www.czasopisma.pan.pl PAN www.journals.pan.pl

ARCHIVES of FOUNDRY ENGINEERING

DE GRUYTER OPEN

ISSN (2299-2944)
Volume 15
Issue 3/2015

DOI: 10.1515/afe-2015-0053

Published quarterly as the organ of the Foundry Commission of the Polish Academy of Sciences

25 – 28

Used Furan Sand Reclamation in REGMAS Vibratory Unit

J. Dańko *, R. Dańko, M. Skrzyński
AGH - University of Science and Technology, Faculty of Foundry Engineering, Reymonta 23 str., 30-059 Kraków, Poland
*Corresponding author. E-mail address: jd@agh.edu.pl

Received 31.03.2015; accepted in revised form 29.05.2015

Abstract

The paper, especially dealt with problems of reclamation of used furan sand, carried out in new, vibratory sand reclamation unit REGMAS developed by researches from AGH-University of Science and Technology, Faculty of Foundry Engineering in Cracow (Poland). Functional characteristics of reclamation unit as well as the results of reclamation of used sand with furfuryl resin are discussed in the paper. The quality of reclaim was tested by means of the LOI and pH value, dust content in the reclaim and at least by the the quality of the castings produced in moulds prepared with the use of reclaimed matrix.

Keywords: Used sand, Mechanical reclamation, Environmental protection

1. Introduction

The reclamation understood as the treatment of used refractory casting materials, allowing the reclamation of at least one of the components of properties similar to the ones of the fresh component and its reuse for the production of moulding and/or core sands, is being done mostly during the final (secondary) reclamation. This operation, aimed at cleaning sand grains from left-overs of spent binding material coatings and removal of technologically useless matrix fractions, constitutes – together with the primary reclamation – the complex system of the reclamation treatment. Due to various properties of binding materials applied in casting, achieving an effective liberation of sand grains from coatings of binding materials requires diversified methods of the secondary reclamation, which needs the application of much more intensive techniques than the primary reclamation. The basic classification criterion constitutes the environment in which the reclamation treatment occurs. In this aspect two basic methods – wet and dry - can be distinguished (Figure 2) [1-9].

The results of the reclamation of used foundry sands with furfuryl (furan) resin performed in the universal vibratory reclaimer developed in AGH University of Science and Technology, Krakow, Poland - are presented in the paper. This vibratory unit allows for the primary and secondary reclamation of used foundry sands originated from moulding technologies more frequently applied in Poland.

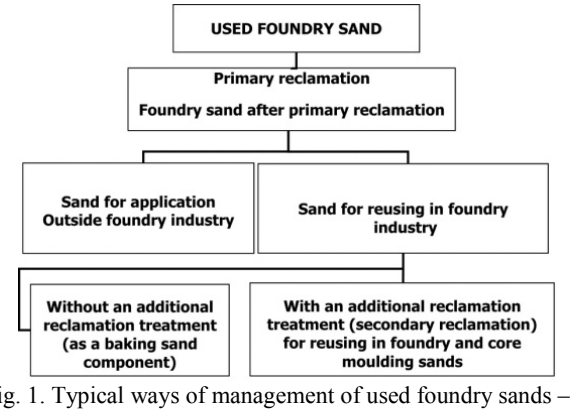

Fig. 1. Typical ways of management of used foundry sands – prepared on the bases [1,3]

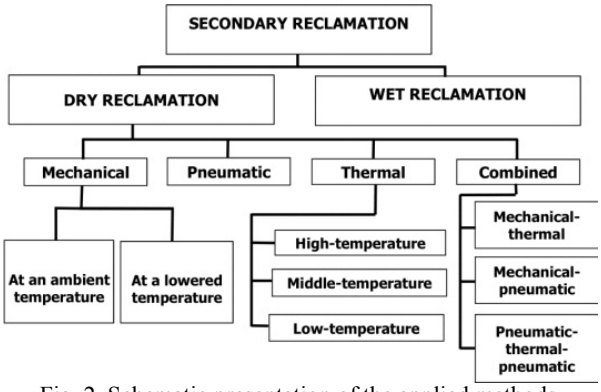

Fig. 2. Schematic presentation of the applied methods of the secondary reclamation [1,3]

2. Device characteristics

Within the project [10] the prototype of the unit of a yield of 1.5 Mg/h was developed. It is used for the reclamation process investigations in the Laboratory of Machines of the Faculty of Foundry Engineering and enables transferring of the obtained results to foundry plants interested in reclaiming small amounts of various kinds of used sands.

