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Study of the influence of the composition of the core of flux-cored wire on the properties of the weld metal

J.N. Sadikov, S.S. Khudoyorov, N.S. Dunyashin,
Z.D. Ermatov, N.T. Rakhmatullayeva, M.Z. Abdullayev

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.
Senior lector of the department of "Technological machines and equipment" of Tashkent State Technical University named Islam Karimov, Tashkent, Uzbekistan.
Assistant of the department of "Technological machines and equipment" of Tashkent State Technical University named Islam Karimov, Tashkent, Uzbekistan.

ABSTRACT: This article provides a study of the characteristics of the composition of the gas phase during submerged arc welding of low-carbon and low-alloy steels

KEY WORDS: low alloy steel, slag, flux-cored wire, ferroalloys, welding

I. INTRODUCTION

Flux-cored wire is a continuous electrode of a tubular or other, more complex structure with a powdery filler - a core. The core consists of a mixture of minerals, ores, ferroalloys, metal powders, chemicals and other materials. The purpose of the various components of the core is similar to the purpose of electrode coatings: protection of molten metal from the harmful effects of air, deoxidation, alloying of metal, binding of nitrogen into stable nitrides, stabilization of arc discharge and others. The components of the core must, in addition, satisfy the generally accepted requirements for all welding materials: ensure good formation of seams, easy separation of the slag crust, penetration of the base metal, minimal spattering of the metal, absence of pores, cracks, slag inclusions and other defects, certain mechanical properties of the seams and welded joints and so on. [1,4]

II. LITERATURE SURVEY

Flux-cored wires are used for welding without additional protection of the welding zone, as well as for gas-shielded, submerged arc, and electroslag welding. Wires used for welding without additional protection are called self-shielded. The materials included in the core of such wires, when heated and melted in an arc, create the necessary slag and gas protection for the molten metal. Currently, flux-cored wires for carbon dioxide welding and self-shielding flux-cored wires are most widely used. Depending on the diameter and composition of the flux-cored wire, welding can be carried out in all three spatial positions [2,3].
Flux-cored wires can be classified according to their purpose, the method of protecting the metal from the influence of air, the type of core, and the mechanical properties of the weld metal. [5].

The purpose of the wire is determined by the class of the metal being welded. Flux-cored wires are used for welding low-carbon and low-alloy structural steels, alloy steels, cast iron, non-ferrous metals and alloys. The most widely used wires are for welding low-carbon and low-alloy steels. [6].

III. METODOLOGY

According to the method of protection, flux-cored wires are divided into two types: 1) self-protecting; 2) for welding with additional protection with gas or flux.

Depending on the composition of the core, wires can be divided into five types - rutile-organic, rutile, carbonate-fluorite, rutile-fluorite, fluorite.

The core of rutile-organic wire consists mainly of rutile concentrate and aluminosilicates (feldspar, mica, granite, etc.). Ferromanganese is used as deoxidizers, and starch or cellulose are used as gas-forming materials. Wires with a rutile-organic core are used as self-shielding wires.

The core composition of rutile-type wires consists mainly of rutile concentrate, aluminosilicates and ores. Ferromanganese, ferrosilicon, ferrotitanium, and ferroaluminum serve as deoxidizers. Wires with a rutile core are used with additional carbon dioxide protection.

Calcium, magnesium, and sodium carbonates are introduced into the core of carbonate-fluorite type wire as gas-forming materials. Rutile concentrate, aluminosilicates, oxides of alkaline earth metals, and fluorite concentrate are used as slag-forming materials. The metal is deoxidized with ferromanganese and ferrosilicon. To further deoxidize the metal and bind nitrogen into nitrides, titanium and aluminum are sometimes introduced into the core of this type of wire. Wires with a carbonate-fluorite type core are most often used as self-protecting wires, but they are also used in combination with additional carbon dioxide protection.

The composition of the core of rutile-fluorite type wires includes mainly rutile and fluorite concentrates; oxides of alkaline earth metals and aluminosilicates are sometimes introduced as slag-forming agents. Ferromanganese and ferrosilicon serve as deoxidizers. Wires with a core of this type are usually used with additional protection with carbon dioxide.

The core of fluorite-type wires mainly consists of fluorite concentrate; oxides of alkaline earth metals are introduced in small quantities. Ferromanganese, aluminum, and magnesium are used to deoxidize metal. Aluminum also binds the nitrogen of the weld pool metal into nitrides. Wires with a fluorite core are used as self-shielding wires.

