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Mineral resources of the Republic of Uzbekistan for the production of fused fluxes for automatic arc welding

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ABSTRACT: This article presents the features of the composition and properties of fused fluxes for automatic arc welding and the mineral resources of the Republic of Uzbekistan for their production.

KEYWORDS: automatic arc welding, flux, fused flux, quartz sand, dolomite, kaolin, fluorspar

I. INTRODUCTION

At the beginning of 2020, global sales of welding technologies and equipment varied around 62 billion dollars, of welding materials 7.8 billion USA dollars. Uzbekistan's need for fused flux welding is 0.5 thousand tons. Their imports exceeded $ 1.2 million. The main producer of fused fluxes in Uzbekistan are Uzmetkombinat JSC. However, the lack of scientific support in the manufacture of welding fluxes and high-quality appropriate materials for the charge not only reduces the quality of the products, but also reduces its share in the domestic and foreign markets. The main reason for this is a scientifically unreasonable approach to the development of a batch composition of fluxes, which necessitates the purchase of raw materials and technologies from abroad.

II. LITERATURE SURVEY

Welding fluxes are called specially prepared metal granular powders with a single grain size of 0.25 - 4.0 mm. With mechanized arc methods of submerged arc welding, the protection of the weld pool and its metallurgical processing is carried out by welding fluxes. Melting fluxes create a gas and slag dome above the zone of the welding arc, and after chemical and metallurgical action in the arc space and the weld pool, form a slag crust on the weld surface, into which oxides, sulfur, phosphorus and gases are discharged [1].

A number of general requirements are imposed on fluxes for automatic and semi-automatic welding [2, 3]:

- obtaining a given chemical composition of the metal welds and their properties;
- ensuring good formation of the weld metal;
- receiving joints without defects (slag inclusions, pores and cracks);
- ensuring the stability of the arc and the welding process;
- easy separability of the slag crust from the surface of the seams;
- stability of arc burning is ensured by ionizable components that are introduced into the flux composition.

The specified chemical composition of the weld metal is ensured by the base and electrode metal, taking into account their changes due to interaction with the flux.

Good formation of the weld metal and easy separability of the slag crust is ensured by regulating the physicochemical properties of the flux (melting points, slurry fluidity, etc.). Cracks, slag inclusions and porosity of the weld metal are suppressed due to refining, deoxidizing, alloying components that are introduced into the flux composition.

Slag during automatic arc welding is introduced artificially to protect the metal from the effects of gases. Melts of non-metallic compounds oxides, halides, sulfides, etc. are called slags. They can be free or form complex compounds.

According to the chemical composition, welding fluxes are divided into oxidizing and non-oxidizing [4-6].

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Oxidizing fluxes contain MnO and SiO2 oxides. The more MnO and SiO2 is contained in the flux, the stronger the flux can alloy the metal with silicon and manganese, but at the same time the more it oxidizes the metal. Oxidizing fluxes are mainly used in welding carbon and low alloy steels.

Oxidizing fluxes practically do not contain oxides of silicon and manganese or containing in small quantities. They mainly contain oxides CaO, MgO, Al2O3, and calcium fluoride (CaF2). They are mainly used for welding high alloy steels.

According to the method of their manufacture, welding fluxes are divided into fused and ceramic [2-4].

Fused fluxes are obtained by fusion of its constituent components.

The advantages of fused fluxes:

- uniformity of flux in chemical composition;
- high mechanical strength, which facilitates transportation.
- relatively high moisture resistance.

The main disadvantage of fused fluxes is that it cannot contain alloying elements in a pure form, because in the process of smelting, they are inevitably oxidized. Doping with fused fluxes occurs by reducing elements from oxides in the flux.

Ceramic fluxes are a mechanical mixture of various natural materials and ferroalloys [5, 6].

Advantages of ceramic fluxes:

- the technology of manufacturing ceramic fluxes allows to introduce alloying additives into the composition;
- high versatility of ceramic fluxes, the possibility of application for welding high alloy steels and alloys, as well as for surfacing surface layers with special properties.

Disadvantages of ceramic fluxes:

- the difficulty of obtaining uniform chemical composition due to different densities of the individual components;
- low mechanical strength of the flux and low moisture resistance.

III. METHODOLOGY

Fused fluxes are used in automatic arc welding of metal structures from low carbon and low alloy steel. The developed composition of fused flux for automatic arc welding of structures made of low carbon steels contains the following components, wt.%: Quartz sand - 23-27; dolomite - 10-12; kaolin - 6-8; manganese concentrate - 50-54; fluorspar - 4-6.