The universal vibratory reclaimer REGMAS, functionally integrated with the pneumatic cascade classifier is intended to the dry mechanical reclamation of practically each used sand. It can be installed in reclamation seats of small and middle size foundry plants which for financial reasons are unable to apply expensive professional systems of the sand grains reclamation. In tese cases the newly developed device could fulfill their technical needs.

The view of the unit with the cascade classifier, without the external screen is presented in Figure 3.

Fig. 3. View of the experimental reclaimer at the background of the reclaim proportioning system into the pneumatic classifier

Used sands, after double separation of metallic contaminations, are supplied to the device charge. The primary reclamation is realised on the crushing grid and on the set of 3 sieves. The lowest sieve is of a conical shape of clearances between vertical elements of palisade (slits) being 1.25 mm. At the reclaimer bottom, in its buffer part, loose metallic abrasive elements (spheres) are placed. Together with the vibratory influence (rotational speed and excitation force) they realise the secondary reclamation. The sand screened via the conical sieve is transferred by the vibratory trough and proportioning system into the cascade classifier, supplied from the bottom by the fan of a controlled air speed. The reclaimer is set in motion by means of two rotodynamic motors of a controlled rotational speed and a set vibration excitation force.

3. Reclamation tests

Not burned, caked sand, after removal of metallic contaminations were used for tests. Prevail amount of sand agglomerates did not demonstrate significant burning and binder thermal destruction, due to which they were characterised by a smaller reclaimability than sands from the casting knocking out, which contained burned layers adjusted to castings. In presented case the used sand before the reclamation process had 3.10% ignition loss, pH=3.01 and dusts content at a level of 0.2%.

Tests were performed for two settings of the excitation force, being 50% and 65% of its maximum value.

4. Program of investigations

The used sand was subjected to the reclamation treatment according to the schedule presented in Figure 4. Used sand agglomerates on the crushing sieve can be seen in Figure 5.

For each set of parameters of the reclamation treatment the following values were determined:

- ignition loss,
- dust content in the reclaim on the trough and after the classification,
- pH value of the reclaim and dusts obtained in the classification process.

The technological suitability of the reclaimed material was determined in the foundry, from which used sands originated. It was applied as a partial substitute of moulding sand grains for making moulds and test castings.

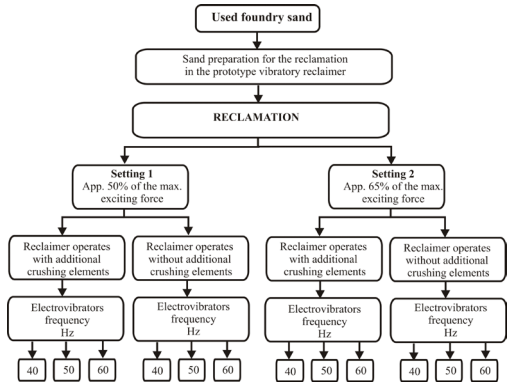

Fig. 4. Assumed parameters of the reclamation tests of used moulding sands with organic binder – in the REGMAS device

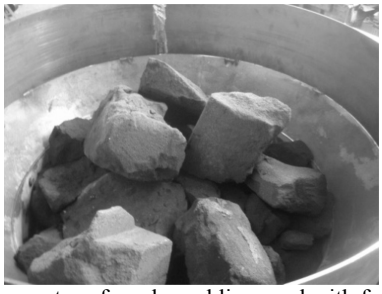

Fig. 5. Agglomerates of used moulding sand with furan resin (on the crushing sieve)

5. Reclamation results

The obtained results of ignition losses, pH values and dusts content of the investigated reclaimed materials are listed in Table 1 and in Figures 6-8. The obtained results confirm that simultaneous increase of the vibration excitation force, electrovibratory motors frequency as well as an application of additional crushing elements causes more accurate cleaning of sand grains from a spent binder, which - after dedusting of the reclaim - is demonstrated in lower ignition losses (Fig. 5).

