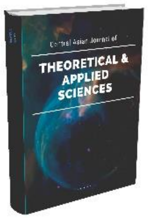

CENTRAL ASIAN JOURNAL OF THEORETICAL AND APPLIED SCIENCES

Volume: 03 Issue: 10 | Oct 2022 ISSN: 2660-5317
https://cajotas.centralasianstudies.org

Explore of the Technology of Liquefaction of High – Quality Ingots From Steel Alloys

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Received 18th Aug 2022, Accepted 19th Sep 2022, Online 30th Oct 2022

Abstract: *In this article, a mode of liquefaction of St3Gsp high – quality structural carbon steel alloy was developed for the liquefaction of high – quality cast products from steel alloys. In addition, the mode of liquefaction of steel alloy in an electric arc furnace was considered, in which improvement of the mechanical properties of high – quality steel alloy was achieved by introducing various fluxes and modifiers into the composition of the alloy during the liquefaction process.*

Keywords: *steel, cast iron, alloy, casting, electric arc, furnace, flux, modifier, oxidation, reduction, ferroalloy, lime, iron ore, bauxite, calcium fluorite.*

INTRODUCTION

It is noted that the main directions of the development of our country are the creation of radically new techniques, materials and advanced technological processes and their introduction into production, ensuring further acceleration of scientific and technical progress [1 – 2]. Improving the quality and assortment of metal for the specified purpose; increase production of new construction materials, coatings and products based on metal powders; development of the production of new polymer and composite materials with a set of required properties; wide use of low – waste, no – waste and low – operational technological processes; it is possible to use highly effective methods of processing, which provide a sharp improvement in the properties of metals and materials, and to implement a number of other measures [3 – 5].

Today, machine – building is the main consumer of metals produced in our country. In the machine-tool industry, in the automotive and aviation industry, in electronics and radio engineering, many machines and parts are cast from metals by casting method.

Metals used in technology are mainly divided into two groups – ferrous and non-ferrous metals. Ferrous metals include iron and its alloys (cast iron, steel, ferroalloys). The remaining metals and their alloys make up the group of non – ferrous metals [6 – 7].

Until now, iron and its alloys, considered the main machine – building material, are of particular importance among metals. Iron and its alloys make up 90% of metals produced worldwide. This is explained by the fact that ferrous metals have important physical and mechanical properties, as well as the fact that iron ores are widely distributed in nature, and the production of cast iron and steel is cheap and uncomplicated [8 – 12].

Along with ferrous metals, non-ferrous metals are also important in technology. This is explained by their unique important physical and chemical properties, which are not found in ferrous metals.

Copper, aluminum, magnesium, nickel, titanium, tungsten, as well as beryllium, germanium, silicon and other non-ferrous metals are widely used in aircraft construction, radio engineering, electronics and other industries [13 – 15].

In the years since our country gained independence, the production of ferrous metals and their alloys has developed rapidly. Such materials make it possible to increase the service life of nodes, save rare metals and alloys, reduce processing costs and labor costs [16 – 17].

MATERIAL AND METHODS

Today, electric arc furnaces are widely used for liquefaction of cast products from high – quality steel alloys. Therefore, an electric arc furnace consisting of a 10 kg base liner was selected in order to liquefy quality cast products from steel alloys in laboratory conditions. The diameter of the electrodes of the furnace is 40 mm, the length is 700 mm, and it is mainly designed for liquefaction in laboratory conditions.

First of all, the chemical composition of $St3G_{sp}$ quality carbon structural steel alloy was developed and solidified before liquefaction. The recommended chemical composition can be seen in Table 1.

Table 1. Recommended chemical composition of $St3G_{sp}$ brand

Brand	C	Si	Mn	P	S	Al	Cr	Ni	Cu
$St3G_{sp}$	0.14 – 0.2	0.15 – 0.3	0.8 – 1.1	0,03 – 0,04	0,035 – 0,05	03 – 05	~0,3	~0,3	~0,3

After the chemical composition of the steel alloy was developed, the furnace was put into operation.

