AJEMA GLOBAL RESEARCH NETWORK

**AMERICAN Journal of Engineering, Mechanics and Architecture**
*Volume 2, Issue 1, 2024 ISSN (E): 2993-2637*

# Investigation of the Effect of Liquid Metal on the Furnace Lining During the Liquidation of Steel Alloys in an Electric ARC Furnace

**Bekchanova Valida, Gaybullaev Murodilla**
*Namangan engineering – construction institute*

**Saidmakhamadov Nosir, Tadjiev Nuritdin, Rizaeva Nigora**
*Tashkent state technical university*

**Abstract:** In this article, the technology of destruction and restoration of furnace lining during steel liquefaction in an electric arc furnace has been developed, thereby increasing the service life of furnace lining. As a result, resource and energy savings were achieved by increasing the technological process. Also, based on the regeneration of the furnace lining in the manufacturing plant, the life of the lining has been improved, and this improved technology has been further improved by researchers, and the life of the furnace lining has been further improved.

**Keywords:** lining, wear – resistance, corrosion, magnesite, magnesite powder, solid materials, induction furnace, electric arc furnace.

## INTRODUCTION

Today, as a result of the development of science and technology, the machine – building and foundry industries are rapidly developing. The development of foundry and mechanical engineering requires a lot of research on the production of high – strength, easy – to – use, cheap, accurate materials and increasing their durability [1]. There are conflicting issues in the selection of materials for machine parts and in the technological process of their processing. For example, the details used in the creation of machines and mechanisms that can ensure long – term risk – free operation should be cheap, compact, neat, and made of high-quality materials. It goes without saying that material handling causes a dramatic increase in cost [2].

Therefore, it is important to choose a liquefaction furnace in order to obtain high-quality bulk products by liquefaction of solid materials.

Currently, one of the modern electric furnaces is the electric arc furnace, and until the 1950s, the industrial technology of electric arc steelmaking was widely used only for the production of low – carbon, high – quality or alloy steels. In the 1960s, the emergence of the ultra – high – power arc furnace and the rapid development of quality steel production technology [3,4]. After the middle of the 80s, pure steel production and the introduction of the products of steelmaking enterprises in the electric furnace to the period of great change, in particular, a series of scientific research on improving the quality of the alloy in the production of steel from large – scale social steel scraps, reducing energy consumption by shortening the period of liquefaction works are being carried out [5,6].

## MATERIALS AND METHODS

Currently, electric arc and induction furnaces are widely used for liquidizing cast parts made of high – quality steel alloys. One of the main advantages of the electric arc furnace is that it is characterized by a large possibility of obtaining quality castings [7].

**1 – picture. The process of loading solids into an electric arc furnace**

In the upper part of the furnace there are graphite electrodes, the dimensions of the electrodes are 200 – 600 mm depending on the size of the furnace, and the length reaches 3 meters [8]. Furnaces are divided into acidic and basic processes. Basic furnaces are common, and the walls are made of magnesite bricks, and the bottom is covered with magnesite powder.

The dimensions of the temperature field through the lining of the furnace made of fire – resistant materials made it possible to determine the following, that is, to determine the liquefaction and fire resistance. Two boundary conditions were chosen to solve this mathematical problem stationary. The temperature and heat exchange in the shell is one of the simplest cases, where the conditions between the solution and the refractory material are represented by convective heat exchange. The first can be measured, the second can be estimated. With this information, the thermal conductivity of the materials and using the FEM approach, from the heat transfer solution to the refractory lining, the temperature at each node is known MCE grids. The specific temperature is the liquid limit, and the specific temperature of refractory materials is called the "node"[9 – 13].

