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Granulation of After Reclamation Dusts from the Mixed Sands Technology: Water Glass – Resolit

J. Kamińska *, J. Dańko

[a] AGH University of Science and Technology, Faculty of Foundry Engineering,
Department of Foundry Processes Engineering, Reymonta 23 St., 30-059 Crakow, Poland
Corrsponding author. E-mail address: kaminska@agh.edu.pl

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Abstract

A technology of sands with water glass hardened by liquid esters is a cheap and ecologic method of producing moulding sands. Due to these advantages, this technology is still very important in several foundry plants for production of heavy iron and steel castings. Reclamation of the mixed moulding and core sands generates significant amounts of dusts, which require further treatments for their reuse. The results of investigations of a pressureless granulation of dusts generated in the dry mechanical reclamation process of the mixture consisting in app. 90 % of moulding sands from the Floster S technology and in 10 % of core sands with phenolic resin resol type, are presented in the hereby paper. Investigations were aimed at obtaining granulates of the determined dimensional and strength parameters. Granules were formed from the mixture of dusts consisting of 75 mass% of dusts after the reclamation of sands mixture and of 25 mass% of dusts from bentonite sands processing plant. Wetted dusts from bentonite sands were used as a binding agent allowing the granulation of after reclamation dusts originated from the mixed sands technology.

Keywords: Environmental protection**,** Loose self-hardening sands, Floster S process, After reclamation dust, Granulation

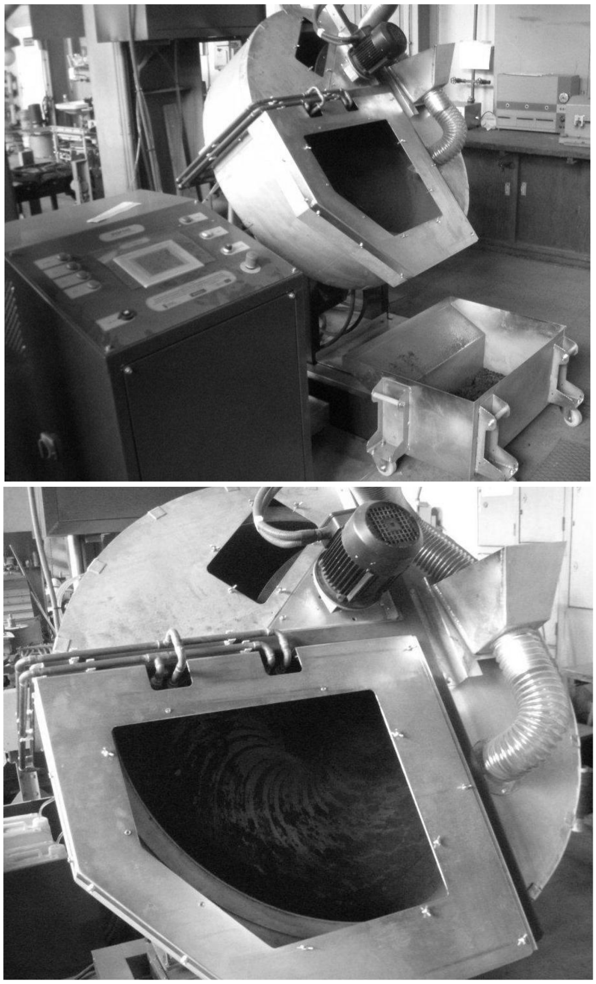
1. Introduction

Loose self-hardening sands with water glass performed in the ester process still constitute an interesting alternative for sands with synthetic resins, called popularly furan sands. This situation is the result of low costs of such sands preparation, very low gas evolution rate and low emission of harmful gaseous substances. An advantage of the ester process over so far applied technologies of sands with water glass and loose hardeners is the result of a smaller addition of binding agents and easier application of a liquid hardener. These hardeners are mainly based on glycerine and ethylene glycol. These are esters of these components, mainly mono-, di- and triacetate of glycerine and diacetate of ethylene glycol. A hardener addition in relation to a binding agent content the most often equals l0-15 %. This process is called in Poland the Floster S [1-3].

