Improving the quality of surfaces of products obtained by electroerosion treatment

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Abstract: The use of electroerosive processing in production helps to achieve the desired results: high processing accuracy, low roughness of the treated surface and low dependence of productivity on the mechanical properties of the processed materials. Despite this, the need for effective processing of parts and improving the technological process of electroerosion treatment is an urgent topic for research. The trouble-free and long-lasting operation time of machine parts largely depends on the quality of the surface layer. Therefore, it has a high demand, since it is all the destruction begins with the surface.

To improve the quality of the surface layer, you can use both conventional methods under certain conditions, and special hardening methods of processing. The use of hardening methods helps to increase the durability of the machine, reduces the need for spare parts and materials, and reduces the cost of manufacturing and operating machines. According to some experts, when the reliability of equipment increases by 5%, the company's profitability increases by more than 30%.

Many years of experience in research on improving the quality of operational properties of parts shows that it is necessary to carry out processing with a combination of traditional and new technological methods, taking into account the subsequent operating conditions of the part in the future. With this approach, the surface layers of parts can be given the desired combination of performance properties, which are ineffective or impracticable under individual technological influences [1].

Therefore, for the effective use of combined treatments, it is necessary to clearly know what the shaping process is due to. Also, knowing the impact indicators of each individual method, you can assess the feasibility of using them in each specific case, based on the company's capabilities and technical requirements for the part being processed [2].

Accordingly, the need for effective processing of complex parts made of difficult-to-process materials has predetermined the emergence of a number of new methods. The use of electroerosion treatment (EDM) helps us achieve the results we need. EDM occurs at a relatively low pulse energy, the volume of metal removed for each pulse is small, and the depth of the hole is insignificant. This mode, with low productivity, allows you to get surfaces with high accuracy and low roughness.

In our opinion, the main advantages of EDM in comparison with other treatment methods include
1. The processing process does not depend on the characteristics of the processed material: hardness, strength, viscosity, etc.

2. Processes do not exert force on the part, allowing you to process thin-walled elements of various parts without deforming them, cut out of a thin material elements of complex shape with small jumpers, as well as process parts made of brittle materials.

3. No burrs on the parts after processing, which reduces labor intensity and eliminates manual labor. As is already known, the properties of the surface layer change significantly after EDM. The resulting surface layer in thickness can be divided into 5 zones (Fig. 1):
   1. zone of saturation of the working fluid elements;
   2. zone of deposition of the EI material;
   3. white layer formed from the molten material of the workpiece;
   4. zone of thermal influence;
   5. zone of plastic deformation.

![Figure 1-Schematic representation of the surface layer](image)

The number and sequence of formation of zones, their structure and properties depend significantly on the material, the electrode tool, the working fluid used and the conditions of the process. The borders between the zones are almost not clear, and in most cases they overlap each other. But each of the zones has its own characteristics that affect certain properties of the surface and in many cases, determine the possibility of successful operation of the part. At the same time, each zone, even of insignificant thickness, plays a very important role [4].

Modern electroerosive machines allow you to get the roughness of the treated surface \( RA = 0.1...0.4 \, \mu m \). These indicators are achieved by connecting the electrode part to the negative pole of the pulse generator and assigning modes with minimal pulse energy. However, it should be noted that the processing of products in finishing cutting modes is characterized by low performance of the EDM process.

In one of the works analyzed by us, it is shown that when processing 38x2n2ma steel on a copying and stitching machine at the finishing modes, the processing performance is 0.05 mm/h. This performance of the EDM process leads to an increase in the technological time and cost of manufacturing the product. Therefore, when composing the technological process, the EDM assigns more rough indicators for the quality of the treated surfaces, which do not allow to fully implement the performance characteristics inherent in the product [5].

Therefore, the development of a technology that allows for finishing the surfaces of parts made of hard-to-process materials obtained by the EDM method is an urgent task.
The use of mechanical processing methods for this purpose is not always effective or feasible, and the use of electrochemical methods of exposure due to the high toxicity of electrolytes requires a large cost to ensure the environmental safety of people and the environment, as well as waste disposal.

The experiment conducted with employees of the Perm NIPU shows that the best solution for this task can be the use of the technology of electrolyte-plasma polishing of complex-profile surfaces (EPP). The method of electrolytic-plasma polishing is based on electric discharge phenomena in the metal-electrolyte system, while the processed part is an anode. In micro-discharges, significant energy is released and there is an intensive process of reducing the height of the surface's microroughness, which leads to its polishing. Also, this technology is environmentally safe and does not require the use of acids, alkalis and other harmful substances in dangerous concentrations.

They experimentally determined that the EPP for 5 minutes of working time can reduce the roughness of the surface treated by the EDM method by an average of 5 times. If the processing of the workpiece by the EDM method to obtain a surface roughness of 1.6 microns, it is necessary to use a mode with a minimum pulse energy (with a current equal to 3 amperes), then the use of finishing technology by the EPP method allows you to obtain a similar roughness value with a more productive EDM mode (with a current equal to 50 Amperes) [6].

It should be noted that the effectiveness of combined treatments depends not only on the combination of effects, but also on the choice of the basic treatment option, which is improved by other methods with known properties.

EDM does not exclude mechanical processing, but in addition to it, it takes its own specific place, corresponding to its features, namely, the ability to process conductive materials with any physical and mechanical properties [7].

We can conclude that in order to improve the quality of product surfaces with minimal costs, we need to correctly select the optimal combination of useful pulse energy, its power, and the frequency of working pulses, and Supplement this with a suitable method of finishing, depending on the required surface quality.

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