arrangements with further binding bridges, stiffening the coal structure. Formed bindings restrict the number of energetic centres being able to bind ethane particles with the structure of hard coal and due to it to lower the amount of sorbed ethane particles. In highly condensed aromatic coal structure there are ranges with positive and negative centres resulting from π electron displacement in aromatic cores of hard coal. Regarding the bindings of electrostatic character one can expect that medium and high carbonized coals with many aromatic and alicyclic group bindings in the process of disintegration, may increase their sorption surface as a result of reproduction of earlier neutralized energetic centres. The disintegration of the compact hard coal structure may be treated as the process of separation of aromatic coal "concentrations" and bindings finding themselves among these "concentrations" with forming separate electro donor and electro acceptor centres. The isolation of free polar centres constitutes the reason for increased number of sorbed ethane particles.

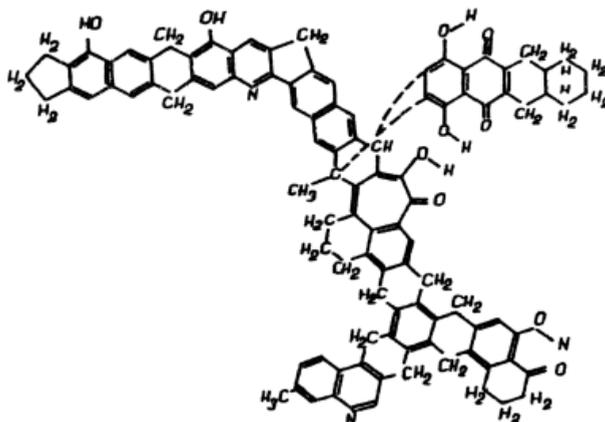


Fig. 1. Model of coal structure by Given

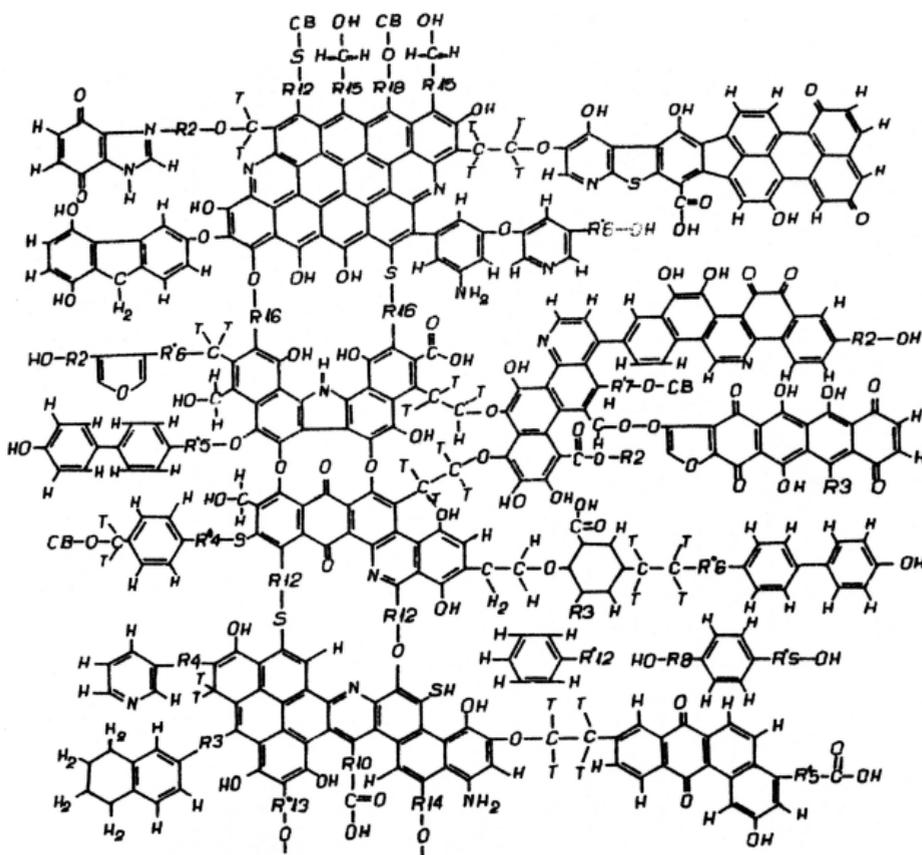


Fig. 2. Model of coal structure by G.R. Hill and L.B Lyon

The research on gas sorption on disintegrated hard coal samples have already been conducted for other sorbates, such as: nitrogen, carbon dioxide, carbon monoxide (Cygankiewicz et al., 2006, 2009).

