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DEVELOPMENT OF THE SCIENTIFIC BASIS FOR THE CREATION OF MULTICOMPONENT COATINGS FROM LOCAL RAW MATERIALS FOR ELECTRODES FOR MANUAL ARC WELDING OF LOW-CARBON AND LOW-ALLOY WELD STEELS

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Abstract:
The development of welding production accounts for more than 50% of the gross output of the world's largest industrialized countries. Scientific research is underway around the world to predict the chemical composition of welds. In this direction, it is possible to select welding materials that provide the operational characteristics of the metal at the design stage. In this regard, it is important to improve the quality characteristics of the electrodes on the basis of modernization of the composition of the coating shaft to reduce the cost of the electrode. At the same time, in order to improve the characteristics of the welded joint, it is necessary to develop a methodology that allows optimizing the coating composition of welding electrodes, which determines the chemical composition of the molten metal [1,2].

Keywords: Welding materials, higher education institutions, methodology, welding materials,scientific research,

The development of welding production accounts for more than 50% of the gross output of the world's largest industrialized countries. Scientific research is underway around the world to predict the chemical composition of welds. In this direction, it is possible to select welding materials that provide the operational characteristics of the metal at the design stage. In this regard, it is important to improve the quality characteristics of the electrodes on the basis of modernization of the composition of the coating shaft to reduce the cost of the electrode. At the same time, in order to improve the characteristics of the welded joint, it is necessary to develop a methodology that allows optimizing the coating composition of welding electrodes, which determines the chemical composition of the molten metal [1,2].

Extensive research focused on the development of energy and resource-saving welding technologies in the world is carried out by the world's leading research centers and higher education institutions, including: Stanford University (USA), International Institute of Welding (France), Technishe Universitaet Wien (Austria), Polytechnic Institute of Viseu (Portugal), University of Nagoya (Japan), National Technologies Institute of Kumoh (South Korea), N. Moscow State Technical University named after Bauman (Russia), I.M. Extensive research is being conducted by the Gubkin Russian State University of Oil and Gas (Russia), Kiev Polytechnic Institute (Ukraine) and other research institutions [3].

A number of scientific studies are being conducted around the world to calculate the composition of the weld metal and the thermodynamic and physicochemical properties of welding slag in arc welding with coated electrodes, including: (Stanford University (USA)) , (Scientists of the International Institute of Welding (France) have developed methods to reduce the amount of harmful compounds in the weld metal, such as hydrogen, oxygen, sulfur, phosphorus, in order to achieve the required welding-technological characteristics, (Moscow State Technical University named after N. Bauman (Russia))) Scientists have determined the degree of dependence of the base metal, slag and metal bath masses due to the characteristics of welding electrodes for low-carbon and low-alloy steels, (Technishe Universitaet Wien (Austria)) arc with coated electrodes Experimental-theoretical methodology for determining the average and partial coefficients of transition of elements in butt welding was developed [4,5].

