

Reclamation of the Inorganic Spent Sand from the Warm-Box Technology in the REGMAS Reclaimer

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Abstract

The results of investigations of the reclamation of spent inorganic moulding sands from the warm-box technology are presented in the paper. The reclamation was performed in the prototype vibratory reclaimer: REGMAS. Water-glass with some organic additions influencing its knocking out properties was the binder of this spent sand. The following indices were applied for the reclaimability assessment: ignition loss, Na₂O content, dusts amounts generated in the reclamation process, pH value of the reclaim as well as strength of moulding sands prepared with the reclaimed material, with the fresh sand and with the mixture: fresh sand-reclaim.

Key words: Reclamation of used foundry sands, Moulding sand, Environmental protection

1. Introduction

The performed investigations were aimed at the determination of the reclaimability [1-4] of spent moulding sands originated from one of the domestic motorisation foundry plants. This spent sand was delivered in a form of not burned, damaged moulds (Figure 1) and in a form of spent sands after the casting process (Fig. 2). Mixtures of these sands in proportion 50%-50% were prepared for tests.

Before the reclamation tests, the spent not burned sand was subjected to removal of metallic contaminations. This operation was performed by means of the sieve with a mesh clearance of 5mm. As a result of separations 1.2 kg of aluminium was obtained, which constitutes approximately 0.20% mass fraction in relation to the sand matrix. The view of metallic contaminations separated from the spent sand is presented in Figure 3.

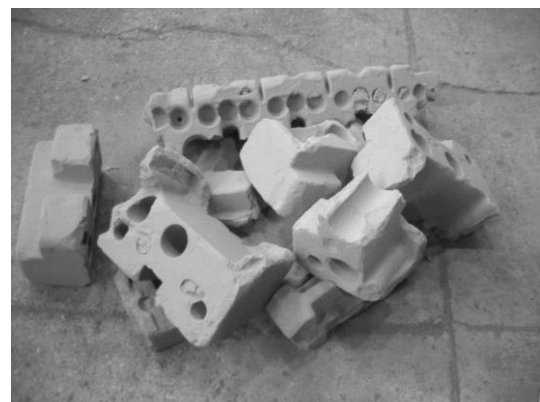


Fig. 1. Agglomerated spent moulding sand

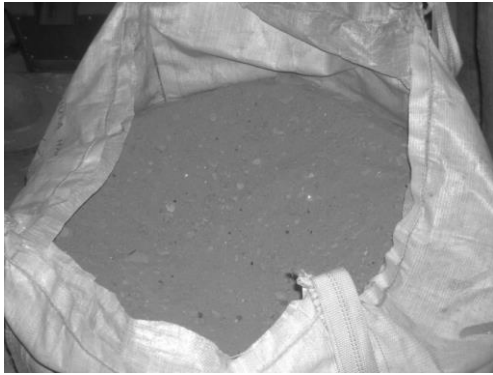


Fig. 2. Burned spent sand



Fig. 3. Metallic contaminations separated from spent burned out sand

2. Experimental stand

Prepared spent sands were reclaimed in the prototype vibratory reclaimer constructed and patented in AGH within the realisation of the project POIG, task 1.3.1 [5-7].

Within the scope of the project the prototype of the device, of a yield 1.5 Mg/h, was developed (Figure 4). This reclaimer is used for investigations of the reclamation process in the Machine Laboratory of the Faculty of Foundry Engineering. It allows transferring of the obtained results to foundry plants interested in reclamations. Spent sands, after removal of metallic contaminations, are supplied to the device charge. The primary reclamation is realised on the crushing grid and a set of three sieves. The lowest sieve is of a conical shape and clearances in between its vertical palisade elements are equal 1.25 mm.

On the reclaimer bottom, in its buffer part, loose metal grinding elements (balls) are placed. Together with the vibratory influence they realise the secondary reclamation. The moulding sand sieved through the conical sieve is transported by the vibratory trough to the pneumatic cascade classifier fed from the bottom by the fan of a controlled air speed. The reclaimer is started by means of two rotodynamic engines of the controlled rotational speed and the set value of the vibrations excitation force.

The universal vibratory REGMAS reclaimer, functionally integrated with the pneumatic cascade classifier, is intended for the dry, mechanical reclamation of practically all spent sands. It can be installed in the reclamation seats of small and medium size foundry plants.



Fig. 4. View of the experimental reclaimer, at the background of the reclaim feeding system into the pneumatic classifier

3. Conditions of experiments

Reclamations were performed in the prototype REGMAS device, where the supply frequency of electrovibrators of 50 and 60 Hz was applied. 3 reclamation cycles, characterised by various intensities of the reclamation process, were performed.

- 1 cycle – frequency of the current supplying electrovibrators, 50Hz,
- 2 cycle – frequency of the current supplying electrovibrators, 60Hz,
- 3 cycle – frequency of the current supplying electrovibrators, 60Hz.