For sorption ethane research, six hard coal samples of varied carbon element, oxygen content and varied moisture and general porosity, have been collected. The basic analysis of the coal samples has been presented in table 1. The physical and chemical characteristic determining general porosity, porous volume determined with the method of mercury porosimetry and the value of specific surface counted from the isotherms of low temperature nitrogen sorption at the temperature of 77.5 K and carbon dioxide sorption at the temperature of 298 K have been placed in table 2.

TABLE 1

Chemical characteristics of coal samples

Properties	Symbol	Unit	Samples from the following mines					
			Pniówek s. 360	Wesoła s. 501	Chwałowice s. 404	Zofiówka s. 404/2	Sośnica s. 413	Jaworzno s. 209
carbon	C_t^{daf}	%	88,45	85,03	84,39	86,89	84,34	77,69
sulphur total	S_t^a	%	0,39	0,32	0,35	0,35	3,50	1,10
sulphur from pyrite	S_p^a	%	0,01	0,07	0,16	0,01	3,20	0,71
hydrogen	H_t^a	%	4,58	4,55	4,97	4,37	3,35	3,37
nitrogen	N^a	%	1,52	1,27	1,07	1,15	1,28	0,87
sulphur from ash	S_A^a	%	0,07	0,22	0,19	0,18	1,27	0,03
sulphur combustible	S_c^a	%	0,32	0,10	0,16	0,17	2,23	1,07
oxygen (calculated)	O_d^a	%	4,58	8,07	8,47	6,17	6,29	11,30
moisture	W^a	%	1,75	3,69	3,39	0,60	1,85	11,11
ash	A^a	%	3,01	2,86	2,65	8,92	14,18	14,45
volatile matter	V^{daf}	%	28,47	32,53	37,91	30,87	35,58	38,14
reflexivity of vitrynite	R_0	%	0,92	0,72	0,70	1,01	0,78	0,51

TABLE 2

Total porosity, pore volume determined from mercury porosimetry and values of specific surface area determined from nitrogen sorption (77,5 K) and carbon dioxide sorption (298 K)

Samples	Range (5-7500 nm)		S_{BET} , m ² /g	S_{D-R} , m ² /g
	Total porosity, %	Volume pores, mm ³ /g		
Sośnica s. 413	2,37	18,18	0,66	103,2
Zofiówka s. 404/2	2,39	18,37	0,36	120,2
Pniówek s. 360	2,81	21,80	0,43	115,8
Chwałowice s. 404	3,47	27,98	0,75	160,5
Wesoła s. 501	3,87	28,85	2,34	120,0
Jaworzno s. 209	13,55	115,44	189,5	170,1

1. Structure and Ethane Properties

Ethane described by formula C_2H_6 constitutes the simplest hydro carbon particle containing one binding carbon-carbon. The particle structure of this hydrocarbon can be described assuming that two coal atoms can join each other by overlapping σ orbital of sp^3 formed hybrid of each of them, The remaining sp^3 hybrid orbitals of each carbon atom interact with $1s$ orbitals of six carbon atoms forming six C-H bindings. The bindings in ethane possess the power of 420 kJ/mole (100 kcal/mole) and are not much weaker than the bindings in methane (CH_4). The bindings between two carbon atoms possesses the length of 1.54 Å. There are six atomic bindings between two carbon atoms and six hydrogen atoms. Considering the differences in electro negativity of carbon element (2.5) and hydrogen (2.1) the binding electron pair finding itself between carbon and hydrogen atoms is moved towards the element with higher electro negativity (Mc Murry, 2000). Due to it the ethane particle characterized by asymmetric moved atomic binding is polarized, and this binding is called a polar binding.

Thereby the ethane particle assumes a dipole particle features. This absolutely fundamental observation explains the influence of electro donor and electro acceptor hard coal centres on dipolar sorption of dipolar ethane particles. Regarding the presence in hard coal elements of more electronegative than the carbon element and less electronegative one can expect that the ethane sorption of dipolar particle features will depend on the number of centres finding themselves in the hard coal structure.

2. Experimental Part

Six different coal samples collected from Polish coalmines, according to PN-90/G-04502 standard, have been crushed in a jaw crusher and then three grain classes: 0.063-0.075 mm, 0.125-0.25 mm and 0.5-0.7 mm have been separated from each sample by means of Fritsch firm sieve set. The sorption isotherm measurements have been carried out with volume method by means of ASAP 2010 apparatus of Micrometrics firm at the temperature of 298 K. This apparatus enables to determine sorption and desorption isotherms of many gases among others hydrocarbons. The hard coal samples before the measurement have been degassed until gaining high vacuum above the sample of 10^{-7} Pa rank. In order to the precise removal of gases contaminated the coal surface after degassing, the samples have additionally been rinsed with helium.

