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THERMAL RECLAMATION OF THE USED MOULDING SANDS

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The paper presents the results of the research on the used moulding sands subjected to mechanical and thermal reclamation at different stages of the process in the foundry. The research on thermal treatment was carried out in an experimental thermal reclamation appliance. The effects of the process were evaluated with the use of a range of criteria, e.g. loss in roasting, sieve analysis, strength, the acidic reaction (pH). The performed investigations indicate that the thermal reclamation, of spent moulding sands knocked-out from the mould supplying reclaimed materials of the proper quality, can fully substitute the mechanical reclamation.

Key words: foundry, thermal treatment and reclamation, used moulding sand, sand testing, criteria

INTRODUCTION

The management of used moulding and core sands, after making castings, is done in various ways. The most often they are subjected to the mechanical reclamation or - rather seldom - to the thermal reclamation or they are utilised in other industrial sectors. In extreme cases they are transported to dumping grounds, which from economic as well as ecological reasons is not proper. Therefore efforts to prolong as long as possible the usage of the given quartz matrix in the foundry plant are undertaken. The selection of the proper intensity of this matrix surface purification is performed [1-8]. The mechanical reclamation is the simplest and the cheapest way of the high-silica sand regeneration. Such mechanical cleaning of grain matrix is also applied for spent sands with an organic binder. The effect of realised operations is the most often crushing of spent moulding sands to as small as possible particles (individual grains) and removal from the grain surfaces thermal degradation products formed due to the contact with hot metals inside the mould. The pneumatic classification accompanying the reclamation process causes also dedusting of technologically useless fractions. In the thermal reclamation devices nearly complete removal of organic binders from grain surfaces is realised. However, as it was shown by investigations presented in paper [9], in irregularities of surfaces of high-silica matrix can accumulate impurities which can not be removed by an additional mechanical reclamation. In the thermal reclaimers, operating with an application of the fluidised bed (the most often used), gaseous products of organic binders decomposition as well as burning products (ashes) are mainly removed during the air blowing through the bed. The purification degree of the matrix subjected to the thermal reclamation and typical supplementing operations is high - comparable with the state of the fresh sand matrix [10].

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RESEARCH AIM

The research aim constituted determination of the thermal reclamation suitability for the used moulding sand (furan) at various stages of its circulation in the foundry plant: moulding sand knocked-out from the mould and the reclaim obtained by the mechanical reclamation. The effects of undertaken investigations were verified by several criteria of the reclaim assessment: ignition losses, bending strength in the hardened state and pH values [11].

REALISATION OF INVESTIGATIONS AND THE ANALYSIS OF RESULTS

The investigations of the application possibility of the thermal reclamation were realised on materials obtained from one of the Polish foundry plants, which applies the furan moulding sand for producing large cast-iron castings (ingot moulds, ballasts). The fresh quartz matrix, moulding sand knocked-out from the mould after a casting solidification and the reclaim obtained after the mechanical reclamation, which was applied for preparing successive portions of loose self-setting sands, were analysed. Under laboratory conditions the additional thermal reclamation was performed in the experimental reclaimer presented in Figure 1. The principle of operation and possibilities of the device were presented in other papers of the author [10].

The compositions of moulding sands prepared in the foundry plant and amounts of components applied under laboratory conditions are presented in Table 1.

The performed experiment was supposed to determine the range of the required temperature of the thermal reclamation, at which the process of the matrix purification from the spent binder would be efficient. The obtained results, as the arithmetic mean of the percentage mass decrement from two 30 g samples heated in the sylite furnace for 2 hour at the given temperature, are presented in Figure 2.

