

РЕЗУЛТАТИ ОТ ТЕХНОЛОГИЧНИТЕ ПОДОБРЕНИЯ ПО ОТНОШЕНИЕ НА ДЕФЕКТИТЕ В ОБЕМА НА МЪРТВАТА ГЛАВА НА СЛИТЪК ОТ АЗОТНА СТОМАНА

RESULTS FROM THE TECHNOLOGICAL IMPROVEMENTS CONCERNING THE DEFECTS IN THE BULK VOLUME OF A NITROGEN STEEL RISER

РЕЗУЛТАТЫ УЛУЧШЕНИЯ ТЕХНОЛОГИИ, СВЯЗАННЫЕ С ДЕФЕКТАМИ В ОБЪЕМЕ ПРИБЫЛИ СЛИТКА СТАЛИ, ЛЕГИРОВАННОЙ АЗОТОМ

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Abstract: This work represents the practical part of a project aimed at investigating the crystallization in blocks of nitrogen containing model alloys produced by the Laybold Heraeus installation for casting under nitrogen pressure. According to the provisions of the contract with KIMM (Korea Institute of Machinery and Materials), 14 ingots were cast with preliminarily assigned chemical composition. A mathematical model was digitally solved for the crystallization of the metal for different variants of the technological parameters. As a result, data were obtained for the temperature field in the area immediately beneath the riser (dead head) of the metal block, the solid phase growth in the riser and the block body, as well as for the type and situation of the open cavity due to metal shrinkage.

Keywords: technological improvements, cast metal, crystallization, dead head.

Introduction

This work represents the practical part of a project aimed at investigating the crystallization in blocks of nitrogen containing model alloys produced by the Laybold Heraeus installation for casting under nitrogen pressure. According to the provisions of the contract with KIMM (Korea Institute of Machinery and Materials), 14 ingots were cast with preliminarily assigned chemical composition. A mathematical model was digitally solved for the crystallization of the metal for different variants of the technological parameters [1-3]. As a result, data were obtained for the temperature field in the area immediately beneath the riser (dead head) of the metal block, the solid phase growth in the riser and the block body, as well as for the type and situation of the open cavity due to metal shrinkage.

The aim of this part of the work is:

1. To implement technological improvements in the mould used for ingot formation with the view of reducing the defects in the bulk of the cast metal;
2. To evaluate the cast metal; to determine the situation of defects in the riser for the different technological variants.

Experimental technique

The cast ingots are in the form of a plate with a rectangular cross section (0.046m/0.092m). The general scheme of the ingot, mould and riser appliance is shown in Fig. 1

The variant, in which a quartz sand and perlitic packing in proportion 1:1 spreads from height $z_2=0.132m$ to $z_7=0.292m$, is designated in the scheme by a dashed line (4'')

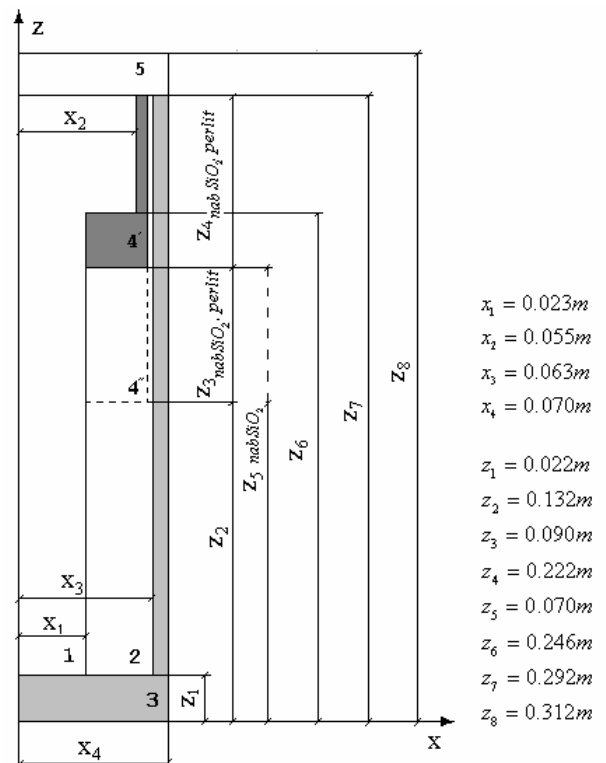


Fig. 1. Scheme of the metal block and the mould

1. Block body;
2. Sand packing;
3. Metal plate and metal cylinder;
- 4'. Packing bush of quartz sand and perlitic;
- 4''. Expanded packing bush of quartz sand and perlitic;
5. Filling.