Due to increasing requirements of buyers concerning the casting quality, the self-hardening sands technology with water glass hardened by esters is more and more often displaced by more expensive self-hardening technologies with resins. To decrease costs the moulds are often made of sands with water glass while the cores of sands with resins, e.g. furan. However, in case of a simultaneous application of furan sands and sands with water glass, the application of the reclaimed material obtained from these sands mixture, is very limited. Inconveniences of an alternative application of sands with water glass and furan sands justified working out new sands with alkaline resol resin hardened by liquid esters. Sands with alkaline resol resin have a binding character similar to sands with water glass. An ester hardener is also used for them [4-7].

In dry reclamation systems of spent sands even up to 10 mass% of after reclamation dusts occur, in which significant amounts of binder left-over or clays removed from sand grains and products of sand abrasion are accumulated [8-11].

Storing of this type of wastes (dusts) requires an application of properly protected dumping grounds, which is connected with considerable costs. Dusts originated from the reclamation of spent moulding sands create serious troubles during their loading and transporting to dumping grounds due to a high dusting degree. Therefore one of the directions of dusts management can be their previous granulating [12-16].



a) b)

Fig. 1. Bowl granulator: a – General view, b – Bowl with the devise for dosing the wetting substance

2. Experimental stand

The granulation process was carried out by means of the prototype bowl granulator designed for granulating dusts of either hydrophilic or hydrophobic properties.

This granulator consists of the rotational bowl located on the axis inclined at the proper angle (with the possibility of its changing) to the level. Scrapers eliminating dust built-ups on bowl walls and a lance with a device for dosing humidifying substance are inside the bowl. Innovatory elements of this device are: the automatic dosage of the determined amount of humidifying substances in dependence of the charge mass determined by weight and also the solution of the bowl drive allowing for the bowl rotational speed stepless changes.

The granulation was performed with using after reclamation dusts originated from the sands mixture reclamation. This sands mixture consisted in app. 90 % of moulding sand from the Floster S technology and 10 % of core sand with phenolic resin, resol type.

The bowl granulator with the control desk and the devise for dosing the wetting substance is presented in Figure 1.

3. Program of own investigations

The chemical compositions of granulated dusts are listed in Table 1. The mixture of dusts consisted of 75 mass% of after reclamation dusts (Table 1a) and of 25 mass% of dusts originated from bentonite sands preparation (Table 1b) was subjected to the granulation process in the prototype granulator.

Table 1.
Chemical composition of the granulated after reclamation dusts: a – dust from the sands mixture, b – dust from the sand with bentonite

a)

Component	Content of component [mass%]
Al_2O_3	1,94
CaO	0,31
Cl^-	0,003
Fe_2O_3	0,89
K_2O	0,20
MgO	0,17
Na_2O	2,70
SiO_2	89,90
SO_3	0,017
ZrO_2	0,070

b)

Component	Concentration [%]
Al	5,64
C	16,80
Ca	0,82
Fe	1,07
K	0,69
Mg	1,17
Na	1,26
S	0,24
Si	24,74
	Concentration [ppm]
Bi	< 6,00
O	42,15
Pb	37,00
Sb	< 1,00

The dusts mixture, approximately 10kg, was fed in portions on the granulating bowl and sprinkled with water in amount of app. 13-15mass% in relation to the dusts amount. The bowl was rotating with the required speeds (5, 10, 15, 20, 25 and 30 rot/min), at inclination angles being 45 and 50°. The wetted material in the bowl underwent agglomeration and the granules, of diameters from 3 to 80 mm, were formed.

4. Investigation results

During the first stage of investigations the optimal addition of bentonite dusts in relation to after reclamation dusts (from the sands mixture) - to achieve a good granulation of dusts mixture - was determined. These dust additions were changed within the range from 15 to 25%, every 2%.

The granulation process was performed after determining the optimal composition of the mixture.

Strength parameters of granules are presented in the paper. They were obtained at the bowl rotational speed being 20 and 25 rot/min for the inclination angle of 45° and 15 and 20 rot/min for the angle of 50°.

Shatter test resistances of granules are presented in Figures 2 and 3 at the rotational speed of the granulator bowl being 20 rot/min (Fig. 2) and 25 rot/min (Fig. 3) at the inclination angle of 45°. When analyzing these diagrams one can observe a continuous resistance decrease - after the first as well as after the third shatter - with the prolonged seasoning period. The highest strength characterizes the initial granulate, while the lowest after 30 days of seasoning. The shatter test resistance of granules determined after the first shatter is of a similar value for both inclination angles of the bowl. In case of the resistance after the third shatter, the higher value characterizes the granulate obtained at the bowl rotational speed being 25 rot/min.

