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# THE ISSUES OF USING PULSE VOLTAGE FOR ELECTROCHEMICAL MACHINING OF THIN-WALLED PARTS WITH A PROFILE CATHODE

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**Keywords:** electrochemical machining, pulse voltage, thin-walled parts, cathode.
**Abstract.** The production of parts with thin-walled structures has become widespread in the rocket and space industry. A progressive method for manufacturing these parts is electrochemical machining. The issues of using pulsed voltage for electrochemical machining of thin-walled parts with a profile cathode are considered. The distinctive features of the electrochemical machining process with pulsed and constant voltage are indicated.

# ВОПРОСЫ ПРИМЕНЕНИЯ ИМПУЛЬСНОГО НАПРЯЖЕНИЯ ДЛЯ ЭЛЕКТРОХИМИЧЕСКОЙ ОБРАБОТКИ ТОНКОСТЕННЫХ ДЕТАЛЕЙ ПРОФИЛЬНЫМ КАТОДОМ

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**Ключевые слова:** электрохимическая обработка, импульсное напряжение, тонкостенная деталь, катод.
**Аннотация.** Изготовление деталей с тонкостенной конструкцией получило широкое распространение в ракетно-космической отрасли. Прогрессивным методом изготовления указанных деталей является электрохимическая обработка. Рассмотрены вопросы применения импульсного напряжения для электрохимической обработки деталей тонкостенной конструкции профильным катодом. Обозначены отличительные особенности процесса электрохимической обработки с импульсным и постоянным напряжением.

**Introduction.** The production of parts with thin-walled structures has become widespread in the rocket and space industry. Currently, these parts are produced by mechanical machining, namely, by milling a solid sheet. Due to the nature of the thin-walled design, the walls of the parts can be easily deformed during machining. In this regard, machining of thin-walled and easily deformable parts is an urgent problem. Therefore, the question arises about the use of progressive and modern processing methods. Recently, electrochemical and electrophysical machining methods have been widely developed.

**Aim of the research.** Consider the key aspects of using pulsed voltage for electrochemical machining of thin-walled parts with a profile cathode. Outline the distinctive features of the electrochemical machining process with pulsed and constant voltage.

**Main part.** Electrochemical machining (ECM) is a processing based on the anodic dissolution process, in which the workpiece, which is the anode, and the electrode tool, which is the cathode, are separated by an interelectrode gap (IEG),

which is filled with an electrolyte solution. The rate of anodic dissolution of the metal during ECM is influenced by the nature and magnitude of the process voltage (current) created by the source of process voltage (current) used [1]. The ECM process can take place at constant or pulsed voltage.

In ECM with a constant voltage, processing is usually carried out using relatively large interelectrode gaps, which ensures fairly effective removal of machining products from the interelectrode gap. At the same time, high machining accuracy cannot be ensured [2]. This is important when machining thin-walled parts of rocket and space technology, where the mass of the manufactured part is important.

In ECM with pulsed voltage, the process of anodic dissolution of the metal does not occur, but the electrolyte flows. Due to this, the interelectrode gap is cleared of machining products and the temperature of the electrolyte is equalized, which helps maintain the design mode of ECM and improves the technological performance of the process. When ECM with pulsed voltage, compared to machining with constant voltage, the following occurs: a reduction in gaps due to better removal of machining products from the IEG; reduction of voltage losses in the near-electrode layers due to less gas filling of the IEG during the period of current flow; reducing passivation during anodic dissolution and increasing current efficiency due to better removal of machining products; an increase in current density at the moment the pulse is applied, which improves the quality of the surface.

The pulse electrochemical machining technologies, known in manufacturing as ET technologies, are becoming increasingly widespread.

The technological characteristics of the ECM process are productivity, dimensional accuracy and the resulting shape, as well as the roughness of the processed surfaces. The factors influencing the technological characteristics of the process include: the volumetric electrochemical equivalent of the metal (alloy) being processed, the composition of the electrolyte used, its electrical conductivity, voltage on the electrodes, current density, current efficiency of the metal, interelectrode gap and technological allowance.

The main parameters of ECM current pulses are: current density (Faraday current and charging-discharging currents of the electrical double layer), duration of voltage pulses, duty cycle of pulses. With increasing pulse duration due to increased gas filling, the increase in the amount of electricity spent on dissolving the metal slows down. At lower IEG, this slowdown begins earlier, and uneven metal removal occurs. Therefore, it is important to determine the value of the pulse duration for a specific case of ECM, depending on the pressure in the IEG, pulse shape, voltage amplitude, current efficiency and a number of other ECM factors. By determining the optimal parameters, it is possible to achieve high productivity of the ECM process with a sufficiently high precision of surface treatment.

There is a known design of the cathode, which repeats the profile of the resulting cavity of a thin-walled part [3]. Electrochemical machining with pulsed

voltage is carried out according to a scheme with a moving cathode with vertical and horizontal feeding to the workpiece (Fig. 1).

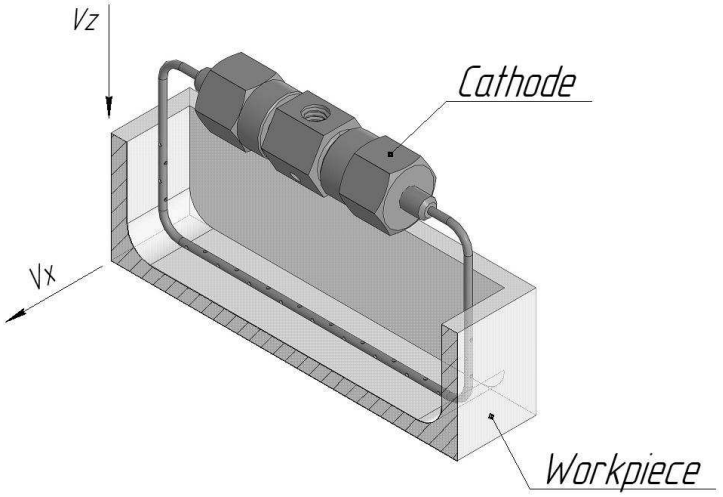


Fig. 1. The scheme of electrochemical machining of a thin-walled part with a profile cathode

While studying the issue of ECM using pulsed voltage, the features of the process were determined. An analysis of the literature data has shown that various aspects of pulsed voltage ECM are currently being increasingly studied and are increasingly being used in practice. In addition, a diagram of the electrochemical machining of a thin-walled part with a profile cathode with a pulsed voltage was presented. The distinctive features of the ECM process with pulsed and constant voltage are indicated.

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