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Investigation of the Process of Electric Contact Surface

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ABSTRACT: This article presents the physical and mechanical processes that occur during electrocontact surfacing, the advantages of this method and the main parameters of the mode

KEY WORDS: surfacing, electrocontact surfacing, pressure, current strength, bimetallic product

I. INTRODUCTION

Metal surfacing is an effective way to extend the service life of machine parts and mechanisms. At present, metal surfacing is an important branch of welding production. With the use of surfacing, complex problems have been solved in the production of power plants, metallurgical equipment, parts of soil-cultivating machines. Surfacing during the repair of worn parts of machinery and equipment is 72.3% of the total volume of surfacing works (27.7% are for the manufacture of new products). [1]

However, the possibilities of increasing the efficiency of the production of machine parts and especially their repair using various types of surfacing are far from being realized. The complexity of repairing machines is several times higher than the complexity of their manufacture. To a large extent, this is a consequence of the imperfection or low efficiency of the existing methods of surfacing parts. So, with electric arc surfacing methods, the thermal effect on the metal of the part is significant, leading to undesirable, and in some cases, unacceptable structural changes and, as a result, to softening. Many surfacing methods are inefficient, especially when repairing parts with low wear. Permissible gaps in the interfaces of modern machines are constantly decreasing, therefore, the number of parts requiring repair with low wear is increasing. Finally, all electric arc surfacing methods are accompanied by intense light radiation, and also pollute the atmosphere with gases. [2]

One of the promising ways to build up metal on the surface of products is electrocontact surfacing. This method consists in contact welding of steel wire or tape.

II. LITERATURE SURVEY

Electrocontact surfacing is carried out on a special installation by joint deformation of the deposited metal and the surface layer of the base metal, heated in the deformation zone to a plastic state by short (0.02–0.04 s) current pulses of 10–20 kA. As a result of each of the successive electromechanical cycles of the process, a single area of deposited metal is

formed on the surface of the base metal, overlapping the neighboring ones. The deformation of the deposited metal per cycle is 40–60%. [3]
Advantages of electrocontact welding:
1. High productivity and low energy intensity of the process of building up a metal layer in the solid phase.
2. The minimum zone of thermal influence of the current on the metal due to the extremely short (up to thousandths of a second) duration of the pulses generated by modern current interrupters.
3. There is no need for a protective environment due to the short-term thermal effect on the filler metal.
4. Absence of powerful light radiation and gas evolution. [4]
Electrocontact welding is used to repair metal surfaces and obtain bimetallic products.
The engineering and repair practice of using various surfacing methods is represented by a large number of different specific tasks, each of which has its own optimal scheme and sequence of technological operations of the surfacing process, that is, its own technological option. [5]
Each of these options, taking into account the specific features of the welded product (design features, metal properties, dimensions of the required deposited metal layer, allowable heating, etc.), differs in the scheme of applying filler metal beads, the scheme for including the deposited product in the electrical circuit of the welding current, the number of simultaneously operating electrodes and the trajectory of their movement, the nature of the preliminary preparation of the surface of the product for surfacing. Finally, taking into account the specific features of the welded products, standard or non-standard technological equipment is designed. Recommendations on the mode of cooling are being developed. The values of the main process parameters are determined by calculation and verified by experience. [6]

III. METODOLOGY

Welding of metal layers for the repair of worn parts or obtaining monolithic surface layers with special properties is carried out by electrocontact welding on special installations. Usually wire, tape are welded to the main part, powder is baked.
The most common wire welding scheme. A continuous metal layer is formed on the part by spiral overlapping beads as the part rotates. The wire is fed by a guide sleeve. Welding current comes from the transformer to the workpiece and freely rotating roller, to which Fw is applied from the pneumatic cylinder through a spring shock absorber. Heating and severe plastic deformation destroy the oxide films in the part-to-part contact and lead to the formation of a metallic bond in the solid state.
With the correct choice of the speed of rotation of the part v_{sv} and the longitudinal movement of the roller v_{prod}, as well as the welding mode, each turn is connected to the adjacent and to the base metal, forming a continuous metal layer.
Welding strip instead of wire improves productivity, but plastic deformation conditions are less favorable. They are sufficient for melting and displacing fusible oxides from the part-to-part contact and for the formation of bonds only in the welding of steels. Sometimes a previously polished and degreased surface is wrapped with a wide tape - a sleeve, and then it is welded. In this way, steel sleeves are connected (with special roller pliers) to the body of the cast-iron cylinder block of tractors. The gap between the ends of the sleeve should be no more than its thickness (0.3-1 mm). First, it is grabbed around the circumference in the middle. Then start welding from the edges with overlapping points. The seams overlap by 25%. The connection is usually formed with melting, but may also be partially in the solid state.
A distinctive feature of the process is that the formation of the compound occurs in the solid phase, which makes it possible not to mix the filler and base metal. The surface layer of the base metal and the filler metal is heated to a plastic state by short 0,02 – 0,04 sec current pulses of 10 - 20 kA.
The advantages of this method in comparison with arc welding methods are:
1. The minimum zone of thermal influence due to the short duration of the current pulses and the absence of deformations;
2. High productivity of the process up to 200 sm^2 of coating per minute;
3. Lack of powerful light radiation and gas emission;
4. No need for a protective environment due to short-term thermal effects.