Iron powder is introduced into the cores of wires of all types in order to increase welding productivity and impart favorable welding and technological properties.

Of the flux-cored wire designs used (fig. 1), the most common are tubular wires (a, b, c). The introduction of part of the shell into the core (d, e, f, g, h) ensures more uniform melting and more effective protection of the metal from air.

During the welding process, flux-cored wire goes through the stages of heating and melting, accompanied by oxidation of iron and alloying elements, decomposition of organic materials, carbonates and fluorides, complex formation, etc. The development of these processes in the core has a significant impact on the interaction of molten metal with gases and slag and largely determines technological parameters of welding.

Heating of the flux-cored wire shell during welding occurs mainly due to the heat generated during the passage of the welding current and the heat generated in the active spot. In this case, a quasi-stationary temperature field is established on the section of wire from the cut of the tip of the mouthpiece to the arc. The heat released in the active spot heats only a small area no more than 1-3 mm in size at the end of the wire. In this section, the wire sheath is heated to the melting temperature and above. The shell area s in cross section is usually 2-5mm^2. Calculations show that during the welding process, the shell of flux-cored wires at the end can be heated to temperatures of approximately 1000° C.

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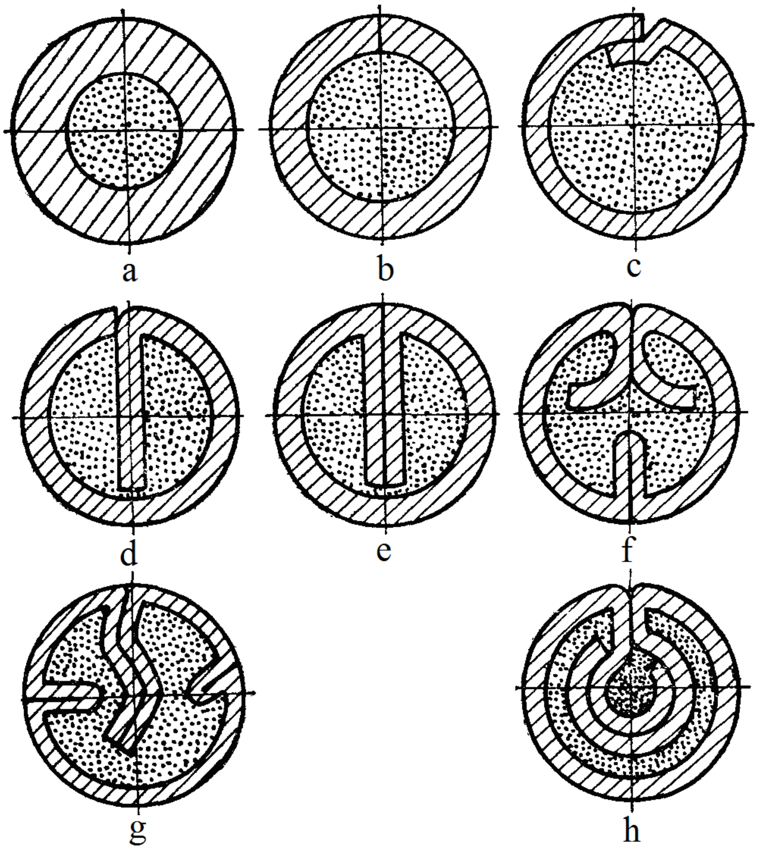

Fig. 1. Flux cored wire design

The core is heated by heat transfer from the arc and the shell. At high wire feed speeds, the heat generated at the end extends over a shorter length than in the sheath, since the thermal conductivity of the core is 1-2 orders of magnitude less than the thermal conductivity of the sheath.

The above calculations and experiments show that already when the flux-cored wire shell is heated at the end, the processes of dissociation and oxidation of the core components intensively develop. The completion of these processes by the time the wire melts depends on the composition of the core and the conditions for supplying heat to its individual sections, determined by the welding mode, the size and design of the wire and the physicochemical properties of the core.

IV.CONCLUSION

The results of the research performed provided the necessary basis for the development and implementation of technology for the preparation of flux-cored wire using components based on local raw materials.

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AUTHOR'S BIOGRAPHY

	**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 30 published scientific works in the form of articles, journals, theses and tutorials. Currently works at the department of "Engineering texnology" 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 180 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 160 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.

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	**Rakhmatullayeva Nazima Toir kizi**, Senior lector was born September 1, 1989 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.
	**Abdullayev Muzaffar Zahidjanovich**, Assistant,was born in June 26, 1989th 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.