DEVELOPMENT OF HIGH PERFORMANCE POLYMERIC MATERIALS FOR HVDC CABLES

Andreas **FARKAS**, ABB AB, High Voltage Cables, Karlskrona, (Sweden), andreas.farkas@se.abb.com
Carl-Olof **OLSSON**, Gustavo **DOMINGUEZ**, ABB AB, Corporate Research, Västerås, (Sweden), carl-olof.olsson@se.abb.com, gustavo.dominguez@se.abb.com
Villgot **ENGLUND**, Per-Ola **HAGSTRAND**, Ulf H **NILSSON**, Borealis AB, Stenungsund, (Sweden), villgot.englund@borealisgroup.com, per-ola.hagstrand@borealisgroup.com, ulf.nilsson@borealisgroup.com

ABSTRACT

For more than 10 years extruded HVDC cables have successfully been used in commercial submarine and land based power links and they are now offered up to voltage levels of 320 kV. In order to meet future requirements on increased power transmission capacity, HVDC power links will need to operate at even higher voltage levels and stresses. In response to this need, a number of high performance polymeric materials have been investigated. Results indicate that development towards higher electrical stresses is viable and that several polyethylene based material concepts meet requirements for HVDC cables operating well above 320 kV.

INTRODUCTION

Extruded HVDC cables in voltage source converter (VSC) systems have successfully been in operation for more than a decade (Fig. 1 and 2). They have been used for land as well as submarine links providing robust and environmentally friendly power transmission around the world. More specifically they are used for applications such as oil platforms, wind farms, undergrounding projects and interconnectors. In addition the absence of AC magnetic and electrical fields and the invisibility of the buried cable link contribute to a competitive project permission process. In contrast to HVAC cables that are limited by their capacitive losses HVDC cables provide transmission of power over very long distances. Due to the excellent operational experience of extruded HVDC cables their total length installed is already in similar order as of classical mass impregnated cables. At present extruded HVDC cables at 300 - 320 kV and power ratings around 1000 MW are offered [1, 2].

Fig. 1. Cross Sound project USA, 150 kV, commissioned 2002.

In order to meet future requirements on increased power transmission capacity, HVDC power links will need to operate at even higher voltage levels and stresses. In response to this need and the fact that converter technology already is available for voltages well above 320 kV, several novel high performance XLPE insulation material concepts have been developed. This paper explains that such XLPE materials, both filled and unfilled, seem to meet the electrical requirements necessary for HVDC cables operating above 320 kV.

In this paper several essential electrical properties e.g. conductivity, breakdown strength and space charge behavior are discussed.

Fig. 2. Laying in progress, BorWin Germany 2009.

SIGNIFICANCE OF ELECTRICAL CONDUCTIVITY FOR HVDC CABLES

Electrical conductivity is defined as $\sigma = j/E$, i.e. the ratio of current density to the electric field. It is a local material property that is useful for characterization of electrical insulation. Sometimes an apparent conductivity is defined as the ratio of average current density to the average electric field. When cables or plate samples are used in high voltage experiments at DC the leakage current that can be monitored at the electrodes is recorded. It is then not possible to evaluate the electric field or the local conductivity in every point in the insulation. Instead the average properties are used in order to estimate the apparent conductivity.