

APPLYING OF THERMO-SPEED TREATMENT OF THE ALLOY IN INDUSTRY CASTING TECHNOLOGIES

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Abstract: *The developed and implemented in the production environment technology for producing alloy AK7ч for the casting "Hull" with a predominance of scrap and waste in the charge and with using thermo-speed treatment in smelting are considered in this topic. It is shown that the technology provides fine-grained structure and increases the mechanical properties of the alloys.*

KEYWORDS: THERMO-SPEED TREATMENT, LOW-GRADE CHARGE, CHILL REFUND, MODIFICATION, CASTING, MELT, MECHANICAL PROPERTIES OF THE ALLOY, STRUCTURE OF THE ALLOY.

1. Introduction

Today various kinds of high-temperature overheating for alloys based on low-grade charge are used to reduce the micro-inhomogeneity of metallic melts. However, the archived state is reversible and often until the filling casting molds this effect could be lost. Basically, this is due to the great technological delay of the process.

High temperature type-order structure of the melt can be fixed by rapid cooling of the melt before casting (that is, by thermo-speed treatment (TST)), since the rate of structural changes in the liquid phase is sufficiently low, despite the relatively high speed of diffusion.

Thermo-speed processing has effective modifying influence on aluminum-silicon alloys [1, 2].

Due to the low rate of structural changes in the liquid phase, rapid cooling of the melt can greatly suppress the clusters transformation. By using TST we can fix high-temperature type of liquid phase at the time of pouring the melt into a mold. Getting a fine-grain structure of the alloy cast by high-temperature overheating (thermal-time treatment), followed by the TST is an important reserve for increasing the mechanical properties of castings of various alloys.

2. Results and Discussion

The main provisions of technology for production of cast aluminum alloys in a furnace ИСТ-0,06 (for example, an alloy AK7ч according to the requirements of State Standard 1583 – 93 of Russian Federation) with optimal parameters of overheating and TST (using the chill-back in the melt) are shown in the article.

While using the thermal-time treatment technology there may be a problem of accelerated cooling of the melt in order to fix the effect of thermal-time treatment, because after high overheating and exposure it's very difficult to rapidly cool the melt from the temperature of thermal-time treatment to a temperature of refining (or casting). While the melt cools slowly, firstly, it is saturated with hydrogen and non-metallic inclusions and, secondly, it loses much effect of thermal-time treatment and there becomes a coagulation of clusters and dispersed particles, that leads to a similar level of micro-inhomogeneity of the melt, which was before the treatment.

Experts offer the following basic solutions to this problem [3]. The first option. The melting technology is implemented under the regime of mixing, when, after the melting charge material portion of the melt (about one-third or half) is poured into dispensing pot, the remaining part of the melt is processed and then parts are mixed, whereby the melt temperature is lowered to the desired level and enables to carry out the casting. The second option is a common practice. It's similar to the first option. Melting is carried out in two separate furnaces, but in one of the furnaces there is the thermal-time treatment, then melts are blended and melt casting is carried out. The third option. After homogenizing overheating the solid charge is added to the melt.

A disadvantage of the first option is that in the case of low-grade charge, after mixing with another portion which is subjected by thermal-time treatment the part of the melt poured into dispensing pot makes microinhomogeneity and significantly reduces the effect of thermal-time treatment. A disadvantage of the second embodiment is that it requires two melting units. The most perspective is a third option, but with consideration of quality of input charge.

In recent years there have been numerous positive effects [2, 4] of the influence of fine-grained refund on the properties of the resulting alloys with various additives into the melt. Such additives (in an amount of from 5 to 100 percentage) either were used as a seed before pouring the melt or immediately immersed them into the furnace together with the main charge. In this case, mechanical, foundry and service properties of the alloys significantly improved. Thus, according to [2], fine-crystalline remelting modification of aluminum alloy (fine-grained mix materials) helped to increase the rate of cooling, reducing the amount of shrinkage defects and reduce gas porosity.

The use of fine-grained refunds (remelting) at 10...90 percentage with addition of a low-grade charge materials contributed to increasing tightness, mechanical properties and fluidity of alloys [4].

Thus, the problem of accelerated cooling after high melt superheat temperature before refining or casting into molds (to effect fixing superheat) can be addressed through the addition of fine-grained refund corresponding to the composition of the obtained alloy, i.e. – to implement thermo-speed processing. The increase of the cooling rate of the melt is due to the following: additives of the fine-grained materials act as a melting micro-fridge, as well as create a modifying effect by making a large number of potential nucleation sites (microheterogeneities of smaller scale and activated insoluble impurities). As fine refund it is advisable to use a specially prepared charge billets and waste and chill casting refund.

