ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 1, January 2024

Research on welding heat-resistant steels

M.M. Abdurakhmonov, A.S. Saidakhmatov, S.S. Khudoyorov,
N.S. Dunyashin, Z.D. Ermatov, J.N. Sadikov

Assistant, Department of Technological machines and equipment, Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan
Assistant, Department of Technological machines and equipment, Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan
Associate Professor, Doctor of Philosophy in Technical Sciences (PhD), Department of Technological machines and equipment, Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan
Head of the Department, Professor, Doctor of Technical Sciences, Professor, Department of Technological machines and equipment, Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan
Professor, Doctor of Technical Sciences, Department of Technological machines and equipment, Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan
Associate Professor, Doctor of Philosophy in Technical Sciences (PhD), Department of Engineering technology, Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan

ABSTRACT: This article provides a study of the features of welding technology for heat-resistant steels

KEY WORDS: welding, steel, technology, bainite, ferrite, pearlite, heat resistance

I. INTRODUCTION

Heat-resistant steels are those intended for long-term operation at temperatures up to 600 S. These steels are used in the manufacture of energy and petrochemical plants. In accordance with the conditions of long-term operation under tension at high temperatures, heat-resistant steels must have creep resistance, long-term strength, stability of properties over time and heat resistance. The listed properties under conditions of economical alloying are achieved by using chrome-molybdenum and chrome-molybdenum-vanadium steels of the pearlitic class.
Chrome-molybdenum steels 12МХ, 15ХМ, 20ХМЛ and 15Х5М with a ferrite-pearlite structure are used for operation at 500-550°C, and chrome-molybdenum-vanadium steels 12Х1МФ, 15Х1М1Ф, 20ХМФЛ, 15Х1М1ФЛ and 12Х2МФСР - for work at 550-580° S. The higher heat-resistant properties of chrome-molybdenum-vanadium steels are due not only to the stabilization of the carbide phase by vanadium, but also to the use of strengthening heat treatment on the bainite structure.

II. LITERATURE SURVEY

Welding of heat-resistant steels is accompanied by a change in the properties of the metal being welded, associated with its melting and crystallization during the formation of a weld, as well as structural changes and elastoplastic deformations in the heat-affected zone. This causes physical and chemical heterogeneity of welded joints and the formation of a local complex stress state, which in some cases impairs the performance and reduces the operational reliability of structures [1-2].
Metallurgical weldability of heat-resistant steels, determined by the ratio of the metal to melting, metallurgical processing and subsequent crystallization of the seam, does not cause significant complications. Welding technology and welding materials at the modern level provide the necessary resistance of the weld metal against the formation of hot cracks and high performance characteristics that meet the requirements for the base metal [3-4].

Thermal weldability is complicated by embrittlement of the metal as a result of the formation of metastable structures in areas of the heat-affected zone heated above the temperature A_{c3}, and softening in areas heated in the temperature range A_{c3} - steel tempering temperature. The formation of brittle structural components (troostite, martensite), as well as the summation of stresses caused by uneven heating and structural transformations, can exhaust the plasticity of the metal and cause destruction of the structure during its manufacture. To prevent the formation of cold cracks, it is necessary to use heating accompanying welding, and sometimes holding welded joints at a certain temperature after welding [5-6].

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 1, January 2024

III. METODOLOGY

The operational reliability of structures made of metal of increased thickness can be ensured only after stabilizing the structure and relieving stress by tempering welded joints. In this case, the tempering temperature of welded joints of chrome-molybdenum-vanadium steels must be no lower than 700°C, since the precipitation of dispersed vanadium carbides from the solid solution at low tempering temperatures leads to embrittlement of the metal in the heat-affected zone and the occurrence of local destruction of welded joints during tempering or during the operation of structures.

The softening of the metal in the heat-affected zone leads to a decrease in the long-term strength of welded joints. This is most characteristically expressed when welding chrome-molybdenum-vanadium steels hardened by heat treatment. The soft layer in welded joints can cause local destruction of hard welded joints during operation, especially under bending loads. The softening of the metal in the heat-affected zone is eliminated by recrystallization during high-temperature heat treatment (normalization with tempering) - However, this creates a need to increase the carbon content and the level of alloying of the welds to improve their thermal workability when cooled from normalization temperatures, since with a low carbon content (0.06 -0.12%) seams after high-temperature heat treatment do not provide the required long-term strength.

