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Investigation on Impact of Magnetic Field on the Corona Discharge Activity in Punga Oil Using Fluorescent Fiber and UHF Sensor Techniques

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ABSTRACT This paper reports the experimental investigation of the corona discharge activity of punga oil under the influence of a local magnetic field and different voltage profiles (AC and DC voltages) using fluorescent fiber sensor as well as UHF sensor technique. The corona inception voltage (CIV) of punga oil is higher under negative DC voltage followed by positive DC and AC voltage, with a marginal reduction in its CIV magnitude observed on the impact of external magnetic field. The dominant frequency of the UHF signal obtained under AC voltage shifted towards lower frequency (0.6 GHz) with the influence of magnetic flux density to about 85 mT. The rise time, pulse width and energy content of the fluorescent signal formed due to corona activity under AC voltage is found to vary under high magnetic fields confirming the inception results. The fluorescent signals formed due to corona discharge under both AC and DC voltages have its dominant frequency at 1 MHz with no shift observed in the presence of magnetic field. Also, there is no variation in the phase resolved partial discharge (PRPD) pattern observed due to corona discharge (with and without magnetic field) signal using both UHF sensor and the fluorescent sensor. The fluorescent fiber-based technique provides a better accuracy on detecting the corona discharges in punga oil at an early stage compared to conventional UHF sensor. The breakdown voltage of punga oil under different voltage profiles with and without the effect of magnetic field follows normal distribution. The dielectric dissipation factor and electrostatic charging tendency (ECT) of punga oil is observed to be higher than the limit set for insulating fluids towards power transformer operation.

INDEX TERMS Corona discharge, magnetic field, fluorescent fiber, UHF sensor, rise time, streaming current.

I. INTRODUCTION

The insulation design of oil-filled power transformers is vital for their longevity and reliable operation in a power system network. Mineral oils have been traditionally used as an insulant and coolant in the power transformers. However, with the recent shortfall of the global oil supply and a general depletion of non-renewable sources, a serious shortage may be expected in the near future [1]. While installing the transformers, fire protection is a primary concern, as they are frequently positioned in high-risk situations such as within buildings and underground installations. Nevertheless, the higher thermal class of ester fluids [2] compared to mineral oil makes them suitable to be placed closer to the buildings, resulting in lower power losses. In view of this, alternative insulants such as vegetable oils (soybean, sunflower, punga) are now being tested for transformer applications [3]. In comparison to the conventional mineral oil, these ester-based fluids derived from various plant seeds have shown better fire class properties with increased

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