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Research on welding technology for magnesium alloys

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

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 Engineering technology, 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

ABSTRACT: This article provides an analysis of the technology of welding magnesium alloys

KEY WORDS: alloy, silumin, duralumin, welding, technology

I. INTRODUCTION

Pure magnesium has relatively low strength and low ductility. Magnesium alloys, which have high specific strength while maintaining low mass, are used as structural materials. Magnesium alloys are highly susceptible to corrosion in many environments. This is explained by the fact that the resulting surface oxide film is not dense and does not have high protective properties, such as the oxide film on aluminum. To protect against corrosion, special protective films or paint coatings are applied to the surfaces of parts made of magnesium alloys. In order to compact oxide films, beryllium additives are often added to magnesium alloys.

II. LITERATURE SURVEY

Magnesium alloys, like aluminum alloys, are divided into wrought and cast alloys. Based on their sensitivity to heat treatment, a distinction is made between magnesium alloys that are thermally hardened and those that are not hardened by heat treatment. According to the alloying system, wrought alloys can be divided into several groups [1-2]:
1. Alloys of the Mg-Mn system are not strengthened by heat treatment and are relatively well welded.
2. Alloys of the Mg-A1-Zn system are not strengthened by heat treatment, but are welded satisfactorily.
3. Alloys of the Mg-Zn-Zr system are strengthened by heat treatment and are characterized by increased heat resistance and low weldability.

In addition, alloys of other alloying systems are used: heat-resistant alloys of the Mg-Th-Mn system, high-strength alloys of the Mg-Al-Cd-Ag system, etc. Casting alloys include alloys of the Mg-Mn system, Mg-Al-Zn system, etc. [3-4]

Magnesium is one of the metals with a high affinity for oxygen. Therefore, magnesium-based alloys are actively oxidized by ambient oxygen under welding conditions. Due to the high melting point, the oxide film on the surface of the edges of the parts being welded makes it difficult to form a common weld pool and must be destroyed or removed during the welding process. A feature of the oxide film is its poor protective properties and ability to retain large amounts of moisture. [5-6]

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III. METODOLOGY

In addition to oxygen, CO, CO_2, water vapor, nitrogen and hydrogen may be present in the atmosphere surrounding the bath. Magnesium reacts with these gases, forming carbides, nitrides and oxides. Unlike other gases, hydrogen has the ability to dissolve in magnesium. During crystallization, solubility decreases sharply. However, the critical concentration of hydrogen in the shielding gas atmosphere, which can cause porosity when welding magnesium alloys, is high and is practically unlikely for real conditions. This is explained by the high solubility of hydrogen in the metal. The main reason for the appearance of pores during welding of magnesium alloys is the release of hydrogen formed during the decomposition of residual moisture contained in the particles of the oxide film. In this case, hydrogen is released in molecular form, bypassing the dissolution stage. To combat porosity in welds, measures are recommended aimed at reducing the concentration of oxide particles mixed into the bath, as well as the use of rational surface treatment of the filler metal and the edges of the parts being welded.

During crystallization, magnesium alloys tend to form a coarse-crystalline structure. Many alloying elements at high cooling rates are capable of forming nonequilibrium eutectics with magnesium. These factors contribute to the occurrence of crystallization cracks. The tendency to crack formation is influenced by the crystallization range of the alloy, the temperature range of brittleness (TIB), as well as the ductility of the weld metal in the BTI. Increasing the resistance of alloys to the formation of crystallization cracks is achieved by introducing modifiers into their composition and using a filler metal in welding that has a chemical composition with a lower tendency to crack formation. One of the characteristic features of most magnesium alloys is their tendency to grain growth when heated. When welding alloys that are strengthened by heat treatment, along with grain growth in heat-affected zones, decomposition of the solid solution and melting of grain boundaries are possible. These processes lead to softening of the metal in the heat-affected zone, and sometimes to the occurrence of cracks.

Magnesium has a high coefficient of linear expansion ($\alpha = 29\cdot10^{-6} 1/°C$). In this regard, welding of alloys based on it is complicated by the high tendency of the welded structures to warp, and sometimes to the formation of cracks. To prevent cracks and reduce warping, it is recommended to weld with heated structures or subsequent heat treatment to relieve stress.

Preparation of parts consists of removing surface contaminants, oxide and protective films, as well as profiling the edges to be welded. Surface contaminants are removed using solvents or special compounds, and oxide and protective films are removed by mechanical or chemical methods. The following technology is used for preparing the surface of parts made of magnesium alloys:

1) degreasing in a bath: 20-30 g/l $Na_3PO_4\cdot12H_2O$, 30—50 g/l $NaCO_3$, 20—50 g/l NaOH; 3-5 g/l liquid glass; 2) washing in running hot water at 50-60°C for 0,5-1 min; 3) removal of the protective coating in an alkaline bath: 200-300 g/l NaOH at 70-80°C for 10-15 minutes; 4) washing in running hot water at 50-60°C for 0,1-1 min; 5) rinsing in cold water; 6) chemical etching in a bath: 150-200 g/l CrO_3, 25-35 g/l NaO_3, 2—3 g/l CaF_2, etching time 2 min at 20°C; 7) rinsing in cold running water; 8) drying with compressed air at 60-90°.

