Weibull analysis as a tool to describe DC breakdown performance and distribution in polyethylene for HVDC at laboratory scale

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A tool at laboratory scale is necessary for characterizing insulating materials dedicated to high voltage (HV) applications before fabrication at full scale. The aim of this work is to give a method for identifying electrical performances of different materials and compositions. Materials are based on polyethylene, and can be cross-linked or not, and some contains additives. The method consists in making thin plates at 100 micrometer thick and submit them to HV tests. The tests are i) DC breakdown voltage V_{bd} obtained after a ramp at 0,5 kV s^{-1}, ii) time-to-breakdown t_{bd} obtained after a DC poling, iii) inverse polarity breakdown voltage V_{bd} obtained after a 24h 5 kV DC poling. In all the cases, the HV generator stops the voltage as soon as a short circuit is detected due to local breakdown. All tests are performed at room temperature. The breakdown voltages V_{bd} or times-to-breakdown t_{bd} are recorded for a population of n = 12 samples for each material. From this population, a discretized Weibull function F(i,n) (from 0 to 100%) is built where i is the i^{th} sample. A linear regression on the function F(i,n) is done first to validate the use of Weibull distribution, second to extract the α parameter which is the 63,3% chance of failure $V_{bd}(63,3\%)$ and $t_{bd}(63,3\%)$ for breakdown voltage and time-to-breakdown respectively and β which is a shape parameter. Results for cross linked materials are shown in graphics α=f(β) and are confronted with optical measurements in the case of dark additives.

Key words

DC dielectric strength; Weibull statistics; Performance evaluation; Shape parameter