3. Discussion of Ethane Sorption Results

The ethane sorption isotherms obtained from disintegrated to 0.5-0.7 grain class samples have been presented in fig. 3a. These isotherms are characterized by their regular course, they are slightly concave regarding pressure axis, which testifies for greater interactive energy of the first adsorptive layer with adsorbent surface from the interactive energy of the first layer with the following adsorptive layer. The isotherms run in rather large intervals from one another which testifies for differentiated sorption features of coals resulting from their chemical structure, oxygen, coal element content, general porosity and the value of specific surface counted from the isotherm of defined nitrogen sorption conducted at the temperature of 77.5 K and carbon dioxide sorption at the temperature of 298 K. The coal collected from “Sośnica” coalmine is

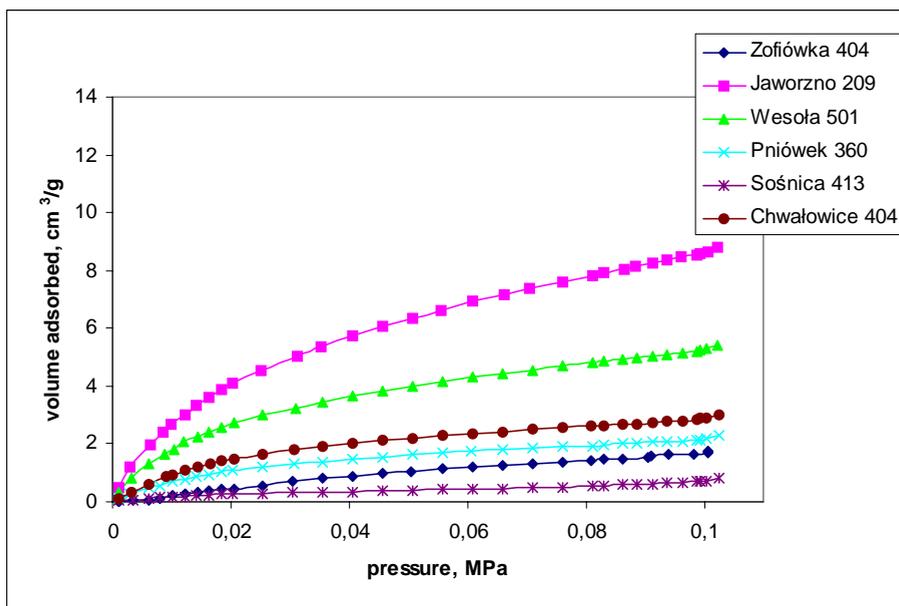


Fig. 3a. Isotherms of ethane sorption at 298 K on coals samples of different coals of 0,5-0,7 mm particle size

conspicuous by its lowest sorption absorptivity. This coal is conspicuous by its great compactness resulting from its little porosity and very large content of ash – 14.18%. This amount of ash results from much content of non-flammable hard coal components. Slightly more ethane, in comparison with the coal from “Sośnica” coalmine is sorbed by the coals from coalmines: “Pniówek”, “Zofiówka”, “Chwałowice”. These are medium carbonized coals of little porosity and small values of the surface counted from nitrogen sorption isotherms. Much greater ethane sorption is, however, shown by the low carbonized coal from 209 “Jaworzno” coalmine and the coal from 501 “Wesoła” coalmine of great general porosity and considerable surface values counted from nitrogen sorption isotherms. These coals are conspicuous by their so-called loose structure with relatively few numbers of aromatic rings in a polymeric arrangement.

In fig. 3b ethane sorption isotherms determined on the basis of the six coal samples are presented. The coal has been disintegrated to 0.125-0.25 mm grain class. From the course of these isotherms results the fact, that disintegration of coal samples increases sorption absorptivity with reference to ethane of all tested coals. Even the hard coal from “Zofiówka” coalmine of “loose” structure and many polar oxygen sorption centres increases its sorption nearly of about 30% in comparison with the sample being in 0.5-0.7 grain class. Much greater sorption increase show medium carbonized coals of small porosity values from “Zofiówka” “Pniówek” and “Chwałowice” coalmines. Their sorption properties in an explicitly grade approach sorption absorptivity of the coal collected from 501 “Wesoła” coalmine, which sorbs ethane quite well. Even the hard coal collected from “Sośnica” coalmine shows the increase of sorption above 70%. Further disintegration of tested coals up to 0.063-0.075 coal grain causes further considerable increase of sorption absorptivity with reference to ethane (fig. 3c). The sorption isotherms

