Short-Circuit Current Interruption in Liquid Nitrogen Environment

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Abstract

Vacuum interrupters have been established over the past decades as standard technique for circuit breakers in electric power distribution systems. Due to its excellent overall electrical performance vacuum technology moves into the focus of further applications. For example, in combination with high temperature superconductive (HTS) equipment (e.g. current limiters) or in HTS subnets, which constitute a possible option for increasing the overall efficiency of electrical power distribution systems, no other type of switchgear can be used directly in the liquid nitrogen environment, which would, however, be desirable for economic reasons. This is evident when alternative insulating and arc extinguishing media are considered: sulfur hexafluoride (SF6) is liquefied and oil is solidified at such temperatures (boiling point of nitrogen: 77 K). Semiconductor switches will not operate under these conditions due to carrier freeze out.

To investigate the possibility of using vacuum interrupters in liquid nitrogen, among other aspects such as mechanics, internal and external dielectric strength, chopping current and overall on-state electrical resistance, the breaking of short-circuit currents has to be considered as well. The influence of such low temperatures on short-circuit current breaking capability has not been investigated so far.

In this investigation two commercially available vacuum interrupter types from two different manufacturers are tested at ambient temperature and in liquid nitrogen. The breaking current is increased until an insulation of the transient recovery voltage (TRV) is not possible anymore. All tests are performed on two different types of vacuum interrupters, but installed in the same switchgear. Thus contact speed and force and the open contact gap are the same, and the results can be directly compared. The short circuit performance did not show any significant change due to the low temperature. An outline of future tests needed to validate the use of VIs at low temperatures will be discussed.