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Research paper

The influence of biomaterial in the binder composition on the quality of reclaim from furan no-bake sands

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Abstract: The aim of this paper is to determine the influence of biomaterial in the binder composition on the quality of reclaim from furan no-bake sands. The biomaterial is introduced into the moulding sand in order to accelerate the biodegradation of post-regeneration dust and thus to reduce the amount of harmful waste from foundries in landfills. This addition, however, can't deteriorate the technological properties of the moulding sand, including its ability to mechanical regeneration. Chemically bonded moulding sands are characterized by high ability to mechanical regeneration, which reduces the consumption of the raw material and costs related to their transport and storage. A side effect of the regeneration process is the formation of a large amount of post-regeneration dusts. According to the tendencies observed in recent years, moulding processes must meet high requirements connected to environmental protection including problems related to the disposal of generated wastes. A partial replacement of synthetic binding materials with biomaterials may be one of scientific research directions on the production of innovative foundry moulding and core sands. The conducted regeneration tests presented in this paper initially proved that biomaterial slightly decreases the quality of reclaim from moulding sand with its addition. However, its ability to regeneration increases with time of the process. In previous research authors tested biodegradability of the dust remaining after the regeneration process. The tests proved that moulding sand with biomaterial added at the stage of the production process is characterized by about three times better biodegradability than the same moulding sand without additive.

Keywords: biodegradability, biomaterial (PCL), mechanical regeneration, organic moulding sand, post-regeneration dust, waste disposal

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1. Introduction

The largest amount of waste generated in foundries comes from the used moulding sands (sometimes up to 90%) [1–3]. It is assumed that on average 1 Mg of castings generates 0.6–1.0 Mg of used sand [4, 5], and according to [2], it is necessary to use about 4 kg of moulding sand to produce 1 kg of casting. The world production of castings amounts to about 100 million Mg [2, 6], including iron castings in chemically hardened moulding sands in the amount of 30 million Mg, which, assuming the degree of regeneration at the level of 40–50%, gives 15–18 million Mg of the used sand [4]. A significant problem is the production of large-size castings of iron alloys, which are characterized by a high pouring temperature (above 1350°C) and a long solidification time. The ratio of the moulding sand to the casting mass is increased in this case. About 70% of the total production of castings are cast iron castings, which confirms that it is the most used alloy in the industry [7]. Cast iron castings are widely used in the automotive industry, in sea and rail transport, in the energy industry, agriculture, construction as: products that do not carry loads, mainly of gray cast iron (cylinders, ingot moulds, pistons); more loaded castings of malleable and nodular cast iron (parts of agricultural machinery, car parts, fittings, camshafts, crankshafts, gears, machine tool spindles), as well as castings with high abrasion resistance of white cast iron (mill balls, brake pads).

This paper is devoted to materials from the sand casting process consisting of the quartz sand with the organic binder based on a resin modified with furfuryl alcohol, hardened with a mixture of sulfur-containing acids, called furan no-bake sands. Due to many technological advantages such as obtaining castings with high dimensional accuracy, the possibility of making compiled moulds, bonding at ambient temperature or good knock-out properties, these moulding sands are currently the most popular in foundry practice [8]. In addition, they can undergo a regeneration process in which the grain matrix is recovered for reuse. It has a positive effect on reducing the consumption of raw material and reducing costs related to transport and storage. However, the result of the process is generating large amounts of post-regeneration dust containing mainly rubbed, residues of binding material and quartz dust. Depending on the regeneration system and its efficiency, an amount of post-regeneration dust can reach 5–10% in relation to the total reclaimed used moulding sand [2]. Additionally, requirements connected to reclaim quality increase the amount of the generated dust.

Regeneration of moulding materials after the production of the casting is aimed at recovering the grain matrix with parameters as close as possible to fresh sand. The recovery of the grain matrix is very important both from an ecological and economic point of view. The most common in foundry practice is mechanical regeneration, which is very efficient in case of moulding / core sands with organic binders [9, 10]. However, the problem of the environmental impact of used but thermally undegraded moulding / core sands is still not solved [11]. Although the amounts of sand sent to landfills are getting smaller and foundries are equipped with sand regeneration systems, the harmfulness of the residual binders left over from the regeneration processes is still a problem.

There are various methods of moulding sand regeneration. Thermal regeneration is most preferred, as it allows to recover 100% of the matrix but is costly and requires the use of an additional heat source, usually natural gas. A cheaper solution is to use mechanical regeneration. Unfortunately, the regenerated matrix can't be used in any production of castings due to the lower quality of castings and the increase in gas emissions during casting [1,4]. Mechanically regenerated quartz matrix from chemically hardened sands can be safely used for the preparation of the same type of moulding sands in the following proportions: up to 90% – for moulds and up to 70% for cores for cast iron and non-ferrous metals, up to 70% – for moulds and up to 50% to cores for cast steel [3].

