CHARACTERISTICS OF GAS-GENERATING COMPONENTS OF ELECTRODE COATINGS AND INFLUENCE WELDABILITY

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Abstract. The processes of gas formation in the region of metal-slag-arc depending on the gas-forming components of coatings of surfacing electrodes have been studied.

Keywords: steel, manual arc welding, nitrogen, dissociation, carbonate, slag-forming, deoxidizing, alloying, micro-alloying, refining components, plasticity, wollastonite.

INTRODUCTION

Alkaline-earth (Ca, Mg) and alkaline (Na, K) metal carbonates provide gas protection for the surfacing zone and the molten metal of the core of electrodes of the main type. The oxide of alkaline earth (Ca, Mg) and alkali (Na, K) metals after the decomposition of carbonate takes part in the formation of surfacing slag [1-4]. 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[3-7].

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) [4-7].

MAIN PART

When creating a coating of surfacing electrodes, which ensures the production of a complexly alloyed deposited metal, it is necessary to reduce the amount of gas-forming components of the electrode coating. It is possible to optimize the gas-slag component of the coating by introducing alloying components (ferroalloys) into the composition of the electrode coating in the required amount[2-6].

This leads to a decrease in gas- and slag-forming components in the coating of the hardfacing electrode and is the reason for the deterioration of the protection of the deposited metal, leading to a decrease in strength properties and the appearance of internal defects. Ensuring reliable protection of the molten deposited metal from interaction with atmospheric nitrogen by optimizing the content of gas-forming and slag-forming components in the composition of the electrode coating is an urgent task.

To ensure the required degree of alloying, maintain protective properties, reduce the content of nitrogen and oxygen in the deposited metal, a composition of metal carbonates is used as gas-forming components, seeking to ensure uniform release of CO_2 in a wide temperature range from 400ºC to 1500ºC, guaranteeing the creation of reliable protection from the molten deposited air. metal.

The temperature range of carbonate dissociation expands. Thermal dissociation of carbonates in the composition begins at lower temperatures than for individual carbonates. In this case, in comparison with the use of a separate carbonate, the protection efficiency increases when using a composition of carbonates, and in the event that a separate carbonate has a larger amount of protective gases formed during melting and heating of the welding electrode. This is determined by the fact that the use of a composition of carbonates makes it possible to ensure a uniform release of protective gases in a wide temperature range, and when using a separate carbonate, the process of formation of a protective atmosphere occurs in a relatively narrow temperature range.

Given that the oxidation processes during the decomposition of carbonates develop much more slowly, it was found that the uniformity of thermal dissociation of carbonates improves the presence of fluorides in a mixture with them, which form a melt that initiates the development of gas formation reactions. A gas protective environment is created from a mixture of fluorides, the presence of which makes it possible to bind hydrogen in the melting zone and carbon dioxide.

Therefore, the simultaneous use of fluorides and carbonates provides reliable protection of the molten metal during the melting of the electrode coating and makes it possible to reduce the content of gas-slag-forming components to 6...8%.

The basis for the development of a rational composition of the gas-slag-forming part of the coating was the analysis of the data presented. To influence the uniformity and completeness of the decomposition of the gas-forming components of the electrode coating, the kinetics of gas formation, allows changing the content of the composition of gas-slag-forming components. As a gas-forming part of the electrode coating, based on the data on the temperature of dissociation of carbonates and the results of calculating the volume of released CO_2, the composition of mineral and organic raw materials, a mixture of carbonates $CaCO_3$, K_2CO_3, Na_2CO_3 and cellulose $(C_6H_{10}O_5)$ n, was used as an object of study (Fig. 1).

I. Mineral raw materials (carbonates of alkali and alkaline earth metals)						**II. organic materials**				
1	Marble for Welding Materials	4416-73	M97-P M92-P	$CaCO_3 \geq 97,0$ $CaCO_3 \geq 92,0$		1	Cellulose electrode	13-7308001-393-83	-	$(C_6H_{10}O_5)_n$
2	Crumb marble electrotechnical	16426-81	EMK-5 EMK-10	$CaCO_3 \geq 91,0$		2	Technical carboxymethyl cellulose	6-05-386-80	-	$[C_6H_7O_2(OH)_{3-x}(OCH_2COOH)_x]_n$
3	Marble fluorinated for welding consumables	5.965-11449-90	MF50N	$45,0 \leq CaCO_3 \leq 55,0$ $45,0 \leq CaF_2 \leq 55,0$		3	wood flour	16361-87	-	$(C_6H_{10}O_5)_n$
4	Flux limestones for steelmaking and ferro-alloy production	14-64-80	F-1	$CaO \geq 54,0$, $MgO \leq 3,5$		4	Lignin and cellolignin electrode	36.44.15.01-042-90	-	-
5	Chalk for electrode coatings	4415-75	-	$CaCO_3 \geq 96,0$						
6	Dolomite raw metallurgical	1484-82	-	$15,6 \leq MgO \leq 17,5$						

				$34,3 \le CaO \le 37,8$		
	Scheme of dissociation of carbonates:		**Carbonate**	**$T_{dis.}$, °C**		**Cellulose combustion reaction:**
	$MeCO_3 \rightarrow MeO + CO_2$		$CaCO_3$	880-1200		$(C_6H_{10}O_5)_n+6nO_2 \rightarrow 6nCO_2+5nH_2O$
	$CO_2 \rightarrow CO+1/2O_2$		$MgCO_3$	350-650		$CO_2 \rightarrow CO+1/2O_2$
			Na_2CO_3	1000		
			K_2CO_3	1200		

fig. 1. Classification of gas-forming components of electrode coatings of surfacing electrodes

In this case, the dependence of the N_2 content in the deposited metal on the percentage composition of cellulose, sodium, potassium, and calcium carbonates was revealed. When developing a mathematical model of the dependence of the nitrogen content in the deposited metal on the percentage composition of cellulose, sodium, potassium and calcium carbonates, 15 electrode coating compositions for manual arc surfacing were studied, in which the content of cellulose, carbonates of alkali and alkaline earth metals was varied. The content of the main slag-forming components CaF_2 and SiO_2 in the charge of the electrode coating is 48%.

The nitrogen content in the cast deposited metal was determined using an ON-3000 gas analyzer on special cut samples with a diameter of 4 mm no later than 36 hours after surfacing. Surfacing was carried out in the following mode: I = 200...240 A, UD = 32...34 V, V = 15.4 m/h.

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. [3-6]
In this connection it seems perspective to use natural vollastonite – mineral, containing hydrogen and no constitution water and other substances. In the work wollastonite concentrate obtained from wollastonite ore of Koitash deposit was investigated. The content of wollastonite in the concentrate made 75% (Fig.2.).

Chemical composition of wollastonite ($CaSiO_3$)

Composition	SiO_2	CaO	Al_2O_3	MgO	Fe_2O_3	Na_2O	K_2O	$MgCO_3$	$CaCO_3$
Percentage %	48,60	37,0	6,62	1,38	0,72	0,55	0,49	3,84	1,43

The mixing of wollastonite 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 [4-7].

CONCLUSION

Marble $CaCO_3$, magnesite $MgCO_3$, sodium carbonate Na_2CO_3, potash K_2CO_3, siderite $FeCO_3$, Wollastonite $CaSiO_3$ combined materials and carbonates of other metals are used as carbonates in the coatings of surfacing electrodes. This compositions of carbonates of alkali and alkaline earth metals reduced the content of oxygen and nitrogen in the deposited metal.

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