NEW CONCEPT OF DRY TYPE OUTDOOR TERMINATIONS FOR EHV AC and DC CABLE TRANSMISSION NETWORKS

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ABSTRACT

This paper presents a new concept of EHV AC and DC dry type outdoor termination design based on a combination of proven existing state-of-the-art technologies of bushings and plug-in cable terminations. The capacitance graded bushing enables an excellent electrical field distribution and has a compact core, which dissipates the heat effectively. It is applicable for extra high voltage. The same concept works also for DC, using carefully selected insulation material for accessory. FEM modelling of the entire system is performed to obtain a technically- and cost- optimized design.

KEYWORDS

Extra High Voltage (EHV), AC-DC, dry type outdoor termination, capacitance-resistance graded bushing, plug-in cable termination, electric stress control, Finite-Element-Method (FEM) modelling

INTRODUCTION

Outdoor cable terminations represent key elements for the reliable interconnection between overhead and underground high voltage AC and DC transmission networks. For systems above 170 kV, the state-of-the-art construction of outdoor terminations implies the assembly of a pre-molded elastomer body with geometrical field control and a hollow core insulator filled with insulating fluid compounds which requires a careful and time demanding assembly process on site. It needs a sealing system, which prevents the leakage of fluid from and ingress of moisture into the termination. A dry type cable termination uses no liquid or gas and is therefore explosion-proof and environment friendly. Dry type bushings have additionally shown advantages in reliability compared to oil impregnated bushings.

Cable accessory manufacturers have developed different designs of dry type outdoor termination [1-3]. The geometry field grading as well as the non-linear resistive field grading cannot effectively reduce the electric stress on the surface of termination; the terminations using these field grading methods need therefore a big diameter. The temperature gradient over the solid insulation in them is high, which limits their application for EHV system. The capacitance graded bushings enable an excellent electrical field distribution and therefore have a compact core. The ohmic loss in conductor can be dissipated effectively, which can be further enhanced using heat pipe technology inside the conductor. Capacitance graded bushings are widely used in EHV systems [4-6].

This paper presents the collaborative research work of a new concept of EHV AC and DC dry termination design based on the combination of proven existing state-of-the-art technologies of bushings and plug-in cable terminations (figure 1). The bushing and the plug-in cable termination are pre-tested. Due to the freedom from maintenance and pre-assembly of bushing unit at factory, there are significant advantages and cost reductions for the customers during the final assembly on site. For retrofit projects, a much shorter cable length is needed for installation.

The feasibility study focuses on the critical interface between the two termination units where the bushing is shaped for the existing proven dry type plug-in cable termination [7]. Based on the successful experience of the AC dry type plug-in cable termination, the geometry is adapted for DC considering the different field distribution by FEM modelling of the entire system. As a result, a technically- and cost-optimized design is obtained.

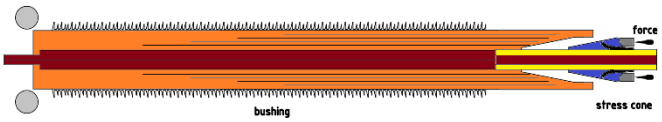

Fig.1 Concept of a dry type outdoor termination, a bushing core combined with a plug-in cable termination

ELECTRIC FIELD IN INSULATION MATERIAL

Electric field and control in homogenous insulation

For design of a high voltage cable system for AC and DC, the crucial point is the electric stress control. When an insulation is loaded with an AC voltage, the displacement current dominates the electric field distribution. The conduction current plays the most important role if a DC voltage is loaded (figure 2).

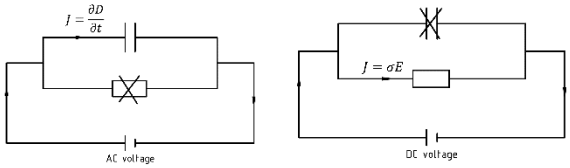

Fig. 2 Simplified circuit of an AC and DC voltage applied over an insulation