Choosing the Optimum Modifier to Increase the Durability of Parts Made of 110g13l Steel

Shukhrat Chorshanbiev[a], Nodir Turakhodjaev[b], Ibrokhim Nasirkhujaev[c] and Asrorkhan Saidakhmatov[d]
Tashkent State Technical University, 100095, University str. 2, Tashkent, Uzbekistan

Keywords: Modifier, Steel, Durability Optimization

Abstract: In this article, the production of high-quality, abrasion-resistant, high-strength grinding cones and other similar details and heavy industrial products for machine-building production enterprises that meet world standards sets an important task for experts and scientists in this field to improve the existing equipment and technology. It is important to improve the existing technology and technologies in this field. In turn, the increase in the level of improvement of equipment in machine-building production enterprises also requires paying great attention to the quality of metals. It is shown that steel plants, as a rule, do not have special equipment for processing steel. Under these conditions, the only and very effective way to practically improve the quality of steel is to process the liquid metal in the steel casting department with special complex modifier alloys. Modification of metals and alloys (its variety) is a deep process of their presence, which actively affects the state of metal solutions during crystallization by introducing small additions of substances (modifiers) that lead to changes in the morphology of mirror inclusions.

1 INTRODUCTION

In production enterprises of the Republic of Uzbekistan, measures are being taken to obtain high-quality cast products during the period of liquefaction of steels with the help of electric arc and induction furnaces. In production enterprises of the Republic of Uzbekistan, measures are being taken to obtain high-quality cast products during the period of liquefaction of steels with the help of electric arc and induction furnaces. In this regard, it is important to increase the priority of research on the improvement of technologies that provide resource and energy efficiency in the liquefaction of steels widely used in industry.

Mechanical engineering consists of a number of technological processes in production enterprises that form a unique technological chain. This chain is closely related to the work unit of each unit and the work quality of the preceding machines. Considering this issue, it can be concluded that the influence of technological chain equipment on the quality indicators of machine-building enterprises and heavy industrial products is great. Therefore, the more efficient operation of machine-building enterprises and heavy industry technological equipment without damage depends to a large extent on the strength of their details. This mainly requires studying the working process of the parts that rub against each other (Dubinin, 1961, Nasser, 2002).

Many scientific practitioners and experts know that metals used in technology are mainly divided into two groups - ferrous and non-ferrous metals. Ferrous metals include iron and its compounds (cast iron, steel, ferrocolates). The rest of the metals and their alloys make up the group of non-ferrous metals.

Until now, iron and its alloys, considered the main material of machine building, are of special importance among metals. 90% of metals produced worldwide are iron and its alloys. This is explained by the fact that ferrous metals have important physical and mechanical properties, as well as the fact

[a] https://orcid.org/0009-0007-7690-7089
[b] https://orcid.org/0009-0009-4970-5785
[c] https://orcid.org/0000-0001-6126-4028
[d] https://orcid.org/0009-0002-2864-9699

Chorshanbiev, S., Turakhodjaev, N., Nasirkhujaev, I. and Saidakhmatov, A.
Choosing the Optimum Modifier to Increase the Durability of Parts Made of 110g13l Steel.
DOI: 10.5220/0014261200004738

In *Proceedings of the 4th International Conference on Research of Agricultural and Food Technologies (I-CRAFT 2024)*, pages 264-268
ISBN: 978-989-758-773-3; ISSN: 3051-7710

that iron ores are widely distributed in nature, and the production of cast iron and steel is cheap and uncomplicated.

The fact that metals have the ability to dissolve various elements allows the atoms of the substance surrounding the metal to diffuse into the metal at high temperature, as a result of which the chemical composition of the metal surface layer changes. Diffusion of atoms into a metal is a chemical process, but temperature plays a major role during this process, so the diffusion process cannot be considered a pure chemical process. Such treatment, which changes the chemical composition of the surface layer of the alloy, is called chemical-thermal treatment. When we study the literature of our country and foreign scientists, the types of chemical-thermal work are described in detail. In recent years, the method of changing the structure of alloys simultaneously with working under pressure is being used more and more widely. Such processing of alloys is called thermomechanical processing. When the alloy is deformed, not only its appearance changes, but also a coating is formed in it, this coated alloy is heat treated. Therefore, thermomechanical indicators should also be included in the literature review process, which is characteristic of our various scientific researches on thermal indicators (Mirboboev et al., 2004).

