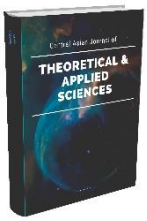

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Extending the Service Life of The Electric ARC Furnace Lining

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Abstract: *MgO – based refractory coatings for electric arc furnaces are widely used all over the world. In order to increase the service life of refractory materials, it is necessary to constantly correct the parameters of knowing the mechanisms of the causes of corrosion. The aging process can change significantly with changes in technology. To increase the fire resistance of the lining with the help of slag, it is possible to use double – saturated slag with CaO and MgO, MgO briquettes or refractory waste, dolomite lime. Slag foaming is very effective against corrosion. An important aspect is the regulation of the FeO content of the slag.*

This research is aimed at analyzing the effect of slag and metal composition in electric arc furnace, and factory data was statistically evaluated according to the degree of corrosion of refractory lining. The degree of corrosion of the lining in an electric arc furnace under the influence of special slag (basic CaO, MgO, FeO, Al2O3, SiO2) and metal components (C, Mn) were analyzed at the factory. In these factories, together with the corrosion data, the values of the slag composition were represented by a diagram in relation to the oxidation potential between basic, acidic and oxides.

Keywords: *liquefaction, steel, magnesite, brick, slag, oxygen, carbon, furnace, liquid.*

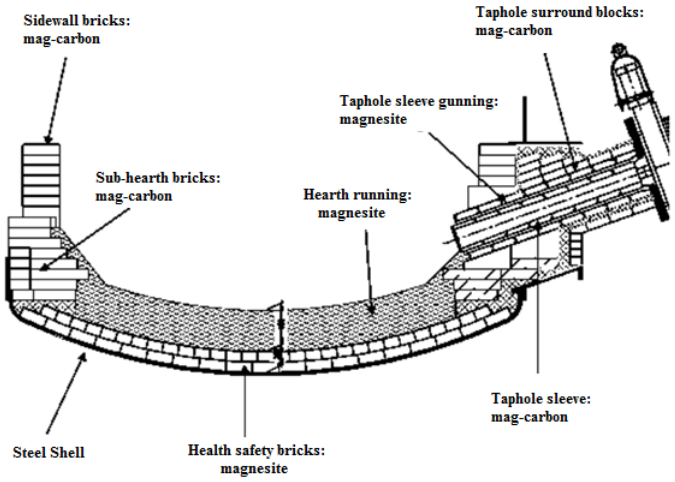
INTRODUCTION

All types of electric arc furnaces are designed for liquefaction of steel and alloy at high temperature, and their refractory lining is covered with basic or acidic materials. The electrodes of ordinary electric arc furnaces are cylindrical and the lining is basic. In recent years, electric arc furnaces have been widely used in steel production. Its inner part is lined with magnesite or chromamagnesite bricks as refractory

materials. Replacing an electric arc furnace repair liner from time to time means a valuable financial investment, as well as hours of downtime and lost production. It is known that electric arc furnace has a high level of corrosion resistance of its lining compared to other steel melting furnaces [1 – 4]. It is necessary to think about extending the service life of the lining of the electric arc furnace, so that the maximum economic efficiency is achieved. This goal, along with the elimination of negative factors, constant exposure to high temperature (1500 – 1700°C), influence on the mechanical properties of metal at low and high temperatures, damage to the lining as a result of chemical interaction with slag and metal (mainly FeO, SiO_2 content), thermal shocks, erosion, direct impact of an electric arc, use of gas, oxygen, etc. [5 – 8]. The simplicity of the structure of these furnaces has the advantages of adjusting the temperature of the furnace by changing the current parameter, working in different environments, and obtaining high – quality special steels from inexpensive solid materials [9].

MATERIALS AND METHODS

Today, liquefaction of high – quality structural steels in an electric arc furnace is widely used. Therefore, a 5 – ton electric arc furnace was selected in laboratory conditions for obtaining high-quality structural steel alloy. The lining of this has been selected from basic materials. Chromamagnesite magnesite bricks were chosen as the material [10 – 14]. The purpose of choosing a basic lining is to remove the slag from the steel alloy by adding flux, i.e. $CaCO_3$, to the slag and make it free of harmful elements. The consumption of refractory materials of the electric arc furnace should be the same, but due to various factors, it may be observed more or less in different parts of the furnace. Due to this, the lining layer of the electric arc furnace has layers of different materials of different thickness in different places, as well as the slag line, side walls, and many furnaces [15 – 17]. The most important part of the furnace, i.e. the slag line with MgO – C lining, materials with various carbon and antioxidant additives were used. Advantages: high strength, fire resistance, low porosity, good mechanical properties, abrasive wear and low wetting by slag. Water – cooled panels or fins were usually mounted on top of the hull. In modern s, it is located in the area of the side walls. It is necessary to control the temperature regime of the refractory lining (check its temperature, measure the temperature of the coolant, etc.) to prevent emergency situations. The most important thing is to distinguish negative factors [18 – 20].



