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Development of technology for the production of coated surfacing electrodes for wear-resistant surfacing

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ABSTRACT: This article describes the development of technology for the production of coated surfacing electrodes for wear-resistant surfacing

KEY WORDS: manual arc surfacing, electrode, technology,

I. INTRODUCTION

Today, on a global scale, manual arc surfacing has a wide field of application, effective in terms of technical and economic indicators. In this regard, ensuring the possibility of applying a metal layer of a sufficiently large thickness and obtaining the most diverse composition of the deposited metal is one of the urgent tasks.

In the world, research and development work is being carried out to improve the quality characteristics of surfacing electrodes based on the modernization of the composition of the coating mixture to reduce their cost. In this direction, including special attention should be paid to the optimization of the composition of the charge of the coating of surfacing electrodes. Among other things, it is considered important to improve the quality characteristics of the deposited metal due to the composition of the electrode coating charge.

II. LITERATURE SURVEY

Modern electrode coatings are complex multicomponent systems. The materials included in them perform a variety of metallurgical and technological functions. Only a rational combination of functions performed in one electrode by various coating components makes it possible to provide the desired properties of both the weld metal and the electrodes themselves. Often, the same components perform several functions at the same time. Therefore, their accepted division by purpose is conditional. [1].

Raw materials used for the manufacture of coatings for surfacing electrodes are subdivided into: mineral raw materials, ferroalloys, artificial chemical materials and organic substances. [2]

Research and development work is being carried out around the world to develop economical and environmentally friendly technologies for producing new welding consumables. In this direction, among other things, special attention should be paid to the problem of using ore and mineral raw materials without deep technological processing in the development of the composition of the charge for the coating of surfacing electrodes. [3]

In particular, it is considered important to create new, better surfacing materials, optimization of the slag base of electrodes for manual arc surfacing, development of methods for reducing the content of sulfur, phosphorus, oxygen and other harmful impurities in the weld metal in order to achieve increasing requirements for welding and technological characteristics [4]

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The composition of the electrode coating is determined by a number of functions that it must perform: protection of the welding zone from oxygen and nitrogen in the air, deoxidation of the metal of the weld pool, alloying it with the necessary components, and stabilization of the arc discharge. [5].

The production of electrodes is reduced to the application of an electrode coating of a certain composition to a steel rod. Electrode coatings consist of a number of components, which can be conditionally divided into ionizing, slag-forming gas-forming, deoxidizers, alloying and binders. [6]

III. METODOLOGY

The manufacture of coated electrodes was carried out by low-tonnage production and research of the technological properties of coated electrodes by pressing in the JV "Tashkent Pipe Plant named after V.L. Galperin ".
The process of making electrodes involves a series of strictly sequential operations for preparing the wire, coating components, dry mixture of components and coating mass, applying it to the rod, followed by drying and calcining the electrodes in order to impart the required strength to the coating.

With the help of special machines, wire of the Sv-09G2S brand for electrodes is pre-straightened, chopped into rods of the required length and thoroughly cleaned of scale, rust, oil and other contaminants.
Straightening and cutting machines straighten wire supplied in coils and cut it into measuring rods for electrodes, the length of which is determined by the composition of the wires (its electrical resistivity) and diameter.

In all cases, straightening is carried out by a fast-rotating drum with straightening breadcrumbs. The wire unrolling from the reel is pulled into the drum, where, passing between the right breadcrumbs rotating at a speed of 3560-8000 rpm, it bends many times with residual plastic deformation and leaves the drum straightened.
Cutting is carried out on a machine with a guillotine cut using a guillotine, which moves during the cutting process at the speed of drawing the wire and then returns to its original position.

Finished rods must meet the following requirements:
1. Limit deviations of the length of the rods must correspond to the standardized maximum deviations of the length of the electrodes and should not exceed 3.0 mm for electrodes of the first group and 20 mm for electrodes of the second and third groups.
2. The deflection boom must meet the following requirements (table 1.):

Table 1. Permissible deflection boom, mm

Rod length, mm	250—300	320—350	360-400	410-450
Permissible deflection boom, mm, no more	0,5	0,6	0,7	0,8

3. The size of the burrs and waviness of the rods should ensure the possibility of their free passage through the control sleeves 60 mm long (Table 2).

