Investigation on dielectric properties of mineral oil by AC and DC method under low electric strength

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Mineral oil has been widely used in power transformers for its stability at high temperature and excellent electrical insulating properties. Understanding its electrical conduction mechanism will help us get a better view of oil status. In this paper, dielectric spectroscopy and DC conductivity measurement will be combined to investigate the mineral oil with different aging times.

As seen from the dielectric spectroscopy result, the conductivity calculated from dielectric response are almost constant with the frequency, whilst the permittivity reveal an increase at low frequency. It seems the response enter a pure ohmic region at medium frequency range (1Hz-100Hz). If only drift of ions contributes to the total conductivity, initial conductivity observed in DC test should be equal to those obtained in AC test.

A simple charge regeneration model has been proposed to explain the duration time of initial conductivity in both AC and DC test. Based on that model, the charge generating rate is determined by both permittivity and conductivity. Since the aged oil has a higher regenerating rate, its original current would sustain for a longer time when compared with that for fresh oil.

Besides, a new model will be used to simulate the dielectric spectroscopy result. Since the charge around the electrode can attract opposite charge in the electrode by electrical force, the permittivity and conductivity of mineral oil will be affected by this extra current. As the frequency goes low, more charge carriers will accumulate in that area. If the electrical potential shift to the next half circle, the electric stress at the boundary of the electrode and the liquid may not be able to keep the existing charge layer in the liquid attached to the electrode and then a notable displacement current will occur. From the simulation, this model fit the experimental data very well.