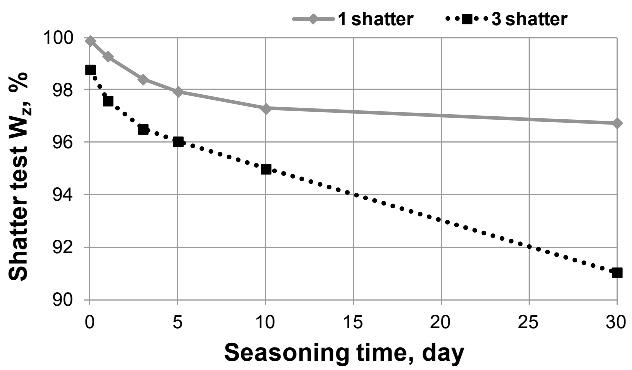


Fig. 2. Dependence of the shatter test resistance on the granules seasoning period, rotational speed of the granulator bowl: 20 rot/min, inclination angle of the bowl: 45°

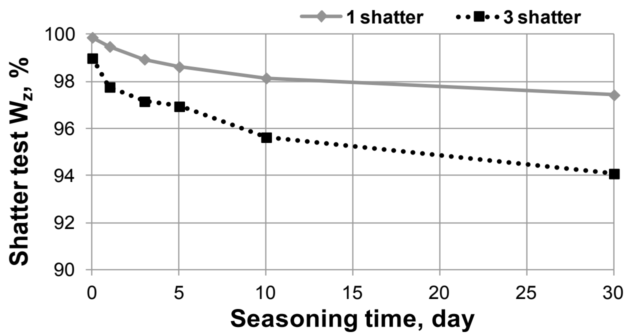


Fig. 3. Dependence of the shatter test resistance on the granules seasoning period, rotational speed of the granulator bowl: 25 rot/min, inclination angle of the bowl: 45°

Figure 4 presents the comparison of the shatter test resistances of granules in dependence of their seasoning period. It is seen that the agglomerate obtained at the rotational speed of the granulator bowl being 25 rot/min is characterized by a higher shatter resistance within the whole seasoning period than the agglomerate obtained at the speed of 20 rot/min.

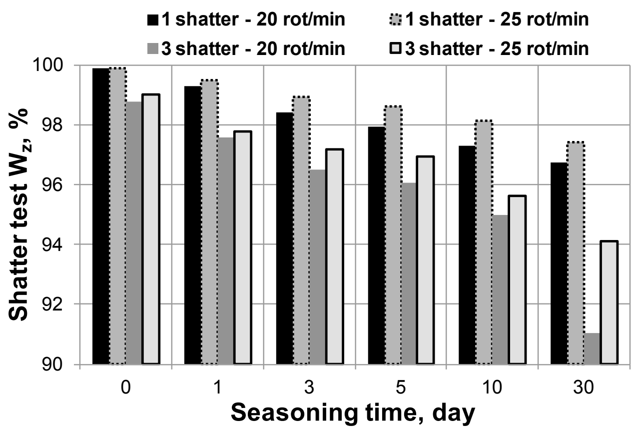


Fig. 4. Dependence of the shatter test resistance after the 1-st and 3-rd shatter on the seasoning period, inclination angle of the bowl: 45°

The dependence of the shatter test resistance of granules on the seasoning period at the rotational speed being 15 rot/min and the bowl inclination angle of 50° is presented in Figure 5. The highest shatter resistance after the first shatter, characterizes the initial granulate and the granulate after 10 days of seasoning. At the beginning, an increasing of the seasoning period does not cause the resistance decrease. The shatter test resistance of granules after the third shatter decreases with the prolongation of the seasoning period.