In arc welding conditions, an increase in the carbon content and the level of alloying of the seams is achieved by using special welding materials.

High-temperature heat treatment of welded joints cannot be carried out locally, like tempering, since this leads to softening of nearby areas of the metal, and volumetric heat treatment of welded structures is limited by the overall dimensions of the furnaces.

Local or general heating of the product accompanying welding is a reliable means of preventing cold cracks, since it reduces the difference in metal temperatures in the welding zone and in peripheral areas, which reduces stresses of the first kind, as a result of which the peaks of these stresses in the heat-affected areas of the metal are smoothed out. Heating also reduces the cooling rate of the metal, which prevents the transformation of austenite into martensite, which is accompanied by a sharp increase in the specific volume of the metal, causing the appearance of stresses of the second kind.

Increasing the temperature of a metal in any structural state increases its plasticity and, consequently, its deformability. Increasing the ductility of the welded joint is as important for preventing the formation of cold cracks as reducing stresses, since cracks form as a result of the exhaustion of the deformability of the metal under the influence of stress.

When welding heat-resistant steels, it is necessary to limit not only the lower, but also the upper limit of heating temperatures. Excessively high heating temperatures lead to the decomposition of austenite in the high-temperature region with the formation of a rough ferrite-pearlite structure, which does not provide the necessary long-term strength and impact toughness of welded joints.

Since stress redistribution and structural transformations can occur after welding is completed, in some cases additional measures are necessary to prevent the formation of cold cracks in welded joints that have not been subjected to heat treatment. These include, for example, holding welded joints after welding at 150–200°C for several hours to complete the transformation of retained austenite and hydrogen evacuation.

For manual arc welding of heat-resistant steels, in most cases, electrodes with a base coating containing calcium carbonate (marble) and fluorite (fluorspar) are used. Electrodes with a coating of this type provide increased deoxidation of the weld metal with a low content of non-metallic inclusions and hydrogen, as a result of which high ductility and impact strength of the welds are achieved. However, for electrodes with this type of coating, in order to prevent the formation of pores in the seams, drying at 80-100° C before use, welding with the shortest arc possible, and careful cleaning of the edges from rust and scale. Small diameter electrodes are most prone to nitrogen-induced pore formation.

For automatic welding in combination with alloyed wires, low-activity fluxes АН-22, ФЦ-11, ЗИО-Ф2 with a reduced content of manganese and silicon oxides are used. This ensures high plastic properties of the seams and stability of the composition of multilayer seams in terms of manganese and silicon content. For semi-automatic welding in a carbon dioxide environment, wires are used that contain, along with the main alloying elements, an increased amount of silicon and manganese.

Welded joints of heat-resistant steels operating under creep conditions without heat treatment after welding do not provide operational reliability due to structural heterogeneity and the presence of residual welding stresses. Therefore, most welded structures made of heat-resistant steels are subjected to heat treatment. The exceptions are welded joints made of chrome-molybdenum steels (12МХ, 15ХМ, 20ХМЛ) with a thickness of less than 10 mm and of chrome-molybdenum-vanadium steels (12Х1МФ, 15Х1М1Ф, 12Х2МФСР) with a thickness of less than 6 mm, as well as cast parts with non-through defects welded with high-nickel electrodes ЦТ-36 and АНЖР -3.

In the manufacture of structures from heat-resistant steels, tempering is usually used. Its advantage is that it can be used as a local heat treatment. Tempering also allows the use of welding materials with a low carbon content, which provides increased technological strength of welded joints. Tempering stabilizes the structure (hardness) of the welded joint and reduces residual stresses. With an increase in the content of chromium, molybdenum, vanadium and other elements that increase the relaxation resistance of steels, the tempering temperature and holding time should increase. A particular danger is posed by insufficient tempering of welded joints of chromium-molybdenum-vanadium steels due to the possibility of dispersion hardening caused by the precipitation of vanadium carbides in the heat-affected zone. The disadvantage of tempering is the impossibility of completely leveling the structure, in particular, eliminating the softened soft layer in the heat-affected zone of welding.

The use of high-temperature heat treatment - normalization with subsequent tempering makes it possible, through recrystallization, to eliminate softening and ensure higher operational reliability of welded joints. However, the use of normalization requires special filler materials that provide higher thermal workability of the welds, close to the workability of the steel being welded.

