Sustainability through SF6 reduction on HV/E-HV cable accessories

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ABSTRACT

The urgency to act on climate change has never been greater, and, in the absence of global regulation, companies are voluntarily stepping up to fill the gap. In the power cables industry, high focus is currently on the accessories, because of their extensive use of SF6 gas, as part of the equipment to carry out routine tests of joints and cable drums, and through their interface to the gas-insulated electrical equipment. The technical challenges connected to the SF6 reduction in the cable accessories are hereby presented, with the main R&D activities consequently generated.

KEYWORDS

cable accessories, green gases, GIS termination, SF6-free, dry-type, SF6 reduction.

INTRODUCTION

The urgency to act on climate change has never been greater, and, in the absence of global regulation, companies are voluntarily stepping up to fill the gap. In the power cables industry, high focus is currently on the accessories, because of their extensive use of SF6 gas, as part of the equipment to carry out routine tests of joints and cable drums, and through their interface to the gas-insulated electrical equipment. For many years, indeed, SF6 has been the preferred dielectric medium in electrical power applications, particularly in high voltage gas-insulated equipment. However, with the recognition that SF6 has an extremely long atmospheric lifetime and very high global warming potential, governments have pursued emission reductions from gas-filled equipment. The electrical power industry has responded to this environmental challenge applying SF6-free technologies to an expanding range of applications which have traditionally used SF6, including gas-insulated switchgear, gas-insulated circuit breakers and gas-insulated lines or bus bars. Some of these SF6-free solutions include gas mixtures containing fluorinated compounds that have low climate impact, among them, fluoroni-trile and a fluoroketone insulating gases. However, the replacement of SF6 with alternative solutions introduces several technical challenges on the GIS cable terminations design, since the operating pressure becomes higher and the partitions shall maintain the same mechanical safety factor. Moreover, potential compatibility issues between the alternative gases and the cable termination itself shall be assessed and mitigated.

Other strategic initiative, focused on the cable accessories industry, is the progressive range extension of fully dry-type products, which don't require at all gases to operate, with the aim of covering all voltage classes and cable cross sections.This paper reviews the technical challenges linked to the SF6 reduction in HV/E-HV cable accessories applications and the consequent R&D activities and results.

GREEN GASES: RECENT DEVELOPMENTS

Integrating SF6-free solutions in Networks

The introduction of SF6-free alternatives in distribution and transmission networks started already in the late 2010's when major OEMs started pilot projects introducing green gas solutions in low ranges of High Voltage (72,5kV, 145kV) equipment.

Currently there is not a unique solution for replacing SF6 in all the complete range of electrical applications in transmission and distribution networks. Many experiences on different kind of equipment have been published during the last 12 years, but all of them reports differences in terms of the green gas formulation adopted and/or about their field application parameters, such as the operating pressure.

In general, the main critical technical and usage properties to be considered when replacing SF6 with a green gas mixture in a network equipment can be summarized as shown hereunder.

- Dielectric strength and operating pressure.
- Compatibility with other materials.
- Influence on leakage behavior.
- Chemical stability of the gas mixture, including considerations about by-products emission in case of electric arc and/or moisture, and degradation mechanisms.
- Arc extinction and recovering as dielectric capabilities.
- Mixture boiling point, dew point, and therefore its functioning at low temperatures.
- Thermal conductivity/ heat transfer properties (electrothermal motion of the gas).
- Environmental, health and safety aspects, such as non-toxicity, non-flammability, and non-corrosiveness properties.
- Gas mixture handling procedures and safety risks.

CIGRE' Working Groups have been already established to make clear this topic, gathering experimental data about the main gas formulation available and collecting knowledge and results of field experiences already developed, with the final goal to define technical brochures and recommendations that could be available to all the interested parties.

The main technical papers already released are:

- TB 802 (B3 section): *Application of non-SF_6 gases or gas-mixtures in MV and HV GIS* [3].
- TB 849 (D1 section): *Electric performance of new non-SF_6 gases and gas mixtures for gas-insulated systems* [4].

In addition, a proposal for the creation of a new working group within the B1 study Committee is currently under evaluation: the main target of the new WG will be to define a technical recommendation about the replacement of SF6 with green