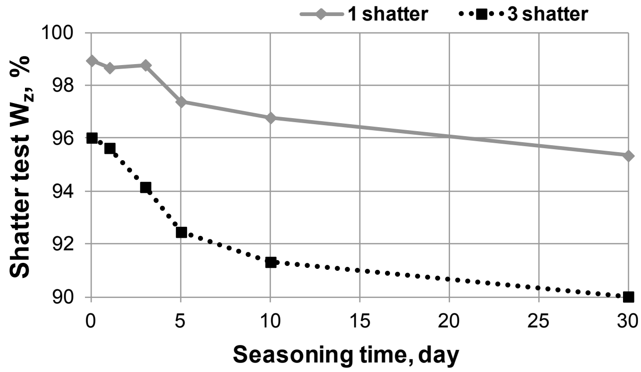


Fig. 5. Dependence of the shatter test resistance on the granules seasoning period, rotational speed of the granulator bowl: 15 rot/min, inclination angle of the bowl: 50°

An analogous dependence of the shatter test resistance on the seasoning period for the speed being 20 rot/min is presented in Figure 6. The granulate after the first shatter achieves in practice 100% of resistance, which means that granules - after being shattered on a steel plate - are not disintegrated. The granulate, after 30 days of seasoning, is characterized by the lowest resistance. A similar pathway has the resistance curve after three shatters, in addition to which resistance values are lower.

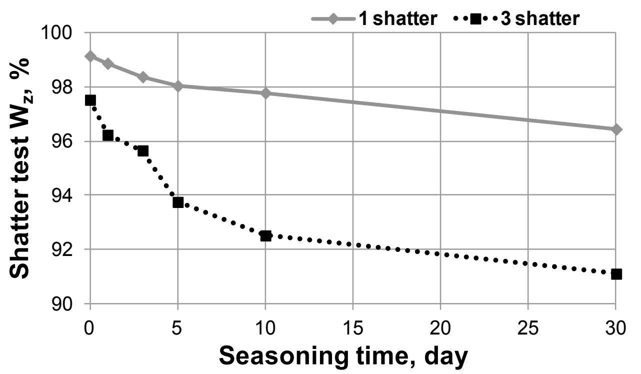


Fig. 6. Dependence of the shatter test resistance on the granules seasoning period, rotational speed of the granulator bowl: 20 rot/min, inclination angle of the bowl: 50°

Figure 7 presents the dependence of the shatter test resistance of granules on their seasoning period. Analyzing this diagram it can be stated, that at the bowl inclination angle being 50° the highest resistance characterizes the granulate, which was formed when the bowl rotational speed was 20 rot/min.

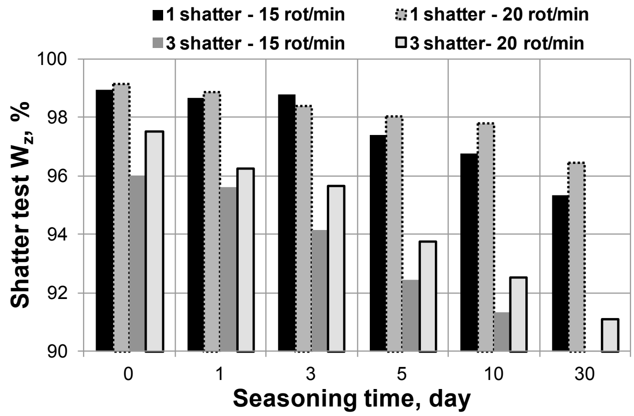


Fig. 7. Dependence of the shatter test resistance after the 1-st and 3-rd shatter on the seasoning period, inclination angle of the bowl: 50°

Rotational speeds for which the granulate was characterized by the highest shatter test resistance at the given bowl inclination angle are shown in Figure 8. Analysis of data from this diagram allows stating, that for the given mixture of dusts the optimal granulation speed equals 25 rot/min at the angle of inclination being 50°.

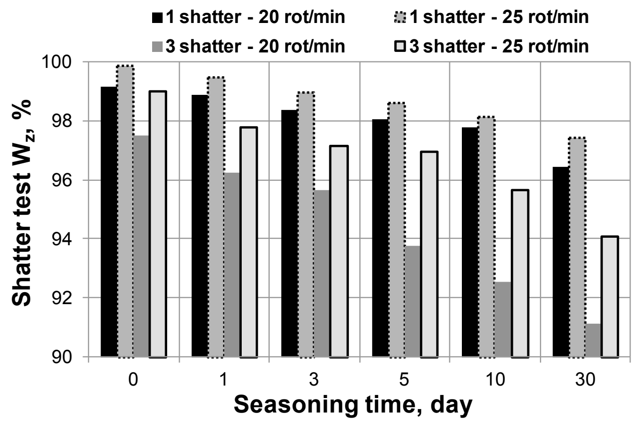


Fig. 8. Dependence of the shatter test resistance after the 1-st and 3-rd shatter on the granules seasoning period; 20 rot/min at the angle of 50°, 25 rot/min at the angle of 45°

Figure 9 presents the influence of the seasoning period on the water content in granules for the bowl rotational speeds at which the granulate was characterized by the highest resistance values. It can be noticed, that the prolongation of the seasoning period causes decreasing water content in granules, due to their drying.

