Dry Outdoor Terminations for XLPE High Voltage Cables: Applications, State, Challenges and Limits

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ABSTRACT

Dry outdoor terminations are becoming increasingly important. The advantages are unrestricted suitability in water protection areas and a smaller hazard area in the event of an accident. Such terminations can generally be installed much more easily and quickly and convince with its sustainability and practical aspects. Dry type AC solutions up to the highest operating voltage of U_m = 550 kV and conductor cross sections up to 3200 mm² are available. A distinction is made between gas-filled and gas-free variants with and without a support function. One of the most important application is the flexible variant on a prefabricated temporary site cable. The demand has increased significantly in recent years and pragmatic approaches to standardisation are being sought. Solutions for U_m = 420-550 kV with completely pre-assembled designs on a quasi-bifilar special drum complete the temporary site cable portfolio to the highest voltage levels.

KEYWORDS

Dry outdoor termination, water protection area, gas-free, flexible design, self-supporting design, sustainability aspects, temporary site cable (TSC), multi chamber drum, quasi-bifilar special drum, qualification tests

COMPLETE OVERVIEW OF APPLICATION RANGE OUTDOOR TERMINATIONS

Accessories are the pivotal components for the XLPE-insulated AC high and extra-high voltage cables for U_m = 72.5 - 550 kV. In the best case, cable system and accessory manufacturers have a complete range of outdoor cable terminations for connecting a cable to an overhead line, transformer bushing or within an outdoor substation. A distinction is made between insulating compound filled cable accessories with support function given by a composite or porcelain insulator which have limited suitability for water protection areas and gas-filled accessories with support function which are fully suitable for water protection areas. Dry outdoor terminations are becoming more and more important. In addition to a smaller hazard area in the event of an accident and the resulting arcing faults, such terminations can usually be installed much more easily and quickly.

Fig. 1: Hazard area after accidents of liquid filled OSE

There are dry solutions up to the highest operating voltage of U_m = 550 kV and conductor cross-sections up to 3200 mm². A distinction is made here between gas-filled and gas-free variants with and without a support function. Gas-free variants are mainly available up to U_m = 245 kV, with flexible variants with restrictions on the maximum permissible lightning impulse voltage. Variants with a support function can be installed in any position. In the case of overhead installations, the alignment of the isolator may have to be taken into account. Flexible, dry and gas-free terminations can be converted to a self-supporting design using external or internal support elements. Advantages and disadvantages of different dry and gas-free constructions compared to the conventional ones are described in [01-13]. In the event of an electrical fault inside the outdoor termination, the environment can be adversely affected if the insulating material is liquid, since the insulating materials are usually combustible and can escape in the case of damage. One of the most important areas of application of such dry outdoor terminations is the flexible variant on a pre-assembled temporary site cable, which is designed for multiple temporary uses and the cable with the terminations is stored, transported and laid from a special multi-chamber drum. The usual lengths for such temporary site cables are in the range between 100 and 500 m with transmission currents of the order of 750 A. When qualifying such TSC, it should be noted that in addition to the type tests based on the relevant standards according to VDE and IEC [14, 15] additional considerations must also be carried out for this special application in order to be able to do justice to an intended use of at least 10 services. These TSC are currently becoming more and more important, especially for German transmission and distribution network operators in connection with investment and conversion activities in high-voltage switchgear as part of the so-called energy transition (‘Energiewende’). The need has grown rapidly in recent years and pragmatic approaches for design harmonisation are being sought [02, 16]. Solutions for U_m = 420-550 kV with total pre-assembled designs on a quasi-bifilar special drum complete the TSC portfolio up to the highest voltage levels.

Outdoor terminations, self-supported with insulating liquid

This type of outdoor termination consists of a composite insulator made of fibreglass-reinforced plastic support tubing with integrally cast sheds made of silicone rubber or alternatively with a porcelain insulator, each with support function.

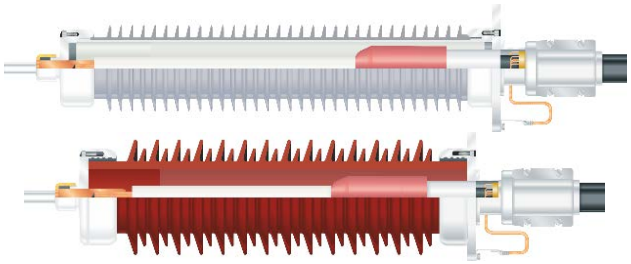

Fig. 2: Outdoor termination with insulating compound (composite insulator above, porcelain below)