The use of mineral resources of the Republic of Uzbekistan for the development and industrial production of fused flux for automatic arc welding is an urgent task. The deposits of mineral resources of the Republic of Uzbekistan are unusually rich, diverse and have significant potential. Considering the above noted features and requirements for the composition and properties of fused flux for automatic arc welding, this paper analyzes the ore-mineral raw materials of the Republic of Uzbekistan, which can be used as components of the flux mixture. This analysis allowed us to identify the objects most favorable for the production of fused flux for automatic arc welding.

Currently, quartz sands of the Jeroyskoye and Mayskoye deposits are widely used as a source of silicon oxide (Table 1). The most promising deposits of quartz sand include Kulantayskoye (Navoi region), Yakkabagskiy (Kashkadarinskaya region) SiO2 content = 87.2 - 98.7%. Table 2 provides information on the reserves of some deposits of quartz sand.

Table 1.The average chemical composition of some quartz-containing raw materials of the Republic of Uzbekistan

Name of the field	**Content, %**						
	SiO_2	**Fe_2O_3**	**Al_2O_3**	**CaO**	**MgO**	**K_2O**	**Na_2O**
Jeroyskoye	97,16	0,16	1,1	0,36	0,24	0,18	0,1
Mayskoye	94,2	0,18	2,8	0,3	0,2	1,2	0,2

Table 2.Known deposits and estimated reserves of quartz-containing resources of the Republic of Uzbekistan

№	Name of the field	Location	Characteristic	Reserves, million tons
1	Mayskoye	Tashkent region	Quartz	2,5

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2	Jeroyskoye	Navoi region	Quartz	13,5
3	Kulantai	Navoi region	Quartz	30,0
4	Yakkabag	Kashkadarya region	Quartz	4,0
5	Obruchevskoe	Syrdarya region	Quartz	3,0
6	Yangiarik	Khorezm region	Quartz	30,0
7	Tabakum	Republic of Karakalpakstan	Quartz	20,0

Dolomite deposits in the Republic of Uzbekistan are located in the Ferghana, Namangan and Kashkadarya regions. The chemical composition of dolomites from the deposits of Shursuv (Ferghana region), Chust (Namangan region) and Dekhkanabad (Kashkadarya region) are shown in table 3.

Table 3.The chemical composition of dolomite raw materials

Name of the field	**Location**	**Content, %**					
		MgO	**CaO**	**Al_2O_3**	**Fe_2O_3**	**CO_2**	**SO_3**
Shursuv	Ferghana region	17,25	33,37	0,11	0,133	40,65	1,90
Chust	Namangan region	12,83	38,90	0,15	0,202	43,08	0,70
Dehkanabad	Kashkadarya region	13,57	37.55	0,366	0,214	44.43	0,80

The color of kaolin is gray, can change to yellow and brown due to impurities of titanium and iron oxides. Melting point 1730-1820°C. Sintering temperature 1350-1450°C. The chemical composition of secondary kaolins depends on the ratio of the main rock-forming minerals (%): SiO_2-50-75; Al_2O_3-17-34; Fe_2O_3-0.2-2.5; CaO - 0.1-1.0; MgO-0.1-0.5; K_2O- 0.3-8.5; TiO_2-0.2-2.0; loss on ignition -3.5-10%. The chemical composition of Angren secondary kaolin is shown in table 4.

Table 4.The chemical composition of secondary kaolin

Name of the field	**Location**	**Content, %**						
		SiO_2	**Al_2O_3**	**Fe_2O_3**	**MgO**	**CaO**	**K_2O+ Na_2O**	**TiO_2**
Angren	Tashkent region	59,39	26,7	1,52	0,4	0,27	1,32	0,3

The analysis of information on fluorspar showed the presence of the following industrial deposits on the territory of the Republic of Uzbekistan: Agata-Chibargata, Karaultash, Yangoly, Shabrez and others. Of the above list of deposits, the largest is the Agata-Chibargata deposit, located in the Tashkent region and represented by a quartz-fluorite residential. The balance reserves of the field amount to 3932.5 thousand tons.

The analysis of the studied deposits made it possible to distinguish among them the objects with the most favorable raw materials for the production of fluxes for automatic arc welding of structures from low carbon and low alloy steels, which confirms the possibility of industrial mining in Uzbekistan of almost all types of mineral raw materials necessary for the production of fused fluxes.

The developed composition of the flux provides:

- good arc stability;
- breaking length of the arc up to 13 mm;

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- satisfactory formation of a seam;
- low tendency of weld metal to the formation of pores and cracks;
- satisfactory separability of the slag crust.

IV. CONCLUSION

Developed fused flux for automatic arc welding of structures of low carbon and low alloy steels, containing the following components, wt.%: Quartz sand - 23-27; dolomite - 10-12; kaolin - 6-8; manganese concentrate - 50-54; fluorspar - 4-6, provides:

- increased productivity;
- low tendency to pore formation in the weld with not removed rust from the surface of the welded base metal;
- low pore content when welding with a long arc at high speed.

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