Table 1.
Ignition losses, pH value and dusts content of the obtained reclaimed materials

Vibratory frequency, Hz	Vibration excitation force: 50%		
	Ignition loss	pH value	Dust content (before classification)
Before reclamation	3.09	3.15	0.00
40	2.83	3.21	0.60
50	2.74	3.34	0.66
60	2.55	3.65	0.93
	Vibration excitation force: 65%		
40	2.75	3.45	1.00
50	2.63	3.76	1.21
60	2.32	3.94	1.65

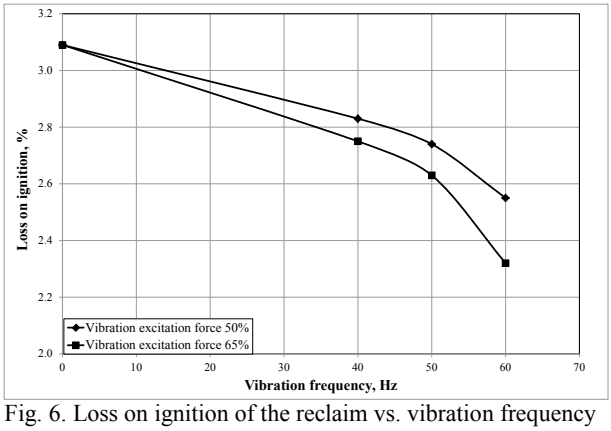

Fig. 6. Loss on ignition of the reclaim vs. vibration frequency

The results of pH measurements presented in Figure 6 obtained for various reclamation conditions of used sands with furan resin and of the after reclamation dusts (under the same conditions) provide important information concerning the proper application of the reclaimed materials for the moulding sands preparation. Sand grains with acidic hardener are of a higher pH when they are cleaned better. Figure 7 presents the dust content in the reclaim prior to the classification treatment. It can be noticed that the more intensive the reclamation treatment – the dust content is the higher. This is because of more intensive reclamation intensiveness in the case of increasing vibratory frequency and higher extraction force.

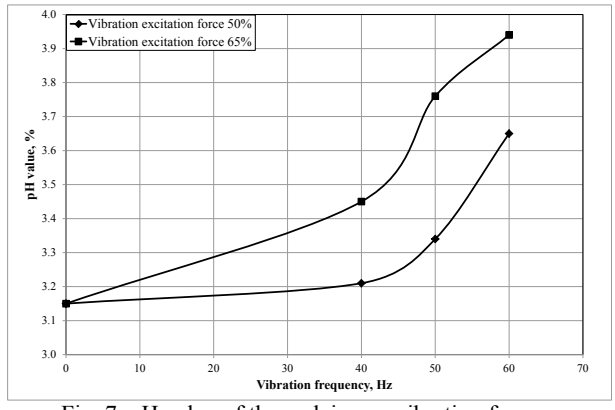

Fig. 7. pH value of the reclaim vs. vibration frequency

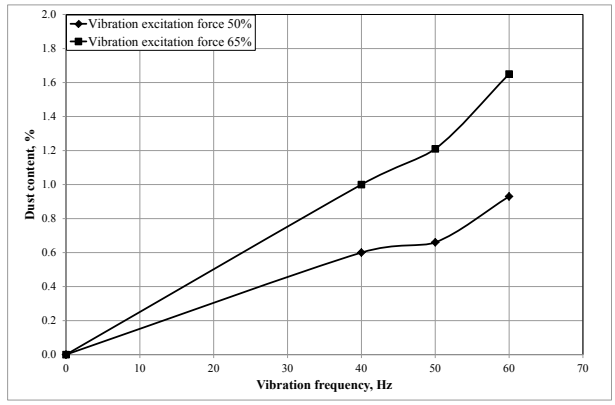

Fig. 8. Dust content in the reclaim before final classification vs. vibration frequency

6. Producing of test castings

The mixture of the obtained reclaimed materials of the ignition loss app. 2.5% was used for making moulds for test castings.

The moulding sand of the following composition was prepared:

- sand grains (reclaim 80% + high-silica sand 20%) – 98.5%,
- furfuryl resin, Permaset 839 – 1.0%,
- hardener, Permacat 145 – 0.5%.

The test casting of the name: 'Road wheel Ø 350' was made of the cast steel L II 450 (PN-ISO 3755 – grate 200-400) of the following chemical composition: C – 0.234%; Si – 0.355%; Mn – 0.845%; P – 0.017%; S – 0.008%; Cr – 0.178%; Ni – 0.040%; Mo – 0.057%.
This cast steel was melted in an arc furnace, a mould pouring temperature was 1580°C.
Ready castings were subjected to a heat treatment – normalising annealing at temperatures 880-920°C.

The technological history of the product of the cast steel L II 450 of the name 'Road wheel Ø 350' is presented in Figure 9 (a-d).

