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The Experience of Using Polymer Coolant in Electrical Contact Baking

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ABSTRACT: The article presents the results of experimental work on the use of an aqueous solution of sodium carboxylmethyl cellulose as a coolant in electric contact baking. The data obtained show the absence of deformation of the restored long parts. Studies on the effect of coolant on phase and structural transformations.

KEYWORDS: electrical contact baking, cooling rate, thermal effect of transformation, ductility, impact strength, sodium carboxylmetrylcellulose.

I. INTRODUCTION

Recently, in the world practice for heat treatment, cooling liquids in the form of aqueous solutions of polymer compounds are increasingly used [2,3].
The use of aqueous solutions of polymer compounds (VRPS) helps to reduce the cost of purchasing quenching media, since they are several times cheaper than mineral oils used in many enterprises for heat treatment. Sanitary and hygienic conditions in thermal workshops are also being improved, fire risk, costs of regeneration using mineral oil, toxicity of vapors released into the atmosphere are excluded.

The purpose of this work is to analyze the experience of using VRPS based on sodium carboxyl methyl cellulose (Na-CMC) in electrocontact baking (ECP). The composition of the aqueous solution is given in[1].

II. RESEARCH METHODOLOGY

Experiments of the process of the effect of VRPS during ECP have shown that it occupies an intermediate position in cooling capacity between mineral oil and water.

Cooling interval, ℃	Average cooling rate V_a, ℃/c		
	Oil	Water	Na-CMC
850-500	8,1	9,2	4,3
500-300	8,8	9,4	3,6

The cooling rate was measured for samples made of steel 45 with a diameter of 50 mm.
The cooling rate was monitored by type XA thermocouples and a KSP-4 electronic self-cleaning device.

The preparation of coolant during ECP includes the following operations: preparation of a 1-1.5% aqueous solution of sodium carboxylmethyl cellulose, then for 72 hours, the solution is continuously moved by a circulation pump. The process of depolymerization of the solution occurs within 20 days. The solution does not move during depolymerization; it is at rest.

Investigations of the effect of VPS on the process of compound formation during ECP and the effect on the properties of the base metal from steel 45 revealed that by changing the solution concentration it is possible to significantly improve the properties of both the baked layer and the base metal.

Borax is added to protect against corrosion. It is known that when restoring the dimensions of worn parts during ECP, various materials in the form of tapes, wires, metal powders, etc. are used to form the working surface. At

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the same time, the restored surface must have high wear resistance and hardness with antifriction properties, while maintaining the so-called “hereditary” structure and properties.

III. RESEARCH RESULTS AND DISCUSSION

Tests were conducted to improve the quality of the coating on samples made of hardened steel 45.

The peculiarity of the ECP of parts such as bodies of revolution with limited dimensions is that the process is accompanied by high heat input per unit volume and for a short period of time, greatly affecting the quality of the coating-substrate connection.

It was revealed that the limited volume of parts during the baking of hollow parts, such as bushings, flanges, with a diameter of less than 60 mm, creates a blockage to the heat flux before the movement of the heat-roller source, which prevents the growth of austenitic grain. Crucial in the distribution of heat is the diameter of the part and the wall thickness. With decreasing diameter and wall thickness, the maximum temperature rises, the heat sink intensifies, which contributes to the appearance of quenching structures. The heat generated that accompanies the ECP process leads to overheating of the metal of the loss and squeezing it out from under the roller. Therefore, the ECPP process is carried out using concomitant cooling. In this case, the cooling rate should be less than the critical cooling rate. Otherwise, unfavorable structures arise in the heat affected zone, creating the danger of the formation of quenching metal structures.

The studies were carried out using an aqueous solution of Na-KMTs as a coolant, the composition of which was developed during the experiments.

Coolant supply was carried out according to the scheme shown in Fig. 1.