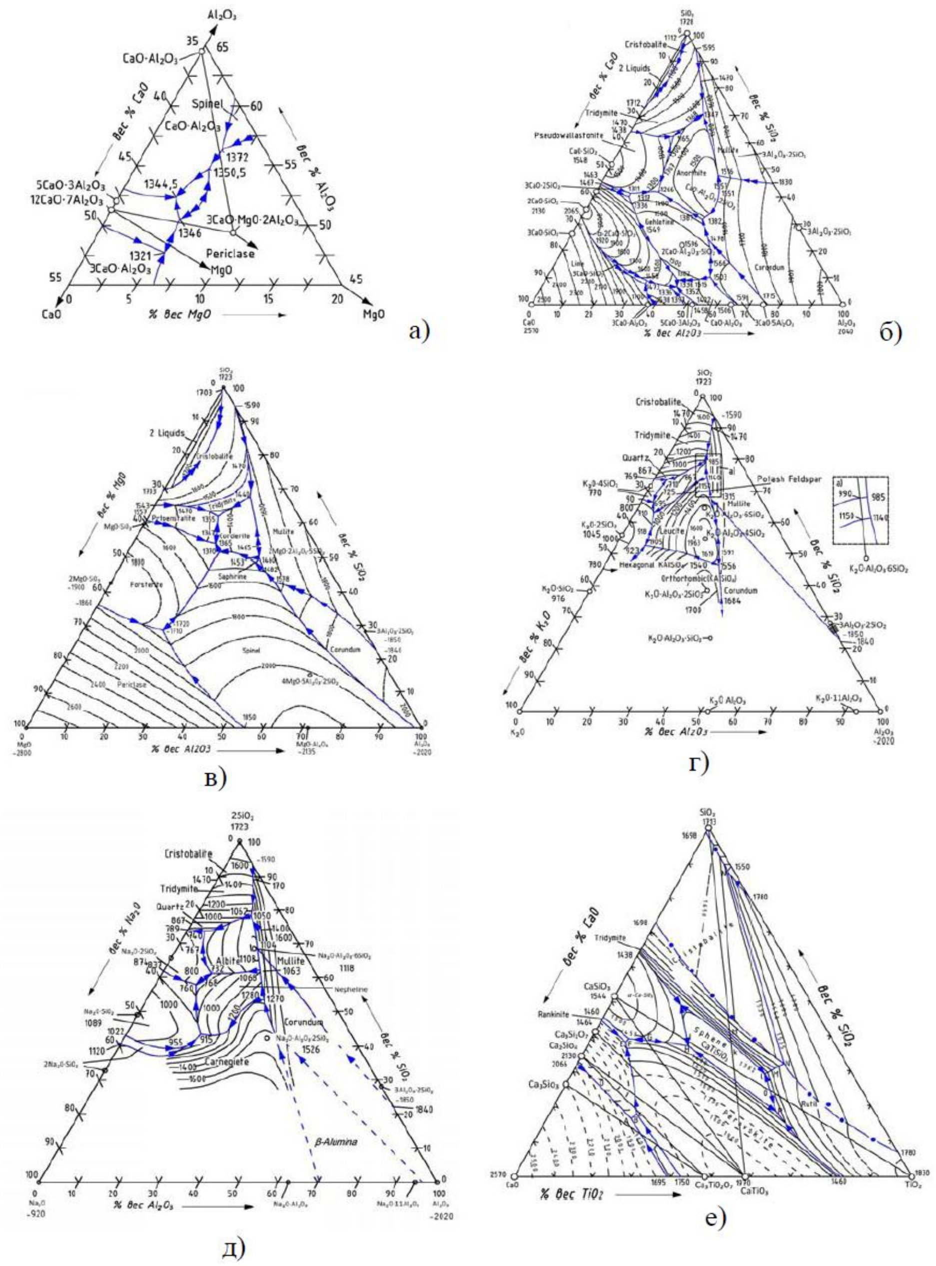
The degree to which the problem has been studied. In the world practice, the selection of primary mineral raw materials on the basis of experimental-statistical methods without the full knowledge of the phenomena with the development of a mathematical model that determines the optimal choice of component composition of the slag system. A lot of research has been done on. The world's leading scientists, including Italian scientists Ramini De Rissone and G. Glaussen, have developed the charge composition of electrode coatings for welding low carbon steels.

Indian scientists S. Majumdar and P. Kanjilal studied the “composition-property” relationship between weld metal and slag on the basis of thermal methods and developed coated electrodes for welding low carbon steels [6].

I.I. from scientists of the CIS countries. Frumin, G.L. Petrov, I.S. Ioffe, I.K. Походня, Э. Votinova, V.V. Podgaetsky conducted and developed research on the development of coating electrodes for arc-welded welding with physical and mechanical properties, given the comparison of the composition of the weld metal and the initial composition. Uzbek scientists M.A. Abralov, R.U. Abduraxmanov, R.M. The Saidovs developed electrodes for spring-arc welding of low-carbon and low-alloy steels.

The cycle of obtaining coated electrodes for arc welding includes a method of selecting the components of the electrode coating shaft on the basis of an improved classification scheme, taking into account their functional application, from their design (formation of high-characteristic weld seam) to production working technology.

Three-way systems of the melting diagram were used, taking into account the substantiation coefficient (Fig. 1) in the selection of the slag base of the electrode coating for spring-arc welding. These three-sided systems have an area where the melting temperature of the slag is 1300 ° C. This temperature satisfies students who are exposed to welding slag when welding steels [7].



