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WAYS TO INCREASE TECHNOLOGY EFFICIENCY OFMANUFACTURING PARTS STRENGTHENED BY PLASMA ELECTROLYTIC OXIDATION

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Strengthening the thin surface layer of a massive part is a progressive direction in engineering technology, as it allows saving expensive alloy steels and other structural materials, increasing the service life and reliability of mechanisms, machines and equipment, and increasing production efficiency. The most important properties of aluminum alloys, which allow them to be used in various industries, include high corrosion resistance and a relatively high ratio of strength characteristics and specific weight. At the same time, such alloys have very good characteristics regarding reuse. However, the low wear resistance of aluminum alloys prevents their even wider use in various industries.

Recently, technological methods of surface strengthening using highly concentrated energy sources, including plasma, have been widely used. The essence of these surface hardening methods is that relatively small volumes of metal are subjected to high-speed, high-intensity, concentrated energy flows followed by rapid cooling. Such processing conditions make it possible to obtain specified physico-mechanical, electrochemical, corrosion and operational characteristics of the surface layers of machine parts and structural elements.

These technological methods include plasma electrolytic oxidation, which is used to form protective coatings on parts made of aluminum and its alloys, as well as metals of the valve group and their alloys in an electrolyte [1-5]. Plasma electrolytic oxidation is a progressive method of strengthening machine parts, which has been intensively developing in recent years, as evidenced by both a large number of publications and their regular citation [1, 2]. An applied high voltage between the part and an electrode, usually made of stainless steel, causes an electrical breakdown of the oxide film and the generation of sparks and micro-arc discharges on the surface of the part, which randomly migrate across the surface, resulting in heating of the part and the electrolyte. Due to the course of plasma-chemical reactions in the discharge channels at high temperatures, oxides are formed that contain different phases, including α-Al_2O_3, which ensures the formation of a coating with high hardness and wear resistance [5]. It is well known that the stability of the coating-substrate interface is related to the interfacial adhesion forces and the electrochemical properties of this region. Therefore, great attention should be paid to the selection of rational thicknesses of the coating layers to ensure both the strength of adhesion to the base and the necessary service life of machine parts during wear in aggressive corrosive environments. The authors mainly focus on studying the structure of oxide coatings, structure, chemical composition and physical and mechanical properties [1-4]. At the same time, due attention is not paid to technological research, which hinders the development of energy-efficient technological processes of strengthening and their introduction into production. To date, the mechanism of formation of the surface oxide layer, its main characteristics, the influence of the initial surface roughness, technological regimes of PEO and mechanical processing of oxide coatings on the performance of machine parts in various operating conditions are not yet understood. There are no sufficiently substantiated scientific and technological bases for the development of energy-efficient technological processes of surface strengthening of aluminum alloys.

The technological manufacturing process includes obtaining a billet from an aluminum alloy, carrying out mechanical processing for forming to ensure the necessary accuracy and roughness of the part's surfaces, surface hardening by plasma electrolytic oxidation, and further mechanical machining (if necessary). Increasing the efficiency of the technological process of manufacturing parts strengthened by plasma electrolytic oxidation must be achieved both at the stage of obtaining the workpiece by mechanical processing, at the stage of PEO strengthening, and at the final stage of finishing (if necessary), taking into account technological heredity.

For the successful development and implementation of energy-efficient PEO technology in production, it is necessary to investigate the influence of the initial surface roughness of the part workpiece, electrolyte composition and current parameters on the growth of the oxide coating and to solve a complex of issues of increasing the bearing capacity of the base, to theoretically justify and experimentally verify the economically feasible surface roughness parameters before the PEO operation , as well as increase productivity and energy efficiency of the PEO technological process. Make a rational choice of allowances and cutting modes during machining of parts with oxide coatings.

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