Topic number 10

Pre-breakdown phenomena and discharges in gas-liquid system

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Presented work consists of two parts: experimental and theoretical investigations of pre-breakdown and discharge in disperse systems. We theoretically investigated the development of discharge in two types of bubble clusters immersed in water and transformer oil: seven and fifteen equidistant bubbles with the prevalence of a horizontal orientation perpendicular to the applied electric field. The bubbles were filled with air. We present the principal difference in the streamer propagation from bubble-to-bubble due to mutual polarization of bubbles. Hydrodynamics simulation for the movement of the dielectric liquid under the electrostrictive stress was performed. We also investigated cavitation of a dielectric liquid under the ponderomotive forces. Results of the simulation are in good agreement with the experiment.

One of the main properties of a system consisting of a liquid with gaseous bubbles is the low electric field strength of electric breakdown in comparison with a pure liquid. Presented work consists of two parts: experimental and theoretical investigations of pre-breakdown and discharge in such disperse systems.

Experimental setup for the investigation of the electrical breakdown in fluid with a gas contains the microporous membrane which is made of anodized alumina with an average pore size (100 ± 50) nm. The distance between the pores is 300 nm, a thickness of the porous layer is 200 microns. Experiments with the penetration of the gas into the liquid through a porous medium are performed. Gas forms bubbles in the liquid which float.

Optical interference method and statistical analysis of interferometric images was used in order to obtain the distribution of the microbubbles. The most probable value obtained for the mixture of "air-water" (without the addition of surfactants) is about 70-80 microns. We experimentally studied the development of discharge in such multiphase system.

We theoretically investigated the development of discharge in two types of bubble clusters immersed in water and transformer oil: seven and fifteen equidistant bubbles with the prevalence of a horizontal orientation perpendicular to the applied electric field. The bubbles were filled with air. We show the principal difference in the streamer propagation from bubble-to-bubble due to mutual polarization of bubbles.

It's well known that the fluid stream flows in the direction towards the high electric field. Fluid behavior with a different permittivity is calculated on the basis of the hydrodynamics numerical simulation in the strong inhomogeneous pulsed electric field. The negative pressure under ponderomotive forces can lead to the cavitations near the needle electrode and can lead to the occurrence of the electrical breakdown in the fluid. Results of the simulation are compared with the experiment for the cavity extension.

The main results are presented in papers [1-8].

This work is supported by the Russian Science Foundation (Project Number **14-50-00124**).

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