INVESTIGATION OF DEPOSITED METAL WELDING-SURFACING CHARACTERISTICS BY USING OF SPECIAL COATED ELECTRODES

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Abstract: The article provides an analysis of the classification of welding electrodes for the restoration of worn machine parts made of steel grade of low-alloy steel.

Key words: low-alloy steel, recovery, electrode, wear resistance, deposited metal, ferroalloy.

Introduction. Low-alloy steel with hardening welding are widely used for the manufacture of working bodies of construction machines (bearing seats, pipe production rollers, etc.) operating under conditions of abrasive wear and shock loads.

When parts made of manganese steels are hardened by wear-resistant surfacing, their low impact-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 increases significantly and the wear resistance of non-deposited sections of machine parts increases.

The main part: For example, OZN-7 electrodes are successfully used to restore parts made of low-alloy steel. However, these electrodes contain a significant amount of ferroalloys (chromium and manganese) in the electrode coating, which leads to the content of a significant amount of their oxides in the aerosol, and the 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 when these steels are melted, a certain amount of manganese oxides passes into the environment from the base metal.

In order to create electrodes of the OZN-7 type with sanitary and hygienic properties at the MPC level in the aerosol, the coating components were changed and, due to their ratio, the content of chromium and manganese oxides in it was reduced. The presence of manganese in the coating due to its low evaporation temperature leads to a high content of its oxides in the aerosol.

The choice of a combination of materials in the coating and their proportions and amounts found provide the least loss of chromium for oxidation and lead to a minimum of its content in aerosol vapors, which 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, it is rational to replace manganese with nickel. Alloying of the deposited metal with nickel contributes to an increase in residual austenite in the deposited alloy, which significantly increases the plastic properties of the alloy and the impact resistance of a high degree of dynamic, and therefore, the service life.

A comparative assessment was made of the widely used electrodes OZN-7 in surfacing parts made of low-alloy steel and experimental OZN-7M electrodes with a reduced content of manganese components in the coating, imported German electrodes ITR-69, standard UONI-13/55. For comparison, UONI-13/55 electrodes were chosen, since they provide an unalloyed deposited layer and, consequently, minimal gas emission.

The emission of dust during welding was evaluated depending on the number of deposited layers (Table 1) and the thickness of the coating (Table 2).

Table 1

Electrode	Layer number	Current, A	Dust emission		Deposited metal content, %							
			[g] dust/[kg] burnt electrodes	[g] dust/[min]	C	Si	Mn	Cr	B	V	Ni	Ti
OZN-7	1 2 3	145	30,48 48,80 46,00	0,451 0,672 0,664	0,55	2,75	3,0	2,9	0,49	0,53	-	-
OZN-7M	1 2 3	145	20,70 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
ITR-69	1 2 3	145	20,70 23,34 34,10	0,302 0,337 0,478	0,68	0,25	0,42	3,60	-	1,18	0,22	-
UONI-13/55	1 2 3	145	17,36 19,74 17,96	0,404 0,315 0,292	0,11	0,30	0,82	-	-	-	-	-
Note: The content (average) of the weld metal is given for the third layer of welding, the electrode diameter is 4mm, except for the ITR-69 electrode (3mm).												

table 2

Electrode	Bushing diameter, mm	Dust emission	
		Burnt electrode	
OZN-7	5,7 5,9 6,1	46,78 46,45 45,91	0,689 0,683 0,661
OZN-7M	5,7 5,9 6,1	28,98 27,76 27,65	0,384 0,355 0,320

UONI-13/55	5,0 6,0	19,83 16,27	0,233 0,200
Note: 1. Surfacing current 140 A. 2. Dust emission was measured on the third layer of hard facing.			

Surfacing was carried out with direct current of reverse polarity. The intensity of dust emission was determined in two ways: the amount of emitted dust in grams, related to the number (in kilograms) of the electrodes burned in this case, the amount of dust (in grams), related to the unit of time (in minutes). As you can see, dust emission, determined in relation to the mass of burned electrodes, and in relation to time, on the first layer is noticeably lower than on the subsequent ones.