In addition, during normalization it is necessary to apply general heat treatment of the entire welded structure, since local high-temperature heating of the welded joint for normalization causes softening of the metal in areas located near the inductor or other heating device, which reduces creep resistance and long-term strength.

IV.CONCLUSION

The results of the research performed provided the necessary basis for the development and implementation of welding technology for heat-resistant steels.

ACKNOWLEDGMENT

This work was carried out within the framework of a business agreement with the Tashkent Pipe Plant named after V.L. Galperin No. 1/2022 on the topic: "Research and development of the composition of ceramic fluxes for automatic arc welding of low-carbon and low-alloy steels"

REFERENCES

[1]. Dunyashin N.S. Development of a multicomponent coating of electrodes for manual arc welding of low-carbon and low-alloy steels. - T .: Fan va texnologiya, 2019 - 160 p.

[2]. Ermatov Z.D. Development of scientific bases for creating multicomponent electrode coatings for manual arc surfacing. Monograph. T: Fan va texnologiyalar nashriyot-matbaa uyi, 2021 - 140s.

[3]. Verkhoturov A.D. Methodology for the creation of welding consumables: monograph - Khabarovsk: Publishing House of the Far Eastern State University of Railway Engineering, 2009. - 128 p.

[4]. Kuznetsov M.A. Nanotechnologies and nanomaterials in welding production (Review) / M.A. Kuznetsov, E.A. Zernin // Welding production. – 2010. – No. 12. – P.23-26.

[5]. Sadykov J.N., Ermatov Z.D. Investigation of physical-mechanical and welding-technological properties of electrodes for wear-resistant surfacing// International Journal Of Advanced Research in Science, Engineering and Technology – India, 2021. – Vol.8, № 11 (November). – pp. 18576 – 18582 .

[6]. Sadykov J.N., Ermatov Z.D. Development of technology for the production of coated surfacing electrodes for wear-resistant surfacing // International Journal Of Advanced Research in Science, Engineering and Technology – India, 2021. – Vol.8, № 11 (November). – pp. 18551 – 18556

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 1, January 2024

AUTHOR'S BIOGRAPHY

	**Abdurahmonov Mansurjon Muridjon ugli**, Assistant, was born May 3, 1993 year in Tashkent city, Republic of Uzbekistan. He has more than 15 published scientific works in the form of articles, theses and tutorials. Currently works at the department of "Technological machines and equipment" in Tashkent State Technical University as an assistant teacher, Tashkent, Uzbekistan.
	**Saidakhmatov Asrorhon Saidakbar ugli**, Assistant, was born November 15, 1993 year in Tashkent city, Republic of Uzbekistan. Has more than 15 published scientific works in the form of articles, journals, theses and tutorials. Currently works at the department of "Technological machines and equipment" in Tashkent State Technical University.
	**Khudoyorov Sardor Sadullaevich**, Associate Professor, Doctor of Philosophy in Technical Sciences (PhD), was born March 7, 1989 year in Tashkent city, Republic of Uzbekistan. Has more than 50 published scientific works in the form of articles, journals, theses and tutorials. Currently works at the department of "Technological machines and equipment" in Tashkent State Technical University.
	**Dunyashin Nikolay Sergeyeevich** , Head of Department, Doctor of Science, Professor was born February 13, 1978 year in Tashkent city, Republic of Uzbekistan. Has more than 140 published scientific works in the form of articles, journals, theses and tutorials. Currently works at the department of "Technological machines and equipment" in Tashkent State Technical University.
	**Ermatov Ziyadulla Dosmatovich**, Doctor of Science, Professor was born in May 16, 1978[th] year in Tashkent city, Republic of Uzbekistan. He has more than 110 published scientific works in the form of articles, these and tutorials. Currently Professor of the department of "Technological machines and equipment" in Tashkent State Technical University, Tashkent, Uzbekistan.
	**Sadikov Jaxongir Nasirdjanovich** , Associate Professor, Doctor of Philosophy in Technical Sciences (PhD), was born March 10, 1975 year in Tashkent city, Republic of Uzbekistan. Has more than 20 published scientific works in the form of articles, journals, theses and tutorials. Currently works as researcher at the department of "Technological machines and equipment" in Tashkent State Technical University