High-Current Vacuum Arcs at Large Gaps: Influence of Electrode Movement

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ABSTRACT

Vacuum interrupters (VIs) have been established as the standard technology in the medium voltage range, e.g,, in distribution networks. For the last decade, the development towards higher voltage levels has been opening a growing number of applications in the HV range like in transmission lines, also forced by demands for reliable SF6-free solutions. Typical designs are based on larger contact gaps and the serial connection of multiple VIs. Larger gaps can lead to a specific behaviour of the arc and the attachment modes at the electrodes which depend in addition on the polarity of the moving contact [1].
We report on analysis of arc modes for larger gaps through a combination of electrical and optical data. Experiments were conducted using CuCr25 butt contacts at peak currents of up to 15 kA and a frequency of 35 Hz, with a contact gap of 30 mm at current zero, and with operating the moving contact either as the anode or as the cathode. The arc behaviour was observed using a high-speed camera (HSC) and optical emission spectroscopy (OES) [2]. The HSC captures the arc dynamics, while a computer-aided evaluation facilitates the analysis of different arc modes. The OES results allow for an estimation of the spatial distribution of copper and chromium atoms and ions in particular in the region of the anode spots. Different arc behaviour and anode attachment modes were observed, particularly influenced by the polarity of the movable contact. The time after contact separation at which the arc changes into a jet mode is longer in case of the moved cathode in comparison with the moved anode.

References

[1] B. WEBER, B. KUEHN, D. GENTSCH, and M. KURRAT, in Proceedings of the 29th International Symposium on Discharges and Electrical Insulation in Vacuum, Padova, Italy, 2020, B1-O1-63. DOI: 10.1109/ISDEIV46977.2021.9586869
[2] R. METHLING et al., in Proceedings of the 31st International Symposium on Discharges and Electrical Insulation in Vacuum, Chengdu, September 2025, p. 293.