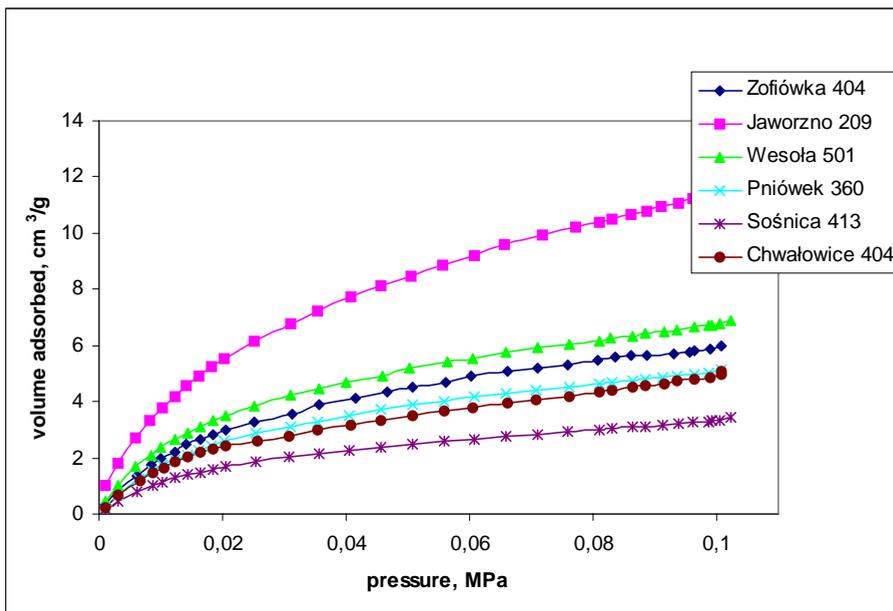


Fig. 3b. Isotherms of ethane sorption at 298 K on coals samples of different coals of 0,125-0,25 mm particle size

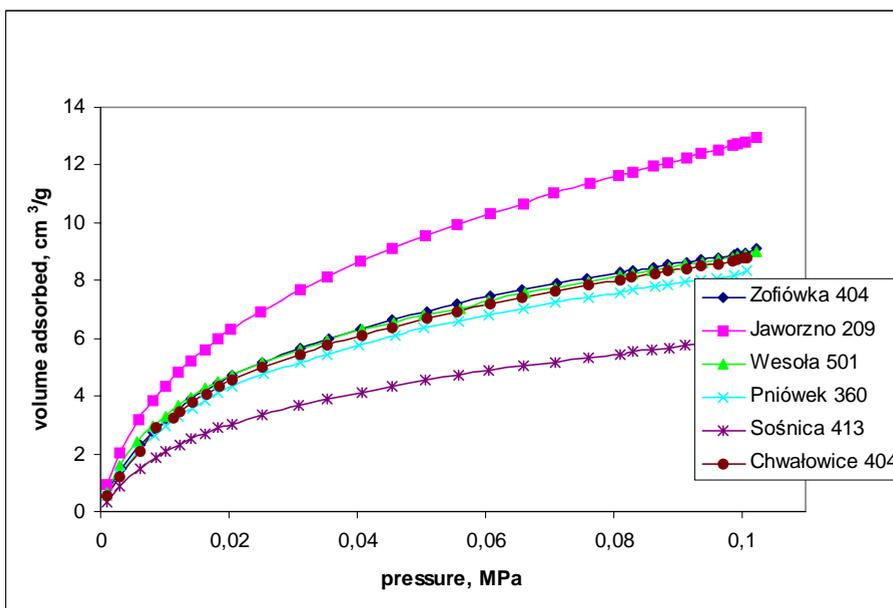


Fig. 3c. Isotherms of ethane sorption at 298 K on coals samples of different coals of 0,063-0,075 mm particle size

determined from the coals of “Zofiówka”, Pniówek” and “Chwałowice” coalmines nearly fully agrees with the course of the isotherm determined from the coal well sorbing ethane collected from 501 “Wesoła” coalmine.

The highest ethane sorption increase occurring together with coal disintegration is observed for medium carbonized coals, which may be characterized by relatively little ethane sorption. They are coals of “compactness” resulting from many bindings appearing among tiny aromatic concentrations. Strongly disintegrated medium carbonized coals sorb ethane in the quantity corresponding with the size of sorbed gas on the medium carbonized coal of “loose” structure and considerable surface concentration of polar energetic centres. It is possible in case of disrupting bindings formed in the process of joining electro donor centres with electro acceptor centres. Every newly formed energetic centre on coal surface constitutes an independent isolated place which binds polar ethane particles. The presence of these centres in hard coals has been evidenced by Anna Marzec (Marzec, 1986, 2002).