The melting technology with a predominance of scrap in the charge has been developed and implemented in the preparation of the alloy casting AK7ч "Body" [5]. The technology includes the steps of: melting charge materials, including low-grade materials (scrap, waste fines, scraps, chips are in blocks of AK7ч, the number of chips was about 40...45 percentage of the total weight of secondary materials), overheating, the melt cooling of the first portion of chill refund (composition AK7ч) to a modification temperature, the modification of the second portion of the chill-refund, refining and casting.

When optimizing the overheat parameters the temperature was varied from 1173 to 1423 K with increment 50 degrees. Exposure time was from 5 to 25 min. with increment 5 min. Composition of the charge (changed in the filling: 10 to 50 percentage – pig Al-Si (M1), from 50 to 90 percentage – a low-grade charge (M2), consisting of scrap and waste of sand and clay molding of composition AK7ч). The optimal values of the parameters were determined by the maximum strength (tensile strength) which is typical for body casting. Nomograms that linking high-temperature overheat parameters (temperature, exposure time)

and strength of the alloy, depending on the composition of the charge had been constructed.

The optimal obtained parameters of high-temperature overheat were the following: temperature was from 1303 to 1323 K (it depends on the composition of the charge). Exposure time was from 10 to 15 min.

Later the modes of melting were investigated to determine the optimum amount of additive of chill refund in the melt (for TST). Pig alloy AK7ч, low-grade charge (various waste of sand and clay molding composition AK7ч: chips in blocks, trimmings, small scrap), chill casting refunds of AK7ч were used as the charge. Melts were overheated to the temperature from 1303 to 1323 K. Content of the charge components (pig alloy, low-grade charge, fine-grained charge), the mass ratio of the input portion of the fine-grained charge (the first and the second portions respectively: 70 and 30, 60 and 40, 80 and 20, 50 and 50 percentage) and the temperature of entering the second portion (1073, 1108, 1143, 1173 K) were varied. The first portion in all cases was administered at a temperature of overheating after isothermal exposure. Refining was carried out before the casting of manganese chloride in an amount of 0,2 percentage by weight of the melt which was introduced by the "Bell". Casting temperature in all cases was from 1003 to 1013 K.

It has been found that the mechanical properties depend on the ratio of the charge components (pig alloy, low grade materials and chill refund), the mass of input portions of chill refund and the temperatures at which these portions are administered. The maximum effect in terms of improving the mechanical properties in all options was shown by the introduction of the first portion of chill refund in the amount of 60...70 percentage of its overall weight, wherein the second portion in the amount of 30...40 percentage was introduced at temperatures of 1108...1143 K and provided a sufficient number of potential nucleation sites for grinding structure.

The optimal ratio of the charge components is following: pig Al-Si alloy (AK7ч) – 0,05...0,12; low-grade charge – 0,71...0,78; chill refund – 0,12...0,17.

The increased mechanical properties are achieved by improving the structure of the alloy by using the proposed composition of the charge, wherein expensive modifiers are not used in the melt. The mechanical properties of the samples cut from a casting "Body", made of alloy AK7ч on the proposed technology, increased. Fluidity determined by the trial process increased by 11...23 percentage.

The proposed process can be successfully used in smelting aluminum alloys in foundries that use chill mold casting. This technology allows the use of low-grade waste in the amount of 80...85 percentage. The developed technology has also been successfully tested in the production of castings from cast

aluminum alloys of different makes produced by different casting methods. Thus, the application of the technology of TSP yielded the desired mechanical properties of the alloys AK12, AK9M2, AK7 (according to the requirements of State Standard 1583 – 93 of Russian Federation) for castings such as "Cover", "Body", "Sleeve", "Insert", obtained by molding gasified models.

3. Conclusion

A resource-saving technology of aluminum alloys (for example, an alloy AK7ч intended for the manufacture of castings "Body") of the low grade charge, including the TST was developed. The optimal technological parameters of high-temperature overheating and additives of chill refund to the melt of composition AK7ч were set. The optimum ratio of pig materials, low-grade charge and chill refund in the charge, that leading to high levels of mechanical properties and fluidity of the alloy, was determined.

4. Literature

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