Transients on DC cables connected to VSC converters

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Oil-impregnated insulation cables, such as mass impregnated (MI) cable and oil-filled (OF) cable, have been applied to DC power transmission. Since then, they have been the mainstream of DC power transmission cables. The oil-impregnated insulation cable technology has developed in response to demand for higher voltage and larger capacity. On the other hand, extruded insulation cables, in which such material as XLPE is extruded on the conductor, were first applied in Gotland to an 80kV DC line in 1999. The main advantages of XLPE cables compared with MI and OF cables are their cost and their environment impact. Nevertheless they are more sensitive to voltage transients and especially polarity reversal.

Application of voltage source converters (VSCs) in power systems is rapidly growing due to advantages such as absence of commutation failures, ability of independently controlling the active and reactive power, and fast dynamic response. Insulated Gate Bipolar Transistor (IGBT) is the power electronic switch used in VSC applications.

The VSC technology does not require the inversion of the voltage polarity when reversing the direction of power flow. This has made the use of extruded insulation cables easier for DC applications. Since then, the number of extruded insulation cables, used in combination with VSCs, has increased for HVDC power transmission applications.

Even if VSC does not require the inversion of the voltage polarity, many events can generate transients on cables that are not covered by standard tests.

This paper presents some examples of typical events that lead to voltage fluctuation on cables connected to VSC converters. DC faults or internal faults in converters can result in significant overvoltages at the DC cables which persist even after the system has been disconnected from the AC networks. Cables discharging and travelling waves propagation generated by faults or grounding switches operation impose stresses on cables insulation that are not well described in literature and usually not covered by cables specifications.

Using the HVDC VSC test system proposed by CIGRE B4 study committee, these transients are described, compared against the standard tests for lightning and switching impulses. Technical solutions to limit stresses on cables are proposed and discussed.