Electrode effect in new mineral oil studied by dielectric spectroscopy

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Dielectric spectroscopy, as a non-destructive measurement, has been employed for analysing dielectric properties of material for many years, including mineral oil that has been widely used in power transformers. Understanding the mechanism of the conduction of mineral oil will benefit the research of oil condition which is important for reliable operation of power transformers.

This paper presents findings from frequency domain dielectric spectroscopy method on new transformer oil supplied by Shell. As the moisture has a significant impact on dielectric properties of oil, Karl-Fischer titration method has been used to measure the water content in the oil before dielectric spectroscopy tests.

It is generally accepted that the main charge carriers in the oil are ions and these ions start to move under the influence of the applied electric field. The movement is also affected by the resistance force from the viscosity. Electrode effect caused by the accumulation of ions in the oil near to the electrode, which would give rise to the real part of permittivity strongly up to very high values while lower the real part of conductivity at very low frequency, has been revealed in the test results. In this paper, the dielectric response of the new oil has been measured using dielectric spectroscopy technique and it has been found that the conductivity of the oil calculated from dielectric response in the low frequency range (100Hz~0.001Hz) comprises three stages: two steady states joined by a transient process. Both the distance between two electrodes of the testing cell and temperature of oil influence the start frequency of the transient process. It has been found that higher temperature and shorter distance lead to a higher starting frequency of the transient process.

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