The surface of the filler metal is processed using the above technology or using a solution of 180 g/l CrO_3 at 90°C for etching; etching time 5 min. Before welding, it is recommended to clean the edges of parts with a scraper.

In structures made of magnesium alloys, all the main types of welded joints used when welding aluminum alloys are used. The exception is connections with flanged edges. Due to the insufficient ductility of magnesium alloys, edge flanging is not used even for thin metal. Butt welding without cutting edges is recommended to weld joints in one pass when single-sided welding on pads that have special profiled grooves, similar to those used when welding aluminum alloys. Double-sided welding of butt joints without cutting the edges is not recommended due to the risk of a large number of oxide inclusions appearing in the seams. When welding joints made of metal with a thickness of more than 6-10 mm, a V-shaped or cup-shaped groove of edges is used, and for metal with a thickness of more than 20 mm, in the presence of a double-sided approach, an X-shaped groove of edges is used. In the latter case, before making a seam on the reverse side, preliminary cutting of the root part of the first seam is necessary.

Welding of magnesium alloys can be performed only if the weld pool and nearby areas of the base metal are reliably protected from the surrounding atmosphere. For structures made of magnesium alloys, arc welding is used in a shielding gas environment - argon with a purity of 99.9%. In industry, gas-shielded arc welding with a non-consumable tungsten electrode, as well as a three-phase arc, is widely used. Manual and automatic butt welding with a tungsten electrode without cutting edges can weld parts up to 6 mm thick in one pass. As the thickness increases, it is necessary to cut and fill the cutting area in several passes. For metal with a thickness of more than 5 mm, automatic consumable electrode welding with jet transfer of electrode metal can be used. For thinner metals, short-arc welding is used with periodic short-term closures of the arc gap. In both cases, the welding process is carried out using direct current of reverse polarity.

Consumable electrode welding is especially effective for joining thick metal. In this case, the productivity of the process increases and, due to better mixing of the bath, the likelihood of oxide inclusions appearing in the weld metal is reduced. When butt welding without cutting, sheets 5-10 mm thick can be welded in one pass with a consumable electrode. For thick-sheet joints (8-10 mm or more), it is advisable to use three-phase welding. Structures made of magnesium alloys are welded using welding equipment used in welding aluminum alloys.

Casting defects (surface) formed during mechanical processing (surface cavities, cracks, etc.) are welded in an environment of inert protective gases. Elimination of defects by welding is achieved by cutting the casting until the defective metal is completely removed. Castings prepared for welding are heated to 250-300°C; thin-walled and stressed castings are heated to 340-350°C. After welding, repeated heat treatment is carried out. When welding, an additive with a composition identical to the composition of the base metal is used.

IV.CONCLUSION

The results of the research performed provided the necessary basis for the development of welding technology for magnesium alloys.

REFERENCES

[1]. Ermatov Z.D. Welding of special steels and alloys. T: Fan va texnologiyalar nashriyot-matbaa uyi, 2023. - 180 p.

[2]. Ermatov Z.D., Dunyashin N.S., Galperin L.V., Nikitin V.N., Sadykov Zh.N. Fusion welding technology and equipment. T: Fan va texnologiyalar nashriyot-matbaa uyi, 2023. -220 p.

[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]. Khudoyorov S.S., Galperin L.V, Dunyashin N.S., Ermatov Z.D., Saidakhmatov A.S., Abdurakhmonov M.M. Study interaction of molten metal and slag in arc welding// International Journal Of Advanced Research in Science, Engineering and Technology – India, 2022. – Vol.9, № 9 (September). – pp. 19771 – 19775.

[5]. Khudoyorov S.S., Galperin L.V., Dunyashin N.S., Ermatov Z.D., Saidakhmatov A.S., Abdurakhmonov M.M. Study of the refining process in electric arc welding// International Journal Of Advanced Research in Science, Engineering and Technology – India, 2022. – Vol.9, № 12 (December). – pp. 20244 – 20249.

[6]. Khudoyorov S.S., Dunyashin N.S., Ermatov Z.D., Sadikov J.N., Saidakhmatov A.S., Abdurakhmonov M.M. Study interaction of metal with complex gases containing oxygen in manual arc welding// International Journal Of Advanced Research in Science, Engineering and Technology – India, 2023. – Vol.10, № 1 (January). – pp. 20324 – 20328.

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 16, 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.

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	**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
	**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 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.