Development of a new compact dry type plug-in outdoor cable termination with standardized plug contour according to CIGRÉ TB 784

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ABSTRACT

Over the past decades, dry type cable accessories have proven to be the most attractive cable connection solution in terms of environmental friendliness, simplicity, safety, installation time and flexibility. This paper presents the development of a dry-type cable outdoor termination for a voltage class of 170 kV, and some of the challenges in the product, process and tooling design that the team had to overcome along the way. The resulting design is a combination of a silicone and epoxy composite insulator and NKT´s xEV Size 5 (S5) plug-in dry type inner cone system originally developed for GIS/Transformer application within the CIGRÉ contour (TB 784). The compact design of the latter allows us to develop a new composite insulator and, accordingly a new dry-type outdoor cable termination in its voltage class. The development was carried out in accordance with the IEC 60840, relevant IEC standards for outdoor and GIS cable terminations and TB 784. This design concept, with a standardized common interface, opens up wide opportunities for quick and safe connection of cable lines with electrical equipment and overhead power lines in case of continuous operation, retrofit and replacement of failed cable terminations without introducing additional cable lengths, and in case of possible emergency situations when a quick solution is required.

KEYWORDS

HVAC outdoor cable termination; dry-type termination; E-field calculation; insulators; GIS cable termination; plug in.

INTRODUCTION

Dry-type technology has become the most sought-after cable accessory technology in last two decades for both AC and DC. From a design point of view, dry-type cable accessories are more reliable in operation than fluid-filled counterparts due to the absence of the insulating fluids – oil or gas. This eliminates potential leaks, any significant changes and degradation of the physical properties of the insulation system. Application in the field is easier, minimizing unwanted exposures to the elements and potential for contamination. Installation procedure is simpler, with minimal risk of errors, which ensures reliable operation throughout lifetime of the device. From an environmental and health point of view, dry-type cable accessories are also preferred. This is evidenced by the fact that the trend of applying "dry-type" cable accessories is already beginning to affect not only outdoor and GIS/Transformer cable terminations, but also cable joints. The advantages of dry-type cable accessories listed above require solving complex engineering problems and developing new, creative designs and implementation of the manufacturing process, tooling and materials. Some of the challenges include mechanical and electrical coupling of solid dielectric media, optimization of the geometry of stress-releiving system, and design of the special composite insulators, including material and process development. However, development team believes that this approach is fully justified by the benefits of this design. Today, the most common high voltage dry-type accessories are for cable connections to GIS/Transformer, using elestomers such as silicone/EPDM rubber and casted epoxy resin as the main insulation. The ones remain most standardized in accordance with IEC 62271-209 [1] and CIGRÉ TB 784 [2], since they are supposed to be connected to switchgears, whilst connection to transformers is additionally regulated by EN 50299-2. The IEC 62271-209 standard regulates only the outer dimensions of cable terminations and the requirements for electrical and mechanical connection, while the internal design of the termination is left to the discretion of cable accessories manufacturers which results in various proposals. In CIGRÉ TB 784, however, the one further step is taken to standardize GIS-cable connection: a well-defined geometry for the internal design (common interface) of a dry-type GIS termination for voltage classes of 123 kV and 145 kV with inner cone conception using elastomer rubber insulation for the stress cone and casted epoxy resin for the insulator. The TB 784 is based on proven design parameters, many years of positive experience in operation and qualification tests. By and large, TB 784 proposes a certain design for the dry-type GIS termination, with the exception of such additional components as compression device, cable gland, lubricants, connector lock-in etc., to be on the discretion of cable accessory manufacturers. The CIGRÉ TB 784 aims to unify thus improve the operational reliability of cable-GIS connections, allowing the switchgear manufacturer to order and use of the common interface epoxy insulator assembly,