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Reclaimability of the spent sand mixture – sand with bentonite – sand with furfuryl resin

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Abstract

Introduction of new binding materials and new technologies of their hardening in casting moulds and cores production requires the application of reclamation methods adequate to their properties as well as special devices realizing tasks. The spent sands circulation system containing the same kind of moulding and core sands is optimal from the point of view of the expected reclamation results. However, in the face of a significant variability of applied technologies and related to them various reclamation methods, the need - of the obtained reclamation products assessment on the grounds of systematic criteria and uniform bases – arises, with a tendency of indicating which criteria are the most important for the given sand system. The reclaimability results of the mixture of the spent moulding sand with Geko S bentonite and the spent core sand with the Kaltharz 404U resin hardened by acidic hardener 100 T3, are presented in the paper. Investigations were performed with regard to the estimation of an influence of core sands additions (10 –25%) on the reclaimed material quality. Dusts and clay content in the reclaim, its chemical reaction (pH) and ignition loss were estimated. The verification of the reclaim instrumental assessment was performed on the basis of the technological properties estimation of moulding sand with bentonite, where the reclaimed material was used as a matrix.

Keywords: moulding sand, reclamation, sand mixture

1. Program and scope of experimental investigations

The problem of the reclaimability assessment of mixtures of the spent sands with bentonite and additions of core sands with organic binder of an acidic character is especially important in foundry plants, which are applying the classic sands with bentonite as moulding sands and sands with organic, acidic binders as core sands [1–4, 6]. Due to a different chemical character of both kinds of sands their mixtures are not easily reclaimed, but in the casting practice where spent sands are not selected, such mixtures occur quite often. The mixture of moulding sands with Geko S bentonite and core sands with the Kaltharz 404U resin, of the percentage fractions given in Table 1, were used in investigations.

Table 1. Mass fractions and symbols of tests

No.	Sand with Geko S bentonite	Sand with the Kaltharz 404U resin	Symbol
	[%]	[%]	
1	100	0	Sand 1
2	90	10	Sand 2
3	85	15	Sand 3
4	80	20	Sand 4
5	75	25	Sand 5

2. Experimental stand

Investigations were realised by means of the testing device, which was the model of the rotor reclaimer (Fig.1) [5]. The properly profiled rotor arms allow to perform the elementary operations of the dry, mechanical reclamation process: rubbing, abrasion and crushing. 2 kg of the investigated spent sand is undergoing the reclamation process in this device. The rotor time and rotational speed are being changed according to the prepared program of experiments. In order to limit the sand heating effect, during the reclamation process, the outside bowl surface of the apparatus is cooled.

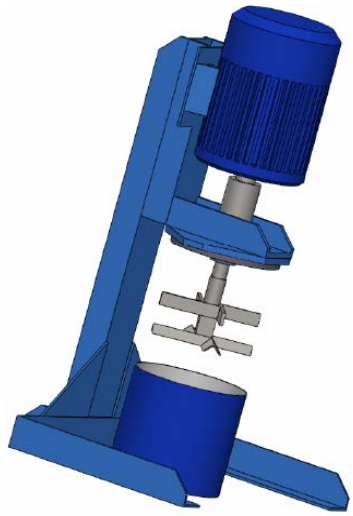


Fig. 1. General view of the rubbing device (testing apparatus) for the reclaimability investigations of various kinds of spent sands and their mixtures

3. Experimental investigations

The following sands were used as testing materials:

- spent sand with bentonite, of the initial composition: high-silica sand – 93%, Geko S bentonite – 7%, water – 3.5% - in relation to the sum of dry components.
- spent sand with the Kaltharz 404U resin, obtained from one of the domestic foundry plants. This spent sand was characterised by the ignition loss of 3.12%.

The sand mixtures (see Table 1) were processed in the testing apparatus according to the investigation algorithm presented in Figure 2.

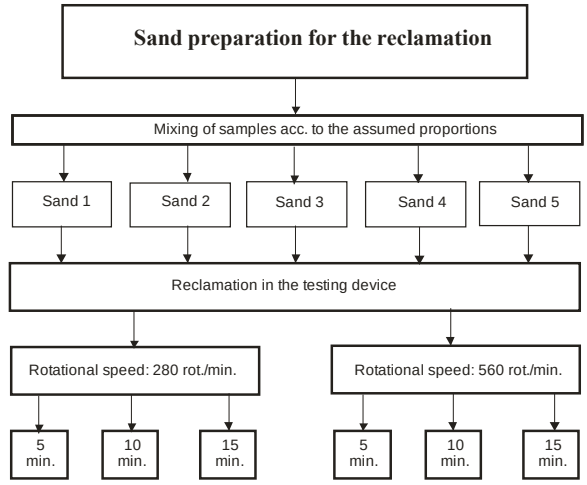


Fig. 2. Investigation algorithm of spent sands mixtures

4. Investigation methodology

The reclaimability assessment of the spent sands mixtures was performed on the basis of measuring [7-9]:

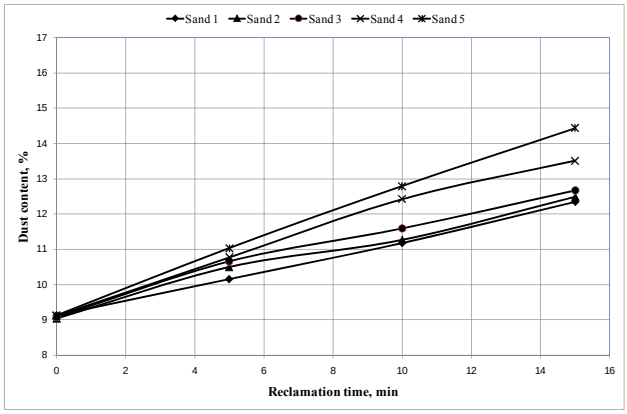
- Dusts content in the reclaimed material, before the final dedusting process,
- Clay content in the reclaimed material,
- Ignition loss,
- pH of the reclaimed material,
- Compressive strength and permeability of sands with the reclaimed material.

5. Obtained results

5.1. Dusts content in the reclaimed material

Analytical results of dusts content in the reclaimed material are presented in Figure 3. Investigations indicate, that the increased intensity of the reclamation influence (time prolongation and increased rotational speed of the impact system) leads to an increased dust content in reclaims, before the final dedusting process. The highest dusts content was obtained for tests marked with symbol Sand 5 for both rotational speeds. In addition, this dust content increase is practically directly proportional to the reclamation treatment time, regardless of the rotor rotational speed.

a)



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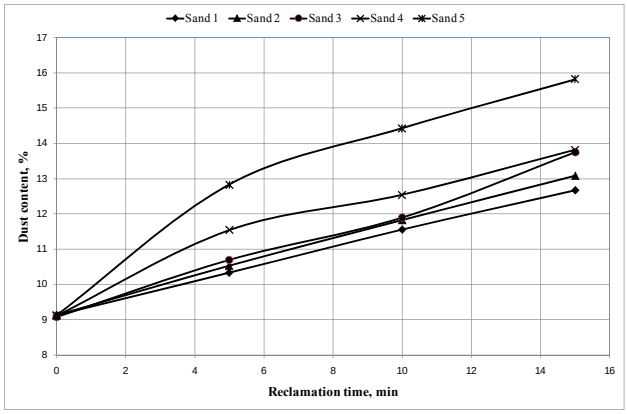
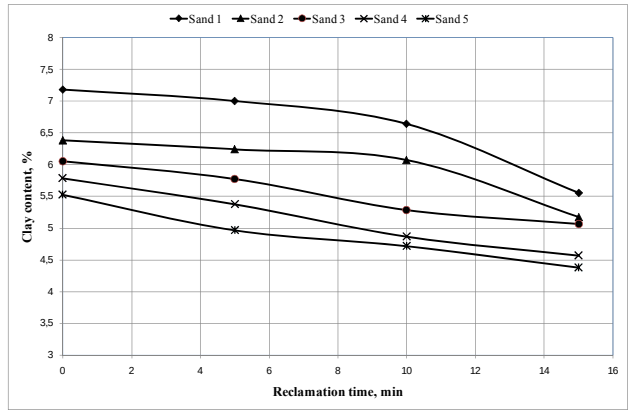


Fig. 3. Dependence of the dusts content generated in the reclamation process on the reclamation treatment time: a) Rotational speed of the reclaimer rotor system: 280 rot./min., b) Rotational speed of the reclaimer rotor system: 560 rot./min.

a)



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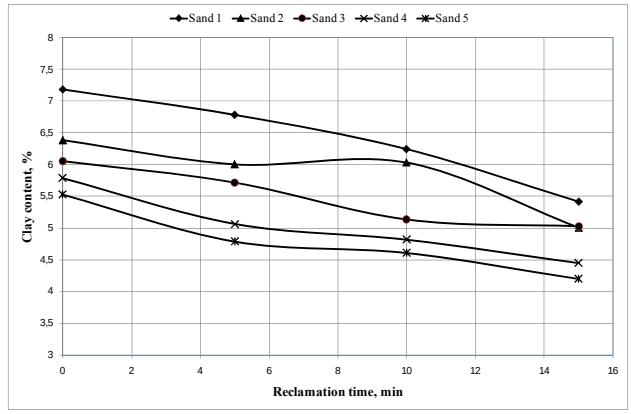


Fig. 4. Dependence of the elutriated clay content on the reclamation time: a) Rotational speed of the reclaimer rotor system: 280 rot./min., b) Rotational speed of the reclaimer rotor system: 560 rot./min.

