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Partial Discharge Patterns of Oil-Paper Insulation under Harmonic Superimposed AC Voltages

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There are plenty of factors that influence partial discharge (PD) phenomena of insulating materials in high voltage direct current (HVDC) system, one significant and severe problem is the distorted voltage caused by harmonics. The minor insulation of valve side windings for converter transformer withstands complex electrical stress, which is fundamental AC voltage superimposed with harmonics. The impact of harmonics on insulation systems in terms of electrical losses, lifetime and dielectric material degradation has been previously considered in many researches, a better understanding of the PD characteristics in oil-paper insulation becomes increasingly practical importance.

Partial discharge tests were performed on an experimental platform with needle-plane and sphere-plane electrode, which were designed to simulate the metallic protrusion and surface insulation defect. Statistical phase distributions and typical parameters of PDs were acquired by detector using pulse current method. By means of harmonic order and total harmonic distortion (THD), as well as phase shift angle, the presence of harmonics can be quantified in a simplest case to measure its impact on PD.

The test results showed that various harmonic compositions superimposed on the fundamental sinusoidal waveform have a significant impact on PD intensity. The maximum discharge pulses Qmax was associated with the voltage slope steepness dU/dt and followed Umax, whereas the value of composed testing voltage Umax had a crucial relationship with harmonics content and phase shift. In addition, in the case of phase-resolved measurements, dU/dt influenced the proper interpretation of patterns and derived statistical parameters.

It is concluded that a knowledge of harmonic content is essential and critical in conducting a proper assessment of PD impact. The intention of this paper is to underline the importance of the awareness of harmonic component inside the applied voltage, especially when PD measurements are related to pattern recognition and diagnose criteria.

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