

Bridging in contaminated transformer oil under DC and AC electric field

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One of the key components in high voltage transmission and distribution systems are power transformers and their consistent operation is of utmost importance to energy utilities and users. However, transformer failures in the systems have gathered pace as more transformers are approaching or exceeding their designed lifetime. Almost 30% of total transformer failures are caused by insulation/oil contamination which has been revealed by recent analysis. Therefore, it is essential to understand the failure mechanisms/processes so the proper measures can be taken to prevent failure.

During the operation it contacts with metal, iron core and pressboard insulation inside a transformer. Contaminants such as metal filings or cellulosic residual can be formed in the oil, especially for transformers with aged paper insulation. During normal operation non-uniform fields are present within the transformer. These contaminants tend to move towards high field regions due to dielectrophoresis (DEP) forces and could form a bridge over a period of time. The bridge may potentially act as a conducting path between two different potentials within the transformer structure, leading to partial discharges or insulation failure.

There are two experimental set up have been established to investigate the bridging effect between two electrodes with different potentials under ac and dc voltages. This paper will explain the full details of the experimental setup and the results. These experiments carried out on different sizes of pressboard particles under three different ac and dc voltages. Several contamination levels have been investigated. Optical images of particle concentration have been recorded along with associated conduction current measurement during experiments. At higher voltages the rate of bridge formation is increased along with an associated current increase. The major differences between ac and dc bridges are the shapes of the bridge. The bridge formation rate for ac is slower than dc.