It should be mentioned that in the second reclamation cycle the material after the first reclamation cycle was used as the feed, while in the third reclamation cycle the material after both previous reclamations stages was used as the feed. mixture of the reclaim-high-silica sand is 50-50.

4. Results of the preliminary investigations of spent sands and reclaims

The spent moulding sands as well as the obtained reclaimed materials were subjected to the following tests:

- Sieve analyses,
- Ignition losses measurements,
- Na₂O content on grain surfaces,
- pH value measuring,
- Dusts amounts generated due to the reclamation.
- Bending strength of moulding sand samples prepared in the warm-box technology, with using the reclaim.

Loss on ignition

The results of ignition losses of the spent sand and the reclaimed materials are presented in Figure 5. The spent agglomerated sand is characterised by higher ignition losses than the reclaim. As the result of the reclamation process performed in the REGMAS reclaimer, decreasing of the ignition loss - from its initial value

0.73% to 0.45% - occurs after the third cycle of the process. It can be noticed that the obtained reclaims are characterised by decreasing ignition loss values as the process intensity increases (see the diagram in Fig. 5). Decreasing of ignition losses is the effect of elementary operations of grinding, rubbing and crushing, which occur in the reclaimer causing a gradual removal of spent binding materials from grain surfaces.

The reclamation process is the most intensive during the first reclamation cycle, in which 21.91% of organic components is removed. In the second cycle 9.59% is removed while in the third 6.85% of this material.

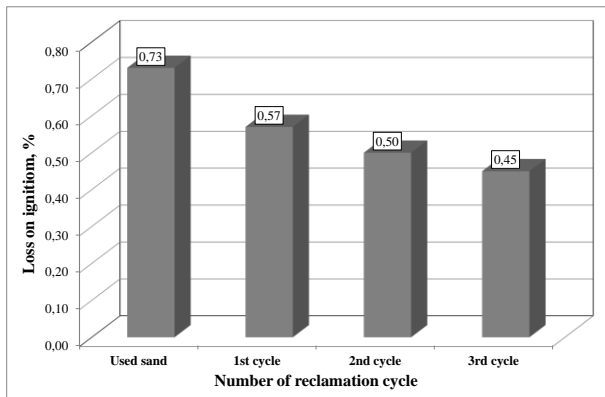


Fig. 5. Ignition losses of the spent sand and reclaimed materials

Na₂O content on surfaces of spent sands and reclaims

The method based on heating the tested material sample with water and then titrating with 0.1 n HCl in the presence of phenolphthalein, was applied for the estimation of the Na₂O content on grain surfaces. The method was developed in the Foundry Institute in Krakow.

The obtained results are presented in Figure 6. The regularity, similar to the described above at assessing loss on ignition values, can be seen in Fig. 6. The Na₂O content on grain surfaces of the spent sand and obtained reclaims indicates that the reclamation process is the most intensive during the first reclamation cycle, when 25.38% of inorganic components of the spent binder is removed. Subsequent reclamation cycles do not cause such intensive removal of spent binding materials. After the third cycle the removal degree is equal 35.38%.

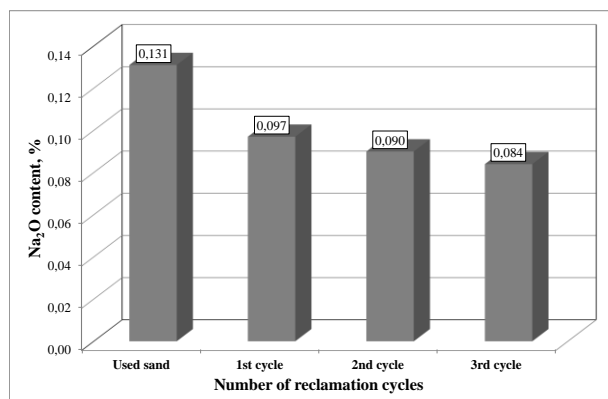


Fig. 6. Results of the Na₂O content on grain surfaces of the spent sand and reclaims

pH reaction of spent sands and reclaims

The obtained results for the spent sand and reclaimed materials presented in Figure 7, confirm the correctness observed previously that the matrix reclamation process and removal of spent binding materials from grain surfaces occurs the most intensively during the first reclamation cycle. It should be emphasised that after the reclamation material is of a visibly basic character, which can be the reason of a significant shortening of the service life of the moulding sand prepared with the reclaimed fraction.

