

**Key words:** method, principle diagram, mock-up specimen, heating device, heat supply system

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## CONDUCTIVITY AND ELECTROHYDRODYNAMIC FLOWS IN LIQUID DIELECTRICS

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**Purpose.** Study the possibility of developing the technical and technological utilization the liquid dielectrics (hydrocarbon and hydro silicious liquids).

**Methodology.** The studies of interaction between and high voltage fields were carried out experimental methods. Some properties liquid dielectric were described.

**Findings.** The review of experimental research of electrohydrodynamic (EHD) processes in liquid dielectrics is represented. Studies of kinematic and volt/ampere characteristics of electrohydrodynamic flow in full range within the voltage scale (i.e. from threshold of beginning to breakdown of gap) in electrode system of wire-plate, cylinder-plate in solutions of buthanol in transformer oil and castor oil are described. To measure the velocity of EHD-flows, tiny bubbles of air, acting as light-dispersal marks, are used. Basing upon the experimental data, a dependence of velocity upon voltage has been developed. Comprehensive analysis of the experimental results as well as the analysis of the data processing results has allowed determining a zonal structure of EHD-flows. The described structure of those zones (in particular, zone of flow acceleration) demonstrates a uniform nature of charge formation in strongly and weakly inhomogeneous electric fields. The EHD-flows are formed along with the growth of voltage. The experiments have shown that volt/ampere dependence is of hysteretic character.

It is known that the electrohydrodynamic (EHD) effects occurring in liquid dielectrics are strongly connected with the passage of electric current [1]. The induced motion of the medium, called EHD flow, is a consequence of interaction of

ions forming a space charge with the neutral component under the action of the external electrical field. Low-voltage specific conductivity of a liquid is characterized by the initial concentration of charge carriers, which depends immediately on the concentration of impurities.

The limited redundant space charge concentration is increasing along with the growth of low-voltage conductivity (growth of ion generative impurities). However, at the same time, the radius of shielding (Debye radius)  $\delta = (\epsilon_0 D / \sigma_0)^{1/2}$  decreases. Therefore, in terms of well cleared liquids, EHD effects should be minor because of the limited amount of space charge arising from insignificant impurities. EHD motion should disappear in ideal dielectrics. On the other hand, in terms of rather good conducting liquids, the zones with no electro-neutrality are of very limited extent. In this case, rather weak EHD effects are expected as well. Consequently, there should be a range of conductivities where the intensity of EHD-processes will be the greatest one.

It is known that the plots of volt/ampere characteristics (VAC) of liquid dielectrics show different zones [2,3]. The first zone corresponds to the ohmic behavior; the second part of the plot demonstrates a quadratic dependence of current  $I \propto U^2$ ; and a third part often corresponds to a power law  $I \propto U^k$  with  $k > 2$ . In the context of the paper, nonlinear parts of VAC plots are correlated with an EHD flow and convective mechanism of conduction.

The experimental data demonstrates that density of space charge and density originating Coulomb's forces at a surface of each electrode are determined both the velocity of ions formation and the velocity of convection removal of space charge.

The EHD-flows are developed along with the growth of voltage and structure. The experiments have shown that volt/ampere dependence is of hysteretic character.

Papers [2-4] indicate that the available VAC are in dimensionless form and give the ratio of the measured current  $i$  to the ohmic current  $i_0$ , i.e.  $I = i/i_0$ , or, equivalently, the ratio of apparent and low field conductivities  $\sigma/\sigma_0$ . In term of the plots, ohmic part of VAC corresponds to  $I = \text{cst}$ , and the square-law part leads to a linear dependence of  $I$  as a function of the applied voltage  $U$ . According to the experimental data given in [2,5], it is clear that the linearly increasing part of the plots corresponds to a mode of convective transport of charge. Basing upon the data analysis, it appears that the deviation from Ohm's law is most marked in the most cleared liquids, and it decreases when the liquid conductivity is increased. It is possible to explain diminution of deviation from Ohm's law by the decrease of relative concentration of a redundant space charge in liquids with higher conductivity, if we take into account that the electrical Reynolds number increases along with the liquid conductivity growth.

The experimental study demonstrates that density of space charge as well as the density owing to Coulomb's forces at a surface of each electrode is determined

both velocity of ions formation and velocity of convection removal of space charge.

**Key words:** EHD flow, ion-molecular structures, high voltage, liquid dielectrics

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## DEVELOPMENT OF AUTOMATIC SPEED CONTROL SYSTEM FOR SYNCHRONOUS DRIVE OF HIGH-POWER TUMBLING MILLS

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**Purpose.** Study the possibilities to increase the efficiency and decrease energy consumption of powerful tumbling mills.

**Methodology.** The studies were carried out through the justification of operating modes of tumbling mills and determination the methods of reaching their maximum efficiency by adjusting the operating mode.

**Findings.** One of the ways of efficiency increasing of powerful tumbling mills is to improve the technology of grinding, as well as the use of more modern systems of electric drive.

The grinding technology involves the following methods of minerals destruction [1]: by friction, impact, and in a combined way. The implementation of these methods in tumbling mills is created by operating modes: cascade, cataract or combined.

The cascade mode of operation has the highest power consumption, followed by a combined, and the last in this list is a cataract operating mode. To increase the efficiency of the mill means to create conditions that allow achieving the maximum productivity with minimal energy consumption of the mill. It is clear that for