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Learning Chemical Characteristics of Low-Toxic Surfacing Electrodes For Welding, Improving The Plastic Properties And Effects To Welding Ability of The Electrode Coating Using Different Raw-Mineral Materials

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ABSTRACT: In the given article fluid flow in both the welding arc and the weld pool will be described and for the restoration of details from manganese steel, O3H-7 type electrodes are used which contain a significant amount of the ferroalloy Cr and Mn in the coating, which leads toa significant content of their oxides in the aerosol is given. In the work the components of the coating, their correspondences are reviewed and designed electrodes O3H-7M, which have ecological properties are responsible for sanitary and hygienic requirements.
The thermo-chemical slag–metal reactions here refer to thermo-chemical reactions that take place at the interface between the molten slag and the liquid metal. Examples of such reactions are decomposition of metal oxides in the flux, oxidation of alloying elements in the liquid metal by the oxygen dissolved in the liquid metal, and desulfurization of the weld metal.

KEY WORDS: welding electrode, slag-forming, deoxidizing, alloying, micro-alloying, refining components, binding components plasticizers, bentonite, kaolin, carboxylmethylcellulose, alkali-earth metals, manganese steel, surfacing electrodes.

I.INTRODUCTION

The usual welding electrode consists of metal core with a covering applied on its surface. The covering serves for improvement of arcing stability, creation of gas and slag protection of molten pool and weld metal, deoxidizing molten metal, alloying, micro-alloying and refining of molten pool. Composition of covering includes stabilizing or ionizing components, aerogenic and slag-forming components, deoxidizing, alloying, micro-alloying and refining components, binding components and plasticizers. Such subdivision is conditional, so as some components carry out several functions simultaneously.

Bentonite contains constitution water, evaporating at temperature of heating more than 640C, i.e. at rather high temperature. In this connection more perfect plasticizers are kaolin, talk and mica. The constitution water, containing in these minerals, increases oxidizing potential of a covering, thus providing intensive desorption of hydrogen at a stage of molten pool cooling and prevents formation of pores in weld metal. With increase of concentration of kaolin, talk, and mica in the electrode covering the transition of hydrogen in filler metal increases.

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II. LITERATURE SURVEY

In the last years, researching electrode coating have been widely implemented. The main work could be summarized into two categories: on the surfacing electrodes and on the welding electrodes.

According to M. A. Abralov, As materials of electrode coverings powders of various substances are used: minerals, ores, ore concentrates, ferroalloys, foundry alloy, pure metals, chemicals, silicates, carbonates, organic compositions etc. Plasticizers are substances, imparting coating better plastic and extrusion properties. In electrode manufacture the following plasticizers are used: minerals (kaolin, bentonite, talk, mica, vollastonite), organic (cellulose, starch, dextrin, wood flour, lignin, carboxylmethylcellulose, sodium and calcium alginates), chemicals (potassium sesquiwater, sodium ash).

In the work of Sindo Kou is given: "Decomposition of Flux suggested that in the high-temperature environment near the welding plasma, all oxides are susceptible to decomposition and produce oxygen. It was found that the stability of metal oxides during welding decreases in the following order: CaO, K_2O, Na_2O and TiO_2, Al_2O_3, MgO, and SiO_2 and MnO (FeO was not included but can be expected to be rather unstable, too)." The authors of many works on the welding metallurgy.

In the capital work of R. M. Saidov is said: “The formation of hydrogen in arch atmosphere occurs as a result of decomposition of constitution water. Taking into account that the content of hydrogen in metal filled by electrodes with the basic covering is controlled the use of kaolin, talk, and mica in coverings of these electrodes is rather limited. It concerns especially kaolin, in which content of constitution water surpasses more than threefold its content in talk and mica.”

III. METHODOLOGY

It is known that parts made of stainless steel manganese with hardening surfacing are widely used for the manufacture of working bodies of construction machines (bulldozers, excavators, grades, etc.), as well as in conditions of abrasive wear shock lands. When hardening parts from manganese steels by wear-resistant surfacing, their viscous shock-resistant core is preserved, and the cutting edge is protected from rapid wear, which increases their service life by 2-4 times. In addition, high-manganese steel undergoes phase hardening during operation, as a result of which its strength is significantly increased and the resistance to wear of deposited of machine parts increases. For example, to strengthen parts made of steel manganese, ОЗН-7. For example, to strengthen parts made of steel manganese, ОЗН-7 electrodes are successfully used. However, these electrodes contain a significant, which leads to the content of a significant amount of their oxides in the aerosol, while their sanitary and hygienic characteristics are higher than the maximum permissible concentrations (MPC).