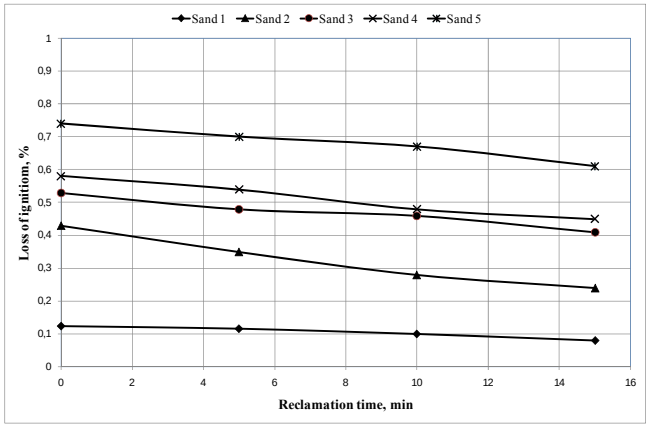
5.2. Clay content

The obtained results of the elutriated clay content presented in Figure 4 indicate, that as the reclamation treatment time is prolonged the clay fraction in the after-reclamation dusts decreases. This is caused by a successive abrasion and decreasing thickness of the spent clay layer on matrix grains. Increased fraction of the spent sand with the Kaltharz resin in the mixture decreases the clay content in the obtained reclaim. This is illustrated by the regular sands arrangement in the clay content order; the smallest content has the mixture marked as Sand 5, while the highest the initial spent sand with bentonite.

5.3. Ignition loss

The analysis of the ignition losses results (Fig. 5) indicates increases of ignition losses of sands before the reclamation treatment and of reclaims as the spent sand with the Kaltharz resin content increases in the investigated mixture. The spent sands with the Kaltharz resin, being of an organic character, undergoes the thermal destruction during the determination of ignition losses to a higher degree than Sand 1 with bentonite, for which this value is practically constant within the investigated range of the treatment time and rotor rotational speeds. An increased intensity of the reclamation treatment for the sands mixture causes a decrease of ignition losses, which is analogous to the clay content change and results from the reclamation processes occurring on the matrix grains surface.

a)



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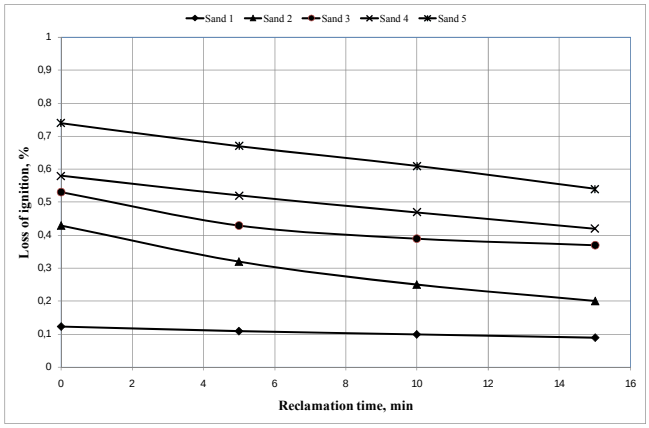

Fig. 5. Dependence of the reclaim ignition losses on the reclamation time: a) Rotational speed of the reclaimer rotor system: 280 rot./min., b) Rotational speed of the reclaimer rotor system: 560 rot./min.

5.4. pH of reclaims

The investigation results concerning the pH value of the tested reclaims are presented in Figure 6.
The results for the longest reclamation treatment time (15 min.) and various rotational speeds of abrasion rotor were selected. On the basis of the obtained pH results it can be seen, that an increase of the spent sand with the Kaltharz resin content in the mixture decreases pH value – however this decrease is not at the level corresponding to this sand fraction in the mixture, but significantly lower.

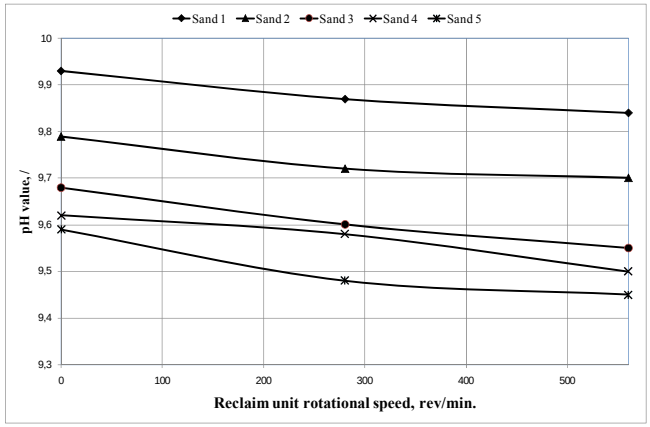

Fig. 6. Dependence of pH on the rotational speed of the reclaimer rotor system; reclamation time: 15 min.

