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Original Research Article

Influence of melt temperature on strength parameters of cyclically activated used-up sandmixes containing water-glass, hardened with microwaves

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ABSTRACT

The paper presents results of a research on a possibility to apply the innovative, combined with activation of the binder, reclamation process of microwave-hardened moulding sands containing water-glass. The sandmix to be examined, prepared of high-silica sand and the selected water-glass grade 145, was subject to the following cyclical processing stages: mixing the components, compacting, microwave hardening, cooling-down, thermal loading the mould to 800 or 1200 °C, cooling-down to ambient temperature, knocking-out, mechanical dry and wet reclamation, refreshing. After each subsequent cycle of processing the sandmix, used and overheated to various degrees, determined was tensile and bending strength. Analysis of the obtained results indicates that it is possible to activate regenerate of used sandmix containing water-glass, hardened by microwave heating. However, effectiveness of activation in subsequent life cycles of the sandmix is significantly affected by temperature of the casting alloy poured to the mould.

1. Introduction

In literature can be found recommendations related to reclamation of used moulding and core sands containing inorganic binders like sodium water-glass, consisting in possibly exact removing envelopes of reacted binder from surfaces of base grains by mechanical, pneumatic, thermal, hydrous and combined methods [1]. This inorganic binder applied in foundry industry is characterised by low cost and low harmfulness for the environment and for humans. Its disadvantages include, first of all, worse knocking-out properties [2] and more difficult processes of cleaning castings of used moulding sands and separating the film of hardened glassy sodium silicate from the base in the reclamation processes. Used sandmixes containing water-glass are not reusable without carrying-out an appropriate preparation process.

However, L. Lewandowski indicates [3] that the binders in that no chemical reaction proceeds during hardening and do not become deactivated by overheating during casting, can be suitable for repeated use. Therefore, a chance of reusing

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binders is provided by physical hardening methods, whose speed significantly hampers chemical reactions cross-linking the binders, for example under action of CO_2 present in the air. Among physical methods of hardening moulding sands containing binders, the innovative microwave heating can be mentioned, ensuring high quality of manufactured casting moulds and cores [4–7].

As shown by the previous researches on activation of used sandmixes [8,9] containing the binders microwave-hardened by dehydration [3], they can be highly susceptible to rehydration [6,10]. It can be found on the grounds of these data that possible is 3-fold or even 5-fold ''activation'' of the film of glassy sodium silicate in the process of binder reclamation in unevenly overheated used sandmix. As for the activation process, it is assumed that the binder in the used sandmix should be of hydrophilic nature, like e.g. hydrated sodium silicate (sodium water-glass) [11,12]. Moreover, proper sequence and parameters of operations of mechanical dry and wet reclamation should ensure, to a possibly highest degree, reduction of the demand for fresh high-silica sand and binder. This is of particular importance at the time of the restrictive law protecting the environment of human life and work, as well as natural resources of the Earth. The innovative technology of activating hydrophilic inorganic binders, being in course of preliminary testing, can make an alternative for modern technologies of biodegradable binders, being currently a subject of intensive examinations [13,14] in which for curing is used microwave heating [15]. The suggested activation technique in the reclamation process of hydrophilic inorganic binders can complement the time-gap between the proved eco-friendly technologies of inorganic binders and the most modern biodegradable binders of moulding sands.

2. Purpose of the research

The performed preliminary research was aimed at evaluating the suggested methodology of reclaiming microwave-hardened moulding sands containing water-glass, consisting, among others, in disintegration of agglomerated used sand and activation of the film of hydrophilic binding material deposited on the surface. Results of the binder reclamation process by mechanical dry and wet activation will be evaluated by means of selected mechanical criteria of the newly prepared sandmix and that cyclically reclaimed. It was assumed in the research that used moulding sand will be subjected to operations of mechanical dry reclamation with additional elements of wet reclamation aimed at weakening cohesive and adhesive bonds of glassy film of hardened and overheated binder in order to restore its bonding properties.

Before starting laboratory examinations on reclamation of sandmixes it was assumed that, by proper selection of the process parameters and introduction of a determined small quantity of refreshing components, it will be possible to employ the microwave-hardened sandmix containing water-glass grade 145 as a circulating sandmix, which is of a great importance from the economical, ecological and technological points of view.

3. Methodology of the research

It was established on the grounds of the previous research [8,9] that content of the most common binder grade 145 in fresh moulding sand will be 1.5 wt%. Moreover, to improve spreading the binder on surfaces of the base grains, 0.5 wt% of water was added to the ribbon laboratory mixer when preparing the first sandmix used in the given cycle. Of the so prepared sandmixes, specimens for mechanical testing were made in a die specially adapted for work in electromagnetic field, as well as casting moulds that were next hardened by microwave heating.

Then, the moulds made of fresh sandmix and cooled-down after quick microwave hardening at the ''Stage V'' were poured with the alloy at 800 °C (Stage VIa) or in another case at 1200 °C (Stage VIb), which is schematically shown in Fig. 1. This way, a specific degree of thermal load (overheating) of the sandmix prepared exclusively of fresh components was achieved for the

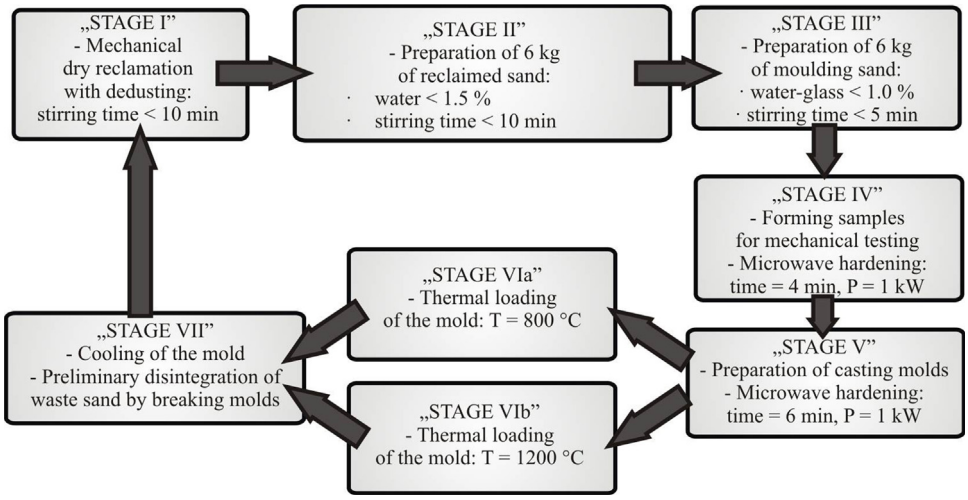

Fig. 1 – Schematic presentation of a processing cycle of used sandmix carried-out in laboratory conditions for thermal loads of the mould of 800 or 1200 °C.