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RECLAMATION OF SPENT MOULDING SANDS WITH INORGANIC BINDERS IN THE VIBRATORY RECLAIMER REGMAS

REGENERACJA MASY ZUŻYTEJ ZE SPOIWEM NIEORGANICZNYM W REGENERATORZE WIBRACYJNYM REGMAS

The results of the reclamation of spent moulding sands with inorganic binder in the prototype vibratory reclaimer REGMAS – are presented in the paper. Spent moulding sands with modified water-glass, burned as well as not burned, present in a form of agglomerates (lumps), were subjected to the reclamation processes.

During individual reclamation cycles the reclaimer efficiency and vibrations amplitudes were determined and physical-chemical and strength investigations were performed for the obtained reclaim materials. The obtained reclaim was used as a component of the matrix of moulding sands with water-glass in the Floster S technology, in which the reclaim constituted 100%, 80% and 50% of the sand matrix – respectively.

Keywords: moulding sand, modified water-glass sand, reclamation, Floster S technology

W artykule przedstawiono wyniki regeneracji zużytej masy formierskiej ze spoiwem nieorganicznym w prototypowym regeneratorze wibracyjnym REGMAS. Procesowi regeneracji poddano zarówno masę zużytą ze szkłem wodnym modyfikowanym przepaloną oraz nieprzepaloną masę zużytą występującą w postaci brył.

W trakcie realizacji poszczególnych cykli regeneracji określano wydajność regeneratora oraz amplitudę wibracji, dla których przeprowadzono badania fizykochemiczne oraz wytrzymałościowe otrzymanych regeneratów. Wykonano następujące badania: zawartość pyłów w regeneracie U_K, analizę sitową osnowy oraz laserową analizę granulometryczną oddzielonych pyłów, odczyn pH, stratę prażenia oraz zawartość Na_2O regeneratu. Uzyskany regenerat użyto jako składnik osnowy mas formierskich ze szkłem wodnym w technologii floster S, w których stanowił odpowiednio 100%, 80% oraz 50% osnowy piaskowej.

1. Introduction

Among moulding and core sands the most environment friendly is the sand with the modified water-glass together with a loose hardener. However, an inorganic character of this binder causes that these moulding sands are characterised by a bad knocking out ability and weak reclaimability [1-7]. One of the methods of improving these parameters is the binder (it means water-glass) modification [8-11].

2. Research equipment

The reclamation of moulding sands with the modified water-glass was performed in the prototype vibratory reclaimer REGMAS (Fig. 1). It allows for the primary and secondary reclamation as well as for dedusting and classification. The primary reclamation realized on the set of sieves in a horizontal system is caused by the operation of two electric vibrators with unbalanced masses. The vibratory drive causes a vertically-torsional motion of the device, which forces the reclaim movement in the trough feeder from its bottom – upwards to the charging opening of the cascade-type pneumatic classifier.

Fig. 1. The vibratory reclaimer REGMAS at the background of the reclaim charging system of the pneumatic classifier

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3. Program of own investigations

The reclamation process in the prototype vibratory reclaimer REGMAS was performed for:

- Spent burned moulding sand after the casting process,
- Spent agglomerated (not burned) moulding sand, which contained also rejected cores.

Three reclamation cycles were performed for each moulding sand at the following frequencies of electric vibratory drives: 40, 50, 60 Hz.

During individual cycles the reclaimer efficiency was determined.

The following investigations were performed after each reclamation cycle:

- Physical-chemical examinations: amount of dusts generated due to the reclamation, dusts content in the reclaim U_K, laser grain size analysis of after reclamation dusts, sieve analysis of the reclaimed material, chemical reaction pH and Na_2O content, ignition losses of the reclaimed material,
- Strength tests.

The obtained reclaim was used as a component of the moulding sands matrices with water-glass in the Floster S technology, in which it constituted 100%, 80% and 50% of the sand matrix. Strength properties (R_g^u and R_m^u) of the prepared moulding sands were determined, after storing time of samples being 1h, 2h, 4h and 24h.

4. Obtained results

Data concerning the device operations efficiency presented in Figure 2 indicate a slightly smaller efficiency obtained for the agglomerated moulding sand reclamation. At a simultaneous reclamation of spent burned and agglomerated sands the average device efficiency is 1.5 Mg/h, in accordance with the constructional assumptions.