2 METHODS

It is important to improve the modern machine-building industry in the world, to create new improved technologies, machines and mechanisms that meet global requirements for various branches of production, to replace competitive and imported industries, to conduct deep fundamental research, and to solve current scientific and technical issues. Also, the production of high-quality, high-strength and high-capacity heavy industrial products that meet world standards has set an important task for experts and scientists in this field.

In this regard, special attention is paid to the development of scientific centers of developed countries, including Russia, Germany, USA, England, Japan, China and other countries, in order to create competitive techniques and technologies in production. In particular, with the help of modifiers of various composition, they carry out a number of scientific and research works on obtaining high-quality castings from parts with high strength properties of steel and increasing the service life of mechanical engineering parts made from them.

Scientists from all over the world have conducted extensive research on the possibilities of heating and cooling the alloy, making changes to its internal structure, chemical, physical and mechanical properties, changing the structure of steel by heating and cooling, and achieved results.

Modern engineering is the main consumer of metals produced in our country. A large number of machine parts and accessories are made of metals in the machine tool industry, in the automotive and aviation industries, in electronics and radio engineering.

Metals used in technology are mainly divided into two groups - ferrous and non-ferrous metals. Ferrous metals include iron and its compounds (cast iron, steel, ferrocolates). The rest of the metals and their alloys make up the group of non-ferrous metals.

Until now, iron and its alloys, considered the main material of machine building, are of special importance among metals. 90% of metals produced worldwide are iron and its alloys. 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 (Nurmurodov et al., 2016, Torakho'jaev et al., 2018).

To stay competitive in the steel industry, steelmakers use a variety of production methods to reduce production costs without compromising product quality. In steel production, the production process plays an important role in its purity. Recently, the increase in the requirements for the level of purity requires the optimization of the production process to meet this demand. Often, the types and distribution of non-metallic inclusions in steel determine the purity of the steel. For optimization, it is necessary to fully evaluate the production process, non-metallic inclusions in steel, and extensive work is being carried out by world researchers to implement many measures to control and clean up non-metallic inclusions in steel.

Grinding cones are widely used in metallurgical enterprises of the Republic of Uzbekistan, including ore crushing units at the enterprise "Almaliq KMK". As a result of the rapid consumption of used grinding cones and many similar parts, their service life is not up to the required level. The average service life of one grinding cone is 3 months. Therefore, in the process of their preparation, a number of measures are being taken to increase the strength of surfaces prone to cracking, and new developed technologies are being put into practice. One of such technologies consists in selecting and adding optimal modifiers

during the melting process to increase the mechanical properties of the obtained cast products, as well as increasing its dispersion, durability and hardness as a result of thermal treatment.

110G13L steels are melted in electric arc furnaces DS-5MT, DSP-3 in the foundry of TsRMZ JSC "Almalik KMK" (Ikramov, 2003; Pakhadnya &Turkevich, 2013).

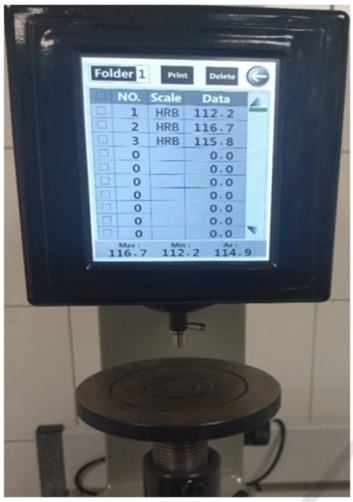

Figure 1: “TP-5018 PAC Tochline” hardness measurement machine.

In accordance with the requi- rements of GOST 977-88, in the casting workshop of the Central Repair Mechanics Plant, a mixture of various chemical elements was melted into 110G13L steel in an electric arc furnace DS-5MT, and we took ingot samples taken as samples. In order to test the hardness of this solution and in the induction melting furnace (Induction Melting Machine), several researches were carried out. We took ferrochrome as an example, which gave the best results from these studies. We added 0.5% to 3% of ferrochrome to the melting solution as a modifier. When added to steel, ferrochromium provides several of the following advantages, i.e. increases hardness and strength improves anti-corrosion properties, increases fluidity, and increases oxidation resistance at high temperatures.

