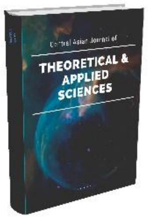

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Improvement of the Technology of Liquidation of A500 Brand Low Carbon Steel Alloy in the Induction Furnace

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Abstract: *The technology of liquefaction of A500 low – carbon steel alloy under laboratory conditions in an induction furnace was improved. Also, the composition of the flux was developed for the formation of slag from liquid metal, and quality cast products were obtained.*

Keywords: *low – carbon steel, induction furnace, flux, electromagnetic, magnesite, chromamagnesite, slag, lining, slag.*

INTRODUCTION

Low – carbon steel alloys refer to steels used for the manufacture of details and structures in machinery and structural engineering. Such steels can be carbon or alloyed. Carbon content in structural steels is not high, but sometimes it can reach 0.8 – 0.85%.

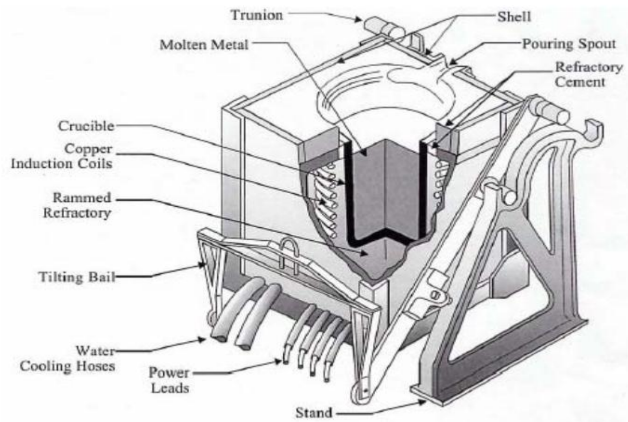
Modern machine parts often work under the influence of high dynamic forces, high voltages and low temperatures. Such conditions lead to brittle decay of the material, as a result of which the reliable life of the machine is reduced. Therefore, in addition to the high mechanical characteristics determined by static testing, the structure must also have high strength, that is, the details and structures used in real conditions must be strong enough to withstand sudden high stress. Construction materials must also have good technological properties: the material must be well processed under pressure (rolling, hammering, stamping, etc.) and well cut, no small cracks should be formed during rolling, sufficient depth of penetration, and carbon on the surface when heated. should not decrease, should not be deformed when pressed and should not form cracks, etc. [1 – 4]. And the steels used in constructions should have good welding properties. Carbon structural steels are of normal quality and quality depending on the content of harmful elements (P, S). It is cheap compared to normal quality steels and hence it is widely used. They are produced in large batches, so the liquation can be large. There will also be non-metallic elements. Details made of such materials are also subjected to additional heat treatment. Normal quality steels are divided into 3 groups: A, B and V. On the basis of this division, the guarantee features are obtained. The mechanical properties of Group A steel are guaranteed. The higher the carbon content, the better the mechanical properties. Such steels should be used as they were designed, etc. under pressure The development of induction furnaces dates back to Michael Faraday's discovery of the principle of electromagnetic induction. However, experiments with induction furnaces did not begin until the late 1870s when De Ferranti began working in Europe, in 1890 Edward Allen Colby patented an induction furnace for melting metals [5 – 7].

Induction ovens are becoming competitive ovens. Chemical reactions in induction furnaces are less than in ceramic furnaces, which allows to achieve the specified chemical composition of the obtained product. In the last 25 years, a new generation of induction melting furnaces has been developed in the industry. Continuous melting methods are widely used in modern foundries as a result of the development of the flexibility of medium frequency induction furnace DC power sources. Power units typical of induction power supplies of the 1970^s include powerful silicon – controlled rectifiers [8 – 12]. They are used with an electrical efficiency above 97% capable of producing the required frequency and amperage for the set. This is a significant improvement over the previous efficiency of 85%. Allows for better fluidization control and maximum utilization during liquid alloy monitoring [13].

MATERIALS AND METHODS

Today, liquefaction of high-quality structural steels in an induction furnace is widely used. Therefore, the IST – 0.02 Induction furnace was selected in laboratory conditions to obtain a quality structural steel alloy. This furnace operates at a low frequency, etc. industrial 50 – 60 hertz, and is designed for liquefaction in laboratory conditions. The lining of this oven has been selected from basic materials. Magnesite and chromamagnesite bricks were selected as materials [14 – 18]. The purpose of choosing a basic lining is to remove the slag from the steel alloy by adding flux, $CaCO_3$, to the slag and make it free of harmful elements. The reason we don't choose acid furnaces is because the steel alloy is also acidic, which will corrode the furnace lining. The walls of acid furnaces are made of dinas bricks. It is used in the production of higher quality structural steels in acid induction furnaces [19 – 21]. Quartz sand or broken glass was used as a flux. In the process of liquefaction of steel alloy in acid – lined induction furnaces, there is some difficulty in removing P and S, which are harmful elements in the steel alloy, from the liquid alloy to the slag. Therefore, when steel is liquefied in such furnaces, harmful elements in the alloy are absorbed and loaded into the furnace. Before starting the furnace, it is necessary to check that it is suitable for work. Once the steel is liquefied, the furnace lining may be corroded. If such a situation is observed, a mixture prepared from magnesite powder is applied to the damaged areas [22]. Then the slurry is loaded through the upper part of the furnace. In normal practice, after heat removal, initial slag loading is done manually with shovels or loaded with several large pieces of scrap metal or compacted bundles of low grade slag. In some cases, with the help of a crane, the blocks are loaded into the furnace. Because of this practice, even when the furnace is fully loaded, it will not be fully loaded, and after a while, it is noticed that the furnace does not use full power. This results in more heating time and more energy. First of all, it is recommended to load the powders into the crucible with the help of badias. This saves loading time, since the bulk of the load must be scanned at the beginning of the load. Therefore, it draws full power to the oven from the beginning. It reduces the loading time of the file.