However, corrosion changes the geometry of the system so that the area in front of T is no longer functional as the furnace refractory material leaves the new temperature distribution consolidation. A new geometric equation was calculated to liquefy and corrode each of the nodes at the fire resistance limit. This equation, the characterization of the wear process control mechanism is formally considered empirical, and the equation based on the phenomenological analysis of the wear phenomena was calculated as the control mechanism of this very complex process [14]. The temperature dependence of the parameters is used for a special corrosion equation, taking into account the difference between nodes and neighboring nodes. With this formulation, the corrosion rate is expressed at a node, in units of length per unit time, as a function of Ti and the temperature difference ΔTi between this node and its neighbor:

$$v(\text{corrosion})_i = \int(Ti;\ \Delta Ti);\ \left[\frac{L}{t}\right] \quad (1)$$

The decay is determined by assuming that the temperature at each node remains constant throughout the time interval Δt:

$(\text{wear})_I = v\ (\text{corrosion})_i\ \Delta t$ ; [L] (2)

As the system geometry was changed, the liner decay rate was obtained through an iterative process to solve the new temperature field. If each iterative cycle occurs after a certain T [15], the process of calculating a node in n – iterations is as follows:

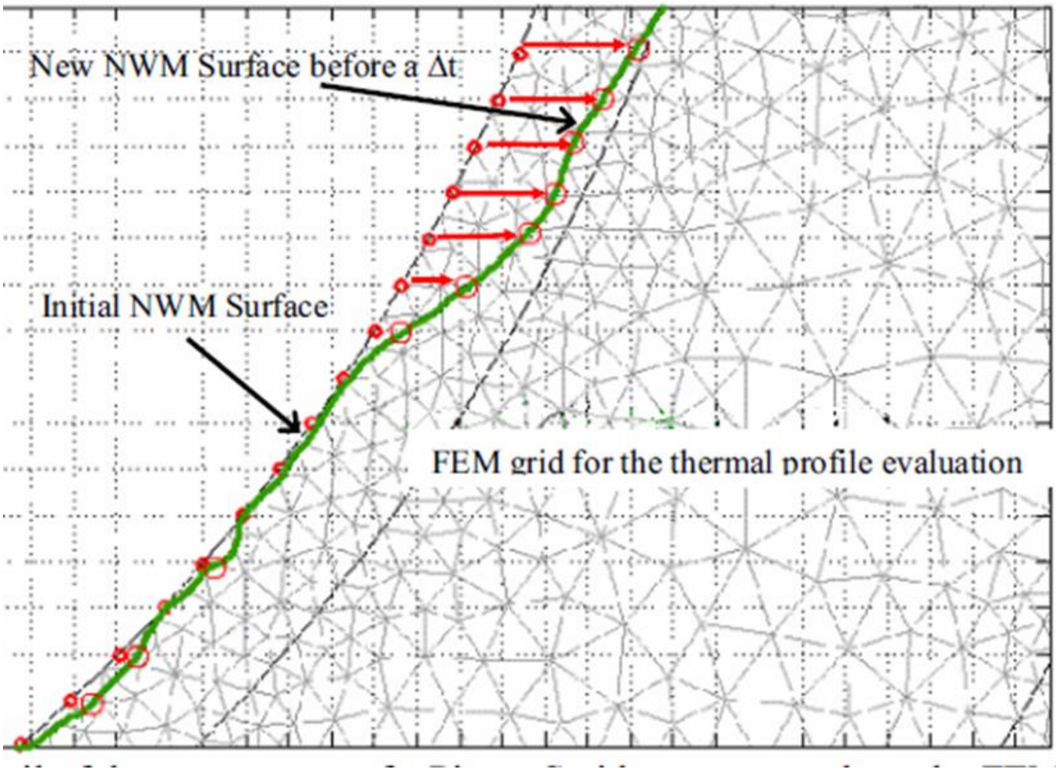
Temperature at node i according to FEM: $T_{i,n-1}$

Corrosion rate at node i: $v(\text{corrosion})_i = f(T_{i,n-1};\Delta T_{i,n-1})$

At decay time T iteration at node n: $(\text{Wear})_i = v(\text{corrosion})_i\ \Delta t$

Determining the new geometry and calculating the new temperature field T determined the melting of the liner and thus the temperature of the melt/melting interface. It should be noted that the attack occurred and the Melts/Refractory interface detected the following [16].

