

GASSING ARC CHAMBER WALL MATERIAL EFFECT ON POST CURRENT-ZERO RECOVERY VOLTAGE BREAKDOWN

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ABSTRACT

Experimental measurements and theoretical calculations were used to identify and quantify important factors that arc chamber insulation has on post-current zero recovery voltage. Gas analysis, pressure measurements, and post current-zero breakdown voltages were used to rank arc chamber wall material according to breakdown voltage. Generally, breakdown voltage increased with pressure at breakdown. However, nylon 6/6, which had a reduced pressure rise but still had a relatively high breakdown strength, was an exception. Pyrolysis of each material was performed to identify gases produced by arc chamber materials. Gas chromatography was used to determine the types and amounts of gases emitted by the various wall materials. Unlike most other materials, nylon 6/6 sample showed a relatively low percentage of hydrogen but high ethylene percentage, along with no carbon residue. The combination of gases that produced high pressures and low solid carbon had the higher breakdown strength. Theoretical calculations showed breakdown strength to depend on the pressure at breakdown, cathode temperature, and contact material (Ag/W), and carbon (C) deposits on the contacts. Based on theoretical calculations, it was postulated that the wall materials not only determined the pressure at breakdown but also, the amount of carbon deposited on the cathode surface (C, along with the W and oxides, provided a good source for thermionic emission). The greater the amount of carbon deposited on the cathode surface, produced from the insulation, the lower the breakdown strength for a given amount of W. This could explain why nylon performed well, since it produced no carbon residue during pyrolysis. Theoretical calculations of the breakdown voltage, based on dielectric breakdown of the plasma sheath formed in front of the cathode, were also compared to experimental values to obtain estimates of sheath thickness and cathode temperatures. Sheath breakdown values were obtained numerically by solving Townsend's criteria for various sheath thickness and cathode temperatures. Experimental values were plotted on the theoretical curves to obtain estimates of the plasma parameters. In addition to ranking the insulation, peak chamber pressure and arc voltages are given for practical MCCB design.