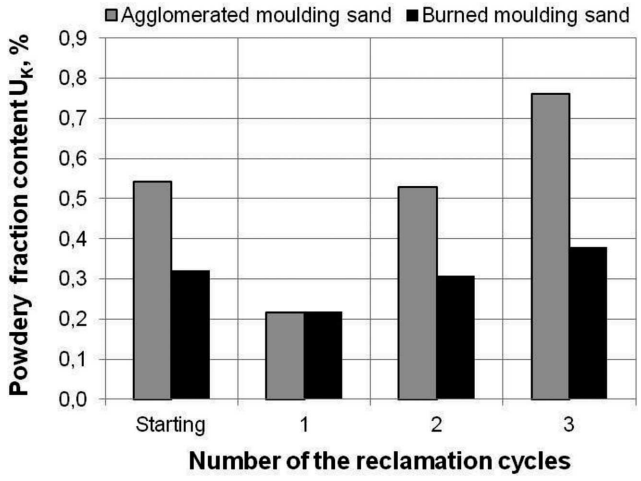

Fig. 2. Operational efficiency of the vibratory reclaimer REGMAS

This device allows for the reclaim effective dedusting, which depends on the velocity of air flowing through the cascade clasifier. For practical needs it is equal 1,0 m/s. Amounts of dusts generated due to the spent moulding sands reclamation in the REGMAS device is listed in Table 1.

TABLE 1

Amounts of dusts generated during the spent moulding sand reclamation

Investigated matrix	Amount of dusts formed due to the reclamation, %
Reclaim after 1 cycle (agglomerated)	1,38
Reclaim after 2 cycle (agglomerated)	1,63
Reclaim after 3 cycle (agglomerated)	1,49
Reclamation of the spent agglomerated moulding sand (SUM)	**4,50**
Reclaim after 1 cycle (burned)	1,22
Reclaim after 2 cycle (burned)	1,52
Reclaim after 3 cycle (burned)	1,42
Reclamation of the spent burned moulding sand (SUM)	**4,16**

Amounts of dusts U_K, which remained in the reclaim after each cycle were determined by dedusting the 100 gram reclaim samples in the fluidisation column. Parameters of this process were as follows: dedusting time 4 min, dedusting rate 1,0 m/s. The results are given in Figure 3. The spent agglomerated sand is characterized by a higher dusts content than the spent burned sand (Table 1). In the reclaim originated from the agglomerated moulding sand also more powdery fractions remains (Fig. 3).

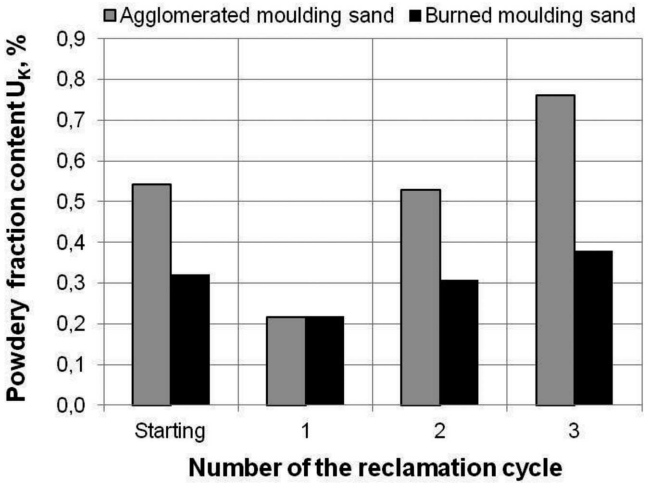

Fig. 3. Amounts of dusts remained in the reclaim

The results of the sieve analysis of the reclaimed materials indicates that in case of the reclamation of spent agglomerated sands the reclaimed material is finer than in case of reclamation of spent burned sands. This can be due to the higher ability for crushing the coatings of the binding material, which was not subjected to high temperature influences.

It seems, that in case of the reclamation of spent burned moulding sands the sand grains granulation is better for being used as the moulding sands matrix.

The results of measuring the pH value, Na_2O content and ignition loss LOI results are presented in Table 2. It can be noticed that spent agglomerated sand is characterized by a lower pH value than spent burned sand. The analysis of obtained results indicates also that the Na_2O content on grains of spent

moulding sands is quite small. Reclamation processes lead to decreasing its content to a level allowing for reusing of the obtained reclaimed materials. As the result of the reclamation process carried out in the REGMAS reclaimer the ignition losses of the reclaimed materials are decreased to 0.75 and 0.27 in case of the reclaim obtained from agglomerates and from burned sands, respectively.