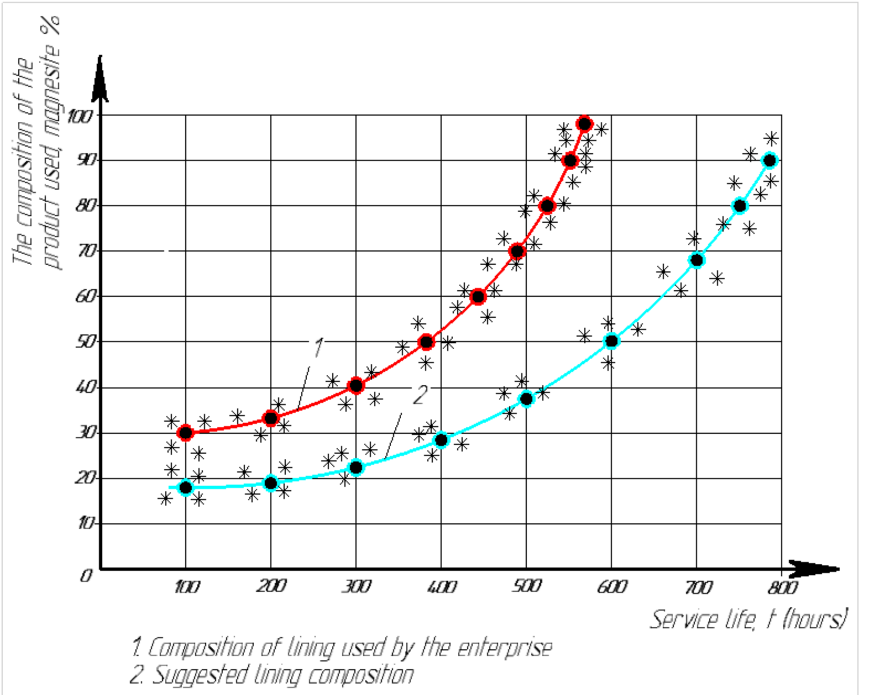
S surface is built into nodes using decay – corrosion equations. This two-dimensional grid is the FEM grid used to calculate the temperature and the decay area is determined independent of the number of digital pixels.




**2 – picture. The NWM and feM gratings were used for the furmen zone of the Pierce-Smith converter, which indicated the geometric difference between the surfaces. The red dots represent the nodes of the NWM surface [17]**

