A High Pressure Flowing Oil Switch for Gigawatt, Repetitive Applications *

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A repetitive oil switch for directed energy applications has been developed in a joint effort between teams at the University of Missouri – Columbia, Alpha Omega Power Technologies and the Boeing Company. The switch uses a synthetic dielectric oil that is simultaneously pressurized to high pressure and flowed at a high velocity through the electrodes. The high pressure has significant benefits, which allow the switch to be reduced in size and increases the lifetime over that of a conventional liquid dielectric switch. The flowing oil also removes gaseous byproducts generated during an arc discharge through the oil and minimizes the gas generated during the discharge thus reducing the flow requirements over a conventional flowing dielectric switch. The fluid flow also ensures that the switch is able to operate at modest to high repetition rates by sweeping out any remaining gaseous byproducts as well as ablation material from the electrodes during the pulse period. The switch has been tested to 17.24 MPa (2500 psig) and 0.75 l s^{-1} at voltages up to 250 kV, repetition rates to 20 pps, and discharge energies per pulse approaching or exceeding 250-300 J discharged in 70 ns.

Testing to date has been performed primarily at 10 pps in 1000 shot bursts at voltage breakdown levels of 220kV-250kV on a 35ns, 4.8 Ω water pulse forming line. The voltage jitter and break down conditions in the high pressure oil under these test conditions are reported for the flow configurations and flow rates. The fluid dynamics within the switch were observed to have a dominant effect on the voltage holdoff. Electrode erosion was examined for both stainless steel electrodes and Schwarzkopf K-33, a small grain structure copper-tungsten matrix. At 250,000 shots the stainless steel electrodes show wear patterns consistent with much longer lifetimes, on the order of 10^7 or more pulses.

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