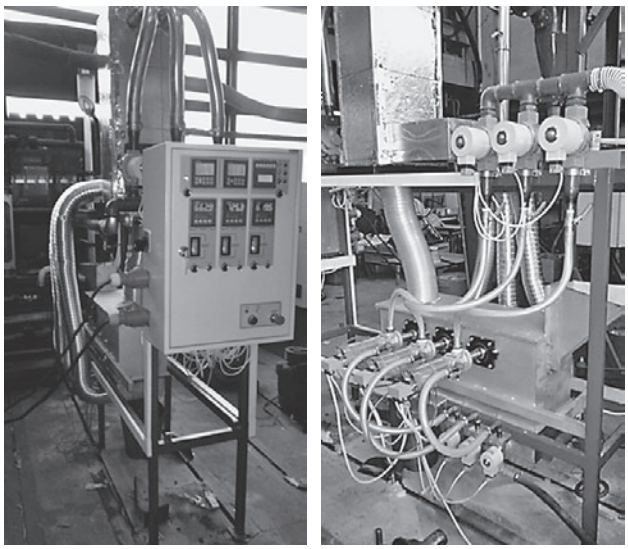

Figure 1 View of the experimental stand for the thermal

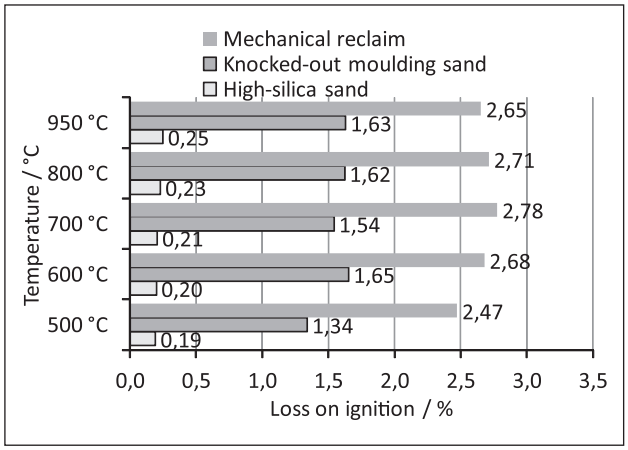

Figure 2 Loss on ignition of the tested materials in dependence of temperature

The obtained results of ignition losses at the given temperatures indicate, that the thermal reclamation performed at 500 °C can left on grain surfaces some organic compounds originated from furan resin. The thermal treatment at the temperature range: 600 – 700 °C should be sufficient for the efficient thermal reclamation. Heating of samples in the furnace at higher temperatures did not cause increased ignition losses.

The thermal reclamation operations were performed in the device presented in Figure 1. Based on the presented above analysis, the burning process was realised at a temperature of 700 °C for 20 minutes, with a sequential blowing - through the reclaimed material bed - warm air recovered from the recuperator. The ignition

Table 1 **Composition of moulding sands applied in investigations**

Moulding sand	Fresh sand (foundry plant)	Mechanical reclaim (foundry plant)	Thermal reclaim (reference moulding sand)
Quartz matrix	100 part by mass	100 part by mass	100 part by mass
FR 75A resin	1,10 part by mass	1,00 part by mass	1,00 part by mass
PU-6 hardener	0,55 part by mass	0,45 part by mass	0,5 part by mass

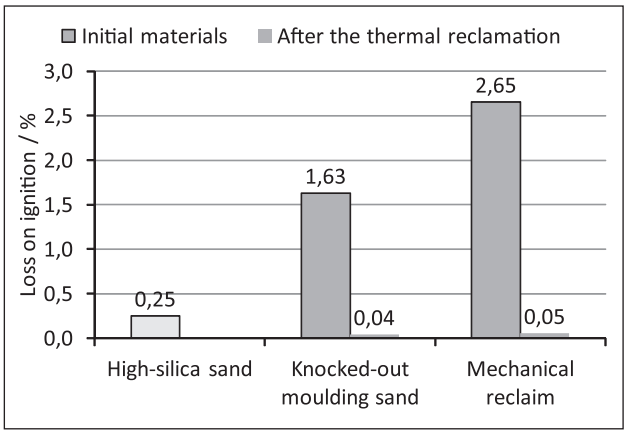

Figure 3 Loss on ignition of the tested materials before and after the thermal reclamation

losses results of the tested materials before and after the thermal reclamation are presented in Figure 3.

It was found that the device operated with a high efficiency. Reclaimed materials obtained after the thermal reclamation had loss on ignition at the level of 0,05 %.