The process of mechanical regeneration produces post-regeneration dust containing significant amounts of binder. Usually, the composition of dusts includes silica, the proportion of which ranges from 40 to 80%, and the ignition loss can be even up to 44% [1]. Contrary to the dust generated in metallurgical processes, none of the companies producing mechanical regeneration systems offers the complex technology and equipment for utilization post-regeneration dusts, which would meet technical and economic expectations of foundry plants [12].

Waste from moulding sands can be used in other industries [1, 3]. The main areas of their application are road construction: concrete mortars, material for shaping layers and for reinforcing embankments, a component of hydraulic sand, in the production of asphalt and Portland cement; filling mine workings; landfill management. The possibility of such use of the used moulding sand depends on mainly environmental but also technical requirements (control of chemical composition; leachability of pollutants – assessment of toxicity and impact on groundwater; quartz content; granulation). The environmental threat from used moulding sands may be heavy metals and organic compounds derived from binders and hardeners, the presence of harmful substances in these binders, such as phenol, formaldehyde and furfuryl alcohol [1]. In the case of dusts after regeneration containing organic binder residues, due to their high calorific value, they can be used for energy purposes. Here, particular attention should be paid to the emission of products harmful to health, such as BTEX or PAH [4].

According to the tendencies observed in recent years, moulding processes must meet high requirements connected to environmental protection including problems related to the disposal of waste from used moulding materials left after regeneration processes [8, 12]. The idea of K. Major-Gabryś [8] is to introduce an additive of biodegradable material to the commercial organic binder. A gradual replacement of binding materials produced from petrochemical origin, with biomaterials coming from renewable resources is one of scientific research directions and is also observed in foundry technologies development [13–16]. K. Major-Gabryś investigated the possibility of using biodegradable materials such as PLA, PHB or PCL as binders of moulding sands. Research results, that showed lower toxicity and greater capacity to mechanical regeneration of moulding sands with biodegradable materials as binders, are presented in separate publications [8, 17–19].

Literature data [20–24] show that it is possible to use biodegradable materials as additives to petroleum binders in order to cause biodegradation of materials from the petrochemical industry. Various synthetic resins can be fragmentized and biologically assimilated, however most of these processes could take tens or even hundreds of years. According to research results of G. Scott [21], one of the solutions for this problem is to partially replace the resins with oxy-biodegradable polymers characterized with short decomposition time. Oxy-biodegradation of polymers is possible, thanks to special pro-oxidant additives which are usually compounds of iron, nickel, cobalt, or manganese together with carefully formulated stabilizers [21]. These additives can dissociate the bonding between carbon atoms. An example is PCL (polycaprolactone), which is compatible with many other polymers. It is partially compatible or mechanically compatible with polymers such as polyvinyl acetate (PVAc), polystyrene (PS), polycarbonate etc. and with other polymers such as polyvinyl chloride (PVC), styrene acrylonitrile copolymer (SAN), poly (hydroxy ether), etc. [22]. Extensive studies on the biodegradability of PCL / polyolefin blends, including the relationship between biodegradability and phase structure, have been presented by A. Iwamoto and Y. Tokiwa [25].

A broad analysis of literature data led K. Major-Gabryś to a new perspective on the production of moulding and core sands, which is based on partial replacement of synthetic foundry resins with biodegradable materials [7, 17–19, 21]. The final target of the study is to accelerate the biodegradation rate of regeneration residues by introducing biodegradable material into the binder's structure. However, such biodegradable polymer should not impact other technological properties of the moulding sand.

In the previous research [26], the residues of the binding material in the form of post-regeneration dust were subjected to biodegradability tests. 8 samples of post-regeneration dust from moulding sand without additive and from moulding sand with biomaterial were tested. Samples of the dust were obtained from the moulding sands before the process of proper regeneration and after 5, 10 and 15 minutes of mechanical regeneration. Biodegradation studies were carried out in the natural environment, which was water from the Vistula River (inoculum). Figure 1 shows the percentage weight loss determined after the biodegradation process [26].

The carried-out research proved that dust samples obtained from the regeneration process of moulding sands without biodegradable additive (samples MS 1) characterize

Fig. 1. Percentage loss of weight and residue materials of samples after completion of the biodegradation process [26]

with slight weight loss after the biodegradation process (3%). Larger weight loss was noted for dust samples after the regeneration process of moulding sands with biomaterial (samples MS 2). In the case of these samples, a weight loss is at the level of 8–9% (Fig. 1) [26].