Table 2. Internal diameter of the control sleeve, mm

Rod diameter, mm	2,0	2,5	3,0	4,0	5,0	8,0
Control sleeve inner diameter, mm	2,05	2,55	3,1	4,1	5,1	8,15

4. The angle of the wire cut in relation to the axis of the rod for all diameters should be within 72-90 °. The cut angle is controlled by a template.
The developed electrodes for wear-resistant surfacing have the following coating composition, wt. %: graphite battle - 8-10, marble (Sovuk bulak) - 10-12; quartz sand (Kulantayskoe) - 3-5; pegmatite (Ketmenchinsky) - 5-7, fluorite - 3-5, silicon carbide - 8-10; ferrosilicomanganese (Uzmetkombinat) - 8-10, ferrochrome - 26-30; ferrotitanium - 8-10, starch (rice) -1-3.

Recycling of electrode coating materials:
1. Washing of lump materials of electrode coatings. Some materials of electrode coatings come into production with significant contamination. This, first of all, applies to lumpy ore and nonmetallic materials supplied in bulk, such as

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marble, silicate lump, fluorspar (lump), etc. Whatever the nature of the pollution, they are completely unacceptable in the production of electrodes of all purposes and brands. Therefore, the recycling of contaminated materials must begin with rinsing.

2. Shredding of materials. For materials used for the manufacture of electrode coatings, operations of coarse crushing, medium crushing and grinding are required. For the materials used for the manufacture of electrode coatings, operations of coarse crushing, medium crushing and fine crushing are required, followed by classification to separate the material of the required granulation.

For coarse crushing, a jaw crusher is used, which provides, along with high productivity, and a high degree of reduction - in the range of 5-6 (the degree of reduction is the ratio of the size of a piece of material before and after crushing). They usually effectively crush fragile materials into pieces ranging in size from 150-250 mm to 10-30 mm. The crushing process is reduced to crushing pieces of material between the cheeks (ribbed plates), of which one performs rocking movements, providing periodic convergence and divergence of the cheeks, and the second is motionless.

For medium crushing, the most commonly used crushing rollers are with smooth rolls. Crushing is carried out by passing the brittle material through rollers with a set gap adjustment. The initial size of the pieces fed into such rollers, depending on their design and the power of the electric motors, can be from 3 to 50 mm. The particle size after milling in the rollers is usually 2-10 mm.

Drying of materials. Before fine grinding, a number of materials must be dried to remove moisture. When grinding wet material, it can clump, stick to the lining of mills, and accumulate in transport systems. Moistened materials will clog the sieves during screening and grading. The crimpability of electrodes using wetted materials is significantly impaired. The drying temperature depends on the properties of the material: for example, marble, in order to avoid its dissociation, should be dried at temperatures not exceeding 650 ° C.

Fine grinding. Ball mills and rod mills are distinguished depending on the type of grinding media used in the fine grinding equipment. In the first, steel balls serve as grinding bodies, in the second, metal rods.
When grinding some ferroalloys, mainly ferromanganese, one should beware of explosions of fine dust suspended in the air. For this, a ready-made powder of an inert material is usually added to the loaded material, which is then taken into account when mixing. So, when grinding ferromanganese, fluorspar is added to it.

Classification of crushed materials. The purpose of the classification is to sort the material according to the size after crushing or grinding. To accomplish this task, screens are used (to separate lumpy material), and for small material - sieves of various designs or air classifiers (separators).

The most widely used are mechanical and vibrating sieves. Usually, when sieving on sieves, two classes are obtained - oversize with a particle size larger than the sieve mesh size and undersize with a particle size less than the sieve mesh size. The performance of the sieve is determined by the characteristics of the mesh. Usually brass or stainless steel meshes are used.

Many materials used as components of electrode coatings interact with aqueous solutions of water glass that have an alkaline reaction. This primarily applies to some metals and ferroalloys. Materials such as ferrosilicon, low-carbon and medium-carbon ferromanganese, ferrosilicon-manganese, etc., react with liquid glass with the release of hydrogen.
The activity of the listed materials depends on their chemical composition. For example, the activity of ferrosilicon increases with increasing Si content. With a content of 25-30% Si, it is practically all in the form of iron silicides FeSi. Therefore, the activity of such ferrosilicon is low. As the Si content increases, the activity of the ferroalloy increases continuously, and at a Si content of 75% (FS75 grade) its use is practically impossible.

As a result of reactions occurring between liquid glass and active materials, the coating mass loses its working properties, and the coating applied to the rod swells. In this regard, the strength of the coating drops sharply and does not meet the requirements of the standard.
The degree of interaction depends not only on the chemical composition of the material used; it is largely determined by its granulometric composition, as well as the modulus of the liquid glass used.

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The thinner the crushed material, the more developed the surface of its interaction with liquid glass. The lower the modulus of liquid glass, the greater its alkalinity and, therefore, the higher its chemical activity. An increase in temperature also promotes the development of appropriate chemical reactions.