When surfacing alloyed metal (electrodes OZN-7, OZN-7M, ITR-65), the intensity of dust emission increases with an increase in the number of layers. When using electrodes UONI-13/55 (low-alloyed metal), it practically does not change. This is obviously caused by an increase in alloying in the second and third layers of the deposited metal. The distribution coefficient of alloying elements between the gas phase and the solid metal practically does not change, and the content of slag-forming elements increases.

Thus, it has been established that dust emission, in addition to the composition of the coating, also depends on the number of layers during surfacing. At the same time, the total level of dust on all layers of surfacing electrodes is significantly higher than that of welding electrodes of the UONI-13/55 type, and only the new OZN-7M electrodes are comparable in terms of dust emission to the UONI-13/55 electrodes.

We studied the effect of changing the coating thickness of experimental, OZN-7 and UONI-13/55 electrodes on the amount of dust released during welding and surfacing (see Table 2). For the manufacture of experimental electrodes, bushings of a standard diameter (6.1 mm) and a smaller one (5.9 and 5.7 mm) were used.

A change in the thickness of the electrode coating also significantly affects the amount of dust released during surfacing and welding. The thicker the coating, the less dust is released into the atmosphere. This is due to the fact that with an increase in the diameter of the sleeve, in order to maintain the level of alloying in the deposited metal, remixing is carried out in the direction of increasing the number of components of the slag protection. The number of charge components responsible for alloying the alloy does not change.

The analysis of the conducted studies showed that in order to obtain surfacing electrodes at the level of MPC in an aerosol, it is rational to reduce the manganese content. Components in the coating, replacing them with a small amount of nickel powder to austenize the weld metal. The environmental properties should not be changed by reducing the diameter of the sleeve and, accordingly, the diameter of the electrodes, so as not to worsen the gas and slag protection. Their comparative wear resistance was determined during abrasive-impact wear on the "Rotor" machine.

The tests were carried out with different energy of a single impact (table 3). As can be seen from the data obtained, the wear resistance of surfacing with new OZN-7M electrodes is slightly higher than with OZN-7 electrodes. Obviously, this is due to the greater resistance of nickel austenite compared to martensite. If we compare these two brands of electrodes in terms of wear resistance with the well-known T-590 electrodes, then their durability is 2.5-3.5 times higher when working under conditions of abrasive-impact wear. Thus, electrodes of high wear resistance OZN-7M have been developed and mass-produced, in terms of ecology at the level of MPC in aerosol.

OZN-7 and OZN-7M electrodes are successfully used for hardening and restoration of ripper tips of imported excavators, drilling augers and bits, excavator buckets, dredge scoops, parts made of low-alloy steel. Hardness in the second layer is 50÷55 HRC, wear resistance in the development of frozen soils of categories 4 and 5 is 2.5÷4 times higher compared to low-alloy steel and 2.5 times higher than known T-590 electrodes in abrasive-impact wear .

Table 3

electrodes	Single impact energy E, J/m^2	Hardness HRC	Relative wear resistance	Note
OZN-7	0 1,0 2,5	51 59 63	- 4,00 3,85	No chipping or chipping was observed
OZN-7M	0 1,0 2,5	50 58 64	- 4,30 4,00	Same
low-alloy steel (standard)	0 1,0 1,5	26 39 42	- 2,00 2,30	-
T-590	0 1,0 2,5	60 59 58	- 1,80 1,10	Spalls on the sample surface at E=2,5·10^5 J/m^2

So, the best option is the new OZN-7M electrodes with a diameter of 5 mm. In terms of price, they are at the level of industrial electrodes OZN-7 and are not inferior to them in terms of technological properties. The microstructure of the deposited metal, consisting of boride-carbide eutectic and austenitic matrix, provides high strength characteristics and meets sanitary and hygienic requirements in terms of MPC in aerosol. Electrodes OZN-7M are promising for wide application in many areas of industry.

Conclusion. 1. For surfacing parts made of low-alloy steel and various structural steels, OZN-7M electrodes have been developed and industrially tested, which have environmental properties at the level of world standards.

2. High environmental properties 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 components in the coating composition.

3. The coating composition of the proposed electrodes is selected taking into account the thickness of the coating of the electrodes.

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