The research presented in this manuscript is concentrated on the quality of the reclaim obtained from mechanical regeneration process of moulding sands. The standard used moulding sand and the used moulding sand with the addition of biomaterial (PCL) left after manufacturing of ductile castings were tested. The influence of the biomaterial (PCL) as a component of the moulding sand on the quality of the obtained reclaim and biodegradability of post-regeneration dusts were investigated.

2. Research methodology

At the first stage the biomaterial (PCL) was added to furfuryl resin to create a new binder. The possibility of using the new binder in making castings from ductile iron was carried out. Castings from ductile iron were made in furan no-bake sands: with both standard and new binder hardened by sulfur acid. At the second stage the mechanical regeneration of used moulding sands was conducted. The quality of the reclaim from the standard moulding sand and the moulding sand with the addition of biomaterial (PCL) was compared.

The following materials were selected as binders or components for the new binder.

– Furfuryl resin, without contain of nitrogen and the free formaldehyde in the range of 0.05–0.15%; the amount of furfuryl alcohol 78%;
– Hardener – an aqueous solution of paratoluenesulfonic acid;
– Polycaprolactone (PCL) – a biodegradable polymer in solid form (powder) from Polysciences, Inc.

Furfuryl resin and the acid hardener are commercial binding materials available at the market and widely used in metal casting practice. PCL was dissolved in furfuryl resin without need of using additional solvent. The new binder contains 95% furfuryl resin and 5% PCL.

The moulding sand mixtures were based on fresh silica sand from Grudzen Las characterized by the following parameters: granulation 0.20/0.32/0.40; d50 = 0.31 mm; pH = 7. Their composition is presented in Fig. 2. The moulding sand without biomaterial was called MS 1 and the moulding sand with biomaterial (PCL) was called MS 2.

The moulding sands were prepared in a laboratory mixer LM-R1, using mixing times: sand + hardener – 60 seconds and sand + hardener + binder – 50 seconds. The shape and design of prepared castings, as well as the sampling site, were determined based on literature data [27, 28]. The aim of introducing the characteristic U-shape was to obtain the highest possible concentration of gas from the moulding material. The metal melting was carried out using the Radyne AMF 45/150 medium frequency induction furnace with crucible of 100 kg capacity of charge and neutral liner. Spheroidization and modification were performed in a slender ladle using FeSiMg9 mortar.

The moulds were poured with ductile iron with a drain temperature of about 1420°C and a pouring temperature of about 1370°C. Figure 2 includes photographs of casting process with the scheme of the casting and the composition of the sand mixtures.

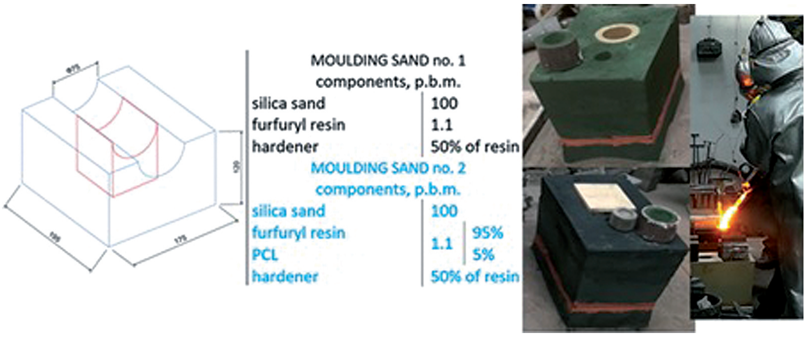

Fig. 2. The scheme of the casting (dimensions in mm), the composition of used sand mixtures, moulds and casting process

The tested samples were mixtures of moulding sands collected after castings production. They included moulding sand's parts heated in different temperatures due to their distance from liquid alloy. Used moulding sands were obtained by crushing the material in Simpson type roller mixer with three-phase electric motor with a power of 1 kW. The tests used rollers with a width of 80 mm (the weight of each the roller was 14 kg). The material was dedusted in the cascade classifier. Crushing time was 1 min. The speed of air flow through the classifier in its free cross-section was 1 m/s, and in the narrowing area was 2 m/s. This process was called the initial regeneration. The material obtained after the initial regeneration was subjected to the process of proper regeneration. The samples were regenerated in experimental testing device – the RD-6 rotor regenerator (Figs. 3b and 3c) according to the schedule presented in Fig. 3a [29, 30]. The rotational speed of