On January 26, 2024, cutting and turning of castings 60x40x20 mm in the laboratory of Tashkent State Technical University, Department of "Casting Technologies" was carried out for 2 hours and 45 minutes in the mechanical shop of the Central Repair Mechanical Plant of "Almaliq KMK" JSC on the S11MV universal lathe. increased and prepared in order to determine the hardness, chemical properties and structures of these metals.

The hardness of cast layers prepared by the most modern metal-102 stationary Rockwell hardness tester was checked at the branch of the federal state autonomous higher educational institution "Misis National Technological Research University" in Olmaliq, Republic of Uzbekistan. According to Gost, designated as NV-186-229.

In this device, the hardness of the metal made of three parts was measured, it was found to be 116.7 when measured from the middle, and 112.2 and 115.8 when measured from the two ends. When we take the average of all sizes, 114.9 HRB and NV-321. (Tursunbaev et al., 2023, Tursunbaev et al., 2024).

3 RESULTS AND DISCUSSION

Together with the professor scientists of Tashkent State Technical University, steel constructions of brand 110G13L and elements added to this steel as a ferrochrome modifier were examined under a special microscope and the desired results were obtained.

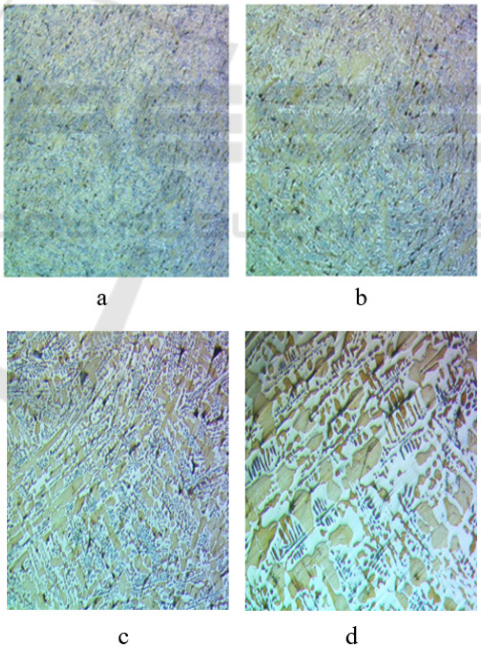

Figure 2: The appearance of the modified 110G13L brand steel structure in different sizes. a- 110G13L-view of the branded steel structure with a size of 5 µm; b- 110G13L-the appearance of the branded steel structure with a size of 10 µm; c- 110G13L-the appearance of the branded steel structure with a size of 20 µm; d- 110G13L-view of the branded steel structure with a size of 50 µm.

As the amount of manganese in carbon steels increases, austenite in the structure begins to stabilize

gradually, as a result of which the as-cast state or the structure after normalization of the alloy changes from pearlite to sorbite, trostite, martensite, and finally to austenite (Rasulov and Grachev, 2004, Kozlov et al., 2003).

Manganese austenite is characterized by its durability and is prone to scurvy. This type of steel is mainly used to increase the corrosion resistance under shock load conditions, where shock occurs on the surface layer of the metal, and the surface layer of the material made of such steel is not contaminated under abrasive cutting conditions, so the use of 110G13L steel in such conditions does not have an advantage over other engineering steels.