In order to distinctly emphasize ethane sorption changes on samples subjected to mechanical process of disintegrated coal, the set of three sorption ethane isotherms have been drafted, obtained from the tested grain classes of the six coal samples. The obtained isotherm sets are presented in figures 4a, 4b, 4c, 5a, 5b, 5c. If one analyses the presented figures, very large changes of ethane sorption absorptivity are visible which occur in the process of coal disintegration. The amounts of sorbed ethane are inversely proportional to the size of coal grain. One can conclude that as the coal disintegrates, the number of polar sorption centres increases on its surface. For the tested coals, ethane sorption factors have been determined which correspond with the amounts of sorbed ethane per 1g coal in each grain class read from the isotherms at the 700 mm Hg ethane pressure. They have been marked by symbols V1, V2, V3 relatively to 0.5-0.7 mm, 0.125-0.25 mm and 0.063-0.075 mm grain classes. The values of these factors are given in table 3.

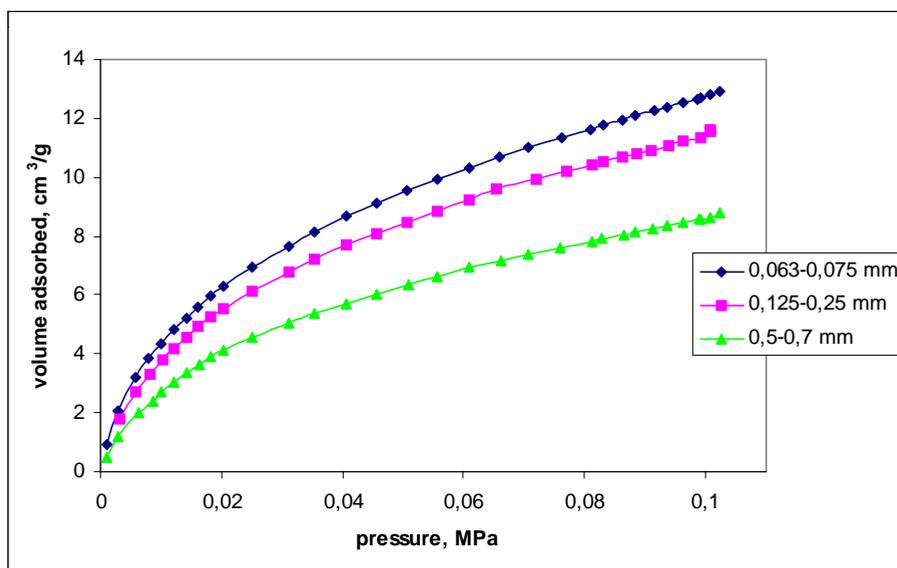


Fig. 4a. Isotherms of ethane sorption at 298 K on coal samples from Jaworzno mine