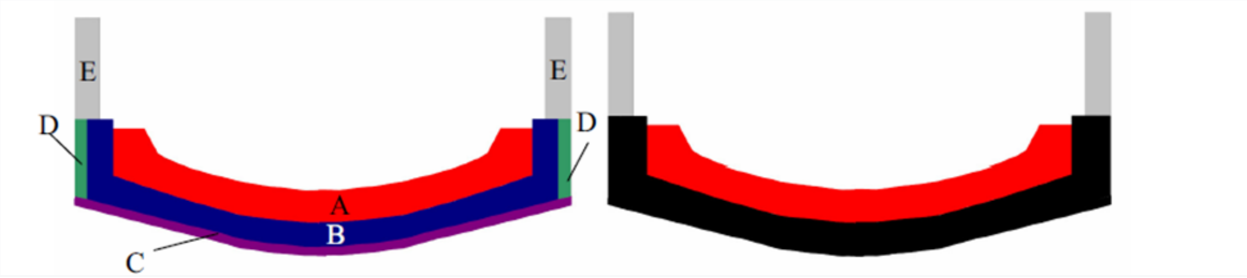
## RESULTS

In the results, it can be seen that for the initial conditions, the results obtained from the continuous wear – resistant measuring instrument shown in Fig. 2 are presented. The average life of the liner was 0.52 cm×h – 1. When the liquid metal was removed only 65 times, the corrosion rate of the furnace interior was observed [18 – 24]. During this initial period, the lining corrosion control mechanism determined the level of corrosion. The FEM-calculated temperature field is formed using the outer wall temperature as boundary conditions. The value of 18 W \ u003d $m^2$ \ u003d k – 1 for ferroalloy and convective heat transfer coefficient was adjusted by experimental decay measurements of flame resistant lining results. The inner layer (lining) of the electric arc furnace for liquefaction of high – quality steel alloys was developed on the basis of the above – mentioned technology [25].




**1 – graph. Graph of increasing the service life of the liner using magnesite powder as a refractory material**

As can be seen in graph 1, magnesite brick was used as refractory material, and its service life was increased by repairing its damaged areas using magnesite powder and slag [26]. As shown in graph 1, the lining composition used by the enterprise and proposed by the researchers was compared based on several experiments. The change in the service life of the lining was studied by spraying the refractory material recycled by the enterprise from 30 to 100% on the damaged surface of the lining after removing the liquid metal from the furnace [27 – 33]. If 30% recycled refractory material is used, the lifetime is 100 hours, 35% is 200 hours, 40% is 300 hours, 50% is 380 hours, 60% is 450 hours, 70% is 480 hours, 80% is 520 hours, 90 550 hours at % and 580 hours at 100%.




**3 – picture. a) The previous condition of the lining** **b) Liner view of the result**

To expand the number of connections, many simulations changed the design of the lining using other materials with higher thermal conductivity λ and changed the external cooling conditions [34, 35].

Before analysis, the reason for the best design with a high level of heat loss is obvious. An isotherm corresponding to the hardening of a high – quality lining ferro marginal alloy, recommended for refractory materials in zones B, C and D, was transferred [36 – 39].

## CONCLUSION

In order to increase the service life of electric arc furnace lining, the corrosion resistance of refractory materials was increased when slag in liquid metal was saturated with CaO and MgO.

The service life of the electric arc furnace liner has been increased.

Using the equations, the characteristics of the wear process, the control mechanism, were formally calculated empirically, and a very complex process control mechanism was created to determine the wear phenomena.

The study of the effect of the temperature of the liquefied steel alloy on the corrosion of the furnace lining and the increase of the service life of the furnace lining was achieved.

## References


1. Bekchanova Valida, Chorshanbiyeva Lobar, Gulyamov Saidsulton, Urinboyev Umidjon, Eshimov Doston. High – quality steel liquefaction technology from fine slag materials // Eurasian Journal of Engineering and Technology www.geniusjournals.org Volume 18| May 2023 ISSN: 2795 – 7640[ 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.
2. Bekchanova Valida, Turakhodjaev Nodir, Chorshanbiyeva Lobar, Gulyamov Saidsulton, Urinboyev Umidjon, Eshimov Doston. TECHNOLOGY OF INCREASING THE SERVICE PERIOD OF LIQUIDATION FURNACES BASED LIQUID SHIBBA //Eurasian Journal of Engineering and Technology. ISSN: 2795-7640. www.geniusjournals.org. – 2023 - .C.85 – 89.
3. Turakhodjaev N.D., Bekjanova V.B., Turaev A.N., Abdullaev F. K., Asatov S.N.. Improvement Of Steel Liquidation Technology in Electric Arc Furnace// Eurasian Journal of Engineering and Technology. Volume 1| November, 2021 ISSN: 2795 – 7640. 8 – 11
4. Valida B. et al. Development of Technology of Liquefaction of Steel Alloys in Electric Furnaces //Spanish Journal of Innovation and Integrity. – 2022. Т. 8. 65 – 69.
5. Bekmirzaev, S., Saidmakhamadov, N., & Ubaydullaev, M. (2016). Obtaining sand-clay casting". Theory and practice of modern. Russia, (4 (12)), 112.
6. Саидмахамадов Н. и др. Технология предотвращения пор в отливах //Экономика и социум. – 2019. – №. 4. – С. 661-672.
7. Саидмахамадов Н. и др. Общая технология производства порошково констукционных материалов //Экономика и социум. – 2019. – №. 4. – С. 673-680.
8. Саидмахамадов Н., Хайдаров У., Эгамбердиев Б. Улучшение подготовки технологий методом специального сливания //Экономика и социум. – 2019. – №. 4. – С. 651-660.
9. 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.
10. 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.
11. 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.