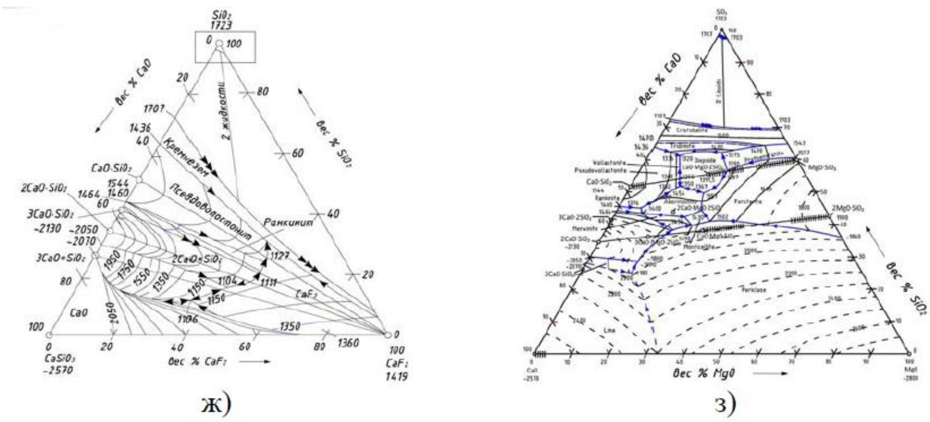


Figure 1. State diagram of three-dimensional systems: a) SaO- Al_2O_3-MgO, b) Al_2O_3-SiO_2-CaO, c) Al_2O_3-SiO_2-MgO, d) Al_2O_3-SiO_2-K_2O, d) Al_2O_3-SiO_2- Na_2O, e) SaO- SiO_2-TiO_2 j) SaO-SiO_2-CaF_2 z) SaO-SiO_2-MgO.

The melting point of SiO_2-SaO-MgO in the system is 1300 ° C, ie when the content is ~ 50% SiO_2, 30% SaO and 20% MgO, SiO_2-SaO-$A1_2O_3$ - ~ 50% SiO_2, ~ 30% SaO and ~ 20% $A1_2O_3$ is limited. SiO_2-SaO-$A1_2O_3$ forms several chemical compounds in the system, along with two or three chemical compounds. These are: $CaO \cdot Al_2O_3 \cdot SiO_2$, 20% CaO, 37% Al_2O_3 and 43% SiO_2 and soluble at 1550 ° C and $2CaO \cdot Al_2O_3 \cdot SiO_2$, 41% CaO, 37% Al_2O_3 and 22% SiO_2 with a melting point of 1590 ° C. (Figure 1). The observed system has a large area of melting temperature of alloys not exceeding 1600 ° C, which ensures the widespread use of slags based on SiO_2-SaO-$A1_2O_3$. The slag in this system is converted to powder on cooling when the SaO content is 48-54% [8].

In the SiO_2-SaO-CaF_2 system, which is the basis for the preparation of the main types of electrodes, the melting temperature ranges are much wider and the slag content is close to ~ 50-60% SaO, 15-25% CaF_2 and 5-15% SiO_2. In the arc zone, CaF_2 dissociates to form fluorine ions of fluorspar, thereby reducing the amount of hydrogen and sulfur in the weld metal.

The effect of K_2O, Na_2O, MgO, $A1_2O_3$ oxide additives on the SiO_2-SaO-CaF_2 system is the effect on the density of the slag (Figure 2) and the viscosity of the slag (Figure 3), as well as the separation of the slag (Figure 4) and the coating properties of the slag (Figure 5). researched. Experiments show that when the amount of K_2O and Na_2O is increased, the viscosity of the slag density and the separation of the slag shell decrease. When the amounts of MgO and $A1_2O_3$ are increased, the density and viscosity of the slag increase [9].

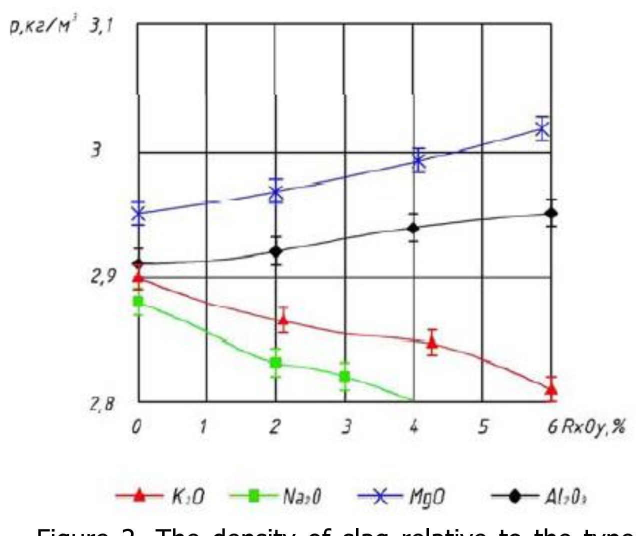


Figure 2. The density of slag relative to the type and amount of oxide in the slag in the system SiO_2-SaO-CaF_2