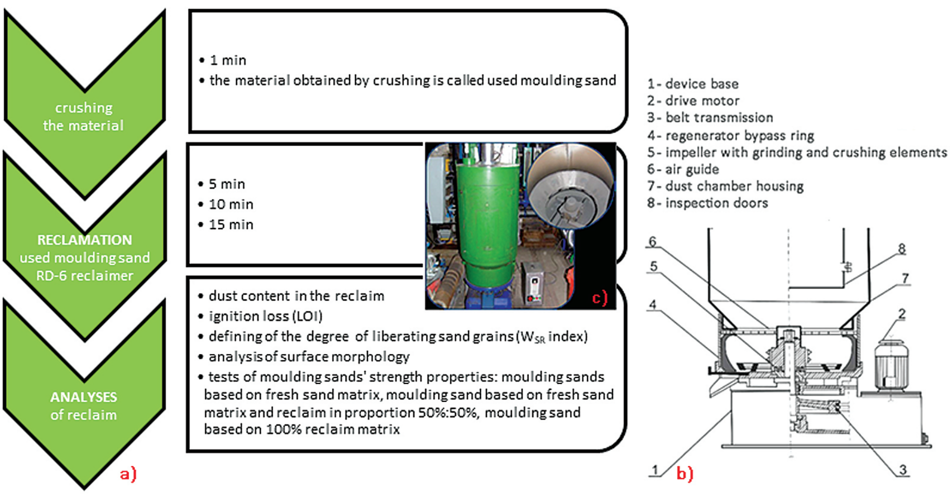

Fig. 3. The schedule of testing moulding sands' ability to mechanical regeneration (a); The RD-6 rotor regenerator: b) fragment of the experimental scheme; c) external view of the regenerator [29,30]

the regenerator stirrer was 1160 rpm. The obtained reclaims were dedusted in a cascade classifier with the parameters described above. The process was carried out with a closed dust chamber in order to determine the amount of generated dust. The proper regeneration process took 5 min, 10 min and 15 min.

The loss of ignition value was defined on the basis of the loss of mass value (UC) of the samples of moulding sands burning in a furnace for 2 h at a constant temperature of 950°C. This parameter was determined each time on 2 samples. According to the obtained results of the ignition loss the degree of liberating sand grains from binders left-overs W_{SR} was calculated. The value of the W_{SR} index is determined from the Eq. (2.1):

$$W_{SR} = \left(1 - \frac{U_C}{S}\right) \cdot 100\% \tag{2.1}$$

where: W_{SR} – index, the degree of liberating sand grains from binders left-overs, %; U_C – mass loss of the sample of the reclaim due to burning in a furnace for 2 h at a constant temperature of 950°C, %; S – total content of the binder and all removable, at the determined temperature, combustible substances determined by total burning of 100 g moulding sand sample before the regeneration, %.

The dust content in the tested materials was determined on the basis of used moulding sand and reclaims sieving in a cascade classifier. The first stage was removing the dust from the used moulding sands, samples for regeneration were prepared. After the regeneration process, the dust content in the reclaims (5, 10, 15 minutes) was determined.

Moulding sands based on fresh matrix, on composition of fresh matrix and reclaim (50%:50%) and on pure reclaim were prepared in a laboratory mixer, type LMB-u. The sand was mixed with the hardener for 30 seconds, then the binder was introduced and the whole mixture was mixed for another 30 seconds. Measurements of the moulding sand bending strength were carried out on an LRu-2 type apparatus after 2, 4 and 24 h in accordance with guidelines given in the PN-83/H-11073 standard.

For SEM examination samples of moulding sands after strength tests were cut by hand with a saw blade, attached to a carbon tape and vaporized with platinum. The tests were carried out using the Jeol JSM 6460LV scanning electron microscope. The microscope is equipped with detectors of backward diffused electron BE and secondary SE. The microscope is also equipped with the INCA X- EDS-act Energy 350 by Oxford spectrometer.

3. Results and discussion

3.1. Regeneration tests and observation of surface morphology

The ability of moulding sands to mechanical regeneration was conducted according to the schedule (Fig. 3) and methodology presented in Section 2. The obtained results are presented in Figs. 4–9.

The obtained results initially prove that the moulding sand without the addition of PCL has better ability to mechanical regeneration than the moulding sand with the additive.