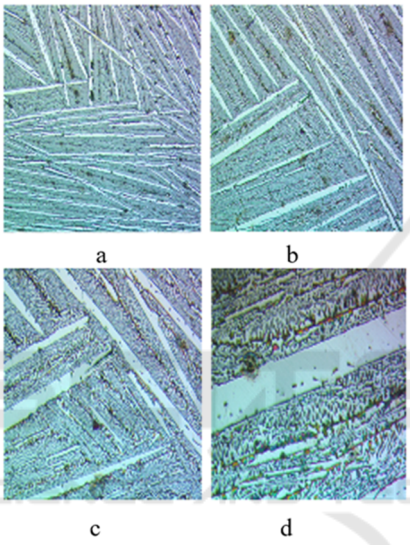

Figure 3: The appearance of structures detected when 1% ferrochrome is added to steel of the 110g13l brand. a- The appearance of the 110g3l brand steel with the addition of 1% ferrochrome as a modifier is 5 µm in size; b- The appearance of 110g3l branded steel 10 µm in size with the addition of 1% ferrochrome as a modifier; c- The appearance of 110g3l branded Steel 20 µm in size with the addition of 1% ferrochrome as a modifier; d- The appearance of 110g3l branded Steel 50 µm in size with the addition of 1% ferrochrome as a modifier.

It is known that the amount of carbon in steel has a strong influence on its corrosion resistance, so in some cases, increasing the amount of carbon in steel to 1.5% leads to a number of complications.

The chemical properties of the "Almalik KMK" JSC MTM(SRMZ) plant were studied in laboratory conditions and the following results were obtained (Novikov, 1996; Tursunbayev et al., 2023).

Manganese increases the stability of austenite and is usually in the range of Mn:C>10 for most standards. If we take into account that the amount of manganese in steel is 9.5 - 10%, then this has little effect on the resistance to bending of steel in abrasive conditions. Therefore, the amount of manganese in it can be reduced to 9%.

Silicon if its content in steel is 0.8-1%, it almost does not affect the strength and plasticity of steel, but it allows to increase the bending resistance of silicon steel only in abrasive bending conditions without forging.

Sulfur if it is present in small amounts in manganese steel, it forms manganese sulfide and does not significantly affect the properties of the (Mukushev et al., 2010; Torakho'jaev et al., 2018; Torakho'jaev et al., 2020).

Phosphorus it begins to have a negative effect on strength properties when its amount increases from 0.06 to 0.08% in 110G13L steels.

Chrome it is used in alloying manganese steels, especially 110G13L steels, in such cases the pre-deformation of the steel is reduced. As a result of alloying steel with chromium in the amount of 5-20%, the plasticity and impact viscosity of the material is significantly reduced, but the hardness of steel increases, for example, as a result of alloying steel with 3% chromium, its hardness increases to NV 255. The advantages of adding ferrochrome to steel are; reduces graininess, increases hardness and strength, and increases oxidation resistance at high temperatures.

Nickel practically does not affect the strength properties of manganese steels. 0.1 - 0.15% of titanium included in the composition of steel allows to increase its resistance to bending, similarly, 0.1 - 0.2% of zirconium affects the strength properties of manganese steels. Chromium microalloying has a good effect on the mechanical properties and bending resistance of steels (Chorshanbiev, 2020, Yu and Schulte, 1983, Parasyuk, 2014).

A large number of various (different types of crushers, parts, teeth of excavator pits, etc.) parts made of 110G13L steel are used in the enterprise of "Almalik KMK" OJSC. The surfaces of such details are made without cracks as a result of exposure to abrasive or abrasive wear under various operating conditions. As a result, a large amount of manganese steel scrap is collected. It is recommended that such steels be microalloyed and modified during remelting to obtain a structure that allows for increased corrosion resistance.

When we measured the hardness of selected modifiers, it was reflected that the hardness of ferrochrome and molybdenum is high.

In addition, copper and ferrosilium were also found to have superior performance compared to other modifiers.

Based on the process of studying the structure of the above-mentioned modifiers, the following conclusions were drawn (Korshunov, 1973; Tsurkan, 2012a; Tsurkan et al., 2012b).

4 CONCLUSIONS

1. The following recommendations were developed as a result of theoretical and practical research on the topic of choosing the optimal modifier to increase the durability of steel parts.
2. Optimum modifiers were selected to increase the strength of steel parts.
3. Properties and structures of several types of modifiers were studied to increase the durability of steels.

REFERENCES

Chorshanbiev, Sh., 2020. Collection of scientific works "Talented youth of New Uzbekistan", first book. "Development of the technology to increase the flexibility of shaft-gear teeth". Educational Publishing House, Tashkent. Bit 8, 212-220.

Dubinin, N.P., 1961. Casting steel, manual, edited by. Moscow, 887.

