Diagram of the plasma torch discharge chamber

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Abstract. The results of experimental studies of the effect of an electric discharge on carbon fiber in the discharge voltage range $U = 0.2 - 1300$ V and at a current $I = 0.03 - 1.8$ A, at atmospheric pressure are presented. Some features of the combustion of an electric discharge with liquid electrodes are revealed. Some features of the effect of an electric discharge on carbon fiber have been established.

1. Introduction

Plasma possesses a number of properties: electrical conductivity, high energy intensity and reactivity, which ensure its application in various branches of technology. Plasma-based processes are increasingly used in materials processing technologies - welding, cutting, spraying of refractory materials, in the metallurgy of rare metals and high-quality alloys, in chemical technology. Plasma is used in power plants - MHD generators, boiler units of steam power plants. Achievements in the development of space technology, high-temperature power and propulsion systems, high-speed aerodynamics are inextricably linked with the success of plasma technology. Plasma installations is used in medical technology, installations for environmentally harmful waste.

A variety of applications and requirements for a plasma jet and a plasma generator has led to a wide variety, both in the organization of the working process and in the design of plasmatrons as plasma generators. As a result, plasmatrons are usually classified according to a number of different essential features.

The most widespread as plasma sources are electric discharges, in which the plasma is heated by the interaction of charged plasma particles with an electromagnetic field.

Depending on the forms of the electric discharge implemented in the generator to obtain plasma, there are electric arc, high-frequency and microwave plasmatrons, as well as generators based on electromagnetic oscillations in the optical frequency range - optical discharges and high-energy particle fluxes - a beam discharge.

The development of technology poses for researchers physicists the task of studying processes with high energy concentrations, high pressures and temperatures. An electric discharge in a liquid is one of such processes, which is widely used in the development of new technological processes for the processing of various materials and in the creation of new means of converting energy-liquid plasmatrons.

In works on the study of plasma, liquid plasmatrons with electrolytic electrodes are well studied. The aim of this work is to develop the simplest scheme of the plasma torch discharge chamber.

2. Experimental installation

A device for obtaining a discharge between a jet electrolytic cathode and a metal anode is shown in Figure 1. It contains an upper electrolytic cell 1, which is a separating funnel made of glass, and which has a valve 2 with which the flow of electrolyte is regulated 6. Valve 2 is connected to a copper hollow tube-cathode 3 to which the negative pole is connected from a high-voltage power source. At a distance
from the surface of the dielectric nozzle, there is a metal anode (workpiece) 4, where \( l_c \) is the total length of the jet. The electrolyte flows down to the lower electrolytic cell 5.

![Picture 1. Devices for obtaining a discharge.](image)

Installation with a metal electrode from power supply systems, electrolytic baths, instrumentation.

Power supply 1 provides a constant voltage supply through current leads 2 to the discharge gap. The electrode (anode) 4 is a work piece that is connected to the positive pole of the power source. Bath 3 serves as a storage tank for spent electrolyte. The electrode (cathode) 5 is connected to the negative pole of the power source by means of a lead wire 2 and provides a current lead to a separating funnel 6 with electrolyte, fixed on a support 8. The electrolyte flow rate is regulated by a valve. Exhaust 7 serves to suck the formed gases from the working area. Measuring equipment 9 measurement of current and voltage in the discharge gap.

![Picture 2. Functional diagram of the experimental setup (solid anode)](image)

1 - Power supply; 2 - current supply wires; 3 - electrolytic bath; 4 - anode; 5 - cathode; separating funnel; 7 - tripod; 8 - hood; 9 - measuring equipment.

3. The discussion of the results

Experimental studies of the temperature distribution for different jet lengths have been carried out. A saturated solution of NaCl salt in industrial water was used as an electrolyte. The temperature distribution for different jet lengths is shown in Figure 3. The metal anode is used in the zero section of the \( T = f (l_c) \) dependence. The beginning of the jet electrolytic cathode is located in the section \( l_c = 20 \) mm (curve 1), \( l_c = 35 \) mm (curve 2), \( l_c = 55 \) mm (curve 3), \( l_c = 60 \) mm (curve 4) and \( l_c = 90 \) mm (curve 5). From an analysis of the dependence of the temperature in the electrolytic cathode jet on the jet
length, it follows that \( l_c = 20 \text{ mm} \), the value of the dependence \( T = f(l_c) \) is exponential (curve 1). With a further increase in the jet length \( l_c \) from 33 to 60 mm (curves 2, 3 and 4), the dependence \( T = f(l_c) \) is extreme. For example, at \( l_c = 60 \text{ mm} \), the value of \( T \) in the interval \( l_c = 0 \div 25 \text{ mm} \) increases, reaches a maximum at \( l_c = 30 \text{ mm} \), and then to \( l_c = 60 \text{ mm} \) the value of \( T \) decreases. From a comparison of curves 1, 2, 3, 4, and 5 it follows that the temperature in the jet electrolytic cathode depends on \( l_c \) and the power input into the discharge. Analysis of the experimental data on the temperature distribution along the jet electrolytic cathode showed that at large \( l_c = 90 \text{ mm} \), the dependence \( T = f(l_c) \) has a falling character and the value of \( T \) is 30 °C on the surface of the solid anode being treated.

![Temperature distribution in an electrolytic jet cathode](image)

It has been established that for surface modification using liquid plasmatrons (metals and alloys), it is necessary to use discharges with a short length \( l_c \approx 20 \div 60 \text{ mm} \).

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