TABLE 2
Values of pH, Na_2O content and ignition losses LOI of the spent moulding sands and of the reclaimed materials

Investigated matrix	pH values	Na_2O content, %	LOI, %
Spent agglomerated moulding sand	10,92	0,135	0,93
Reclaim after 1 cycle (agglomerated)	10,90	0,118	0,82
Reclaim after 2 cycle (agglomerated)	10,83	0,106	0,75
Reclaim after 3 cycle (agglomerated)	10,80	0,102	0,75
Spent burned moulding sand	11,41	0,142	0,39
Reclaim after 1 cycle (burned)	11,35	0,121	0,34
Reclaim after 2 cycle (burned)	11,20	0,112	0,31
Reclaim after 3 cycle (burned)	11,05	0,105	0,27

Bending and tensile strength tests were performed on samples of the following moulding sands prepared on the matrix consisting of:

- fresh high-silica sand (SAND 1),
- reclaim from the burned sand after 1, 2 and 3 reclamation cycles (SAND 2, 3 and 4 – respectively),
- reclaim from the agglomerated sand after 1, 2 and 3 reclamation cycles (SAND 5, 6 and 7 – respectively),
- reclaim from the agglomerated sand after 3 reclamation cycles heated at a temperature of 350°C for 3h (80%) + fresh high-silica sand (20%) (SAND 13),

The composition of the moulding sand was as follows:
Matrix (fresh or reclaimed sand) 100 parts by mass,
Binder – water-glass 145 3.5 parts by mass,
Hardener – Flodur 1 0.7 parts by mass.

Bending and tensile strength, was determined after the storing time of 1h, 2h, 4h and 24h by means of the LRu-2e apparatus.

After 24 hours of hardening, in accordance to expectations, the moulding sand containing 50% of the reclaim and 50% of fresh sand has a higher strength than the moulding sand containing 80% of the reclaim and 20% of fresh high-silica sand. In addition, moulding sands on the matrix from the spent agglomerated sand are generally of a significantly lower strength than sands containing partially burned agglomerated moulding sands.

In order to remove a hardener excess, before preparing the moulding sand on the matrix containing the reclaimed material after 3 cycles this reclaim was heated for 3 hours at a temperature of 350°C. The obtained R_g^u and R_m^u strength values of moulding sands containing the heated reclaim is presented in Table 3. Strength values of moulding sand prepared on the matrix of the heated reclaim are significantly higher than the values obtained for not heated reclaim, however they are not satisfying. Due to a considerable cost of such heating the application of this procedure is not recommended.

TABLE 3
Strength results of the moulding sand prepared on the matrix of the spent aggregated moulding sand reclaim, heated at a temperature of 350°C for 3 hours (SAND 13)

Moulding sand composition: reclaim/sand	1h		2h		4h		24h	
	R_m^u	R_g^u	R_m^u	R_g^u	R_m^u	R_g^u	R_m^u	R_g^u
100/0	0,018	0	0,028	0,118	0,030	0,122	0,044	0,153
80/20	0,028	0	0,030	0,097	0,031	0,138	0,061	0,249
50/50	0,042	0,101	0,082	0,192	0,149	0,328	0,774	0,949

5. Conclusions

The obtained results indicate that - in the prototype vibratory reclaimer REGMAS - there is a possibility of the mechanical reclamation of moulding sands rated in the group of sands difficult for the reclamation. On the basis of the physical and chemical examinations and strength tests of the obtained reclaimed materials, it can be also stated:

- The spent agglomerated moulding sand from the investigated technology with modified water-glass is characterised by a higher dusts content than the spent burned moulding sand. In the reclaimed material originated from the agglomerated (lumps) moulding sand remain more powdery fractions, at simultaneously larger dimensions of dust particles.
- The pH value of the spent agglomerated sand is lower than of the spent burned moulding sand. This can be caused by not completely burning of the moulding sand organic component contained mainly in a hardener.
- Reclamation processes lead to decreasing the Na_2O content in the reclaimed matrix.
- Spent agglomerated moulding sands are characterised by higher ignition losses LOI than burned sands. During the reclamation process, in both cases, ignition losses of reclaimed materials decrease by app. 20%.
- Sands prepared on the matrix of reclaims from spent not burned moulding sands are in practice without any strength, which is mainly caused by the active hardener residue cumulating in these reclaims, radically decreasing their service life. Trials of applying these reclaims (after previous heating to 350°C) for preparations of moulding sands confirmed an improvement of strength properties, however the obtained level did not meet the technological requirements.

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