The main criterion of the assessment of the reclamation efficiency is the bending strength of the moulding sand prepared on the bases of the reclaims. To be able to perform comparisons the bending strength tests were carried out for the moulding sand made of the fresh quartz matrix (according to the composition recommended by the binder producer) and of the reclaimed material obtained from the reference moulding sand. As can be noticed in Figure 4, the better bending strength was achieved for shaped elements made of the reclaimed grain matrix (after the thermal reclamation) in each of the tested setting times.

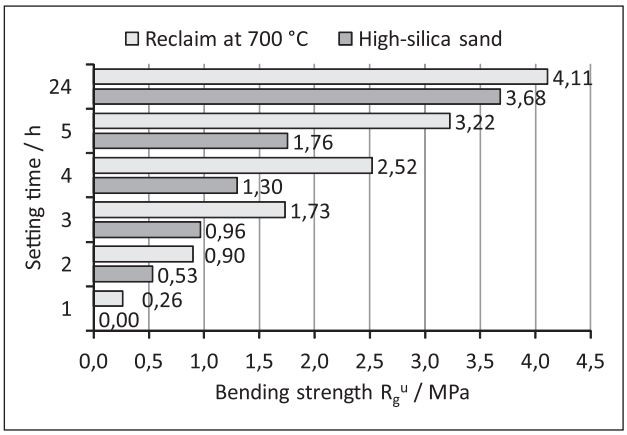

Figure 4 Bending strength of moulding sands prepared on the fresh matrix and on the reclaimed material

In view of the satisfactory bending strength results achieved for the reference moulding sand, the tests for moulding sands prepared on grain matrices obtained after the thermal reclamation of the moulding sand knocked-out from the mould and of the reclaim obtained by the mechanical reclamation - were also performed. The presented in Figure 5 comparison of bending strength of moulding sands indicates that the thermal reclamation applied after the mechanical reclamation provides better results than the thermal reclamation of the knocked-out spent moulding sand. This is caused by better dedusting of the mechanically reclaimed material for which, despite larger amounts of the binder in the whole moulding sand (see Figure 2), the resin burning process is more efficient.

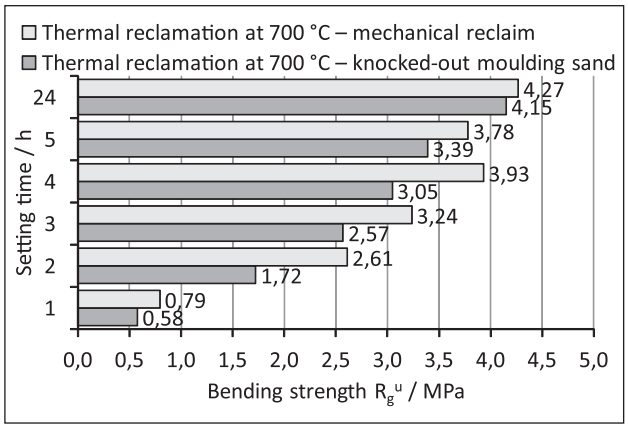

Figure 5 Bending strength of moulding sands prepared on the basis of reclaimed materials

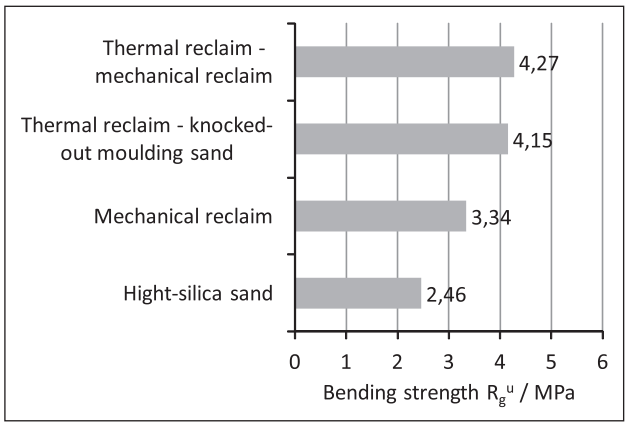

Figure 6 Bending strength of shaped elements made of the moulding sands prepared on various matrices, after 24 hours of setting

How essential are differences when the thermal reclamation is performed for the knocked-out spent moulding sand and for the mechanically reclaimed material, was also analysed. As the reference point the results of bending strength of the moulding sand prepared on the fresh sand and on the grain matrix after the mechanical reclamation - were assumed. The obtained results are presented in Figure 6.

