EXPERIMENTAL AND SIMULATION ANALYSIS OF THE JITTER RESPONSE OF A SINGLE-SHOT OIL SWITCH WITH A HIGH-K PARTICLE SUSPENSION

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ABSTRACT

This dissertation investigates oil switching systems to address and reduce the jitter observed in the breakdown electric field strength of a pressurized, oil dielectric. The experimental work is conducted in two phases, the first of which examines the effects of oil chemistry on breakdown statistics, and the second of which considers the effects of high-K particle additions to the best-performing fluids. A single-shot high voltage advanced dielectric test stand (HVADTS) was designed and built to test these oils. The HVADTS is capable of applying a 250 kV pulse with a '1-cos' rise-time of 1.6 μs to a pressurized oil dielectric. Numerous oil chemistries were evaluated, including straight-chain hydrocarbons and branched olefins, silicone and ester fluids, alkylbenzene and transformer oil. Following the oil chemistry evaluation, a high-K particle dielectric was added in concentrations up to 5 % (by weight) to the best-performing fluids. Parameters such as particle concentration, gap spacing, electrode surface conditions and ambient fluid pressure are investigated experimentally. The experimental analysis is supported by PIC electrostatic simulations and a suite of diagnostics such as SEM imagery, optical profilometry, water titration, mass-spectrometry, and particle measurements. The dissertation discusses several methods to successfully reduce the switch jitter of a self-break oil switch.