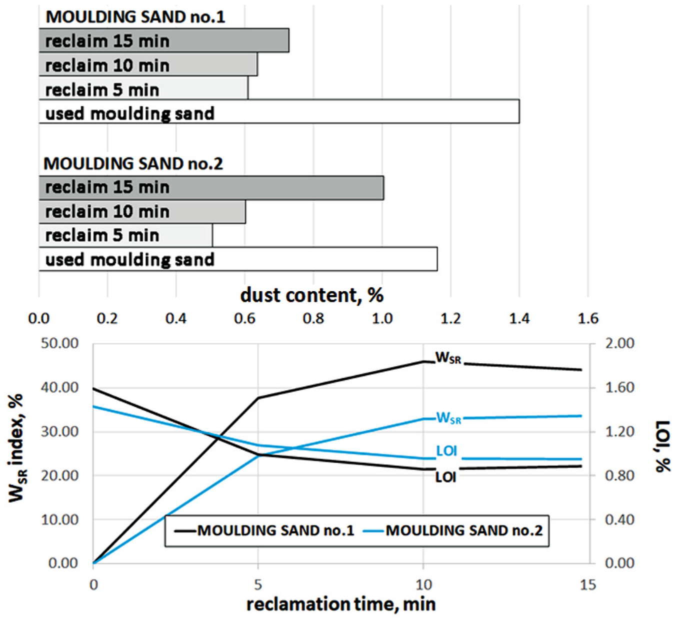

Fig. 4. Dust content, ignition loss (LOI) and the degree of liberating sand grains from binders left-overs (W_{SR} index) vs regeneration time for used moulding sands (0 min) and reclaimed sands after 5, 10 and 15 min of regeneration

Loss on ignition for the moulding sand with PCL is higher than for the standard moulding sand while its W_{SR} index is lower (Fig. 4). In the case of moulding sand no. 1 the decrease in LOI from 1.6 to 0.8% is observed, while in the case of moulding sand no. 2 the decrease in LOI from 1.4 to 0.95% is observed which proves less efficiency of moulding sand no. 2 regeneration. However, it should be noted that the obtained results for both moulding sands show high ability to mechanical regeneration. Initial studies [4] of moulding sand with PCL as a binder regeneration showed a tendency of the binder to stick to the tooling during the mechanical regeneration process. It is believed that the addition of PCL to the resin increases the difficulty of separating the residual binder material from the matrix grains. Studies show that this phenomenon decreases as the regeneration cycle lengthens to 15 minutes (Fig. 4). These observations are confirmed by examinations of the dust content in the reclaims. The longer the regeneration process, the greater the dust content is blown away from the reclaim from moulding sand with new binder (Fig. 4). The longer the regeneration process, the more dust is released. In the case of the moulding sand with a new binder, the efficiency of the regeneration process carried out for 15 minutes increased by approx. 30% compared to the process carried out for 5 or 10 minutes (Fig. 4). Which confirms the assumption that the use of PCL as an additive to the binder may require a longer time of moulding sand regeneration with its use. The problem will be solved by using thermal-mechanical regeneration process which is optimal for moulding sands with organic binders.

The last parameter of reclaim quality assessment were tests of bending strength of moulding sands based on fresh matrix and moulding sands based, both fully and partly, on the reclaim obtained in the regeneration process described in chapter 2 of this paper. Moulding sands based on fresh silica sand, moulding sands based on 100% of reclaim matrix and moulding sand based on fresh silica sand and reclaim in proportion 50%:50% were tested. Other components of the moulding sand are analogous to the sand compositions presented in Fig. 3. There were used reclaims obtained after 5, 10 and 15 min of regeneration process. SEM observations were carried out for selected fractures of the moulding sand formed after the test of strength after 24 h of hardening. The obtained results are presented in the Figs. 5–9.

The carried-out tests showed that the moulding sand based on fresh matrix with the new binder is characterized by higher strength than the standard moulding sand based on fresh matrix (Fig. 5). Inaccurately removed residual bonding material can fill the matrix grains, giving them a more spherical shape. Then the demand for bonding material decreases. Hence, better strength properties of moulding sands based on 100% reclaim may result. These observations are consistent with the ignition loss studies which showed lower loss values when using the 10-minute, and especially the 15-minute regeneration cycle.

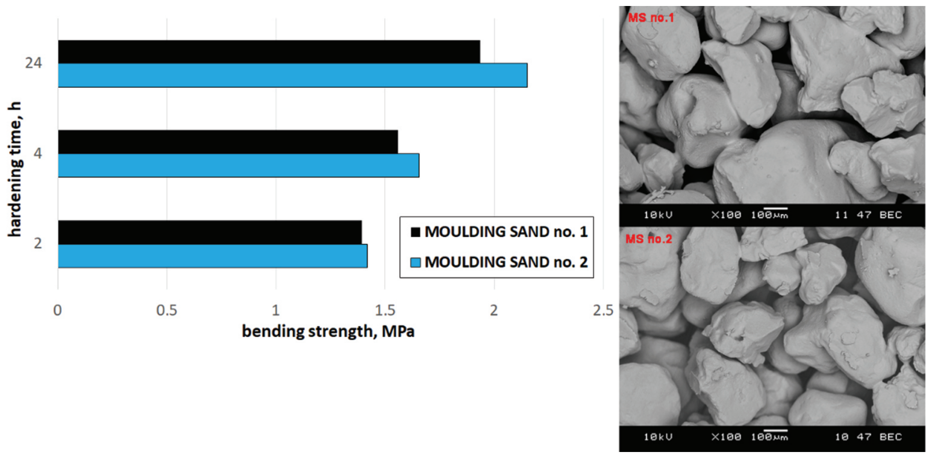

Fig. 5. The influence of PCL additive on bending strength of moulding sand based on fresh silica matrix with SEM observation

