TMF-Contacts in Vacuum Interrupters with gaps above 20 mm

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ABSTRACT

In the evolving power generation and transmission sector, efficient and secure power grids are the key element of implementing renewable energy sources in the production and consumption balance. The reliable galvanic separation of power lines under any given condition is the unique property of a circuit breaker in this environment. Beside the interrupting capability, the conduction of rated currents with minimal losses is an essential requirement. Being mostly in closed position, these potential losses can accumulate over the course of the lifetime considered in life cycle assessment (LCA) of a circuit breaker and needs to be addressed in design choices. In medium voltage power grid (<52 kV) vacuum circuit breakers (VCB) are primarily used over gas pressure switches due to their many economically and environmental advantages. Recent developments showed the successful implementation of VI´s in voltage grids above 52 kV as well as finished products for high voltage application at 145 kV. [HEI18]

These developments utilize enlarged gap distances to meet the necessary requirements of higher voltages and higher transient recovery voltages. In combination with the requirements for short circuit interrupting current, axial magnetic field (AMF) contacts are used in market-ready products. These contacts have increased interruption capabilities, but are more complex to design and have increased permanent power losses under current load due to an inner coil and/or ferromagnetic arrangement producing the magnetic field during short circuit current interruption. [FEN98]

This paper focuses on the spiral-type transversal magnetic field (TMF) contacts, which distribute the interruption energy by moving constricted (or pinched) plasma columns over the contact surface. The limits of this technology about high voltage application with enlarged gaps are not yet defined. Typical VI´s with TMF-contacts uses in general gap distance between 10 and 20 mm, which is reached within a 50 Hz-sinusoidal halfwave. With increasing gap distance, the influence of the generated electrical field decreases, reducing the controlled movement of the arc. [LIP03]

To generate this condition in a laboratory environment a programmable servo drive is used to separate the contacts. This paper shows the necessary setup and results in a vacuum test set-up with two gap distances of 20 and 40 mm and TMF-contacts (68 mm diameter). Beside the recorded electrical data (current, voltage, gap distance) the tests are observed with a high-speed camera to investigate the dynamic plasma behaviour. Based on previous works the movement over the contacts is evaluated with a developed software for vacuum arcs. [WEB21] Focus is on the difference in rotation and movement of increased gap distances under similar conditions. Examples of an increased number of uncontrolled jet modes can be seen with increased gap distances.

References

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