The significant influence of the thermal reclamation on the bending strength of moulding sands prepared on the thermally purified grain matrix in relation to the fresh moulding sand and the one prepared on the mechanically reclaimed material, was found.

Loose, self-setting moulding sands are bound as the result of chemical reactions occurring between hardeners and resins. Therefore one of the essential assessment criterion of the obtained reclaim is its pH value. The results are presented in Figure 7.

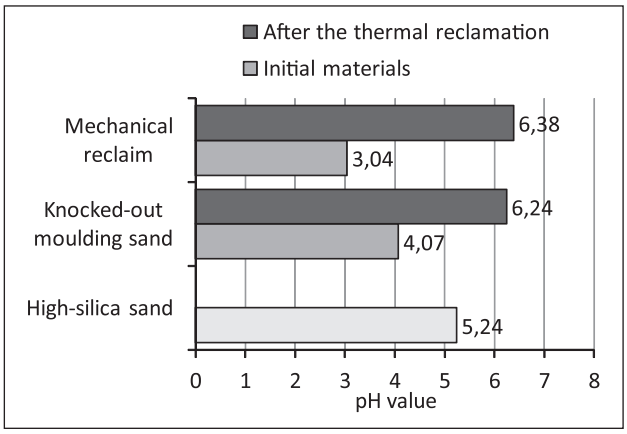

Figure 7 Determinations of pH values of the tested materials

The thermal reclamation of the spent knocked-out moulding sand and of the mechanically reclaimed material decreases acidity of initial materials. Probably this is the factor, which influence increasing the bending strength of moulding sands prepared on the reclaims obtained after the thermal reclamation.

The essential parameter having an influence on moulding sand properties constitutes the amount of technologically useless fractions (lower than 0,1 mm), which presence increases a demand for binding agents. Therefore it is necessary to apply the pneumatic classification after the reclamation operations. The powdery fractions in the tested materials are presented in Figure 8. This parameter is determined on 100 g samples blown by the air with a rate of 1 m/s for 4 minutes in the fluidising column of a diameter of 50 mm.

As can be noticed (Figure 8), the thermal reclamation process realised in the fluidised bed, apart from the

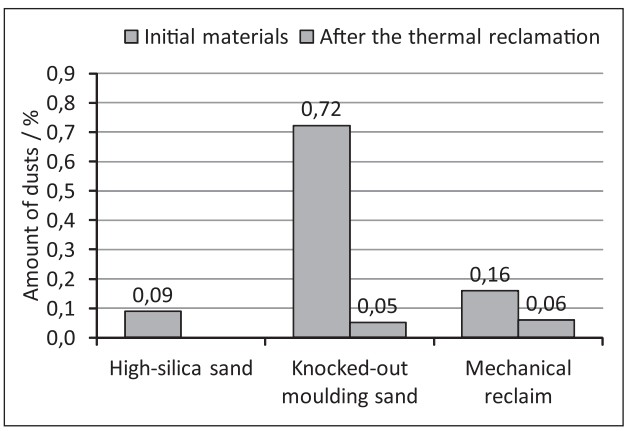

Figure 8 Amount of technologically useless fractions in the tested materials

removal of spent binders from grain surfaces also decreases technologically useless fractions in the grain matrix.

CONCLUSIONS

The mechanical reclamation of the used furan moulding sand applied in the foundry plant fulfils generally the refinement function of knocked-out sand and its dedusting. However, on the bases of the determined ignition losses, it is not possible to tell that the - so-called -secondary reclamation was realised, since the binder amount in the reclaim is even higher than the resin and hardener amounts added to fresh sands. Accumulations of spent binders on surfaces of matrix grains in successive cycles of technological circulation, are seen. The performed investigations indicate that the thermal reclamation, of spent moulding sands knocked-out from the mould supplying reclaimed materials of the proper quality, can fully substitute the mechanical reclamation. During the thermal reclamation realised in the fluidised bed the efficient pneumatic classification also occurs. This simplifies the technological line of devices and operations related to performing the efficient reclamation process.

Acknowledgements

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Note: The responsible translator for English language is J. Pawlikowska-Czubak, Kraków, Poland