Environmental issues in the welding and surfacing of manganese steels are especially important, since during the melting of these steels, a certain amount of manganese oxides enters the environment from the base metal, and its presence in the coating due to the low evaporation temperature leads to a high MnO content in the aerosol.

The choice of a combination of materials in the coating and their proportions and quantities found ensure the smallest loss of chromium during oxidation, which minimizes its content in aerosol vapor, therefore, it makes it possible to abandon the use of toxic manganese as a deoxidizer and improve the sanitary and hygienic characteristics of the electrode coating.

To improve sanitary and hygienic indicators, a rational replacement of manganese by nickel was performed. Alloying the deposited metal with nickel increases the residual austenite in the deposited alloy, which significantly increases the plastic properties of the alloy and resistance to shock with a high degree of dynamism and, therefore, resistance to operation.

A comparative assessment was made of the widely used ОЗН-7 electrodes for surfacing parts made of manganese steel, experimental electrodes with a low content of manganese components in the coating, imported German ITR-69 electrodes, standard УОНИ-13/55 and new modified ОЗН-7М electrodes. For comparison, the УОНИ-13/55 electrodes were chosen, since they give an undoped deposited layer and, therefore, minimal gas emission. Dust emission during welding was evaluated depending on the number of deposited layers (Table 1) and the thickness of the coating (Table 2).

It was found that dust emission, in addition to the composition of the coating, also depends on the number of layers during surfacing. In this case, the total level of dust on all layers of the surfacing electrodes is significantly

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higher than that of the welding electrodes of the УОНИ-13/55 type, and only the new ОЗН-7М electrodes are comparable in terms of dust emission with the УОНИ-13/55 electrodes,

Table 1

The dependence of the allocated amount of dust during welding from the number of deposited layers

Types of Electrode	Layer number	Current, A	Dust allocated		Deposited metal content,, %							
			[g] dust [kg] burned. electrodes	[g] dust [min]	C	Si	Mn	Cr	B	V	Ni	Ti
1st experiment	1 2 3	145	30,48 48,00 46,00	0,451 0,672 0,664	0,55	2,7	3,0	2,9	0,49	0.53	-	-
2nd experiment	1 2 3	140	20,30 23,34 27,65	0,291 0,320 0,373	0,57	1,40	0,42	2,97	0,48	0,40	1,15	0.07
3rd experiment	1 2 3	115	20,70 23,34 34,10	0,302 0,337 0,478	0,68	0,25	0,42	3,60	-	1,18	0,22	-
5th experiment	1 2 3	145	17,36 19,74 17,96	0,404 0,315 0,292	0,11	0,30	0,82	-	-	-	-	-
Note: Soder. the deposited metal is shown along the third layer of surfacing, the diameter of the electrodes is 4 mm, with the exception of the ITR-69 electrodes (3 mm)												

Table 2

Dependence of the allocated amount of dust on the thickness of the electrode coating

Electrode	Bushing diameter mm	Discharge dust	
		[g] dust [kg] burned. electrodes	[g] dust [min]
1st	5,7 5,9 6,1	46,78 46,45 45,91	0,689 0,683 0,661
2nd	5,7 5,9 6,1	28,98 27,76 27,65	0,384 0,355 0,320
3rd	5,0 6,0	19,83 16,27	0,233 0,200
Note: 1). Current at surfacing 140 A. 2). The allocated amount of dust was controlled on the third layer of surfacing.			

Changes in the thickness of the coating of the electrodes (table. 2) also significantly affect the amount of dust emitted during surfacing and welding. The thicker the coating, the less dust is released into the atmosphere. (table 2)

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Table 3
Dependence of wear resistance of deposited metal on the brand of electrode

Electrode	Single impact energy E, J/m^2	Hardness, HRC	Relative wear resistance	Note
O3H-7	0 1,0 2,5	51 59 63	- 4,00 3,85	No spalling or chipping
O3H-7M	0 1,0 2,5	50 58 65	- 4,30 4,00	-//-
110Г13Л (эталон)	0 1,0 2,5	26 39 42	- 1,00 1,00	-//-
T-590	0 1,0 2,5	60 59 58	- 1,80 1,10	Chips spalls on the surface shaped when E=2,5*10^{5}J/m^2

The wear resistance of the deposited metal during abrasive-impact wear, carried out on a Rotor machine, showed the following data (Table 3). As can be seen from the data obtained, the wear resistance of surfacing with O3H-7M electrodes is slightly higher than with the use of O3H-7 electrodes. Obviously, this is due to the greater resistance of nickel austenite compared to manganese. If we compare these two brands of electrodes in terms of wear resistance with the well-known T-590 electrode, then the resistance of new modified electrodes is 2.5-3.5 times higher when working in conditions of abrasive-shock wear. Thus, O3H-7M electrodes with a diameter of 5 mm are the best option. The microstructure of the deposited metal, consisting of a boride-carbide eutectic and an austenitic matrix, provides high strength characteristics and meets the sanitary and hygienic requirements for MPC in aerosol.

