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GRANULATION PROCESS OF FOUNDRY DUSTS ORIGINATED FROM BENTONITE SAND PROCESSING PLANTS

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Preliminary Note – Prethodno priopćenje

The results of the investigation results of the granulation process of foundry dusts generated during the mechanical reclamation of spent sands with bentonite and also dusts from the sand processing plants are presented in the paper. The following parameters of the final product were determined: moisture content (W) and granules shatter test (W_z) performed directly after the granulation process and after 1, 3, 5, 10 and 30 days and nights of seasoning, water-resistant ability of granules after 24 h of immersing in water, surface porosity e_p and volumetric porosity e_v. In addition the shatter test and water-resistant ability of granulated products dried at a temperature of 105 °C was estimated.

Key words: mechanical reclamation, foundry dusts, environment protection, granulation.

INTRODUCTION

Analysis of a structure and amount of wastes generated in foundry plants brings information concerning waste management efforts by their recycling or a reclamation of some components. Used foundry and core sands constitute the largest part of wastes, however their reclamation allows only to recover sands grains. Dusts from a furnace dedusting and slag from metal melting processes can be reused either in a foundry practice or in other industrial branches [1, 2].

In the dry reclamation systems of spent sands, apart from the reclaim, even up to 10 wt % after reclamation dusts are formed, in which significant amounts of binders and clays removed from sand grains and products originated from sand abrasion are cumulated [3].

Storage of this type of wastes (dusts) requires the preparation of the properly protected dumping grounds, which is connected with significant costs [4]. Certain properties and the form transformation of dusts decide on the management possibility of the after reclamation dusts. The most often chemical, grain and phase compositions as well as a volatile part and silica content, pH value and influence on the surrounding environment are taken into account [5].

Dusts from the bentonite sand processing plant are very difficult for loading and transporting to dumping grounds, due to their high degree of dusting. Therefore one of the management direction of such dusts can be their previous granulation [3].

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PROGRAM OF INVESTIGATIONS

Dusts originated from the bentonite sand processing plant were subjected to the granulation process in the prototype disk granulator [6]. The chemical composition of the tested dusts is given in Table 1.

A foundry dust in an amount of 10 kg, was partially fed into the granulating disk and water sprinkled in an amount of app. 17 mass % in relation to dusts. The granulating disk was rotating successively with the given speeds (5, 10, 15, 20 and 25 rpm), at the angle of inclination being 40 and 45 degrees for each speed. The wetted material was agglomerating in the disk and granules of diameters from 3 to 40 mm were formed.

Table 1 **Chemical composition of dusts from the bentonite sand processing plant (dry dusting)**

Element	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 obtained results of the physical, chemical and strength properties of dusts from the bentonite sand processing plant and from the reclamation system of the analogous spent sand were presented in [7].

THE OBTAINED RESULTS

The most favourable granulation results for two angles of inclination of the granulator disk: 45 and 50 degrees, are presented in the paper.

An example of sizes of the obtained granules is given in Figure 1.

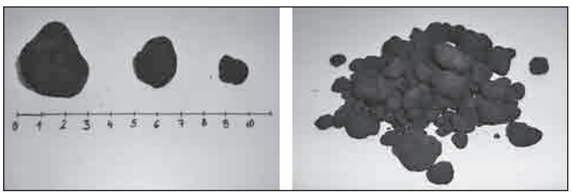

Figure 1 Fractions of the granulated product from dusts originated from the moulding sand processing plant, rotational speed of the granulator disk – 25 rpm, angle of inclination – 40 °, scale under the description in cm

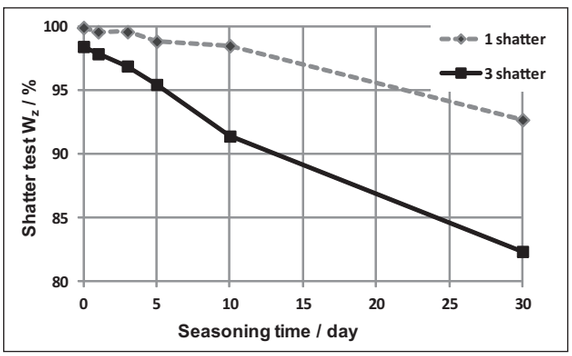

Figure 2 Dependence of the shatter test on the granules seasoning time; rotational speed of the granulator disk: 25 rpm, angle of inclination of the disk: 40 °

Figure 2 presents the dependence of the shatter test on the seasoning time, for the rotational speed of the granulator disk being 25 rpm and the angle of inclination of the disk: 40 °. The raw granulated product obtains 100 % strength after the first shatter. Granules after being shattered on the steel plate are not breaking. The lowest strength is obtained after 30 days of seasoning. After 3 shatters the strength decrease is observed when the seasoning time is prolonged.