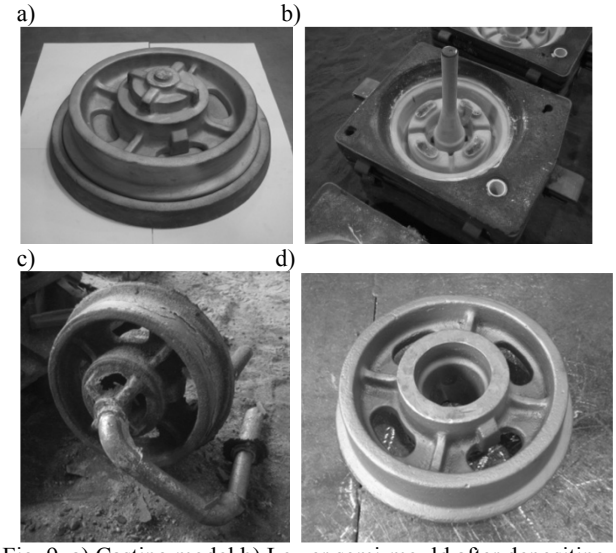

Fig. 9. a) Casting model b) Lower semi-mould after depositing of the protection coating c) Steel casting after being knocked out from the mould d) Test casting after cleaning in the shot blasting machine

The quality of the steel castings made in moulds, which sand grains contained 80% of the reclaimed material and which was prepared in a common paddle mixer, metall technical acceptance conditions determined by the foreign co-operant of the Polish foundry. These conditions, apart from resistance tests, took into consideration requirements concerning the surface quality, dimensional conformity and magnetic inspection to confirm the lack of inner faults.

Introducing 80% of a reclaimed material, as a fresh sand substitute, into the moulding sand did not cause the necessity of changing the technological process of the steel casting production existing in the foundry plant.

7. Conclusions

The performed investigations of the functional qualities of the developed vibratory reclaimer REGMAS fully confirm the structural and exploitation assumptions. The possibility of obtaining satisfactory effects of the reclamation process and pneumatic classification at the yield of 1.5 t/h, can be stated. Investigations allowed to perform immediate improvements of the existing device structure as well as to develop assumptions for building the series of types enabling to raise the reclaimed material quality in relation with the one presented in the hereby paper. The industrial tests of the reclaimed material from used sands with furfuryl resin for making steel castings were carried out and indicated the potential possibility of using this device in foundry plants applying these sands. It can be installed in reclamation seats of small and middle size foundry plants.

Acknowledgements

The project is co-financed by the European Regional Development Fund within the framework of the Polish Innovative Optional Programme, No. WND-POIG.01.03.01-12-007/09.

References

[1] Dańko, J., Dańko, R., Łucarz, M. (2007). *Processes and equipment for recovery of matrix of used moulding sands.* Cracow: Scientific Publishers Akapit (in Polish).
[2] Dańko, R. (2007). Development of energetic model for dry mechanical reclamation process of used foundry sands. *International Journal of Cast Metals Research.* 20(4), 228-232.
[3] Integrated Pollution and Control (2005). Reference Document on Best Available Techniques in the Smitheries and Foundries Industry. European Commision, May 2005.
[4] Dianjie, L., Linling, S., Dong, E. (2010). Reclamation process and equipment of used of self hardening sand. In 69th World Foundry Congress, 16-20 October 2010 (pp. 665-673). Hangzhou China.
[5] Ignaszak, Z. (2011). Contribution to determination of the life time of chemically self-hardening mould sand. *Archives of Foundry Engineering.* 11(4), 55-60.
[6] Tordoff, W.L., Miller, J. & Trembly, J. (1999). New development in sand reclamation. CIATF Technical Forum, 1999, (pp. 377-386).
[7] Wang, J.N. & Fan, Z.T. (2010). Freezing-mechanical' reclamation of used sodium silicate sands. *International Journal of Cast Metals Research.* 23(5), 257-263.
[8] Łucarz, M. (2014). Influence of the thermal reclamation of the spent core sand matrix on its reuse. *Archives of Foundry Engineering.* 14(spec. 1), 27-30.
[9] Łucarz, M. (2013). Utilisation of the reclaim from the cold-box technology in the core sands production. *Archives of Foundry Engineering.* 13(spec.3), 107-112.
[10] Design and development of a novel type of vibratory reclamation system using modern techniques for reclaiming spent moulding sands. Polish Innovative Optional Programme, No. WND-POIG.01.03.01-12-007/09.