Before starting the furnace, it was checked that the working part of the furnace is ready for work. If there were cracked or eroded areas, these areas were covered with magnesite powder. Then, the furnace was loaded with small solid materials, i.e., iron, iron ore, and limestone, and the electrodes were lowered. Depending on the size of the furnace, an electric current with a voltage of 100 – 360 volts and 1 – 4 kA was sent from the transformer through flexible copper cables, creating an electric arc between the electrodes and the metal part of the concrete. Si, Mn, P and partly C in the liquid alloy were mainly oxidized by the oxygen in the air, and when these oxides reacted with lime, a basic slag was released. A certain amount of iron ore was added to the furnace in order to speed up the oxidation process in the metal bath and obtain a quality ingot [18 – 20]. As the temperature of the liquid alloy increased, carbon began to oxidize violently. In this, the liquid metal is mixed well and the bamisoli boils. In this case, with the separation of H_2, N_2 and other gases in the furnace, metal and non – ferrous materials were cleaned and the composition became more even. A certain amount of bauxite or calcium fluorite (CaF_2) was added to the slag after it was removed from the furnace to completely transfer the harmful S in the metal to the slag. Additionally, limestone and modifiers were added to the furnace. As a modifier, Mo powder was placed in a steel cell and added to the liquid metal. The main purpose of adding Mo to the liquid metal in the steel cell was to allow the modifier to mix well with the liquid metal without burning. The purpose of adding a modifier to the liquid alloy is to increase the number of crystallization centers during solidification of the cast product, improve the mechanical properties of the cast product, and increase its strength. Then the iron was recovered from the FeS in the metal bath and the sulfur was transferred to the slag as CaS. Then, to reduce Fe from FeO in the furnace, for example, ferromanganese or other reducing agents and, if necessary, a certain amount of alloying elements were introduced. In the electric arc furnace, for the first time, oxygen in the air oxidized Fe to form FeO. Therefore, the recovery of Fe from FeO in this process is considered important and promotes the production of high – quality steel alloy.

In this process, the following reaction occurred:

$$Fe + \frac{1}{2} O_2 = FeO \quad (1)$$

$$FeO+Mn \quad (MnO)+Fe+Q$$

$$2\ FeO+Si \quad (SiO_2)+2Fe+Q$$

$$3\ FeO+2Al \quad (Al_2O_3)+3Fe+Q$$

As the reduction of Fe from FeO increased, the color of the slag became lighter. White slag contained 55 – 60% CaO, up to 0.5% FeO. The carbon in the superheated slag reacts with the lime to form calcium carbide:

$$3C + CaO\ CaC_2 + CO$$

In the presence of CaO in the composition, favorable conditions were created for the reduction of Fe and Mn from FeO and MnO in the metal:

$$[3\ FeO] + (CaC_2)\ 3Fe + CaO + 2CO;$$

$$[3Mn] + (CaC_2)\ 3Mn + CaO + 2CO$$

This process took 0.5 – 1.0 hours. The slag solidified as a white powder upon cooling. During the process, a sample was taken and the chemical composition was checked.

Due to the occurrence of the above – mentioned reactions, quality steel castings were obtained. At the end of the process, metal samples were taken from the bath from time to time, and their composition and properties were monitored in the express laboratory. When the steel reached the desired composition, the casting chute was opened and the metal was poured into the ladle. After normalizing the amount of carbon and other elements in the alloy according to GOST requirements, the liquid alloy was poured into a sand – clay mold and the expected results were achieved.

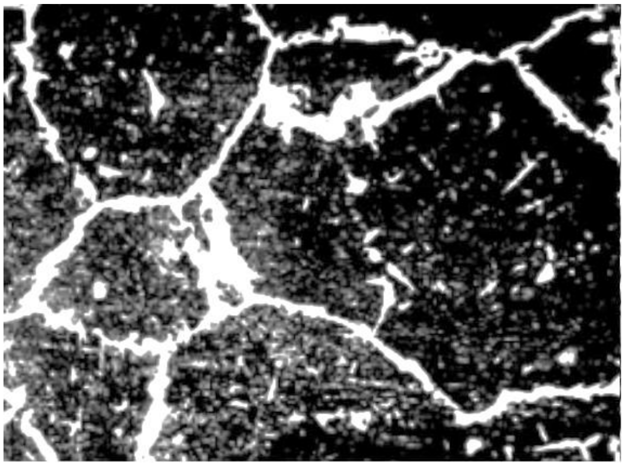
RESULT

High – quality steel alloys were liquefied in an electric arc furnace, poured into a sand-clay mold and cooled, then the surface of the cast products was cleaned of sand stuck to them by burning. Then the samples were processed step by step using 500, 1000 and 2000 micron SiC abrasive papers. The chemical composition of the samples was determined by SEM Zeiss EVO MA 10 scanning electron microscope and is listed in Table 2.

