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.
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.
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.
The investigation results concerning the pH value of the tested reclaims are presented in Figure 6.

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

<table>
<thead>
<tr>
<th>Kind of sand</th>
<th>Rotor rotational speed</th>
<th>Treatment time</th>
<th>$R_k$</th>
<th>$P^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand 1</td>
<td>rot./min.</td>
<td>min.</td>
<td>MPA</td>
<td>$10^{-3}$ m$^3$/Pas</td>
</tr>
<tr>
<td></td>
<td>Before reclamation</td>
<td>0</td>
<td>0.115</td>
<td>285</td>
</tr>
<tr>
<td></td>
<td>280/560</td>
<td>15</td>
<td>0.098/0.087</td>
<td>300/310</td>
</tr>
<tr>
<td>Sand 2</td>
<td>Before reclamation</td>
<td>0</td>
<td>0.105</td>
<td>280</td>
</tr>
<tr>
<td></td>
<td>280/560</td>
<td>15</td>
<td>0.092/0.080</td>
<td>305/310</td>
</tr>
<tr>
<td>Sand 3</td>
<td>Before reclamation</td>
<td>0</td>
<td>0.105</td>
<td>290</td>
</tr>
<tr>
<td></td>
<td>280/560</td>
<td>15</td>
<td>0.090/0.087</td>
<td>300</td>
</tr>
<tr>
<td>Sand 4</td>
<td>Before reclamation</td>
<td>0</td>
<td>0.080</td>
<td>285</td>
</tr>
<tr>
<td></td>
<td>280/560</td>
<td>15</td>
<td>0.075/0.070</td>
<td>290/315</td>
</tr>
<tr>
<td>Sand 5</td>
<td>Before reclamation</td>
<td>0</td>
<td>0.065</td>
<td>290</td>
</tr>
<tr>
<td></td>
<td>280/560</td>
<td>15</td>
<td>0.062/0.062</td>
<td>315/315</td>
</tr>
</tbody>
</table>

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 Kaltarz 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 Kaltarz 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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References

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

Streszczenie
Wprowadzanie nowych spojów 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 oczekiwania 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 różnicowania sposobów regeneracji wyłania się potrzeba oceny uzyskiwanych produktów regeneracji w oparciu o usystematyzowane kryteria i ujednoliconie 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.