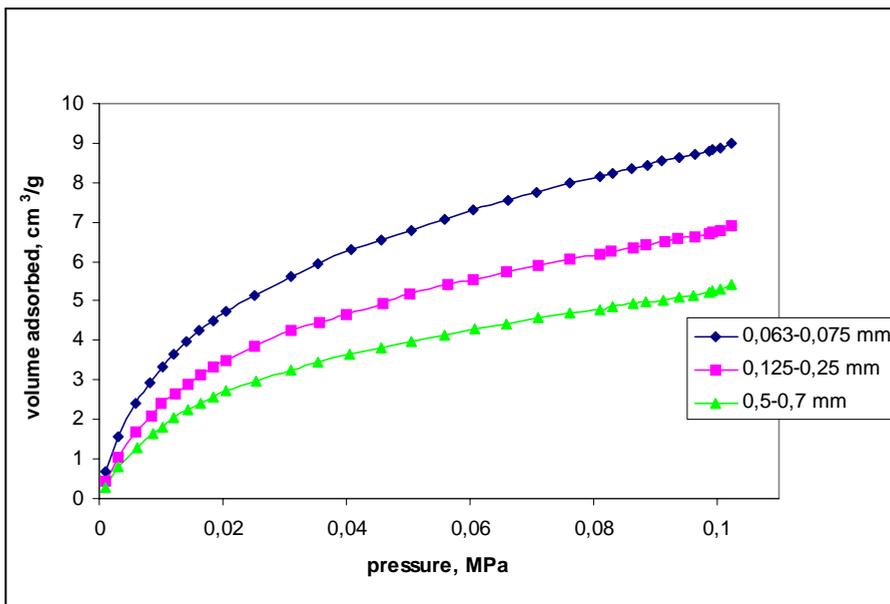


Fig. 4b. Isotherms of ethane sorption at 298 K on coal samples from Wesola mine

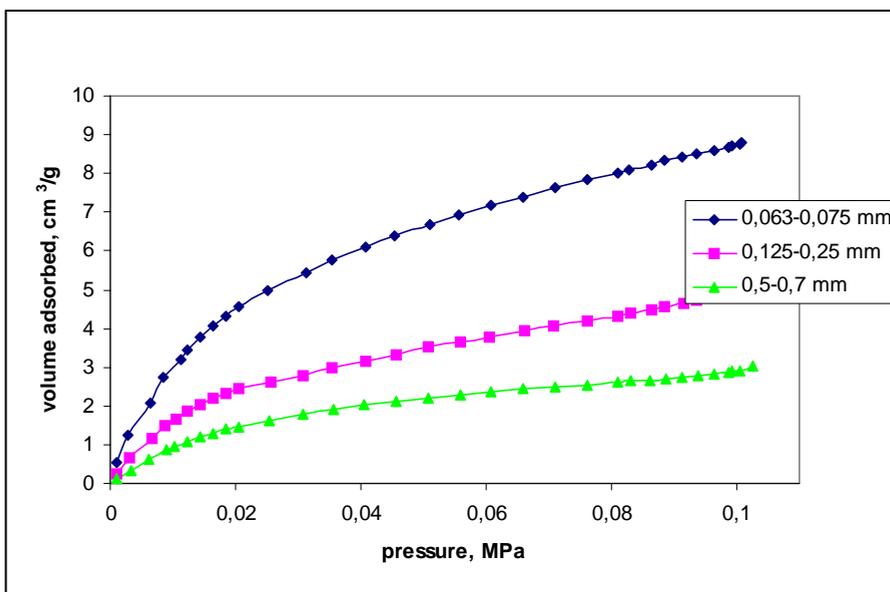


Fig. 4c. Isotherms of ethane sorption at 298 K on coal samples from Chwalowice mine