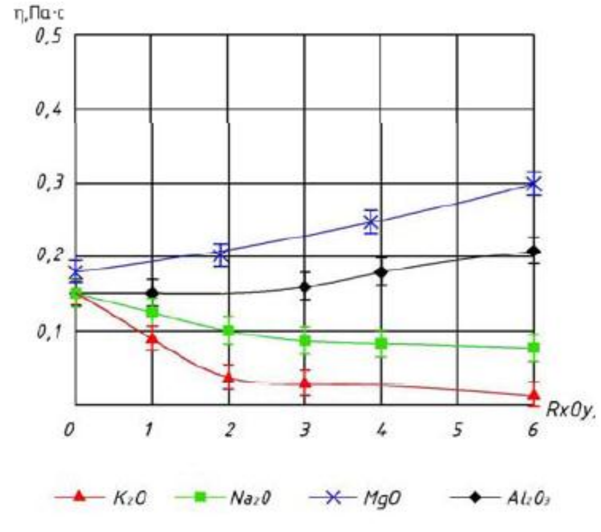


Figure 3. The viscosity of slag relative to the type and amount of oxide in the SiO_2-SaO-CaF_2 system is given.

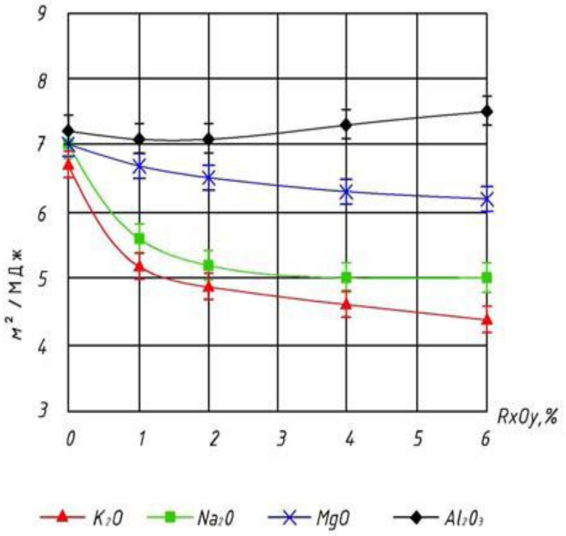


Figure 4. In the SiO2-SaO-CaF2 system, the separation of slag relative to the type and amount of oxide in the slag is given.

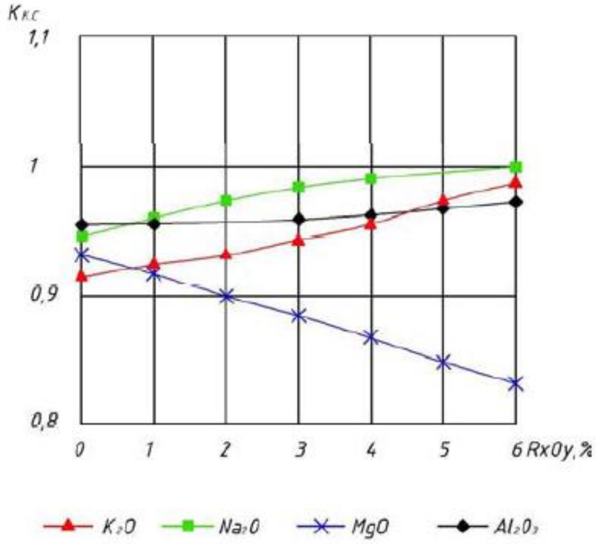


Figure 5. The SiO2-SaO-CaF2 system shows the slag coverage relative to the type and amount of oxide in the slag.

Studies have shown that the slag formed as a result of welding is formed in the cemented form of some glassy substances of the sum of the crystals of a separate solid phase. In the slag structure, dendrites, i.e., two calcium silicates, 2CaO · SiO2 are formed. These two complex constituents cause an increase in the temperature range of slag crystallization. This leads to a decrease in the concentration of large complex anions of silicon and reduces the viscosity of the slag. The conversion of the two calcium silicates into an increase in the slag volume results in the slag decomposition, which has a positive effect on the slag separation [10].

Some of the oxides do not decompose into separate solid phases, but instead form a vitreous halogen phase and remain liquefied. The presence of sparingly soluble phases in the slag under study leads to an expansion of the crystallization interval. That is, such conditions of crystallization lead to the formation of coarse-grained slag. The formation of complex phases in the slag composition forms insoluble constituents.