As a result, the following recommendations can be made:

For surfacing of parts from manganese steel and various structural steels, O3H-7M electrodes are preferred, which have environmental properties that meet the MPC (maximum permissible concentration) requirement.

High environmental properties in the modified electrodes are provided by a decrease in the content of Cr and Mn oxides in the aerosol due to the optimal quantitative and qualitative ratio of the components in the coating composition.

The metal deposited with O3H-7M electrodes has increased resistance in conditions of intense abrasive wear.

Designed for welding parts and parts that work in abrasive conditions of the deposited layer with moderate impact loads.

Brand: T - 590

Classification: Melting Electrode

Type of coating: Special

Type of welding current: alternating, constant direct polarity

Weld seam position: bottom

Description: T-590 electrodes are designed for welding parts, where work in abrasive wear with moderate impact loads [6].

T-590 electrodes allow to provide the deposited layer metal with high values of wear resistance under wear conditions with using abrasive material. The weld metal has tendency to form micro cracks, which, however, do not reduce, basic performance properties such as durability and performance overlaid parts [6].

Technological features of surfacing of electrodes T-590.

In order to avoid chipping of the deposited layer, it is recommended that weld steel parts in more than two or three layers, and products from cast iron - no more than one layer. For surfacing a thick layer the lower layers are deposited by electrodes of other brands, similar to the brand base metal.

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Mandatory calcinations before surfacing: 180-200 ° C; 2 h.

Table 4 - The chemical composition of the weld metal:

Chemical element	Not more,%
C (carbon)	3,2
Mn (manganese)	1,2
Si (silicon)	2,2
Ni (Nickel)	
Cu (Copper)	
Fe (Iron)	
Ti (Titan)	
Cr (Chrome)	25,0
Mo (Molybdenum)	
S (Sulfur)	
P (Phosphorus)	
B (Bor)	1,0

Melting characteristic: deposition rate - 9.0 g / A • h.

Surfacing performance (for diameter 4.0 mm) - 1.9 kg / h. Consumption

electrodes per 1 kg of weld metal - 1.4 kg.

In my practical work I am going to control quality of several points of welding joint and effects of chemical characteristics of low-toxic surfacing electrodes for welding, improving the plastic properties are described. Improving quality of coated electrodes for welding and surfacing is global issue, therefore this given materials are vital for welding society.

IV. EXPERIMENTAL RESULTS

Among organic plasticizers very effective are carboxylmethylcellulose, electrode cellulose, sodium and calcium alginates. Even at mixing them in amount 0,5-1,5 % the plasticity of coating increases sharply. However there is also sharp increase of hydrogen content in filler metal, that is especially inadmissible at the use of electrodes with the basic type of covering.

In this connection it seems perspective to use natural vollastonite – mineral, containing hydrogen and no constitution water and other substances. In the work vollastonite concentrate obtained from vollastonite ore of Koitash deposit was investigated. The content of vollastonite in the concentrate made 75%. Chemical composition: 48,60(%) SiO_2, 37,0(%) CaO, 6,62(%) Al_2O_3, 1,38(%) MgO, 0,72(%) Fe_2O_3, 0,55(%) Na_2O, 0,49(%) K_2O, 3,84(%) $MgCO_3$, 1,43(%) $CaCO_3$. The mixing of vollastonite concentrate in the covering of the basic type favours improvement of plastic properties of coating. It is connected to the strongly pronounced fibre-needle shaped form of particles: the relation of length of particles to width changes in limits from 3:1 up to 10:1. Moreover the arising shear stress is reduced at coating flow at pressing of electrodes and extrusion pressure accordingly.

V. CONCLUSION AND FUTURE WORK

Availability of oxides of alkali and alkali-earth metals in vollastonite concentrate facilitates ionisation of gas and promotes increase of arcing stability. Arch length of fracture was determined at welding on reverse polarity continuous current, supplying the arch from the welding rectifier of the mark BD- 302. At mixing vollastonite concentrate in the composition of covering of the basic type crushing of drops of electrode metal and obtaining weld metal with small- scales structure is observed.

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