12. 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.
13. 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.
14. 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.
15. 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.
16. 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.
17. 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.
18. 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.
19. 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.
20. 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.
21. Nosir S. et al. Development of Technology for Production of Wear – Resistant Cast Products //Middle European Scientific Bulletin. – 2022. – Т. 25. 516 – 522.
22. 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.
23. 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. Т. 2. 37 – 43.
24. Valida B. et al. Development of Technology of Liquefaction of Steel Alloys in Electric Furnaces //Spanish Journal of Innovation and Integrity. – 2022. Т. 8. 65 – 69.
25. Nosir S. et al. DEVELOPMENT OF QUALITY STEEL ALLOY LIQUIDATION TECHNOLOGY //American Journal of Interdisciplinary Research and Development. – 2022. – Т. 7. – С. 74-83.
26. Valida B. et al. Explore of the Technology of Liquefaction of High–Quality Ingots from Steel Alloys //Czech Journal of Multidisciplinary Innovations. – 2022. – Т. 8. – С. 1-7.
27. Nosir S. et al. Improvement of Technology of Liquefaction of Gray Cast Iron Alloy //Global Scientific Review. – 2022. – Т. 6. – С. 19-28.
28. 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. – С. 105-115.

29. 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.
30. Nosir S. et al. CAST IRON LIQUEFACTION TECHNOLOGY //EDITORIAL BOARD. – 2022. – C. 812.
31. Nosir S. et al. Development new brands of resistance white cast Irons //European Journal of Research Development and Sustainability. – 2022. – T. 3. - №. 1. – C. 116-120.
32. Valida B. et al. Improvement of the Technology of Liquefaction of A500 Low–Carbon Steel Alloy in an Electric ARC Furnace //Central Asian Journal of Theoretical and Applied Science. – 2022. – T. 3. – №. 12. – C. 159-164.
33. Valida B. et al. Extending the Service Life of The Electric ARC Furnace Lining //Central Asian Journal of Theoretical and Applied Science. – 2022. – T. 3. – №. 12. – C. 153-158.
34. 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.
35. Saidmakhamadov N. M. et al. DEVELOPMENT OF TECHNOLOGY FOR LIQUEFACTION OF STEEL ALLOYS: DEVELOPMENT OF TECHNOLOGY FOR LIQUEFACTION OF STEEL ALLOYS. – 2023.
36. Saidmakhamadov N. et al. IMPROVEMENT OF THE TECHNOLOGY OF CASTING SHAFT COMPONENTS FROM 35XGCL BRAND STEEL IN AN ELECTRIC ARC FURNACE //American Journal of Interdisciplinary Research and Development. – 2023. – T. 15. – C. 59-66.
37. Saidmakhamadov N., Abdullaev K., Khasanov J. DEVELOPMENT OF 280X29NL BRAND RESISTANCE WHITE CAST IRON LIQUEFACTION TECHNOLOGY //Теория и практика современной науки. – 2022. – №. 2 (80). – С. 3-8.
38. Saidmakhamadov N. et al. Improvement of liquidation technology of construction steels //Техника и технологии машиностроения. – 2022. – С. 57-62.
39. Saidmakhamadov N. M. et al. Improve Casting Properties of Steel Alloy //Miasto Przyszłości. – 2023. – T. 40. – C. 323-328.