Factors influencing the Chopping Current in Vacuum Interrupters

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ABSTRACT

For medium voltage switchgear applications, vacuum is mainly used as insulation in interrupters. Vacuum interrupters provide excellent switching properties and avoid the use of greenhouse gases like SF_6. Additionally, this type of interrupter is complete maintenance free over its life cycle.

During an interruption operation an arc is created, which in vacuum only consists of vaporized metal from the switching contact electrodes. Since this arc becomes unstable near the natural current zero crossing it can chop abruptly. Especially at inductive loads this high $di(t)/dt$ can lead to high transient overvoltages. These might cause damages in primary equipment and provoke electromagnetic interferences e.g. on protection devices.

To reduce the chopping current I_{ch}, which characterizes the max. current just before arc chopping, different measures are known. A proper choice of the switching contact material compound is the most important. Easy evaporating materials with low thermal conductivities [1] like tungsten carbide silver (WCAg) provide a low I_{ch} in a range between 0.7 to 2.5 A. WCAg is used in load break switches or contactors for interrupting operational currents. In contrast, circuit breakers with copper chromium (CuCr) electrodes have higher values around 5 A. Due to the required high breaking capacity, which can only be achieved with a low material erosion rate, chopping performance is only of minor importance.

Another method for I_{ch} reduction is the application of superimposed magnetic fields. Radial or axial fields generated by special contact geometries are primarily used to ensure an even distribution of the arc over the contact surfaces and thus reducing the load. [2] illustrates, that axial fields at specific flux densities B can reduce I_{ch} at certain conditions. However, as this contribution shows, this cannot be generalized as characteristic behaviour for every contactor material: Some show worsening at increasing B. This contribution investigates externally applied fields with flux densities up to $B_{DC,max}$ = 200 mT. To evaluate the statistical behaviour of chopping currents at each flux density 50 interruption operations are performed at each parameter set.

In addition to the above-mentioned factors, the speed of the contact separation during an interruption operation also influences the chopping current: A reduced speed ensures a longer arc burning time and thus a reduced I_{ch} [3]. Also, the electrical connection (fixed or floating potential) of the vapor shield inside the interrupter chamber must be considered. As [4] shows, a fixed or floating connection changes the qualitative behaviour of I_{ch} over the evaluated flux density range.

References

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