The shatter test dependence on the seasoning time, for the rotational speed of 20 rpm and the angle of inclination of the disk: 45 ° - is presented in Figure 3. The raw granulated product is characterized by the highest shatter test after the first shatter. This strength decreases when the seasoning time is prolonged. The strength curve after 3 shatters is of a similar pathway, while the highest strength is obtained after 1 day of seasoning.

Figure 4 presents the influence of the seasoning time on the water content in granules. Both curves are of an analogous pathway. A prolongation of the granules seasoning time causes decreasing of their water content.

The dependence of the shatter test after the first shatter for granules dried at a temperature of 105 °C - is presented in Figure 5. When the angle of inclination equals 40 °, the initial increase of the rotational speed

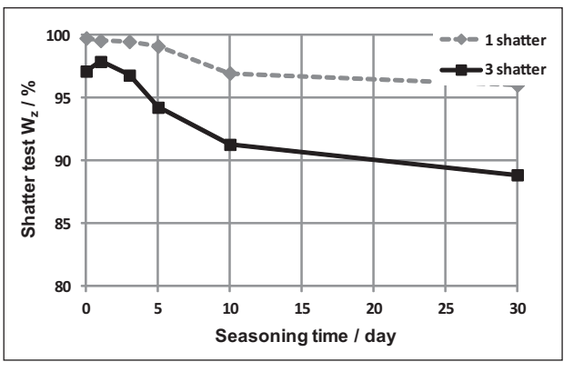

Figure 3 Dependence of the shatter test on the granules seasoning time; rotational speed of the granulator disk: 20 rpm, angle of inclination of the disk: 45 °

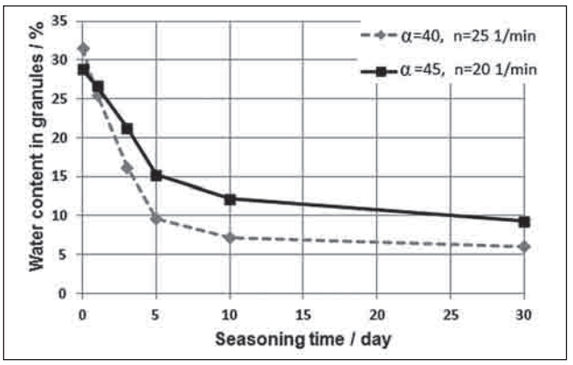

Figure 4 Influence of the seasoning time on the water content in granules

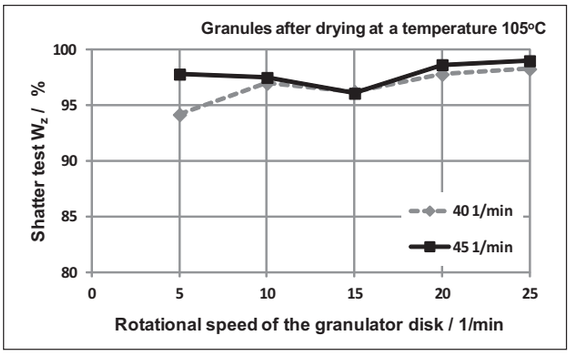

Figure 5 Dependence of the shatter test after the first shatter on the rotational speed of the granulator disk for granules dried at a temperature of 105°C

from 5 to 10 rpm causes the strength increase, while the successive speed increase to 15 rpm - its small decrease. When the angle of inclination equals 135 ° an initial increase of the speed from 5 to 15 rpm causes the strength decrease. After exceeding the rotational speed of 15 rpm for both angles: 40 ° and 45 ° an increased strength is observed.