Technology of casting

The conditions of preparation and casting of the experimental meltings are shown in Table 1.

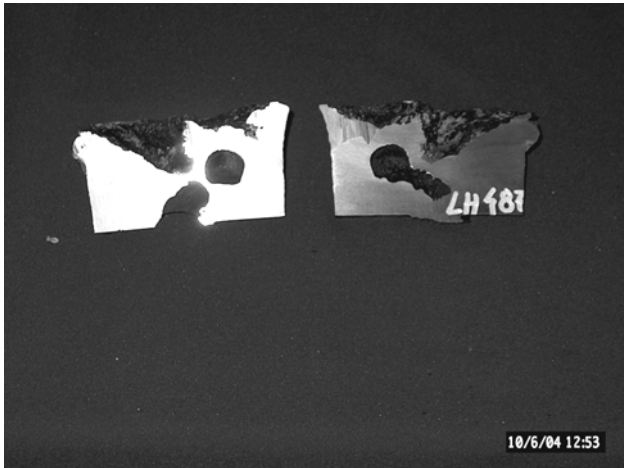
———	Preparation for casting	Conditions for casting	Mould preparation
<u>Basic melting</u> <u>LH 487 -</u> <u>Cr23N1.2</u>	Furnace burden: Armco iron =6790g Metal chromium Cr=1225g Mn _{lamellae} =100g FeSi=30g	Melting of the furnace burden. Closing of the installation. Raising the pressure to 2 MPa, feeding with a container of nitrided chromium 1365g, Al=15g, SiCa=30g. Measured temperature of casting: 1635°C.	The mould is made of quartz sand and sodium silicate. its internal surface is covered by zirconium coating. perlite filling is made on the riser surface.
<u>LH522 -</u> <u>00Cr20N1.2</u>	Furnace burden: Armco iron=7665g (0.02%C+0.04%Si) Metal chromium Cr=780g (96%Cr+0.04%C) Mn _{lamellae} =100g	Melting in vacuum 0.8bar, duration of about 70 min. Normalizing the pressure to the atmospheric value, opening of the machine. Alloying with metal chromium. Closing the chamber. Increasing the pressure to 1.8MPa. Feeding with a container of nitrided admixtures. Increasing the pressure to 3.2MPa. Normalization of 10min. Casting of the metal. Temperature of casting – 1625°C.	The mould is made of quartz sand and sodium silicate. Its internal surface is covered by zirconium coating. The bottom of the mould represents a metal plate with a thickness of 0.022m. A filling of perlite and an exothermal mixture is made on the riser surface.
<u>LH523 -</u> <u>00Cr20N1.2</u>	Furnace burden: Armco iron=7565g (0.02%C+0.04%Si) Metal chromium Cr=980g (96%Cr+0.04%C) Mn _{lamellae} =100g	The conditions of melting and alloying are analogous to the previous ones. The chamber is closed with subsequent increase of pressure to 1.8MPa. Feeding with a container of nitrided chromium 1555g, Al=10g, SiCa=30g. The pressure is increased to 3.0MPa. Normalization of 10min. The metal is cast in the mould. Temperature of casting – 1635°C	The mould is made of quartz sand and sodium silicate. Its internal surface is covered by zirconium coating. The bottom represents a metal plate with a thickness of 0.022m. Packing of quartz sand and perlite envelopes the riser and 20mm beneath it. A filling of exothermal mixture is made on the riser surface.
<u>LH524 -</u> <u>00Cr20N1.4</u>	Furnace burden: Armco iron=7230g (0.02%C+0.04%Si) Metal chromium Cr=980g (96%Cr+0.04%C) Mn _{lamellae} =90g	The furnace burden melting and the alloying are carried out in analogy to the preceding melting. After closing the chamber of the machine, the pressure is increased to 2.1MPa. Feeding with a container of nitrided chromium 1190g, Al=10g, SiCa=30g. Increasing the pressure to 3.5MPa. Normalization of 10min. Casting the metal in the mould. Casting temperature – 1640°C.	The mould is made of quartz sand and sodium silicate. Its internal surface is covered by zirconium coating. A 0.022m thick metal plate is placed at the bottom. Perlite and a thermal bush of an exothermal mixture envelope the riser.
<u>LH537 -</u> <u>00Cr22N1.0</u>	Furnace burden: Armco iron=6950g (0.02%C+0.04%Si) Metal chromium Cr=1250g (96%Cr+0.04%C) Mn _{lamellae} =40g	The machine chamber is closed and the pressure is increased to 2.1MPa. Feeding with a nitrided chromium container 1250g (N=9%), Al=10g, SiCa=30g. Increasing the pressure to 3.2MPa. Normalization of about 10min. Casting the metal in the mould. Temperature of casting 1640°C.	The mould is made of quartz sand and sodium silicate. Its internal surface is covered by zirconium coating. A 0.022m thick metal plate is placed at the bottom. The zone with the bush of quartz sand and perlite in proportion 1:1 reaches 160mm from the front part of the ingot towards the interior and envelopes ½ part of its body. Exothermal mixture is placed on the top surface of the riser and surrounds it.

