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Electro-Convection in Liquids in Absence of Ionization

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It is known that a nonuniform electric field can exert forces on neutral matter. In liquids, these forces may cause intense movement. The governing physics here are electrostatics and fluid dynamics.

In paper [1], we calculated heat transfer in a vessel filled with transformer oil using COMSOL MULTIPHYSICS®. This was probably one of the first attempts to analyze EC numerically. The present paper is a continuation of this investigation.

We concentrate mostly on 2-D geometries. Liquid movement and heat transfer influenced by electric forces is studied in horizontally oriented coaxial electrode systems as well as in more complex shapes. In addition, we examine oil lift and possible splash by a vertical metal electrode partially immersed in oil in a coaxial geometry. Time-resolved solutions match closely the experimental results (videos and still photos). The described approach can be useful for studying electrohydraulic phenomena. Mechanism of electrical energy conversion to heat is unclear in the performed simulations; it can be a subject of further investigation.

[1] A. Pokryvailo, "Impact of Electro-Convection (EC) on Heat Transfer in Liquid-Filled Containers", Proc. COMSOL Conference 2015, Boston MA, 7-9 October 2015, 7pp. Available at COMSOL site.

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