Ikramov, U. 2003. Tribanika. Tashkent, Uzbekistan. 77, 84, 126.

Korshunov, V.V., 1973. *Issledovanie vliyaniya modifitsirovaniya na kinetiku protsessa usadki i deformatsionnuyu sposobnost' stali 110G13L [veya 110G1ZL]* (Avtoreferat dissertatsii kandidata tekhnicheskikh nauk). Chelyabinsk.

Kozlov, L., Kolokoltsev, V.M., Vdovin, K.N., Ten, E.B., Dolgopolova, L.B., Filippenkov, A.A., 2003. Production of steel ingots, textbook L. Yes. Kozlov., Moscow, Mrs. 357.

Mirboboev, V.A., 2004. Structural Materials Technology. Tashkent, Uzbekistan. 148, 157, 162

Mukushev, D.A., Tsurkan, A.N., Samsonov, Yu.P., Makushev, V., Kanya, A., 2010. Increasing the wear resistance of the lower parts of bulldozers. Bulletin of the Siberian Branch of the Academy of Military Sciences, A. Appendix to VN Bulletin.

Nasser, I., 2002. Materials Science. Tashkent "Uzbekistan" 173-179.

Novikov, I.I., 1996. Theory of Heat Treatment of Metals. - M: Metallurgy, 123-178.

Nurmurodov, S., Rasulov, A., Torakho'jaev, N., Bakhodirov, K., Yakubov, L., Abdurakhmanov, Kh., Tursunov, T., 2016. Development of new structural materials with improved mechanical properties and high quality of structures using new methods. Journal of Materials Science Research, Canada. Canadian Center for Science and Education, 5(3), 52-58.

Pakhadnya, V., Turkevich, Z., 2013. Fizika-technicheskie problem sovremennogo materialovedeniya. Kyiv-Akademperiodika 39, 55, 77.

Parasyuk, P.F., 2014. The main component is steel 110G13L, and the mode of heat treatment and durability is sought. Technology, organization and mechanization of liteynogo proizvodstva, Jorn. SNIITEITEJMASh 9,18,79.

Rasulov, S.A., Grachev, V.A., 2004. Anthrax metallurgy. Tashkent "Teacher", 87, 89, 95, 142.

Torakho'jaev N., Chorshanbiev Sh., Sadikova N., Chorshanbiev Q., 2020. Journal of Critical Appraisal. "Methods for increasing the strength of shaftgear teeth operating in highly abrasive grinding environments". Journal of Critical Review, 103(4), Roosevelt Rd, Da'an District, Taipei City, Taiwan.

Torakho'jaev, N.D., Yakubov, L.E., Tursunov, 2018. Mathematical Model of Heat Treatment to Improve TX Mechanical Properties. Composite materials. - Tashkent, 3, 56-60.

Tsurkan D. A., 2012a. Increasing the structural strength of 110g1zl steel and cast parts used in special machines by modification by Mo, Ni alloy and Polzunovskaya vestnik N 1/1.

Tsurkan, D.A., Leontiev, A. N.,. Ishkov, A. V., 2012b. Improving the durability and operational reliability of caterpillar engine parts of agricultural machinery and special machines. Altai State University newsletter.

Tursunbaev, S., Turakhodjaev, N., Mardonakulov, S., & Toshmatova, S., 2024. Effect of germanium oxide on the properties of aluminum casting details in agricultural machinery. *BIO Web of Conferences*, 85. https://doi.org/10.1051/bioconf/20248501024.

Tursunbaev, S., Turakhodjaev, N., Odilov, F., Mardanokulov, S., & Zokirov, R., 2023. Change in wear resistance of alloy when alloying aluminium alloy with germanium oxide. *E3S Web of Conferences,* 401. https://doi.org/10.1051/e3sconf/202340105001.

Tursunbayev, S., Turakhodjayev, N., Mardanokulov, S., Zokirov, R., & Odilov, F., 2023. The effect of lithium on the mechanical properties of alloys in the Al-Li system. *E3S Web of Conferences*, *390*. https://doi.org/10.1051/e3sconf/202339005046

Yu, A., Schulte, 1983. Praizvodstva atlivak iz stali., Kiev-Donetsk. izd Vitsha scale. 183.