Model for the Welding of Axial Magnetic Field Vacuum Interrupter Contacts

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Abstract

Vacuum interrupters are required to perform a wide variety of roles within vacuum circuit breakers. One particular duty is passing short-circuit currents while the contacts are closed, without the contacts welding together. The flow of current through practical contacts generates a repulsive blow-off force, which has to be balanced by a closing force from the circuit breaker mechanism plus the force from atmospheric pressure acting on the vacuum interrupter's bellows. The magnitude of the applied closing force is an important parameter in a vacuum circuit breaker's design. Axial magnetic field (AMF) vacuum interrupters have an additional attractive force because of the parallel currents flowing in the two AMF coils. This force is calculated using three-dimensional finite element analysis (FEA) for practical AMF designs using contact diameters ranging from 48-100 mm. These results are then compared to two dimensional FEA models and analytic formulas, including the effect of the current frequency on the results (DC vs. 50 Hz). These attractive forces can then be combined with the other forces acting on the closed vacuum interrupter contacts to calculate the threshold welding current: i.e. the current above which the contacts will form a weld. Calculations of the total closing force compares the difference in the threshold welding current between AMF and other VI contact designs.