The influence of electric discharge on two-phase water-oil system interface

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In this work, electrohydrodynamic flows and the formation of electrical breakdown across the interface between water and transformer oil in a pulsed electric field are studied experimentally and using mathematical modeling. In the investigated voltage range, which is obviously lower than the oil breakdown voltage, breakdown occurs through the growth of a water cone through the oil to the high-voltage electrode and the closure of the gap. Depending on the electrical conductivity and amplitude of the applied voltage, after the cone reaches the high-voltage electrode, current may flow without plasma formation, a plasma region may appear after touching, or a plasma region may appear before touching the cone due to breakdown through individual droplets sprayed from the top of the cone. The two-dimensional modeling performed showed good agreement with the experiment of the shape of the resulting cone. The time lag of approximately 1.4 times from the experiment is probably due to the two-dimensional formulation of the problem, in which a portion of the field strength associated with the extension of the high-voltage sphere along the third direction in the model is lost. Taking into account the electrical conductivity of water can also speed up the process due to greater displacement of the field from water and its strengthening at the interface. Thus, it seems appropriate to carry out further calculations in a three-dimensional formulation and experimental estimates of the effective thickness of the interface taking into account capillary waves to refine the model formulation.