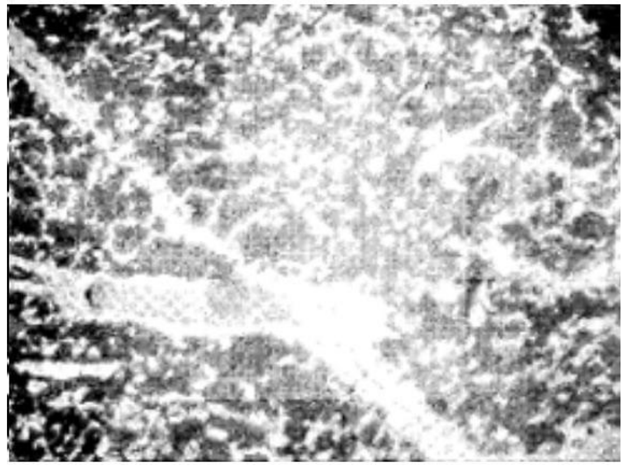
Table 2. Chemical composition of $St3G_{sp}$ liquefied brand

Brand	C	Si	Mn	P	S	Al	Cr	Ni	Cu
$St3G_{sp}$	0,2	0,3	1,0	0,04	0,040	0,4	~0,3	~0,3	~0,3

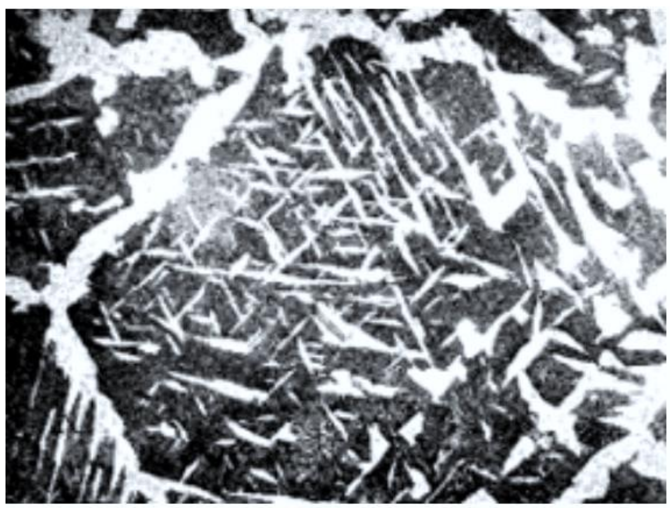
Samples were metallographically and elementally studied at the "Center of Advanced Technologies under the Ministry of Innovative Development" at a magnification of x500 to 2000 times on a SEM Zeiss EVO MA 10 scanning electron microscope, and the obtained results are shown in Fig. 1 – a, b, c.



1 – a – fig. Image of St3G$_{sp}$ alloy magnified x500



1 – b – fig. Image of St3G$_{sp}$ alloy magnified x1000



1 – v – fig. Image of St3G$_{sp}$ alloy magnified x2000

1 –a, b, c – pictures SEM Zeiss EVO MA 10 scanning electron microscope showing the microstructure of St3G$_{sp}$ steel

1 – a, b, v – figures, it can be seen that when a 10 µm area is magnified x500 in the scanning electron microscope, a ferrite – pearlite and less austenite structure was observed. In Fig. 1 – b, a large – grained, pearlite – ferrite and austenite structure was observed when a 10µm area was magnified x1000 in a scanning electron microscope. In Fig. 1 – v – a ferrite – pearlite and less primary cementite structure was observed when a 10 µm area was viewed with a magnification of x2000 in a scanning electron microscope.

CONCLUSION

In conclusion, the chemical composition of St3G$_{sp}$ grade carbon structural steel alloy was developed and solidified before liquefaction. Earthquake resistance, corrosion resistance, and service life of cast parts made of St3G$_{sp}$ steels were achieved by adding fluxes and modifiers to the liquid alloy to reduce harmful elements in the alloy. Then, in order to reduce Fe from FeO in the furnace, ferromanganese or other reducers, and a certain amount of alloying elements were also introduced.

After pouring the resulting liquid alloy into a sand-clay mold, it was viewed with a magnification of x500 to x2000 in a scanning electron microscope in order to see its microstructure. As a result, large grain, pearlite-ferrite and austenite structures were observed.