They intensify the process and increase the strength of the connection by pre-notching, creating reliefs on the wire or part (heat release is localized), preliminary cold deformation of the wire with a roller without current (diffusion processes are activated, for example, recrystallization).
Electrocontact welding can be used to obtain coatings with a thickness of 0,2 mm. The features of heating are determined by the shape change of the surfacing zone, the nature of the deformation and the conditions of heat removal. The heating zone of the base metal to the temperature of structural transformations extends no deeper than 0,3 mm, which is 6–10

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times less than the propagation depth of the heat-affected zone during electric arc surfacing. The filler wire and the base metal in the contact zone are heated to temperatures of 1400 - 1500° C in 0,02 – 0,04 s.
The connection of metals in the solid phase during plastic deformation occurs due to interatomic forces of interaction. The deformation parameters are the value ε and the speed v, which should provide a given thickness of the metal layer and its connection with the surface of the product. At a certain thickness of the coating metal layer h, that is, a given value of wire deformation, the interaction conditions can be provided by an appropriate choice of temperature and strain rate. These conditions can also be provided by choosing the wire diameter, which determines ε and v for any h at constant temperature and pressure.
The properties of the deposited metal in electrocontact welding are determined by the chemical composition of the filler metal. Carbon steels under severe conditions acquire the maximum hardness of hardening. Mild steels practically do not change hardness after surfacing. Electrocontact welding makes it possible to deposit metal layers without mixing with the base metal, which is important when forming layers with special properties. One of the characteristics of various surfacing methods is the degree of reduction in the fatigue strength of the deposited parts, which depends on the state of their surface before surfacing and subsequent machining.
The fatigue strength of samples deposited by electrocontact method was determined from the data of tests of samples for bending with rotation with a sign-changing symmetrical stress cycle. When the joint zone was cooled with water, the fatigue strength decreased by 20–25%. This is explained by the fact that during electrocontact surfacing, when the metal cools, compressive stresses arise, the magnitude of which depends on the mode. With electric arc methods, on the contrary, during the crystallization of liquid metal, tensile stresses are formed, which contribute to a greater decrease in fatigue strength.
In the restoration and manufacture of parts, metals and alloys are used that have different physical, mechanical and electrophysical properties. To study the nature of the interaction of metals in the process of surfacing, the method of successive detachment of a single area is used. With an equal strength connection, the deposited metal is completely removed from the base metal. If the strength of the additive is greater than the strength of the base metal, then tear marks are observed on it. This method allows one to qualitatively evaluate the processes occurring on the surface of the samples.

The main parameters of electrocontact surfacing:

1) pressure created by the electrode:

$$v = 0,55 g d^2 (D \cdot ar\cos(1 - (d - \delta)/D))/\delta ,$$

где g – давление, равное 8-9 кгс/мм^2;
where g is a pressure equal to 8-9 kgs/mm^2;
D is the part diameter, mm.
δ - thickness of the deposited bead, mm.

2) current value:

$$I_э = \sqrt{\frac{Q_{об.э}}{0,24 R_э t_э}} ,$$

where $Q_{ob.e}$ is the amount of heat for surfacing a single area of a given thickness, J;
R_e is the resistance of the chain section of the surfacing roller-detail, Ohm;
t_e is the duration of the current pulse, s

IV.CONCLUSION

Electrocontact welding is used primarily in the restoration of precision parts due to the possibility of applying a thin metal layer of 0,1 mm, as well as to increase the corrosion resistance and wear resistance of surface layers.

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