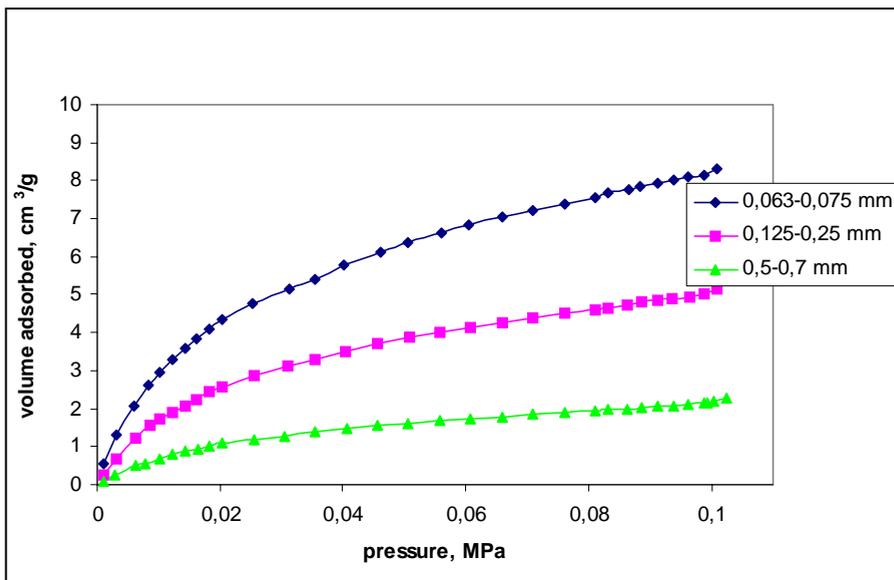


Fig. 5a. Isotherms of ethane sorption at 298 K on coal samples from Pniówek mine

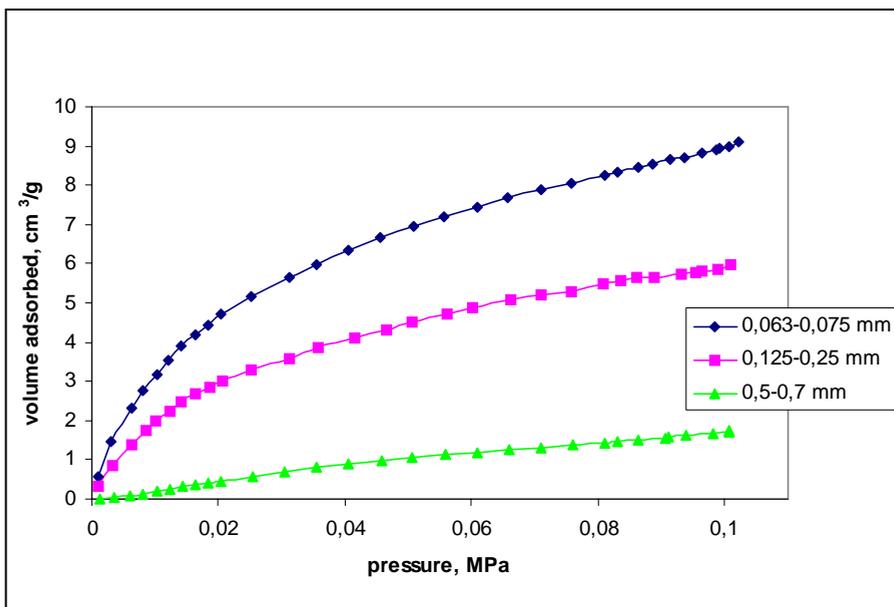


Fig. 5b. Isotherms of ethane sorption at 298 K on coal samples from Zofiówka mine

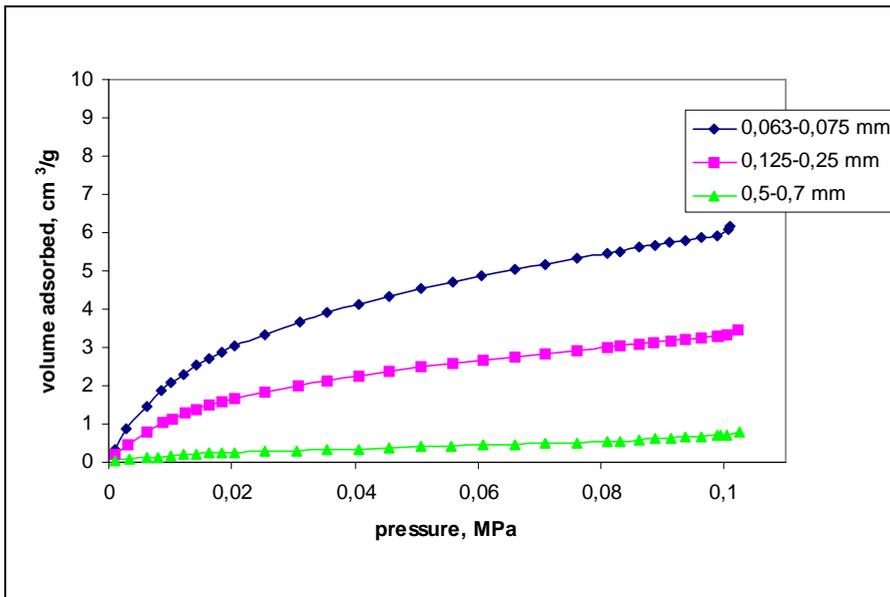


Fig. 5c. Isotherms of ethane sorption at 298 K on coal samples from Sośnica mine

TABLE 3

Ethane sorption coefficients determined from sorption isotherms

Samples	% C ^{daf}	% O ₂	mois- ture, %	V1, cm ³ /g 0,5-0,7 mm	V2, cm ³ /g 0,125-0,25 mm	V3, cm ³ /g 0,063-0,075 mm	V2/V1	V3/V1	V3-V2
Jaworzno, s. 209	77,69	11,30	11,11	8,3	11,1	12,4	1,33	1,49	1,3
Wesoła, s. 501	85,03	8,07	3,69	5,0	6,6	8,6	1,32	1,72	2,0
Chwałowice, s. 404	84,39	8,47	3,39	2,8	4,7	8,5	1,68	3,03	3,8
Pniówek, s. 360	88,45	4,58	1,75	2,1	4,9	8,0	2,33	3,81	3,1
Zofiówka, s. 404	86,89	6,17	0,60	1,6	5,7	8,7	3,56	5,44	3,0
Sośnica, s. 413	84,34	6,29	1,85	0,7	3,2	5,8	4,57	8,28	2,6

From the data of table 3 results that all medium carbonized coals (“Chwałowice” “Zofiówka”, “Pniówek”), after disintegration to the 0.063- 0.075 mm grain size, sorb ethane in the amounts corresponding with the ethane sorption on the coal of “Jaworzno” coalmine disintegrated to 0.5-0.7 mm grain class. All strongly disintegrated coals show such a great sorption increase. Certain deviation may be observed only in case of the coal from “Sośnica” coalmine.