In the case of moulding sands based on reclaim obtained in a 5-minute regeneration cycle, higher strength of moulding sand based on 100% of reclaim were observed than moulding sand based on a matrix composed of fresh quartz sand and reclaim (50%:50%) (Fig. 6). This phenomenon is more noticeable in the case of moulding sands with the addition of PCL. Their strength is also lower than that of an analogous moulding sand prepared on the basis of fresh grain matrix. It was found that the phenomenon was reduced when the reclaim obtained in the 10- and 15-minute cycle was used as a component of the moulding sand (Figs. 7–8).

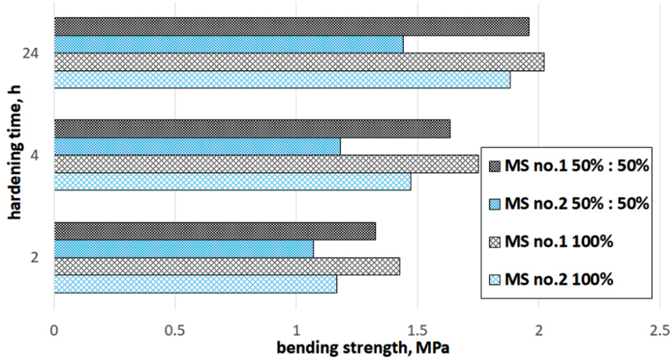

Fig. 6. The influence of PCL additive on bending strength of moulding sand based on fresh silica matrix and the reclaim after 5 min of regeneration

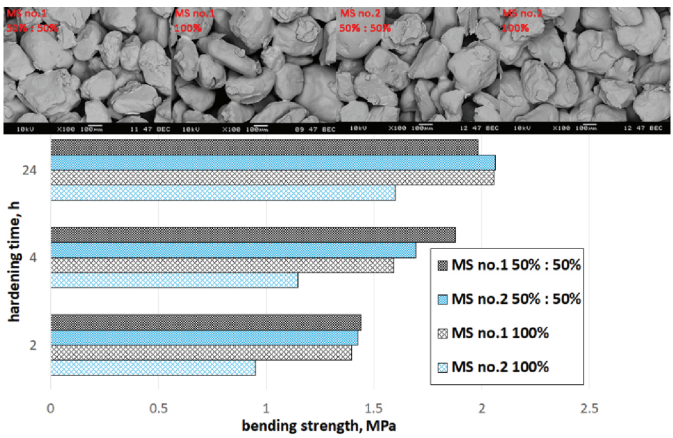

Fig. 7. The influence of PCL additive on bending strength of moulding sand based on fresh silica matrix and the reclaim after 10 min of regeneration with SEM observation

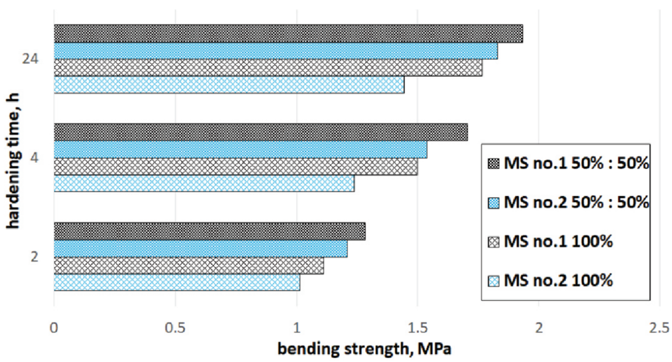

Fig. 8. The influence of PCL additive on bending strength of moulding sand based on fresh silica matrix and the reclaim after 15 min of regeneration

The observations of the morphology of the fracture surface do not show differences between the moulding sand with and without the addition of biomaterial (Figs. 5, 7, 9). In both cases, mechanical destruction of the adhesive type can be observed which according to literature data [31–36] is typical for moulding sands with organic binders. Destruction takes place along the matrix grain – binding material. In the case of both tested moulding sands, the binding material is dispersed in droplets, which proves the low binder content and its high viscosity. In the conducted tests, no differences in the bond binder structure caused by the addition of biodegradable material were observed.