After the ingot casting the risers were cut off and halved along the middle section. in this way it becomes possible to observe and evaluate the blind riser provoked by metal shrinkage during

hardening. the transverse sections of the risers of the investigated ingots are shown in Fig. 2.

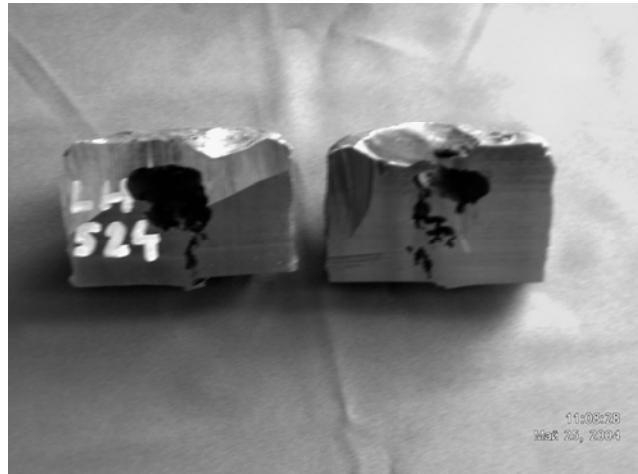
Metal block

Basic melting LH 487 – Cr23Ni1.2



Metal block

LH524 – 00Cr20Ni1.4



LH522 – 00Cr20Ni1.2



LH537 – 00Cr22Ni1.0



LH523 – 00Cr20Ni1.2

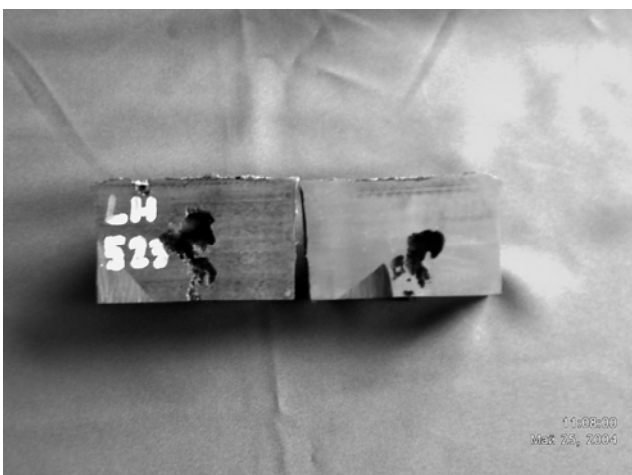


Fig. 2 Mode and location of the blind riser provoked by metal shrinkage during hardening.

It is seen in the photos that in the case of the basic melting – without metal cooling plate at the bottom and only with perlite filling, there is a blind riser penetrating in the ingot's

body. The blind riser situation is better for meltings LH522, LH523 and LH524, where its gradual shifting towards the riser upper end is observed but there are still minor defects in

the body/riser boundary area. Only in melting LH537 the defects are shifted in the upper part of the riser. In the body/riser area the material is flawless and suitable for use.

Conclusions

1. Technological measures are applied for improving ingot macrostructure, which include: heating up the metal of the riser by burning exothermal mixtures, mounting of a metal plate at the mould bottom and reducing the thermal conductivity coefficient of the mould wall.
2. Due to the applied technological improvements the liquid metal spreads into the ingot's body and shifts the blind riser in the upper part of the riser. The ingot remains dense, with slightly concave front part and without cavity, provoked by metal shrinkage, but with only insignificant inhomogeneities in the last 20-25 mm of its height.

References

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The results from the approximate calculation of the cavity depth due to shrinkage of the cast metal will be published in our next work.