In an induction electric furnace, an alternating electric current passes through copper tubes. In the furnace, an electric current passes through refractory materials and a magnetic field is created due to the excitation of metal charges. This causes an electric current to flow through the metal charge itself, generating rapid heat and causing the metal to liquefy. Although some surfaces of the oven can get hot enough to pose a risk of burns, the inductors focus on liquefying the slag, not the oven.



1 – picture. Overview of the induction electric furnace

It takes about 3 – 5 minutes to remove slag from liquid metal. During this time, it is recommended to turn off the oven. The main reason for this is that the temperature of the liquid metal rises during the removal of slag from the liquid metal. It is also necessary to pay attention to the fact that the flow of water moving in the inductor does not cool the liquid metal when the furnace is turned off. After mixing the liquid alloy with a ladle, samples were taken from three places, and the chemical composition was checked in the laboratory, FeO (Iron oxide) was added to the furnace to reduce the amount of carbon in the alloy, and after the amount of carbon and other elements in the alloy was normalized according to GOST requirements, the liquid alloy was poured into a sand-clay mold and the expected results were achieved.

RESULT

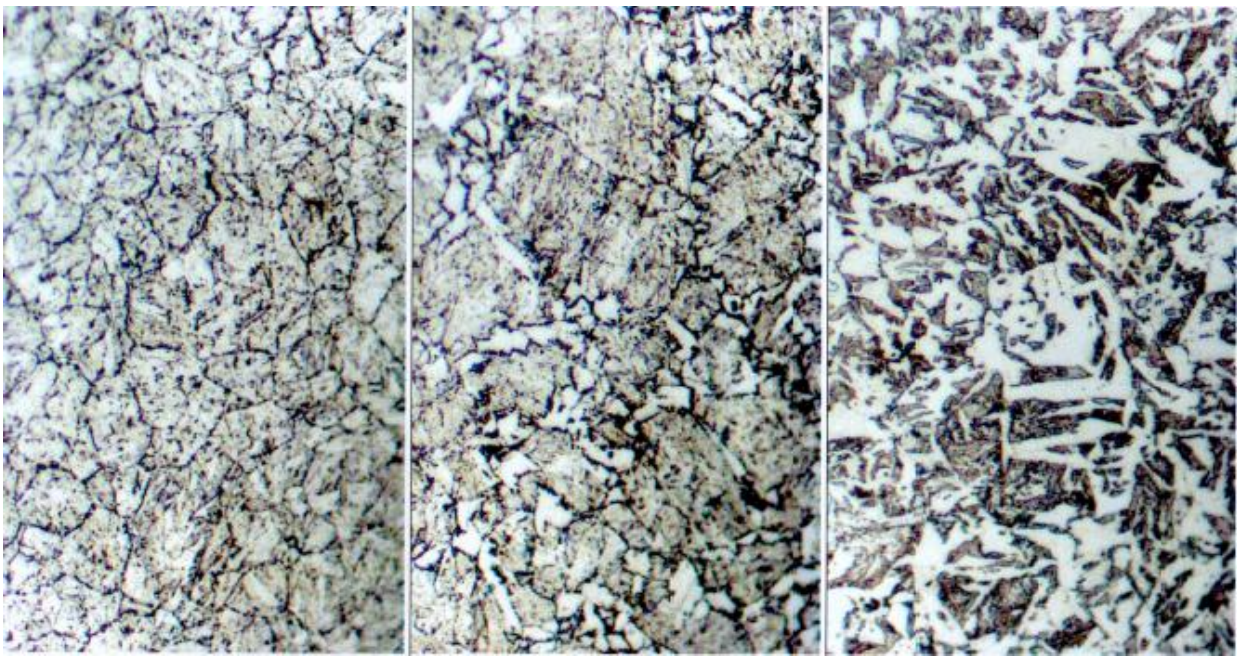
High – quality structural steel alloy cast samples were removed from the mold and surface cleaned with SiC.

Fig. 2. Samples cast from low-carbon steel alloy A500

Table 1 Chemical composition of liquefied A500 brand

Brand	C	Si	Mn	P	S	Cr	Ni	Cu
A500	0,21	0,6 -0,9	0,9 - 1,5	0,018	0,035-0,045	~0,3	~0,3	~0,3

Then it was determined in the spectral analysis device model "SPEKTROLAB – 10 M". The samples were metallographically examined at the scanning electron microscope, and the obtained result is shown in Figure 3.



a b v

Fig. 3. Image of A500 alloy magnified x500 times

a – Reinforced layer, b – Transition layer, v – Base metal

3a – as can be seen in the picture, Sorbitum, a 1.1 mm thick zone when viewed in a scanning electron microscope with a magnification of x500. 3b – picture Pearlite sorbite structure + ferrite, 1.8 mm thick zone. 3v – picture Pearlite sorbite structure + lamellar pearlite + ferrite structure was observed.

CONCLUSION

The earthquake resistance, corrosion resistance, and service life of cast products made from structural low-carbon A500 steels were achieved by reducing harmful elements in the alloy by adding flux to the liquid alloy.

The optimal liquefaction technology for liquefaction of A500 alloy was developed.

Furnace lining is designed based on liquid metal relationship graph. This made it possible to liquefy high-quality steel alloy.

In the period of liquefaction of the alloy, the technology of liquefaction was developed based on the introduction of flux into the furnace, which ensures the technology of obtaining high-quality cast products. As a result, it is important to develop the technology of loading flux elements into the furnace in the composition of liquid metal.

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