Modelling the Non-equilibrium Electric Double Layer at Oil-pressboard Interface of High Voltage Transformers

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In large oil-filled power transformers, cellulose-based pressboard and paper are used throughout for electrical insulation. Microscopic views have shown that pressboard insulation is a fibrous and porous structure with non-homogeneous surface. It has been recognised that the pressboard structure is more porous towards the edge [1]. The pores within the pressboard allow oil absorption during impregnation process and provide paths for oil to penetrate until saturation is reached. The ratio of fibre and oil changes as the material structure changes from a medium of bulk oil-pressboard composite toward the bulk oil medium. The porosity of pressboard can also result in impurities within the oil being drawn into the pressboard. It has also been recognised that physicochemical process of a liquid in contact with solid wall leads to the formation of electric double layer (EDL) in the liquid region [2, 3]. The material properties and geometry of pressboard thus lead to a complex oil-pressboard interface. A 2-D model of oil-pressboard interface has been constructed using Comsol Multiphysics Finite Element Analysis software and this is shown in Figure 1. The mathematical model considers the dissociation of a generic impurity in the oil into positive and negative ions and considers the role of the porous and non-homogeneous wall of pressboard in the formation of the EDL. The pressboard, which is represented by different arrays of fibre, promotes preferential adsorption and desorption processes between ions in the oil and unoccupied fibre surfaces of oil impregnated pressboard. The model studies the non-equilibrium charge density profile in the EDL at the oil-pressboard interface when the oil is in the stationary condition. Results of the simulation will be presented in the Colloquium.

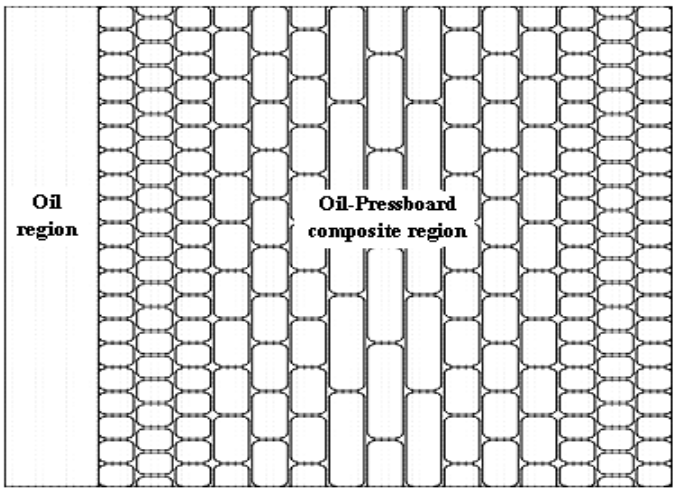

Figure 1: 2-D model of oil-pressboard interface

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