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Improvement of liquidation technology of construction steels

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In this article, two different amounts of aluminum were added to the steel 3 brand alloy to test their mechanical and casting properties. As a result of the addition of aluminum, the gas pores in the steel alloy were reduced by 70 – 75%. It was also possible to obtain a uniformly distributed ferrite and perlite structural castings with increased ductility at the expense of aluminum during the casting of steel alloys.
Key words: hardness steel, non – ferrous, structural strength, limestone

Modern engineering is the main consumer of metals produced in our country. In machine – building, automobile and aviation industries, electronics and radio engineering, many machine and instrument parts are made of metals.

The metals used in the technique are mainly divided into two groups – ferrous and non – ferrous metals. Ferrous metals include iron and its compounds (cast iron, steel, ferroalloys). The remaining metals and their alloys form a group of non – ferrous metals.

Iron and its alloys, which are still the main mechanical material, play a special role in metals. Iron and its alloys make up 90% of the world's metals. This is explained by the fact that ferrous metals have important physical and mechanical properties, as well as the fact that iron ores are widespread in nature, while the production of pig iron and steel is cheap and uncomplicated [1 – 3].

Construction steels are steels used to make parts and structures in engineering and construction. Such steels can be carbon or alloyed. The carbon content in structural steels is not more than 0.5 – 0.6%, but in some cases it can even reach 0.8 – 0.85%. Modern machine parts often operate under the influence of high dynamic forces, high voltages and low temperatures. Such conditions lead to brittle erosion of the material, which in turn reduces the reliable service life of the machine. Therefore, in addition to the high mechanical characteristics determined by static testing, it must also have high structural strength, ie the strength of the parts and structures used in real conditions must be sufficient, able to withstand sudden high stresses [4 – 6].

Today, liquefaction of steel alloys is mainly carried out in induction and electric arc furnaces. First of all, we choose the liquefaction furnace before liquefaction of steels. Because steel is acidic, it must be liquefied in basic furnaces. The main reason for this is that if liquefied in acid furnaces, the furnace lining will break down quickly. It is therefore recommended to dilute in ground furnaces. If the steel alloy is liquefied in an induction furnace (IST), the alloy will be filled from the bottom of the furnace after the shaft is loaded into the furnace. As a result, the top of the induction furnace lining can crack due to heating, and through these cracks, the liquid alloy can pierce the lining of the furnace. For this reason, an electric arc furnace with a base lining is used to liquefy steels.

In the laboratory of the Department of “Casting Technologies” of Tashkent State Technical University, steel was liquefied in an electric arc furnace of 20 kg [7 – 8]. The walls of these furnaces are made of magnesite or chromagnesite bricks, and the surface is covered with a steel sheet. The electric arc furnace is shown in Figure 1.

Figure 1. Appearance of electric arc furnace

After the furnace was put into operation, the first furnace was filled with secondary shale and metal. The electric arc was then lowered into the furnace and liquefaction began. Limestone ($CaCO_3$) was then added to the furnace as a flux. Ferroalloys (FeSi 90, FeMn 95, Al) were then loaded into the furnace. In order to reduce gaseous pores in the steel and improve the ductility of the alloy, steel 3 was introduced into the AL furnace [9 – 11].

Two different chemical compositions have been proposed for steel 3 brands for liquefaction, and the chemical composition of the alloy is given in Table 1. Of the proposed steel 3 brands, only the amount of aluminum has been changed.

Table 1

Recommended chemical composition for steel 3 brands

Brands	**C**	**Si**	**Mn**	**Al**	**Cr**	**Cu**	**As**	**P**	**S**
Steel 3 (1 – sample)	0,14 – 0,22	0,15 – 0,3	0,4 – 0,65	0,3 – 0,4	гача 0,3	гача 0,3	гача 0,08	0,022-0,024	0,007-0,009
Steel 3 (2 – sample)	0,14 – 0,22	0,15 – 0,3	0,4 – 0,65	0,4 – 0,6	гача 0,3	гача 0,3	гача 0,08	0,022-0,024	0,007-0,009

The steel alloy was then completely liquefied, the liquid metal was removed from the slag, and the liquid metal was mixed and the alloy was sampled from three locations to check the chemical composition of the alloy. The chemical composition of the alloy was tested on the equipment "SPEKTROLAB – 10M". The liquid alloy was then poured into a heated bucket and poured into a sand – clay mold [12 – 14].

After pouring the liquefied alloy into the sand-clay mold in an electric arc furnace, they were cleaned of sand using a vibrating device, and then the chemical composition, structure and hardness of the alloy were determined [15].

The chemical composition was determined using the equipment "SPEKTROLAB – 10M" and the obtained chemical composition is given in Table 2.

Table 2

Chemical composition from steel 3 brands

Brands	**C**	**Si**	**Mn**	**Al**	**Cr**	**Cu**	**As**	**P**	**S**
Steel 3 (1 – sample)	0,18	0,21	0,5	0,35	0,22	0,28	0,07	0,022-	0,009
Steel 3 (2 – sample)	0,20	0,25	0,56	0,45	0,23	0,25	0,06	0,024	0,007

The microstructure of the obtained alloy was determined using a scanning electron microscope (Carl Zeiss EVO – MA – 10) [16]. In Figures 1 – 4, the steel microstructures of steel 3 were magnified x500 and x1000 times. As a result, the structure of steel 3 (sample 1) is larger, forming a more perlite structure. The steel 3 (sample 2) structure was smaller and formed a more ferrite structure.

