Long term performance of XLPE insulation materials for HVDC cables

Virginie **ERIKSSON** (1), Johan **ANDERSSON** (1), Villgot **ENGLUND** (1), Per-Ola **HAGSTRAND** (1), Anna **KONTRO** (1), Ulf H. **NILSSON** (1), Emy **SILFVERBERG** (1), Annika **SMEDBERG** (1)

1 BOREALIS, Stenungsund, Sweden,
virginie.eriksson@borealisgroup.com, carljohan.andersson@borealisgroup.com, villgot.englund@borealisgroup.com, per-ola.hagstrand@borealisgroup.com, anna.kontro@borealisgroup.com, ulf.nilsson@borealisgroup.com, emy.silfverberg@borealisgroup.com, annika.smedberg@borealisgroup.com,

The dielectric of the cable will be exposed to small amounts of oxygen during the manufacturing steps and its operation. This requires that the materials are properly stabilised against the thermo-oxidative ageing as otherwise the morphology and the chemical structure of the XLPE can be negatively affected. As a consequence, a change of the electrical properties could be expected as they are linked to these material characteristics. In addition, during operation, the extruded cable will be subjected to electrical, thermal, mechanical and environmental stresses that can have an influence on the ageing rate of the entire cable construction. This is a critical issue since it will affect the safe operation of the extruded cable and could lead to a premature failure. However, based on the existing literature, it seems that the thermal ageing is not a problem for AC cables in operation and that failures in the field could not be related to high temperature and electrical loading. Due to the more recent implementation of extruded HVDC cables, such statistical information is not yet available, but 15 years of good operational experience is reported.

A novel unfilled cross-linkable polyethylene (XLPE) material has recently been developed. Extruded HVDC cables using this material as insulation have been qualified for voltage level of 525kV, according to the CIGRE recommendation TB 496. In order to reach these high voltage levels, the insulation material has improved physical and chemical cleanliness as well as an optimised composition based on a lower peroxide level leading to low DC electric conductivity and controlled space charge accumulation. In combination with the appropriate control of the key properties, long term performance of the insulation material, especially mechanical and ageing properties also need to be safeguarded.

The purpose of this paper is an investigation of the long term mechanical and thermal performance of HVDC insulation material. Due to its macroscopic properties, conventional HVDC XLPE insulation has very good mechanical properties at elevated temperature and as a consequence the extruded cable maintains its shape and integrity even at overload temperature. To demonstrate the long term mechanical performance and that the dimensional stability during operation are maintained even though the insulation material has a lower cross-linking level, key mechanical properties such as creep and stress crack resistance at different temperatures have been measured in comparison to conventional HVDC XLPE.

The thermo-oxidative ageing of insulation material has also been studied. Influence of ageing temperature on mechanical and key electrical properties will be discussed in relation to the chemical and physical characteristics of the material. The combined influence of electrical and thermal constraints on dielectric properties will be addressed in a separate paper.