Comparison of different contact geometries for current interruption in vacuum using long gaps up to 45 mm

Marius Hinz[1], Dietmar Gentsch[2], Timo Meyer[1], Michael Kurrat[1]
[1] TU Braunschweig, elenia –Institute for High Voltage Technology and Power Systems
[2] ABB AG, Calor Emag Mittelspannungsprodukte, Oberhausener Str. 33, 40472 Ratingen
E-mail of corresponding author: marius.hinz1@tu-braunschweig,de

ABSTRACT

The evolving expansion of decentralised renewable energy generation facilities requires an efficient and reliable electric transmission grid. A key component is the circuit breaker, which must operate with low losses in closed position and also be capable of interrupting a fault current across a wide range of switching conditions. The climate-friendly and low-maintenance vacuum circuit breaker has been established in the medium-voltage sector for several years and are the dominating technology in this voltage levels [1]. When the contacts get opened under load, a vacuum arc is formed, which can be observed and analysed. To meet the requirements of higher voltage levels, studies at higher contact gaps are necessary. For high-voltage applications, many studies involving axial magnetic field (AMF) contacts, which promise a high switching capability at long gaps [2]. The alternative contact geometry of the transversal magnetic field (TMF) contacts offers the advantages of lower losses when closed with a lower manufacturing cost [3]. Both contact geometries use the formation of magnetic field, to distribute the vacuum arc over the whole surface. However, the application of the TMF contacts at higher voltage levels remains underexplored.

This study presents the results of current interruptions in a vacuum environment at large contact gaps up to 45 mm for various opening trajectories. Both TMF and AMF contacts were used for current interruptions up to 31.5 kA for frequencies of 50 Hz and 35 Hz. The lower frequency enables the larger contact gap of 45 mm at current zero. The different opening trajectories are implemented with a programmable servo drive

For each measurement, electrical data (current, voltage and gap) and optical data were captured and used for the evaluation. The vacuum interrupter is fitted with two angle arms and mirrors, enabling a high-speed camera to capture images with 30.000 fps from two angles. A python program allows a three-dimensional analysis of the vacuum arc between the contacts. Particular emphasis is placed on the analysis of different arc modes (diffused and constricted arcs), as well as an assessment of local contact erosion caused by the charge distribution on the contact surfaces.

References

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