The properties of acid-type electrodes were studied:

№1 - J422 (JV LLC "Tashkent Pipe Plant"),

№2 - mas. %: feldspar (Lolabulak excavation site) - 21.0-24.0; dolomite (Dehkanabad mineral resources) - 13.0-15.0; kaolin (Angren mineral wealth) - 2.0-4.0; rutile - 32.0-35.0; ferrosilicon manganese - 20.0-23.0; cellulose - 5.0-6.0.

№3 - mas. %: feldspar (Lolabulak excavation site) - 21.0-24.0; dolomite (Chust deposit) - 13.0-15.0; kaolin (Angren mine) - 2.0-4.0; rutile - 32.0-35.0; ferrosilicon - 9.0-11.0%; ferromanganese - 9.0- 13.0%; cellulose - 5-6%.

№4 - mas. %: feldspar (Lolabulak excavation site) - 21.0-24.0%; dolomite (Shursuv deposit) - 13.0-15.0%; kaolin (Angren mine) - 2.0-4.0; rutile - 32.0-35.0; ferrosilicon - 9.0-11.0%; ferromanganese - 9.0-13.0%; cellulose - 5-6%.

Steel St3sp was selected for the preparation of weld specimens. Before welding, the electrodes were rolled at a temperature of 180-200ºC [11].

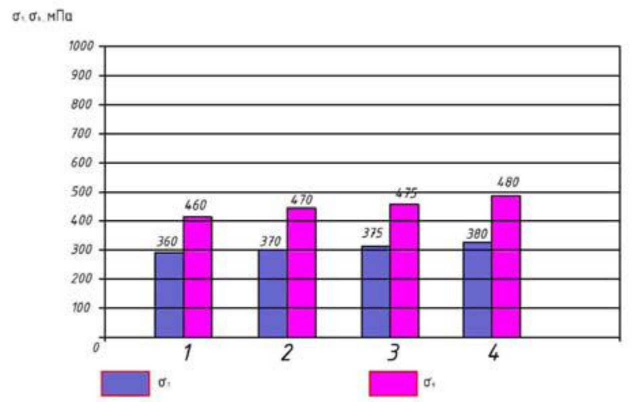


Figure 6. Histogram of values of yield strength and strength limit of welds made with electrodes 1-4

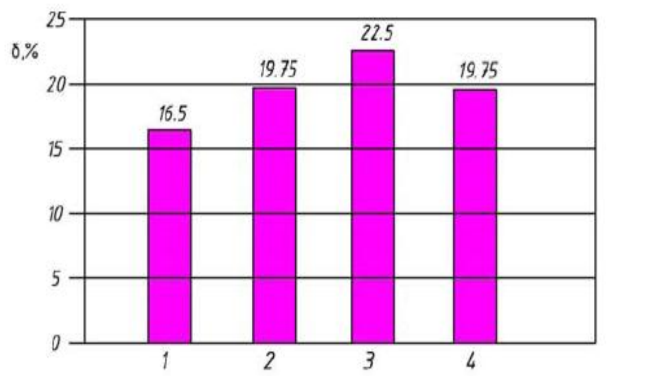


Figure 7. Histogram of the value of the relative elongation d of welds made with electrodes 1-4

Based on the results of the research, a technological guideline for the preparation of coatings for electrodes of basic and acidic types was developed.

CONCLUSION.

The reserves of mineral resources of the Republic of Uzbekistan are sufficient, they are the basis of welding materials (marble, dolomite, quartz sand, kaolin, feldspar). As a result, it is possible to improve the technological properties of slag in arc-welded welding of elements in the form of one-component (marble, quartz sand).

Scientific principles for the formation of multi-component coatings of basic and acid-type electrodes using local raw materials for welding low-carbon and low-alloy steels have been developed. The obtained results allow to predict the properties and composition of the cast structure of the weld and reduce the cost by 20-25% by reducing the performance of costly experiments using unique equipment.

Taking into account the basicity coefficient and solubility diagram, the slag-based compositions of base and acid-type welding electrode coatings based on local raw materials were recommended. As a result, the strength characteristics of the welded casting structure can be increased by 10-15%.

The technology of preparation of coatings for welding electrodes of basic and acidic types using materials with low ionization potential has been developed. This technology allows to increase the strength characteristics of the welded casting structure by 12-14%.

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