1 – picture. The side walls of the fire-resistant lining of the electric arc furnace

The effects of slag components (CaO, MgO, FeO, SiO_2, Al_2O_3) and metal (C, Mn) phases on the service life of the liner were graphically analyzed during the experiment in an electric arc furnace. Based on the statistical data of the plant, slag, metal content, corrosion rate were selected. The ascending order of the eating process is placed. The threshold between low and high decay was set at 0.1 cm for each melt, so data were divided into 2 groups of 12 light – labeled and 12 dark – labeled plants.

In each case, average values of specific oxides of slag (metallic elements) were used. The slag and metal samples are taken by the operator using a long steel ladle, and temperatures are sampled from the slag hatch zone at approximately the same time (7 – 12 minutes per side panel).

At a temperature of 1550 – 1560°C, the amount of carbon in steel is 0.06 – 0.08%. Even with small differences in sampling depth, location, or timing, non – automatic (manual) sampling is likely to cause differences between sample data and actual thermal exposure data [21 – 22]. An oxygen fume was used prior to sampling because it facilitated sampling while providing information on slag and metal content. The consumption rate of the refractory lining area was also considered important for other enterprises. Therefore, in the slag zone, the use of tube due to oxygen and the use of an oxygen fuel burner were used. Another important feature is that MgO saturation in the slag was not reached in all the analyzed samples, indicating that the plants contain approximately ~ 6 – 8 % MgO. It was done by looking at the corrosion rate (MgO – C bricks with 15% carbon content) and calculating the difference between new and used firebrick [23 – 24].

When heated in an electric arc furnace, a gradual increase in oxygen in the metal and a decrease in other elements (with their affinity for oxygen) occur in the particles. Corrosion can be prevented if Si, Al, Ti, P elements are included in the solid materials for the electric arc furnace. But the abundance of these elements means a high price. Then (SiO_2 + Al_2O_3 +TiO_2 + P_2O_5) these reactions separate and increase the service life of the liner. Carbon and manganese play an important role in the process of eating. If their metal content falls below a certain critical value, then as a result, excessive oxidation of the metal and a sharp increase in the FeO content in the slag occur. Metal dissolves carbon with unsaturated carbon and with refractory material MgO – C is formed. Due to the different connection between metal and slag, the process became intense in the slag holding zone. The lining of the electric arc furnace is made of magnesite and carbon bricks, due to the effect of the chemical reaction of metal and slag (reaction of slag oxide, metal with oxygen) and the mechanical damage of the surface of the lining, the viscosity of the slag, the angle of wetting, and the interphase tension between the slag and the metal. The dissolution of MgO in the slag is a step to prevent the corrosion of the liner. One of the advantages of the foaming process is that it not only reduces the consumption of refractory material, but also increases the durability of the lining. After the slag foaming operation was carried out in the electric arc furnace, the life of the sidewalls was increased by three times. When slag foams in an electric arc furnace, there is a significant change in the corrosion mechanism, because the presence of CO gas bubbles in the refractory material slows down the corrosion. Also, damage to the lining is reduced.

2 – picture. Electric arc furnace lining process

After liquidizing the steel alloy, the amount of carbon is 0.25% more, because it prevents the oxidation process. Then samples of the finished metal are taken and sent to the laboratory.

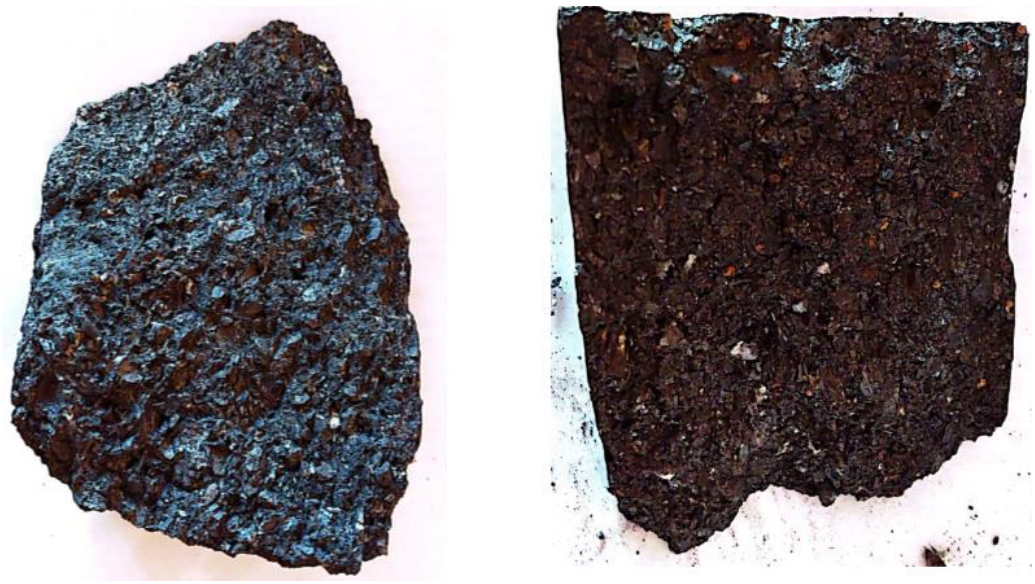
Also, after the expected result was achieved, the furnace was bent forward and poured into the prepared cavity. When the slag appeared, it was quickly poured into the slag bath through the loading door of the furnace, bringing it to a reverse slope. Depending on the brand of steel alloy, its liquefaction temperature is different, and the average liquefaction time is 2 – 3 hours.

