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Investigating of the Knocking Out Properties of Moulding Sands with New Inorganic Binders Used for Castings of Non-ferrous Metal Alloys in Comparison with the Previously Used

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Abstract

The article presents the results of investigations, which make a fragment of the broad-scale studies carried out as a part of the project POIG.01.01.02-00-015/09 "Advanced materials and technologies".
One of the objectives of the introduction of new inorganic binders is to provide a good knocking out properties of moulding sands, while maintaining an appropriate level of strength properties.
Therefore, a logical continuation of the previous studies were carried out the tests knocking out properties of moulding sands with new inorganic binders, including making moulds, pouring them by the chosen of non-ferrous metal alloys, knoking-out, and determining the knocking out work.
The results of the study were related to the research results obtained by applying the moulding sand performed by existing technology.

Keywords: Innovative foundry materials and technologies, Inorganic binders, Modification, Knocking out properties, Residual strength

1. Introduction

Inorganic binder, which is soluble sodium silicate, belongs to a group ecological binders. The interest in this type of non-toxic binders is associated with the growing ecological and economical requirements [3,4,8].

Howewer, these binders are losing to the organic binders, due to unfavorable characteristics of the moulding sands with their participation, which include worse knocking out properties.

The study on improving knocking out properties of the moulding sands with inorganic binders for years involved in many research centers in Poland [1,2] and abroad [3-5], including the FoundryResearch Institute [6-8].

The main aim of the research is the improvement of knocking out properties and reclamability of moulding sands with these binders, while maintaining an appropriate level of technological properties.

2. Aim of research

The purpose of the executed structural project is to introduce to the production of foundry moulds and cores, new ecological binders to replace the sands used so far for casting of non-ferrous metal alloys, i.e. the bentonite, resin-bonded sands. The waste materials from these technologies have a negative impact on the environment.

With constantly growing requirements for environmental protection are becoming increasingly important these technologies, while ensuring the required technological parameters, provide the least possible harmfulness for environment. The current market non toxic inorganic binders (sodium water glass) due to its disadvantageous characteristics (worse knocking out properties and the related worse reclamability), not previously used for casting non-ferrous metals

One objective of introducing the new technology is to ensure good knocking out properties of moulding sands, while maintaining an appropriate level of strength properties.

Therefore, with new type of inorganic binders, developed within the framework of the project [9,10], was carried out the study, including making testing moulds of sands with new ecological binders, pouring them by the chosen of non-ferrous metal alloys, knoking-out, and determining the knocking out work.

The results were referenced to the results obtained in applying the moulding sands carried out by previously used technology.

The strength of sands with elevated temperatures, enabling identify shake-out work, was also determined

3. Investigating of the knocking-out properties of moulding sands with laboratory parts of inorganic modified binders

Selected as a result of physico-chemical and structural studies [9,10] modified binders were technological evaluated, by applying them to carry out the testing moulds and research to determine the knocking out properties.

The binders selected for testing:

- „A" modified by the synthetic thermoplastic polymer,
- „B" modified by the copolymer obtained by emulsion polymerisation,

as potentially the most beneficial for non-ferrous casting. Lots of binders for laboratory tests were made under laboratory conditions by the manufacturer of inorganic binders, Vitrosilicon in Iłowa.

In our studies were applied in parallel two methods of determination knocking out properties of moulding sands:

- Evaluation method of the knocking out properties recommended by the Polish standard PN-85/H-11005
- Evaluation of the knocking out properties based on the measurement of the residual strength.

Moulds and cores for testing knocking out properties prepares both with new modified inorganic binders (modified hedratied sodium silicates), hardened by flodur, and for comparison with an organic binder (furan resin) and bentonite. In these moulds were made casts of Al-Si alloy (AK9) and copper alloy (MO59).

The test was carried out on the experimental stand organised in the Foundry Reserch Institute. With the moulding sands as described above have been made moulds with dimensions 320x250x100/100.

Temperature of the liquid alloy AK9 before removing melting pot from the furnace and pouring moulds was 730 0C, the weight of metal in the mould after casting was about 3.0 kg. MO59 liquid alloy temperature before removing melting pot from the furnace and pouring forms was 1130 0C, the weight of metal in the mould after casting was about 8 kg.

3.1. Study of knocking out properties – technological test

This method is a technological test, which uses standard cylindrical samples (Φ50x50) made of the test moulding sand. Prepared samples (cores) are placed in the cavity mould made of the same moulding sand, from which shall be made cylindrical samples (cores), using a particular model.

To prepared moulds poured liquid alloy, of which the castings in the testing sand. After cooling the casting to ambient temperature, puts it together with samples (core) in the device for the determination of knocking-out properties. A measure of the knock-out work is needed to remove the core from the casting, which is calculated using the formula:

$$L_w - 1{,}6\ n,\ [J]$$

where:

- 1,6 – value of the work of one number of bob blow, J,
- n- number of bob blows

A measure of the knocking out properties is the number of blows of a bob weighing 3,3 kg.

Made test castings, after shake out and cooling to ambient temperature, were placed together with the core in the device to test knocking-out properties and determined the number of bob blows necessary to remove the core from the casting.

Evaluation of knocking-out properties of moulding sands with selected binders made (carried out) for aluminium alloys and copper. The results of these studies are showed in graphs.