5.5. Technological properties of moulding sands prepared on the reclaim matrix

The obtained reclaimed materials were used as a total substitute for sand in the classic moulding sand with bentonite, of the following composition:

- matrix (reclamation products of the spent sands 1–5) – 93%,
- Geko S bentonite – 7%,
- water – 3.5% in relation to dry components.

The results of compressive strength and permeability are shown in Table 2.

On the basis of the data given in Table 2 it is possible to state, that an increased intensity of the reclamation process causes a slight increase of sand (prepared with the reclaimed material) permeability. This is caused by a decrease of an elutriated clay content as well as a rubbed resin binder in the matrix, which constitutes the obtained reclaim, thus - per saldo – by a decrease of fine fractions in the new moulding sand.
The analysis of sands compressive strength indicates, that it decreases as the sand component with the Kaltharz resin increases. This compressive strength decrease is the highest (46%) for the sand containing 25% of sand with the Kaltharz resin.

Table 2. The results of compressive strength and permeability of sands prepared on the matrix of the reclaimed materials after the final dedusting

Kind of sand	Rotor rotational speed	Treatment time	R_c^w	P^w
	rot./min.	min.	MPa	$10^{-8}m^2/Pas$
Sand 1	Before reclamation	0	0.115	285
	280/560	15	0.098/0.087	300/310
Sand 2	Before reclamation	0	0.105	280
	280/560	15	0.092/0.080	305/310
Sand 3	Before reclamation	0	0.105	290
	280/560	15	0.090/0.087	300
Sand 4	Before reclamation	0	0.080	285
	280/560	15	0.075/0.070	290/315
Sand 5	Before reclamation	0	0.065	290
	280/560	15	0.062/0.062	315/315

6. Conclusions

The following final conclusions can be drawn on the grounds of own investigations concerning the reclaimability of the spent sands mixtures containing the classic sand with bentonite and the spent sand with the Kaltarz resin:

- Taking into account properties of the classic sands prepared with the reclaim it can be stated that 15% is the limiting value of the spent sand with the Kaltahrz resin content in the mixture, which – after the reclamation process - can be used as the classic sand matrix. Above this value the strength properties of sands drop significantly – at 20% of the spent sand with the Kaltahrz resin content by 30 %, while at 25% content by 46 %. However if the obtained reclaim is used, instead of a moulding sand, for rebounding the sand in amounts of 5 – 15 mass percentage, then its unfavourable influence on the sand with bentonite is much lower and occurs only as an accumulation during successive sand circulations.
- Increased reclamation intensity causes an increased dusts content in the obtained reclaimed materials, which lowers the total reclamation yield and requires the reliable classification system.
- Increased reclamation intensity decreases the reclaim clay content and ignition losses. The obtained results - concerning these parameters - correspond with the results concerning dusts content, which is increasing along with the process intensity.
- The pH value of the obtained reclaims slightly decreases as the reclamation time and the rotational speed of the testing device impact-abrasive rotor system increases. However, this decrease is quite small, not reflecting neither the treatment intensity nor spent sands proportions in the mixture undergoing the reclamation process.

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Regenerowalność mieszaniny mas zużytych – masa z bentonitem – masa z żywicą furfurylową

Streszczenie

Wprowadzanie nowych spoiw i technologii ich utwardzania w procesach wykonywania form i rdzeni wymaga stosowania adekwatnych do ich właściwości sposobów regeneracji i realizujących je urządzeń. Optymalny z punktu widzenia oczekiwanego efektu regeneracji jest system obiegu masy zużytej, w którym znajdują się masy formierskie i rdzeniowe tego samego rodzaju. Jednak wobec znacznej różnorodności stosowanych technologii mas i odpowiedniego do nich zróżnicowania sposobów regeneracji wyłania się potrzeba oceny uzyskiwanych produktów regeneracji w oparciu o usystematyzowane kryteria i ujednolicone zasady ich określania z tendencją do wskazania, które z nich są najważniejsze dla danego systemu mas. W pracy zostały przedstawione wyniki badań regenerowalności mieszaniny zużytej masy z bentonitem Geko S oraz zużytej masy rdzeniowej z żywicą Kaltharz 404U utwardzaną za pomocą kwaśnego utwardzacza 100 T3. Badania zostały przeprowadzone pod kątem oceny wpływu ilości dodatku masy rdzeniowej w przedziale 10–25% na jakość regeneratu. Ocenie poddano zawartość pyłów i lepiszcza w regeneracie, odczyn chemiczny regeneratu (pH) oraz strata prażenia. Weryfikacja oceny instrumentalnej regeneratu została przeprowadzona w oparciu o badanie właściwości technologicznych masy z bentonitem, której osnowę stanowił regenerat.