The number of the formed granules - of the size above 3 mm - is presented in Figure 6. When the angle of inclination of the granulator disk is 40° the largest number of granules above 3 mm is formed at the rotational speeds 5 and 20 rpm (above 50 %), while the smallest at 15 rpm (app. 38 %). In the case of the angle of 45 ° the rotational speed increase from 5 to 25 rpm

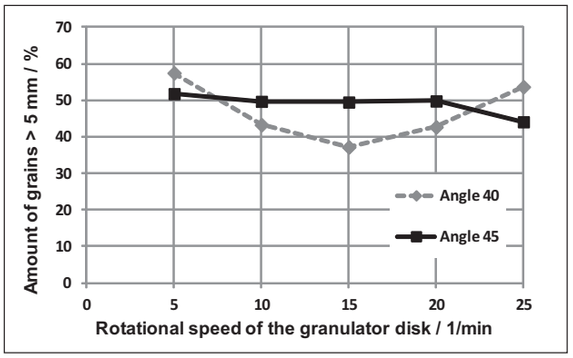

Figure 6 Number of granules of the size ϕ > 3 mm, in dependence on the rotational speed of the granulator disk, granulation time – 5 minutes

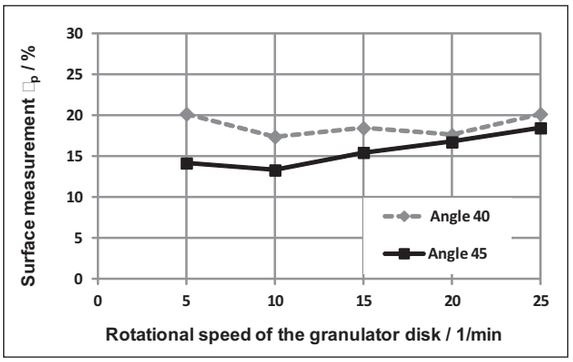

Figure 7 Surface measurement of granules in dependence on the rotational speed of the granulator disk

does not cause any quantitative changes in the formation of granules of the size above 3 mm. The speed increase to 25 rpm causes an insignificant decrease of such granules number.

The surface measuring means counting the number of granules occupying the constant area. The area of 66 cm^2 was assumed in this study.

The results of the granules surface measurement are presented in Figure 7. For both angles, 40 ° and 45 °, the rotational speed increase from 5 to 10 rpm causes a slight increase of the granules size. However, a further increase of the rotational speed causes gradual decreasing of their size. Granules formed at the angle of inclination being 40 ° are characterised by smaller sizes than granules formed at the angle of inclination being 45 °.

The volumetric measurement is aimed at the determination of the approximate granulation density. The constant volume of the beaker - being 279 cm^3 - was assumed in these examinations.

The results of the volumetric measurements are presented in Figure 8. The rotational speed increase of the granulator disk does not cause any significant changes in the density of the obtained granules, for both angles of inclination: 40 ° and 45 °.

CONCLUSIONS

The obtained results indicate that the granulator allows to obtain granules from dusts originated from the bentonite moulding sand processing plants. The charac-

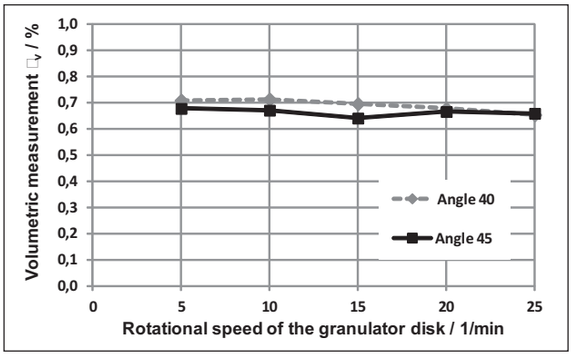

Figure 8 Volumetric measurement of granules in dependence of the rotational speed of the granulator disk

teristics of the work parameters of the granulator and their influence on the granulation process allows to state the following:

The optimal rotational speed of the disk for the angle of inclination of the granulator being 40 ° - should be 25 rpm. For this speed the strength decrease is observed when the seasoning time is prolonged.

The optimal rotational speed of the disk for the angle of inclination of the granulator being 45 ° - should be 20 rpm. At this speed granules are characterised by the highest shatter test.

Comparison of the obtained results for the optimal rotational speeds for the given angles of inclination of the granulator disk, allows to state that the best granulation results for the dusts from the bentonite sand processing plants are obtained at the angle of inclination of the disk being 40 ° at the rotational speed of 25 rpm.

An increase of the angle of inclination of the granulator disk from 40 to 45 °, causes the size increase of the obtained granulated product. This feature is the most visible for the lower rotational speeds of the disk (5, 10, 15 rpm).

For the angle of 40 ° the largest number of granules of size > 3mm is formed at speeds being 5 and 25 rpm, while for the angle of 130 ° at speeds being within the range: 5 – 20 rpm.

Acknowledgements

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Note: "ANGOS" Translation Office responsible for English for language, Krakow, Poland