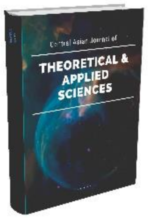

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Technology of Processing the Liquid Steel Alloy Obtained in an Electric ARC Furnace Outside the Furnace

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Abstract: *This article presents technologies for cleaning low–alloyed steel alloys liquefied in an electric arc furnace from gas pores and non-metallic inclusions based on out-of-furnace processing.*

Keywords: *Stirring of liquid, argon, inert gas, ladle, out-of-furnace, slag.*

Introduction. Competitive forces and market globalization in the metallurgical and machine-building industries continue to develop and implement new technologies for steel and cast iron production in the 21st century. The industry's response to its unique local and global technologies is leading to the gradual improvement of existing technologies, as well as major changes in several important areas, such as the production of steel and its alloys.

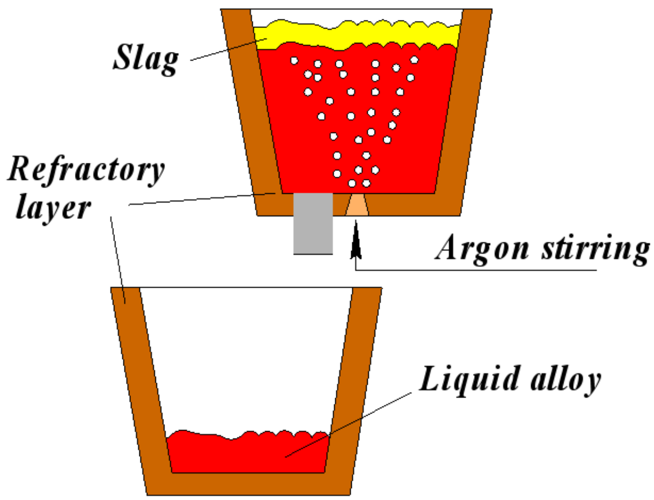
In addition, the steel and its alloy manufacturing industry is providing ever-increasing quality standards for steel castings. Therefore, researches on improving the technology of liquid alloy processing are ongoing at metallurgical plants and foundry production enterprises. Taking into account such conditions and based on the experiences of the steel casting industry, the technologies of liquid metal processing using inert gases are widely used.

Main part. Stirring of liquid metal using argon inert gas. Regardless of the technological process of liquefaction of alloys, the most important aspect of liquefaction of steel alloys is to create an alloy with a homogeneous composition and a homogeneous structure throughout the volume. The most accurate way to ensure this process is to mix the liquid alloy well. Due to the high temperature of the liquid metal, direct mechanical mixing does not give good results. Because under the influence of the high temperature of the liquid metal, the mixing mixer causes contamination of the liquid metal with exogenous inclusions as a result of erosion. An alternative method is pneumatic mixing, in which gas bubbles move through the bulk of the liquid metal to achieve vigorous mixing. This process requires the gas to be chemically inert to the liquid metal, a common method for this is mixing through an inert gas.

In this technological process, the alloy was treated outside the furnace to remove non-metallic inclusions and gases in the liquid alloy. Reduction of non-metallic inclusions and gases in steel alloys is one of the most important problems today. Despite the presence of non-metallic inclusions in steels in small amounts (from 0.01% to 0.02%), they significantly affect the properties of the steel.

In this method, the inert gas argon is passed through the liquid alloy in the ladle under a low pressure. (pic. 1).

It was carried out by sending argon gas from the bottom of a special ladle. The argon flow rate was set at a minimum of 5 L/min at the beginning of the process. When the liquid metal temperature reached 1560 – 1565 ℃, the rate was changed to 12 L/min and kept constant. The metal was thoroughly mixed and cleaned of gas and non-metallic inclusions.



Pic 1. The process of cleaning liquid alloy through inert gas

Another important factor affecting the quality and mechanical properties of cast shaft parts is gases in the liquid alloy. As a result of the analysis of the shafts produced at the production enterprise, the presence of gas pores in the alloy was determined [1 – 5].

In order to clean the liquid metal from these gas pores, aluminum (Al) element was added in the amount of 0.5% based on the weight of the total alloy in the out-of-furnace state. Aluminum (Al) was added to the liquid alloy in different methods. In the first case, when the liquid metal in the furnace is ready, that is, it has reached the temperature of pouring into the ladle, 0.2% aluminum was put into the heated ladle and the liquid alloy in the furnace was poured over it. In the second method, 0.2% of aluminum was added to the liquid alloy poured into the ladle heated from the furnace after cleaning from slags. In the third stage, liquid metal ready for pouring was added in the amount of 0.1% during pouring into the sand – clay mold. A total of 0.5% of aluminum was added. The process in ladle was as follows.

$[3FeO] + [2Al] \rightarrow (Al_2O_3) + [3FeO] + Q$ (1)

Results. Here, aluminum serves to remove oxygen in the form of aluminum oxide. By using this method, it was possible to remove the liquid alloy from gas pores in the alloy.

a) **b)** **c)**

Pic 2. Appearance of gas pores in cast products

a – cast shaft detail with gas voids in the manufacturing plant; b – shaft detail with a significantly reduced amount of gas pores, cast with aluminum (Al) elements in the liquid metal composition based on the first method; c – shaft detail, cast with aluminum (Al) element in the liquid metal composition based on the second proposal, without the amount of gas pores observed [6 – 12].

Conclusions. As a result of cleaning the liquid alloy using inert gas, it was reached possible to obtain a quality cast product free of gases in the composition. As a result of the introduction of the developed technology, the amount of gas pores in the cast products obtained from steel alloy has decreased by 8 – 12%, a technology has been developed that allows to increase the mechanical properties of cast products by 16 – 18%, and the service life by 1.5 – 1.7 times.

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