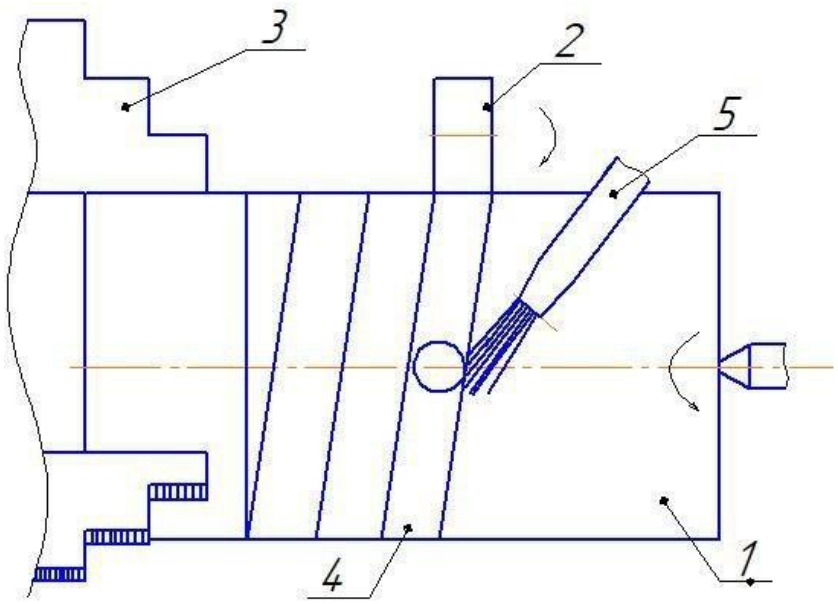

Fig. 1. Coolant supply circuit

1- Detail
2- Roller
3- Cartridge
4- Adhesive layer
5- Coolant supply

Coolant is supplied to the zone, the connection in the course of baking. This eliminates the ingress of fluid along the contact line of the roller-part. The fluid supply begins after the first 4-7 turns are baked, depending on the magnitude of the current and the diameter of the part.

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Reducing internal stresses significantly increases the reliability and durability of the restored parts using the EPC method. Along with an increase in toughness during cooling with VPS, an increase in the strength characteristic is observed as compared to cooling in oil: σb-20-25%, ductility δ-20-50%, φ-30-60%. On the samples cut from the metal of the shaft of steel of grade 45, cooled in the VRPS and oil environment, an increase in the ductility of the base metal compared to cooling in oil is seen.

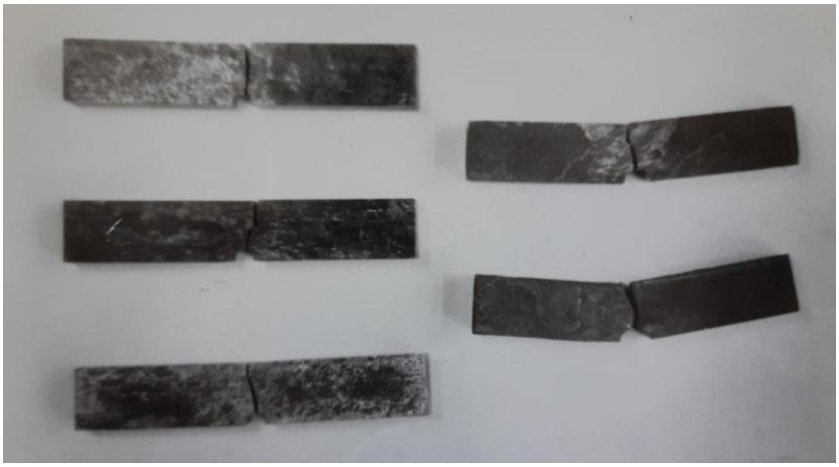

Fig.2. The influence of the cooling medium on the toughness of the samples

On the left are samples cooled in oil
On the right is cooling in the VRPS medium.

Tests for impact bending found that the use of Na-CMC-based coolant significantly increases the impact strength. The increase in impact strength is associated with an increase in the ductility of the base metal in the coating-component joint zone and reduces internal stresses, contributes to an increase in the endurance limit of the restored parts.

A further increase in impact strength can be achieved by surface plastic deformation (PPD) after ECP. The PPD was carried out at a current strength of 30-35% of the magnitude of the current sintering and with forces of 0.5 Rs. By applying various combinations of the current strength of the pressing force and the PPD, it is possible to increase the endurance limit of the restored or hardened parts. The test results are shown in the table:

№	Processingscheme	The average value of impact strength, a_n , J/m^2
1	Liquid supply to the contact zone of the roller-part	0,21
2	The fluid supply according to the proposed scheme	0,94
3	Fluid supply according to the proposed scheme and PDP	1,2-1,3

IV. CONCLUSION
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1. The use of a cooling liquid based on an aqueous solution of sodium carboxylmethyl cellulose has been shown to effectively increase the mechanical properties of the base metal of the restored parts during ECP.
2. A significant increase in the toughness of the metal of the restored part increases the endurance of the parts.

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