The first coal disintegration from initial 0.5-0.7 mm grain class to 0.125-0.25 mm grain class is characterized by the increase of ethane sorption factor from 1.33 to 4.57. Further coal disintegration to 0.063-0.075 mm grain size results in further considerable ethane sorption factor increase marked by the values of sorption factor from 1.49 to 8.28. This increase is brought about by many changes occurring in coal structure. Highly molecular aromatic coal structure

(Hill model) may be transformed into the structure characterized by low condensation of aromatic arrangement (Given model). In the process of such a great coal disintegration, the reproduction of many energetic centres becomes possible which are neutralized in the initial coal structure. The reproduced energetic centres become the independent places where binding further dipolar ethane particles occurs. It may be assumed that realised surface energy is conspicuous by its active sorption energy that has originated in the process of mechanical coal disintegration. Surface energy in the process of ethane sorption is emitted to surrounding in the form of emanated sorption heat. It results from the data of table 3 that sorption absorptivity of medium carbonized hard coal samples disintegrated to 0.063-0.075 grain class exceeds the low carbonized sorption absorptivity in the initial grain class. It is characterised by the low condensation of aromatic polymer and by the great surface polar concentration of polar oxygen groups. The example of such a structure constitutes the coal collected from 209 "Jaworzno" coalmine. This phenomenon is possible to explain by precise analysis of highly molecular coal structure elaborated by G.R. Hill and L.B. Lyon. According to the model aromatic nuclei include from two to nine cyclic rings where aromatic arrangements both carbon and hetero cyclic enter into composition. The authors of the model also distinguished alicyclic rings of different numbers of coal atoms and the arrangement of alkyl chains. The presence of transverse coal bindings in the coal structure has also been proved which constitute coal, oxygen, nitrogen and not often sulphur bridges. In this model it has also been predicted special furcations which prove the spatial hard coal structure. Because of these causes the model elaborated by Hill and Lyon produces the possibility of explanation for the phenomenon of producing loose structures of aromatic arrangements of low grade aromatic condensation. In the process of mechanical hard coal disintegration, the possibility of breaking intermolecular or atomic bindings appears which results in revealing on the coal grains extra not neutralized energetic centres (Wystemp, 2004). As a result of the decrease of aromatic ring condensation the number of electrostatic fields increases caused by oscillating π electrons being in separated rings. In newly formed low condensed aromatic "cores" the number of polar oxygen groups increases for example: $-\text{OH}$, $-\text{COOH}$, $-\text{CO}$ which constitute the cause of forming on the coal surface discontinuous electrostatic field. Energetic changes occurring in hard coal structure of medium carbonized grade change in a radical way sorption properties, particularly with reference to the particles of compounds of polar features.

Medium carbonized hard coals show great susceptibility to grinding in comparison with low and high carbonized coals (Róg, 2007). There is great likelihood of appearing these coals in disintegrated form in coalmines. Disintegrated coals are characterized by considerably greater sorption absorptivity regarding ethane in comparison with coals being in thicker grain class. It produces the danger of desorption to coalmine atmosphere not-desorbed ethane particles bounded with energetic centres on hard coal surface. It also exists great likelihood of increased absorptivity of these coals with reference to other sorbates including oxygen, leading to increasing emanated sorption heat, particularly on the surfaces of newly appeared tiny coal grains. The heat may cause coal self heating. The problem of methane role in coal constitute a new problem and is little recognized particularly from the point of view of risk at work in mining and making use of energy finding itself in adsorbed ethane layers of hard coal structures.

4. Conclusions

On the basis of obtained results of conducted research of ethane sorption in three grain classes of six tested hard coals the following conclusions can be drawn:

1. Sorption absorptivity of tested hard coal samples is inversely proportional to the size of coal grain. The amounts of sorbed ethane increase together with disintegration of all tested coals.
2. The greatest increase of ethane sorption occurring together with disintegration is observed for medium carbonized coals. Medium carbonized coals after their grinding to 0.063-0.075 mm grain class sorb ethane in the amounts surpassing sorption absorptivity of hard coals of 0.5-0.7 initial grain class and are characterized by "loose" spatial structure and great surface condensation of sorption centres.
3. The disintegration of compact medium carbonized coals results in releasing single sorption centres which is the reason for increasing surface polarity of these coals.
4. It exists a real possibility of oxygen sorption increase on the extra coal surface. The process of adsorption on coals constitutes an exothermic phenomenon and increasing the amount of sorbed oxygen from coalmine air may become the reason for the increase of coal self-heating leading to appearing sources of fire in a coalmine.

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