RESULTS

The inner layer (lining) of the electric arc furnace for liquefaction of high-quality steel alloys was developed based on the above technology. The liquefaction process was started at low power to prevent overheating of the side walls of the furnace. In order to protect the inner wall of the furnace and to speed up the liquefaction process, a liquid metal residue was left at the bottom of the furnace. After liquidizing the steel alloy, the carbon content increased by 0.25%. As a result, the oxidation process was prevented. By this time, the main slag was formed, i.e. 55% manganese, 15% silicon and 15 – 20% iron oxide. Carbon monoxide from the slaked lime-coke mixture reacting with the iron oxide in the slag caused the slag to foam. This foam protected the sidewalls and provided a high strength parameter. When metal is liquefied in an electric arc furnace (C, Mn), important elements increase the resistance to corrosion of refractory materials.

Chemical composition of shale obtained from basic furnace lining

Chemical composition Chemical composition								
CaO	SiO_2	MnO	FeO	Cr_2O_3	TiO_2	CaF_2	CaS	MnS
41 – 42	34 – 36	17 – 18	0,5 – 0,7	0,8 – 1,2	0,9 – 1,1	0,2 – 0,4	0,2 – 0,4	0,1 – 0,2



3 – picture. Samples of chromomanganese bricks used in electric arc furnace lining

CONSLUCION

In conclusion, it can be said that as a result of this study, the effect of slag and metal on increasing the consumption of refractory materials in electric arc furnaces in factories is devoted to analysis. The slag – metal – lining interaction, the most critical corrosion zone of lining based on magnesium oxide, was studied. Slag foaming was performed in an electric arc furnace, and the life of the sidewalls was increased by 1.4 – 1.5 times. When slag foams in an electric arc furnace, significant changes have occurred in the

corrosion mechanism, as CO gas bubbles are slowed down due to the presence of refractory materials. As a result, it was possible to increase the service life of the furnace lining from 400 to 600 times. By reducing the heat transfer level of the furnace lining, it was possible to increase the liquefaction process up to 5 – 6 percent. This served to strip the material of the lining of the furnace.

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, he focused on developing the technology of loading flux elements into the furnace with liquid metal content.

REFERENCES

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. Nosir S. et al. Technology for Obtaining High Quality Castings from Resistance White Cast Iron //Eurasian Journal of Engineering and Technology. – 2022. – Т. 5. – С. 139-148.
11. Nosir S. et al. Technology to Increase the Hardness and Resistance of High–Chromium White Cast Iron //European Multidisciplinary Journal of Modern Science. – 2022. – Т. 6. – С. 665 – 670.
12. Nosir S. et al. Development of Technology for Production of Wear – Resistant Cast Products //Middle European Scientific Bulletin. – 2022. – Т. 25. 516 – 522.
13. Nosir S. et al. Improvement of the Technology of Obtaining High – Chromium Wear – Resistant White Cast Iron //Spanish Journal of Innovation and Integrity. – 2022. Т. 07. 498 – 504.

14. 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.
15. 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.
16. Nosir S. et al. DEVELOPMENT OF QUALITY STEEL ALLOY LIQUIDATION TECHNOLOGY //American Journal of Interdisciplinary Research and Development. – 2022. – T. 7. – C. 74 – 83.
17. Valida B. et al. Explore of the Technology of Liquefaction of High–Quality Ingots from Steel Alloys //Czech Journal of Multidisciplinary Innovations. – 2022. – T. 8. – C. 1 – 7.
18. Nosir S. et al. Improvement of Technology of Liquefaction of Gray Cast Iron Alloy //Global Scientific Review. – 2022. – T. 6. – C. 19 – 28.
19. Nosir S., Bokhodir K. Development of Liquefaction Technology 280X29NL to Increase the Strength and Brittleness of Castings //International Conference on Reliable Systems Engineering. – Springer, Cham, 2023. – C. 105 – 115.
20. Valida B. et al. Technology of Increasing the Service Life of Based Lining Based on Recycling //Central Asian Journal of Theoretical and Applied Science. – 2022. – T. 3. – №. 11. – C. 43 – 48.
21. Nosir S. et al. CAST IRON LIQUEFACTION TECHNOLOGY //EDITORIAL BOARD. – 2022. – C. 812.
22. Kamol D. A. et al. Development new brands of resistance white cast Irons. – 2022.
23. Valida B. et al. Improvement of the Technology of Liquidation of A500 Brand Low Carbon Steel Alloy in the Induction Furnace //Central Asian Journal of Theoretical and Applied Science. – 2022. – T. 3. – №. 12. – C. 1 – 6.
24. Nosir S. et al. IMPROVING THE TECHNOLOGY OF LIQUIDATION OF WEAR–RESISTANT WHITE CAST IRON //Open Access Repository. – 2022. – T. 9. – №. 8. – C. 10 – 16.