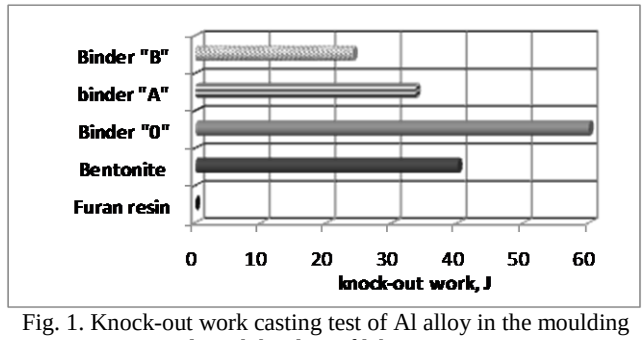

Fig. 1. Knock-out work casting test of Al alloy in the moulding sands with binders of laboratory test

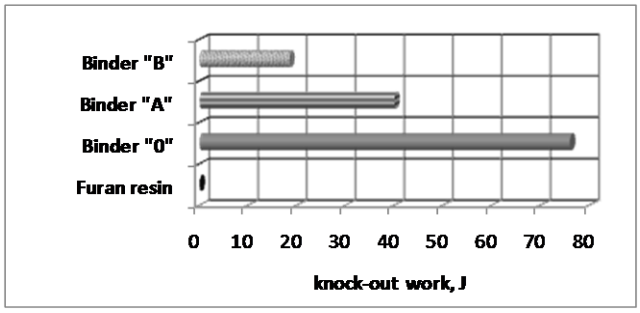

Fig. 2. Knock-out work casting test of Cu alloy in the moulding sands with binders of laboratory test

3.2. Study of knocking out properties based on the measurement of residual strength.

In parallel with the made moulds, from the moulding sands prepared with unmodified and modified inorganic binders and furans moulding sand, were made Samales for residual strength test, as other method of evaluation of knocking out properties.

In this method determines the strength of moulding sand change with increasing temperature. The test starts at ambient temperature, and then starting at 100 °C, the temperature is raised each time at 100oC. The sample after heating at the desired temperature cools to ambient temperature and measure its compression strength.

Based on the obtained results, it is proposed to knocking out properties of moulding sand.

The results of residual strength shown in graph below.

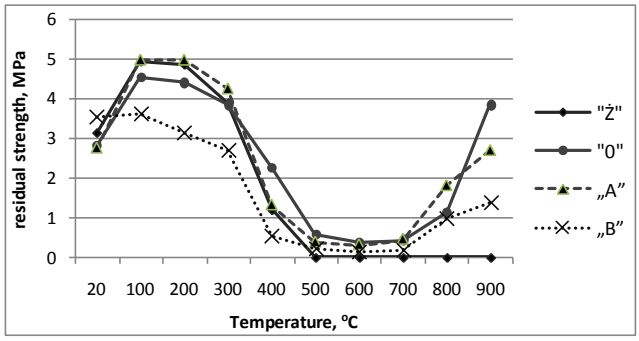

Fig. 3. Residual strength of moulding sands with inorganic and organic binders

4. Investigating of the knocking-out properties of moulding sands with idustrial part of inorganic modified binders

For further trials are applaied industrial lots of modified binders. They were made in the conditions of the production company Vitrosilicon from Iłowa. Because of the the probability of differences between parties industrial and laboratory-made, for lots of binders obtained industrially, verification testing of physico-chemical and technological control study were carried out.

For testing knocking out properties of moulding sand with industrial parts of binders, as in the case of laboratory tests are carried out in moulds and casts of the test.

Because for moulds have been used modified binders from industrial production, for comparison, tests were also made with unmodified binder of trade.

The results presented in the form of graphs.

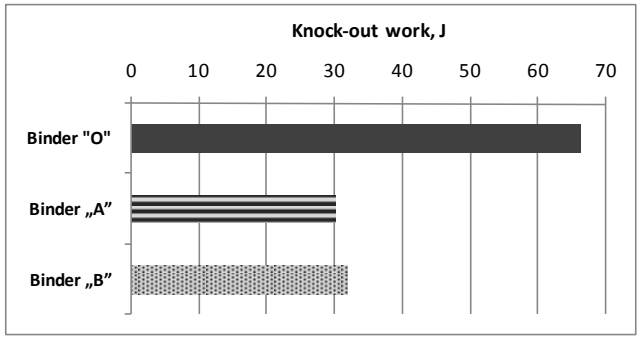

Fig. 4. Knock-out work casting test of Al alloy in the moulding sands with binders of industrial test

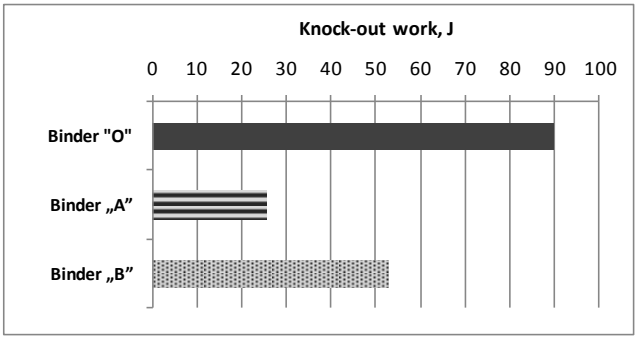

Fig. 5. Knock-out work casting test of Cu alloy in the moulding sands with binders of industrial test

In comparison with unmodified binder, obtained moulding sands with new inorganic binders, have a much better knocking-out properties, especially for aluminum alloys.

5. Conclusions

Carried out (two methods) research the knocking-out properties of moulding sand with new, modified inorganic binders show that the new generation of binders allows for significant improvement knocking-out properties of moulding sand with those binders.

The study confirmed that the proposed method of modification and obtained in this way selected binders allow achieving beneficial technological parameters, both at ambient temperature, as well as elevated temperatures.

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