ELECTRIC FIELD MEASUREMENTS ON XLPE/EPDM 2-LAYER INSULATION SYSTEMS UNDER DC STRESS

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ABSTRACT

Interface between an HVDC extruded cable insulating part and its accessory – in joints or terminations – forms a critical area. This interface is exposed to electrical and thermal stresses which may induce the breakdown of the cable system, and in turn reduce the reliability of the electric energy transport from the supplier to the customer.

The present paper concerns a study of the electric field evolution at the coaxial interface in a 2-layer insulation system consisting of an EPDM sleeve fitted on an XLPE cable. The system was subjected to a dc field of the order of 10 kV/mm and a thermal gradient of 20 °C during a thousand hours, and the electric field evolution was recorded periodically. The electric field measurements were carried out using the Thermal Step Method industrial facility installed in the Nexans HV Competence Centre of Calais.

KEYWORDS

Space charge – Electric field measurements – HVDC cables – Thermal Step Method

INTRODUCTION

HVDC extruded cable systems were introduced in the power transmission networks at the end of the 90's. They were generally associated with new generation converters based on IGBT technology. Besides, the availability of new polymeric materials with improved dielectric behavior under DC stress made possible the development and the qualification of cable systems at constantly increasing rated voltage levels. The demand for HVDC extruded interconnections is currently booming and many land and submarine cable projects are on track. This technology remains however to be fully assessed in a very conservative business with huge stakes, and quite a long time should elapse before extruded cables replace the highly reliable paper insulated technology, unless the laying conditions require to only consider the synthetic cable option.

The design of a suitable insulation system for HVDC extruded cables requires investigating thoroughly the electric field distortions resulting from space charge build-up as a function of time under DC stress. This was exhaustively studied and published considering the cable itself.

It is now widely agreed that the interfaces between cable and accessories are the critical areas of the system. Few works were purely dedicated to the issue of dielectric discontinuities at these interfaces. In this communication, the interfacial effect is studied through original electric field measurements on a 2-layer insulation systems consisting of EPDM sleeves fitted on XLPE cables. This was made possible by means of a recent evolution of the industrial facility, based upon the Thermal Step Method, installed in the Nexans HV Competence Centre of Calais.

EXPERIMENTAL FACILITY

Theoretical background

The investigation was performed using the Thermal Step Method (TSM) in double capacitor configuration [1]. This configuration allows to ensure optimum TSM signal measurements, since one capacitor is compensating for the polarization and conduction currents which can flow across the insulation of the other capacitor under DC field. An illustration of the double capacitor configuration is given in Figure 1(a).

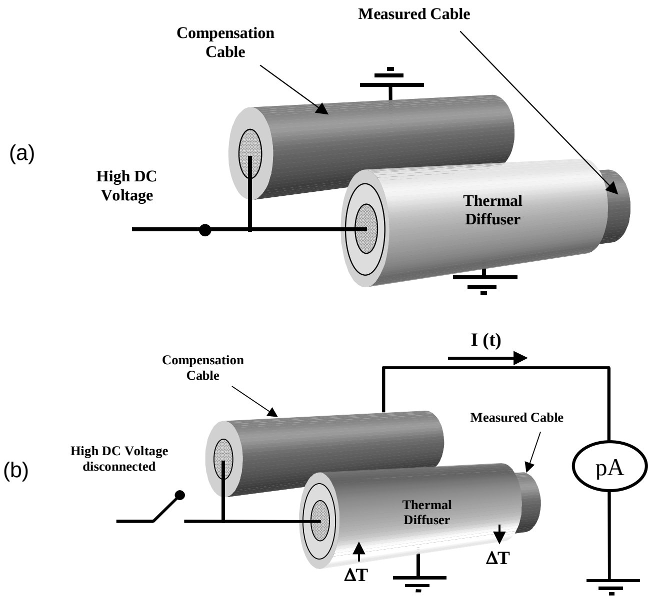

Figure 1: "Under field" TSM signals measurements on cables in double capacitor configuration. (a) : the DC field is applied prior to the measurement. (b) : the measurement is performed on the "measured cable" after disconnecting the DC source.

The compensation sample, e.g. a "compensation cable", is placed oppositely to the "cable under test". A double capacitor is obtained by connecting one side of the compensation cable to a current amplifier and the other one to the measured specimen via an electrode. A voltage can then be applied to both cable core, and a thermal step to the measured sample. The TSM signal is recorded via the compensation cable, as seen on Figure 1(b).

Even if the TSM signal is recorded when the DC voltage is disconnected to avoid any perturbations, the voltage