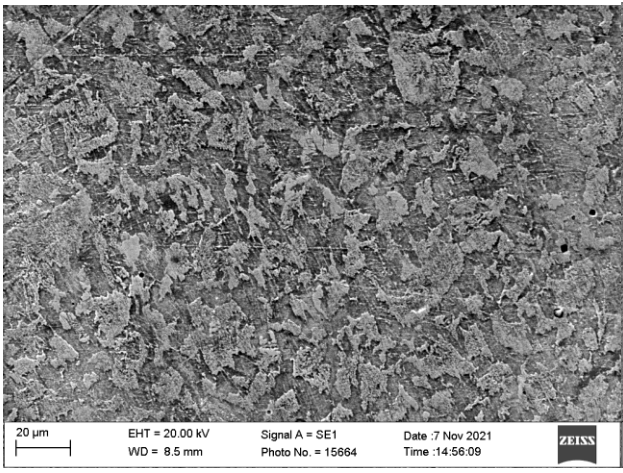

Figure 2. Steel 3 (sample 1) x500 times magnification using a scanning electron microscope

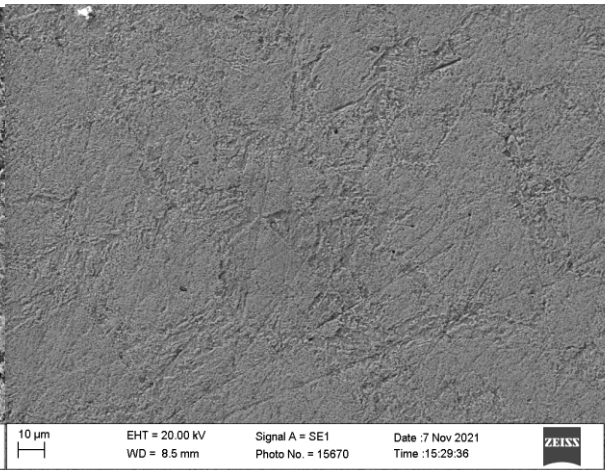

Figure 3. Steel 3 (sample 2) x500 times magnification using a scanning electron microscope

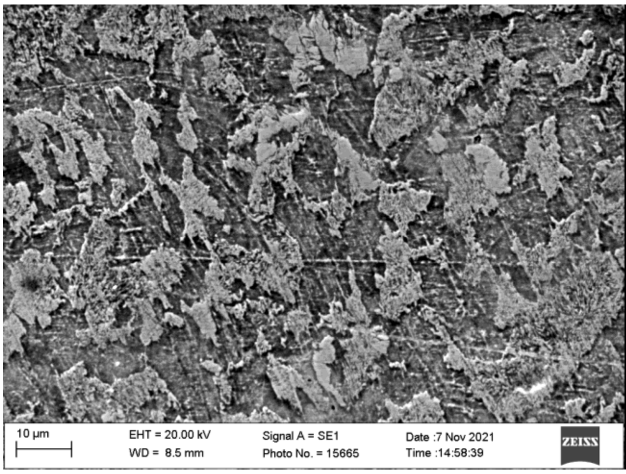

Figure 4. Steel 3 (sample 1) x1000 times magnification using a scanning electron microscope

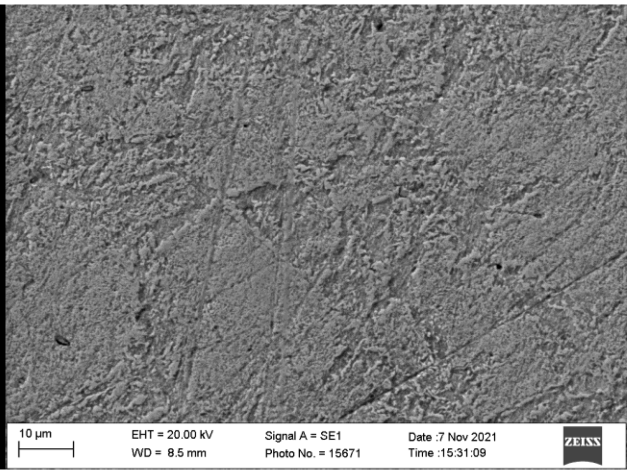

Figure 5. Steel 3 (sample 2) x1000 times magnified image using a scanning electron microscope

Based on the above experiments, a technology has been developed to increase the service life of cast products made of steel grade 3 alloys. Based on the analysis of the initial results, the following conclusions were made:

- there is an opportunity to increase the processing resource by 2 – 5 times and develop resource – saving technology in the production of castings;

- as a result, more perlite and ferrite structures were observed on the surface of the sample microfields in steel 3 (sample 1) and steel 3 (sample 2), and the hardness index was determined using a hardness measuring device TK – 2M to determine the hardness of the sample steel 3 (sample 1) NB 31 – 32, steel 3 (sample 2) NB 33 – 35 was obtained;

- two samples were cast by means of steel 3 and 70 – 75% of the gas pores were cleaned by adding aluminum to them..

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