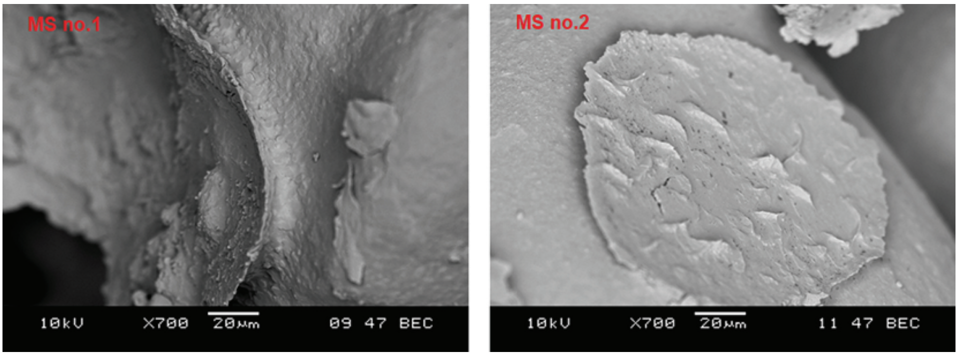

Fig. 9. Observation of surface morphology and binder bridge (SEM tests, ×700) of moulding sands based on 100% reclaims: without additive (MS 1) and with PCL additive (MS 2)

4. Conclusions

Authors' new perspective on the production of foundry moulding and core sands based on partial replacement of commonly used in foundry practice synthetic resins with biodegradable materials may be a direction in improving ecological character of moulding sands with organic binders.

Analysis of literature data and the author's own research yield the following conclusions:

1. The conducted regeneration tests initially proved that the moulding sand without the addition of PCL has better ability to mechanical regeneration than the moulding sand with the additive. The ability to regeneration of moulding sand with biomaterial increases with time of regeneration.
2. Bending strength tests showed that moulding sand with biomaterial based on fresh silica sand has better properties than standard moulding sand. The analogous moulding sands based on 100% reclaimed sand and reclaim combined with fresh silica sand (50%:50%) are characterized by worse strength properties. The quality of moulding sands with biomaterial increases with time of regeneration.
3. The observations of the morphology of the fracture surface do not show differences between the moulding sand with and without the addition of biodegradable material.

The presented results are part of complex comparative research concerning mechanical and thermal behavior of various types of moulding and core sands, their ability to mechanical regeneration as well as investigation of biodegradation rate of moulding sands with new binders.

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Wpływ biomateriału w spoiwie na jakość regeneratu otrzymywanego z samoutwardzalnych mas furanowych

Słowa kluczowe: biodegradowalność, biomateriał (PCL), organiczna masa formierska, pyły poregeneracyjne, regeneracja mechaniczna, utylizacja odpadów

Streszczenie:

Tematem niniejszej pracy jest określenie wpływu dodatku biomateriału (PCL) do spoiwa na jakość regeneratu z samoutwardzalnych mas furanowych. Zadaniem biomateriału jest przyspieszenie biodegradacji pyłów poregeneracyjnych i tym samym doprowadzenie do zredukowania na składowiskach ilości szkodliwych odpadów pochodzących z odlewni. Dodatek ten nie może jednak pogarszać właściwości technologicznych masy, w tym jej zdolności do regeneracji mechanicznej. Autorzy przeprowadzili proces regeneracji mechanicznej, a następnie badaniom poddali regeneraty z mas formierskich utwardzanych chemicznie przeznaczonych do produkcji wielkogabarytowych odlewów żeliwnych.

Odlewy żeliwne znajdują szerokie zastosowanie w motoryzacji, transporcie morskim i kolejowym, w energetyce, rolnictwie oraz budownictwie. Produkcja odlewu wielkogabarytowego o złożonym kształcie, charakteryzującego się wysoką jakością przy zachowaniu wymaganych właściwości użytkowych, obejmuje wiele etapów procesu produkcyjnego. Jednym z nich jest odpowiedni dobór technologii mas formierskich i rdzeniowych. Masy formierskie i rdzeniowe wykorzystywane są do produkcji odlewów w około 80% wszystkich odlewni. Największą ilość odpadów wytwarzanych w odlewniach stanowi zużyta masa formierska / rdzeniowa i sięga ona czasem nawet 90%. Przyjmuje się, że średnio z 1 Mg odlewów powstaje 0,6–1,0 Mg zużytej masy [4, 5], a według [2] do wyprodukowania 1 kg odlewu potrzeba około 4 kg masy formierskiej. Światowa produkcja odlewów wynosi około 100 mln Mg [2, 6], w tym odlewy żeliwne w masach formierskich utwardzanych chemicznie w ilości 30 mln Mg, co przy założeniu stopnia regeneracji na poziomie 40–50% daje 15–18 mln Mg zużytego piasku [4].