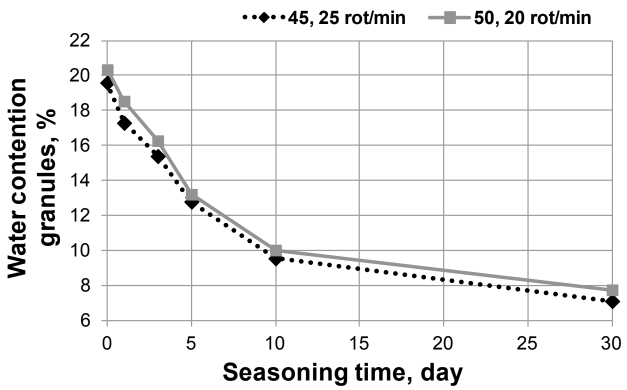


Fig. 9. Influence of the seasoning period on the water content in granules

4. Conclusions

The obtained results indicate that the applied granulator allows to obtain granules from dusts originated from the reclamation of the mixed moulding sands with additions of dusts from the bentonite sands processing plant. The characteristics of the granulator operation parameters and their influence on the granulation process allows to state the following:

- The determined, optimal composition of the dust mixture: 75 mass% of dusts obtained from the reclamation of the moulding sands mixture with water-glass and phenolic resin and 25 mass% of dusts from the bentonite sand, allows to obtain granules of the needed dimensions and strength.
- For the inclination angle of 45° the recommended rotational speed of the bowl should be: 25 rot/min. For this rotational speed only a negligible resistance decrease is observed with a prolongation of the seasoning period.
- For the bowl inclination angle of 50° the optimal recommended rotational speed of the bowl should be equal 20 rot/min. At this speed the granules are characterised by the highest shatter test resistance.
- The comparison of the obtained results for the recommended rotational speeds for the given inclination angles of the granulator bowl allows to state, that for dusts generated during the mixed sands reclamation the best granulation results are obtained at the inclination angle of 45^{o} and the rotational speed of 25 rot/min.

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Granulacja pyłów poregeneracyjnych z technologii mas mieszanych: szkło wodne – rezolit

Streszczenie

Technologia mas ze szkłem wodnym utwardzanym ciekłymi estrami jest tanią i bardzo ekologiczną metoda wytwarzania mas formierskich. Z uwagi na te zalety technologia ta ma nadal duże znaczenie w wielu odlewniach do wykonywania form dla produkcji ciężkich odlewów żeliwnych i staliwnych. Regeneracja mieszaniny masy formierskiej oraz mas rdzeniowych tworzy znaczne ilości pyłów poregeneracyjnych, które wymagają dalszej obróbki w celu ponownego ich zagospodarowania.

W pracy przedstawiono wyniki badań procesu bezciśnieniowej granulacji pyłów generowanych w procesie suchej regeneracji mechanicznej mieszaniny mas zużytych składających się w około 90 % z masy formierskiej z technologii Floster S oraz 10 % z masy rdzeniowej z żywicą fenolową typu rezolowego.

Badania miały na celu wytworzenie granulatu o określonych parametrach wymiarowych i wytrzymałościowych.

Granule tworzono z mieszaniny pyłów składającej się w 75% mas. z pyłów uzyskanych po regeneracji mieszaniny mas oraz w 25% mas. Z pyłów z masy z bentonitem. Nawilżony pył z masy bentonitowej został użyty jako spoiwo umożliwiające granulowanie się pyłów poregeneracyjnych z technologii mas mieszanych.

Słowa kluczowe: Ochrona środowiska, Sypkie masy samoutwardzalne, Proces Floster S, Pył poregeneracyjny, Granulacja.