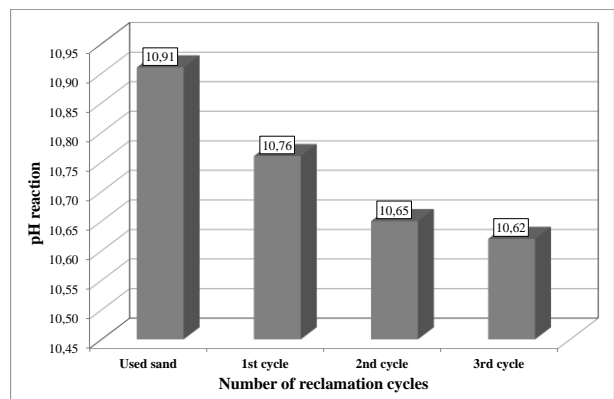


Fig. 7. pH values of the investigated spent sand and reclaimed materials

Amounts of dusts generated during the reclamation process

Amounts of dusts generated as the result of the reclamation process performed in the REGMAS reclaimer are presented in Figure 8. The total amount of dusts generated during all three cycles equals 4.92%. The highest amount was formed during the first cycle - 2.42%, during the second cycle - 1.28%, while the lowest - 1.12% was generated in the third cycle of the reclamation process.

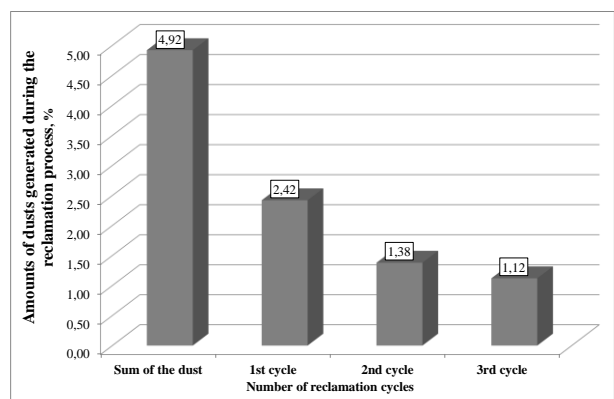


Fig. 8. Amounts of dusts generated as the result of the reclamation process – total and in individual cycles

Strength investigations of moulding sand samples prepared with the reclaims

The final stage of investigations constituted measuring the bending strength of the following moulding sand samples:

- Moulding sand prepared with the fresh quartz sand matrix (sand 1),

- Moulding sand prepared with the matrix with the reclaim after 3 reclamation cycles (sand 2),
- Moulding sand prepared with the matrix: reclaim from the agglomerated sand after 3 reclamation cycles (75%) + fresh quartz sand (25%) (sand 3),
- Moulding sand prepared with the matrix: reclaim from the agglomerated sand after 3 reclamation cycles (50%) + fresh quartz sand (50%) (sand 4).

Table 1. Results of bending strength of moulding sand samples with the fresh sand, reclaimed material and with the mixture: fresh sand-reclaim

Matrix	Bending strength R_g^u , MPa		
	1h	4h	24h
Sand 1	0.55	1.13	2.51
Sand 2	0.31	0.77	1.65
Sand 3	0.42	0.95	2.19
Sand 4	0.47	1.03	2.33

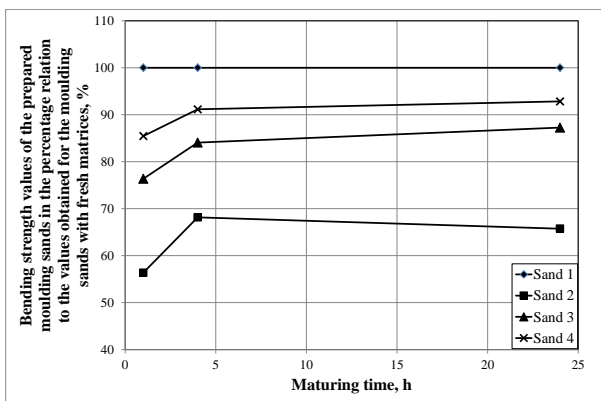


Fig. 9. Bending strength values of the prepared moulding sands in the percentage relation to the values obtained for the moulding sands with fresh matrices

It can be noticed, on the bases of the obtained bending strength results of core sands prepared on the fresh matrix and with the reclaimed material, that strength properties are increasing with increasing fraction of fresh quartz sands in the matrix. The safe bending strength, being approximately 80% of the value obtained for fresh quartz sand, is obtained when the reclaim content in the matrix equals 50% .

5. Conclusions

The performed preliminary investigations confirm the possibility of the reclamation of the tested spent sand in the REGMAS reclaimer. It is also confirm by the instrumental examinations. The highest intensity of the reclamation process was obtained during the first cycle of this process.

Investigations of the moulding sands prepared with the reclaimed material indicate, that it is possible to use at least 50% addition of the reclaim to fresh quartz sand.

It should be mentioned that the tests described in the paper were performed before construction changes of the reclaimer, which significantly improved the efficiency of processes related to the spent binders removal from martix grains.

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