Prezentowany w pracy temat poświęcony jest materiałom pochodzącym z procesu odlewania do form piaskowych wykonanych z piasku kwarcowego ze spoiwem organicznym na bazie żywicy modyfikowanej alkoholem furfurylowym, utwardzanej mieszaniną kwasów zawierających siarkę. Masy te, w obrębie mas utwardzanych chemicznie, cieszą się obecnie największą popularnością ze względu na zalety technologiczne wykonywanych z nich form i rdzeni. Dodatkowo charakteryzują się one dużą podatnością na proces regeneracji mechanicznej, który jest podstawowym procesem służącym do odzyskiwania osnowy ziarnowej ze zużytej, wiązanej chemicznie masy formierskiej i rdzeniowej. Proces ten ma za zadanie uzyskanie wysokiej jakości regeneratu, przy zachowaniu jego maksymalnej efektywności, co jest kluczowe z ekonomicznego i ekologicznego punktu widzenia. Regenerat z mas na bazie żywicy modyfikowanej alkoholem furfurylowym może stanowić nawet 60% osnowy ziarnowej stosowanej do otrzymania kolejnych form odlewniczych. Stosowanie procesu regeneracji wpływa pozytywnie na zmniejszenie zużycia świeżego surowca oraz obniżenie kosztów związanych z jego transportem i magazynowaniem. Szeroko stosowane procesy regeneracji mechanicznej zużytych mas formierskich i rdzeniowych wiązanych chemicznie generują jednak duże ilości pyłu poregeneracyjnego. Pył ten zawiera głównie pozostałości materiału wiążącego oraz pył kwarcowy. Ilość pyłu poregeneracyjnego może sięgać 5–10% w stosunku do całkowitej masy materiału poddanego regeneracji. Wysokie wymagania związane z jakością regeneratu dodatkowo zwiększają ilość powstającego pyłu. W przeciwieństwie do pyłów powstających w procesach metalurgicznych, żadna z firm produkujących układy regeneracji mechanicznej mas formierskich i rdzeniowych nie

oferuje kompleksowej technologii i urządzeń do utylizacji pyłów poregeneracyjnych, które spełniałyby oczekiwania techniczno-ekonomiczne zakładów odlewniczych [12]. Problem zagospodarowania tych pyłów jest istotny dla każdej odlewni stosującej tę technologię, głównie ze względu na wysokie koszty ich termicznej utylizacji. Składowanie tych pyłów w wyznaczonej części składowiska wiąże się z wysokimi kosztami. Niektóre odlewnie, posiadające obszerne zaplecza, gdzie składują zabezpieczone pyły. Nie rozwiązuje to jednak problemu, ponieważ pyły pochodzące z regeneracji mas wiązanych spoiwami organicznymi ulegają rozkładowi w środowisku naturalnym w czasie zbliżonym do rozkładu plastiku.

Zgodnie z tendencjami obserwowanymi w ostatnich latach, procesy formierskie muszą spełniać wysokie wymagania związane z ochroną środowiska, w tym problemy związane z unieszkodliwianiem odpadów ze zużytych materiałów formierskich oraz po procesach regeneracji. Jednym z kierunków badań naukowych jest stopniowe zastępowanie materiałów wiążących pochodzenia petrochemicznego biomateriałami pochodzącymi ze źródeł odnawialnych. Ta nowa perspektywa produkcji mas formierskich i rdzeniowych dla odlewnictwa, polegająca na częściowym zastąpieniu powszechnie stosowanych w odlewnictwie żywic syntetycznych materiałami biodegradowalnymi, może być kierunkiem poprawy ekologicznego charakteru mas ze spoiwami organicznymi, uwzględniającym właściwe zarządzanie odpadami. W ramach pracy zbadano wpływ biomateriału (PCL) jako składnika masy formierskiej na jakość otrzymanego regeneratu. Przeprowadzono regenerację mechaniczną zużytych mas formierskich Wcześniejsze badania autorów [26] wykazały, że masa formierska z dodatkiem biomateriału (PCL) wprowadzonego na etapie procesu produkcyjnego charakteryzuje się około trzykrotnie lepszą biodegradowalnością niż ta sama masa bez dodatku. Stopień biodegradacji układów określono w wodzie z rzeki Wisła. Miejscem poboru wody był Stopień Wodny Kościuszko w Krakowie. Przeprowadzone badania wstępne wykazały, że masa bez dodatku charakteryzuje się większą zdolnością do regeneracji mechanicznej niż mas z biomateriałem. Zdolność do regeneracji masy z biomateriałem wzrasta z wydłużeniem czasu regeneracji. Należy jednak podkreślić, że obie masy charakteryzują się dużą zdolnością do regeneracji mechanicznej, co jest charakterystyczne dla mas ze spoiwami organicznymi.

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