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INVESTIGATION OF PHYSICAL PROCESSES IN THE GAS DISCHARGE REGION BETWEEN LIQUID ELECTRODES

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Abstract: Electrophysical, hydro-gas-dynamic, and thermal characteristics of a discharge arising between liquid electrodes are considered. Spatial visualization of flow patterns in the gas discharge region is performed by using the schlieren technique.

Keywords: gas discharge, liquid electrodes, jet–droplet flow, schlieren technique.

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In addition to studying discharges between solid electrodes, it is of significant interest to investigate gas discharges between liquid electrodes [1–8].

The present study is based on experimental investigations of electrophysical, hydro-gas-dynamic, and thermal characteristics of a discharge arising between liquid electrodes.

We considered discharges arising between a metal anode and liquid cathode, jet–droplet cathode and metal anode, and jet–droplet cathode and liquid anode (Fig. 1) under the following conditions: voltage $U = 200$–1000 V, ambient pressure $p = 10^5$ Pa, specific electrical conductivity of the electrolyte $\sigma = 0.10$–$0.12\ \Omega^{-1} \cdot \text{cm}^{-1}$, jet flow velocity $v = 0.1$–0.4 m/s, distance between the electrodes $d = 0$–2 mm, and jet length $l = 5$–10 mm. A 7% solution of NaCl in technical water was used as an electrolyte. A copper bar with a diameter $d_{\text{bar}} = 1.5$ mm or a copper plate with $d_{\text{pl}} = 1$ mm was used as a solid electrode.

It follows from Fig. 2, which shows the oscillograms of the voltage and current strength in the discharge between the metal anode and liquid cathode, that the discharge at a constant voltage $U = 400$ V arises in the form of pulses with a frequency $\nu \approx 40$–400 Hz and duration of $\tau_I \approx 2$ ms; the current strength varies in the interval $I = 0.4$–0.8 A. As the voltage U increases up to 700 V, the frequency of oscillations decreases to $\nu \approx 20$–30 Hz, the current strength in the microdischarges increases from 2 to 11 A, and the discharge power P increases approximately from 0.2 to 8.0 kW.

The discharge between the jet–droplet cathode and metal anode at the voltage $U = 600$ V arises in the form of short pulses with the current strength $I = 0.4$–1.6 A and frequency of oscillations $\nu = 100$–200 Hz. As the voltage increases up to $U = 1000$ V, the frequency of current oscillations decreases to 40–50 Hz, the current strength varies in the interval $I = 2.2$–2.8 A, the power is $P \approx 0.1$–2.8 kW, and the current pulse duration is $\tau_I \approx 2.5$–5.0 ms.

Discharge formation between the jet–droplet cathode and liquid anode at the voltage $U = 600$ V leads to the emergence of "wide" pulses with the current strength $I = 0.6$–2.0 A and frequency $\nu \approx 20$–30 Hz. As the voltage increases up to 900 V, the frequency of oscillations varies in the interval $\nu = 30$–40 Hz, the current strength varies in the interval $I = 0.6$–2.0 A, and the discharge power is $P \approx 0.4$–1.8 kW.

It follows from Fig. 3, which shows the temperature distribution and the field of temperature on the electrode surface in the gas discharge region, that the metal anode surface is heated up to $T_{\text{a}} \approx 373$°C, while the gas

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