REFERENCES

1. Bekmirzaev, S., Saidmakhamadov, N., & Ubaydullaev, M. (2016). “Obtaining sand – clay casting”. Theory and practice of modern. Russia, (4 (12)), 112.
2. Саидмахамадов Н. и др. Технология предотвраשения пор в отливах //Экономика и социум. – 2019. – №. 4. – С. 661-672.
3. Саидмахамадов Н. и др. Общая технология производства порошково констукционных материалов //Экономика и социум. – 2019. – №. 4. – С. 673-680.
4. Саидмахамадов Н., Хайдаров У., Эгамбердиев Б. Улучшение подготовки технологий методом специального сливания //Экономика и социум. – 2019. – №. 4. – С. 651-660.
5. Turakhodjaev, N., Saidmakhamadov, N., Turakhujaeva, S., Akramov, M., Turakhujaeva, A., & Turakhodjaeva, F. (2020). Effect of metal crystallation period on product quality. Theoretical & Applied Science, (11), 23-31.
6. Turakhodjaev, N. D., Saidmakhamadov, N. M., Zokirov, R. S., Odilov, F. U., & Tashkhodjaeva, K. U. (2020). Analysis of defects in white cast iron. Theoretical & Applied Science, (6), 675-682.
7. Shirinkhon, T., Azizakhon, T., & Nosir, S. (2020). Methods For Reducing Metal Oxidation When Melting Aluminum Alloys. International Journal of Innovations in Engineering Research and Technology, 7(10), 77-82.
8. Djahongirovich, T. N., & Muysinaliyevich, S. N. (2020). Important features of casting systems when casting alloy cast irons in sand-clay molds. ACADEMICIA: An International Multidisciplinary Research Journal, 10(5), 1573-1580.
9. Nodir, T., Nosir, S., Shirinkhon, T., Erkin, K., Azizakhon, T., & Mukhammadali, A. (2021). Development Of Technology To Increase Resistance Of High Chromium Cast Iron. The American Journal of Engineering and Technology, 3(03), 85-92.
10. Nodir T. et al. Development of 280X29Nl Alloy Liquefaction Technology to Increase the Hardness and Corrosion Resistance of Cast Products //International Journal of Mechatronics and Applied Mechanics. – 2021. – Т. 154. – С. 2021.
11. Turakhodjaev N. et al. Quality improvement of the steel melting technology in an electric arc furnace //ACADEMICIA: An International Multidisciplinary Research Journal. – 2021. – Т. 11. – №. 7. – С. 48-54.
12. Saidmakhamadov N., Abdullaev K., Khasanov J. Теория и практика современной науки //теория и практика современной науки Учредители: ООО" Институт управления и социально-экономического развития". – №. 2. – С. 3-8.
13. Nosir S. et al. Development of High Chromium White Cast Iron Liquefaction Technology //Eurasian Journal of Engineering and Technology. – 2022. – Т. 4. – С. 123-127.
14. Nosir S. et al. Development of technology for obtaining quality castings from steel alloys //Eurasian Journal of Engineering and Technology. – 2022. – Т. 5. – С. 135-138.

15. Nosir S. et al. Technology for Obtaining High Quality Castings from Resistance White Cast Iron //Eurasian Journal of Engineering and Technology. – 2022. – T. 5. – C. 139-148.

16. Nosir S. et al. Technology to Increase the Hardness and Resistance of High–Chromium White Cast Iron //European Multidisciplinary Journal of Modern Science. – 2022. – T. 6. – C. 665 – 670.

17. Nosir S. et al. Development of Technology for Production of Wear – Resistant Cast Products //Middle European Scientific Bulletin. – 2022. – T. 25. 516 – 522.

18. Nosir S. et al. Improvement of the Technology of Obtaining High – Chromium Wear – Resistant White Cast Iron //Spanish Journal of Innovation and Integrity. – 2022. T. 07. 498 – 504.

19. Nosir S. et al. Study of the Effect of Copper Addition on Secondary Carbides with High Chromium Wear – Resistant White Cast Iron //International Journal of Innovative Analyses and Emerging Technology. – 2022. T. 2. 37 – 43.

20. Valida B. et al. Development of Technology of Liquefaction of Steel Alloys in Electric Furnaces //Spanish Journal of Innovation and Integrity. – 2022. T. 8. 65 – 69.

