

Observation of partial internal flashovers on vacuum interrupter test specimen without metal vapor shield

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ABSTRACT

In medium voltage, the vacuum interrupter (VI) has emerged as the predominant switching technology [1]. As SF₆ is subsequently banned in Europe for higher voltages, the emerging gap in technology can be filled by vacuum technology [2]. To efficiently enhance its electric strength and enable an application at higher voltages, among other things a more profound comprehension of the VI as an insulation system is imperative.

The present contribution is an examination of a modified VI devoid of a metal vapor shield with the objective of observing the influence of the shielding on the breakdown process under lightning impulse stress. The results of the performed measurements are documented in the form of voltage data and recordings with a high-speed camera.

A reference measurement of a VI with metal vapor shields reveals the presence of an external flashover path on both halves of the split ceramic insulation structure. In certain experiments involving the modified VI, an external flashover is observable on only one half of the ceramic structure. In addition to the camera footage, it is observed that these breakdowns exhibit a voltage curve that is significantly different from the typical flashovers, where the entire path is externally visible. Therefore, it is hypothesized that the other part of the breakdown propagates inside the VI in vacuum.

While the occurrence of partial internal breakdown is discernible in positive polarity as well as in negative polarity with an inverted VI, the non-observable part is invariably located on the anode side of the VI. Furthermore, it has been observed that subsequent to multiple instances of breakdown, a slight deconditioning effect may be discerned in the series of measurements where partial internal breakdowns are assumed to occur.

The observation of the transition from external to internal breakdown or vice versa leads to the conclusion that it is necessary to observe breakdowns in VIs more closely especially when raising the external flashover voltage to a point where internal breakdowns may occur even on non-modified VIs. The results indicate that a combination of breakdown processes occurs concurrently and is not always limited to the external insulation. A more thorough examination of the mechanisms behind the observed phenomena is necessary to provide a precise description of the breakdown process of VI as an insulation system.

References

- [1] Falkingham, L. T.: The Strengths and Weaknesses of Vacuum Circuit Breaker Technology, 1st International Conference on Electric Power Equipment - Switching Technology, Xi'an, China, 2011.
- [2] Regulation (EU) 2024/573 OF THE EUROPEAN PARLAMENT AND OF THE COUNCIL of 7 February 2024 on fluorinated greenhouse gases, amending Directive (EU) 2019/1937 and repealing Regulation (EU).