By pretreating powder materials, their activity can be reduced when interacting with water glass solutions. These processing methods include:
- water method of passivation, in which the powder material is treated with water, or better - with an aqueous solution of strong oxidants (potassium permanganate $KMnO_4$ or chromium peak $K_2Cr_2O_7$);
- passivation by heating powder materials in an oxidizing atmosphere;
- long-term exposure of the crushed material before its use (slow passivation with atmospheric oxygen).

The preparation of a dry batch of electrode coatings is one of the most critical processes in the production of electrodes. Only with the exact execution of all operations of this process can a consistently high quality of electrode products be ensured. Dry batch preparation includes:
- weight dosage of components in accordance with the formulation of coatings for specific brands of electrodes;
- mixing of the suspended components in order to distribute them uniformly in the dry charge by weight;
- control sieving of the dry charge, which guarantees the absence of coarseness and foreign inclusions.

Surfacing electrodes are made by crimping. This can be done only under the condition that the coating mass applied to the electrode rods has certain properties, the main of which are:
- high plasticity, that is, the ability to flow out of the press head at a constant speed, providing a uniform arrangement of the coating on the electrode rods;
- the ability to maintain plasticity for a sufficiently long time, at least for the crimping cycle;
- the ability to provide a sufficiently high hardness of the coating, which makes it possible to transport the electrode and clean its ends without damaging the coating; - the ability to ensure the stability of the wet coating against softening, swelling, as well as against crushing under its own weight on the conveyor chains when heated in the drying zones of the conveyor oven; - the ability to ensure the resistance of the electrode coating against the formation of cracks during the drying-calcination process; - the ability to provide high strength and the required moisture content of the coating of finished electrodes.

Preparation of the coating mass is carried out in the following sequence:
The dry charge poured into the mixer is leveled for 10-15 s. Liquid glass is poured onto the dry charge in the amount of 95–97% of its mass; dry charge is mixed with liquid glass. 1-2 minutes before the end of mixing, introduce the last portion of liquid glass (3-5%). Do not pour liquid glass into the mixer in small portions, this can lead to the formation of lumps from a sticky thick coating mass, moistened on the surface with the last portions of liquid glass.

The finished coating mass should clump in the hand under strong squeezing, and when it is shifted between the thumb and forefinger, the mass flow should be observed. The finished coating mass is poured into a suitable container and sent to subsequent operations: making briquettes or, if there are no briquette presses, directly to pressing.

At the present time, the coatings are applied to the rods practically only by the method of high pressure crimping on special units. Electrode-coating units mechanically feed electrode rods into the press, which come individually from the hopper to the conveyor for feeding them into the coating head. The coating mass is fed by piston pressure into the head from the press cylinder, where it is loaded in the form of briquettes.

At the exit from the coating head, the electrodes are calibrated with a calibrating sleeve (die) made of hard alloy. Its inner diameter determines the outer diameter of the finished electrode. Leaving the coating head at a speed of 150–800 pcs/min, the electrodes have a relatively strong coating. They go to the transceiver conveyor, which serves to receive electrodes from the electrode coating press and transfer them to the conveyor of the cleaning machine. The stripping machine is designed to remove the coating from one end of the electrode under the electrode holder and to clean the end of the other end. After the stripping unit, the electrodes, as a rule, immediately go to heat treatment.

Heat treatment of electrodes is carried out with the aim of imparting sufficient mechanical strength to the coating with a moisture content in it within the limits contributing to the normal course of the welding process, allowing to ensure the specified chemical composition and properties of the deposited metal and welded joints. Typically, thermal conditions for calcining electrodes made using liquid glass solutions as a binder, along with mechanical strength, provide moisture resistance of the coating (except for cellulose electrodes).

The complete cycle of heat treatment includes preliminary drying, final drying, calcining and cooling. Immediately after crimping the electrodes, the moisture content of the coating is 9–12%. The permissible moisture content after heat treatment depends on the type of coating. So, electrodes with a basic coating should have a moisture content of no more than 0.2% of the coating mass. In this case, the determination of moisture content is carried out at 400 ± 10 ° C with bringing the coating sample to constant weight. To ensure the specified humidity, the electrodes must be baked at high temperatures (260-300 ° C) for a sufficiently long time.

IV.CONCLUSION

In the course of the research carried out,
- technology for preparing coatings of surfacing electrodes from local raw materials;
- the composition of the slag base of modern import-substituting surfacing electrodes;
- the composition of the slag-forming components of the electrode coating increases the wear resistance of the deposited metal in conditions of abrasion by abrasive materials by 13-15%.

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