DIAGNOSTIC TESTING OF MV ACCESSORIES BY TIME DOMAIN SPECTROSCOPY (TDS)

Carl Potvin, Institut de recherche d'Hydro-Québec (IREQ), (Canada), Potvin.Carl@ireq.ca
Daniel Jean, Institut de recherche d'Hydro-Québec (IREQ), (Canada), Jean.Daniel@ireq.ca
Daniel Lalancette, Institut de recherche d'Hydro-Québec (IREQ), (Canada), Lalancette.Daniel@ireq.ca
Jean-Luc Parpal, Institut de recherche d'Hydro-Québec (IREQ), (Canada), Parpal@ireq.ca
Jean-François Drapeau, Institut de recherche d'Hydro-Québec (IREQ), (Canada), Drapeau@ireq.ca
Simon Bernier, École de Technologie Supérieure (ETS), (Canada), Stintense@gmail.com
Richard L'Écuyer, Institut de recherche d'Hydro-Québec (IREQ), (Canada), Lecuyer.Richard@ireq.ca

ABSTRACT

A Time Domain Spectroscopy (TDS) measuring device developed at IREQ was used to assess the dielectric losses of joints recuperated from service. Analysis of the dielectric losses in polarization and depolarization of various types of joints suggests at least two different aging mechanisms: (i) global slow degradation of the insulation by water treeing and (ii) local degradation on specific joint designs. Also, the dielectric losses of joints do not correlate with the number of years in service and one advanced degraded joint alone could explain all the losses measured on one phase of a line.

KEYWORDS

MV XLPE cables and accessories, water-tree aging, diagnostic tool, dielectric spectroscopy in the time domain,

INTRODUCTION

Dielectric spectroscopy is a powerful diagnostic tool for studying electrical insulation and, in particular, for water-tree degradation of XLPE cable insulation [1-3]. Two methods can be used to measure the dielectric losses: Time Domain Spectroscopy (TDS) and Frequency Domain Spectroscopy (FDS). With the TDS method, the losses are measured both in the polarization and depolarization modes while with the FDS method they are only measured in the polarization mode. If water-treeing is the only degradation process of the polymeric insulation, then polarization or depolarization losses can provide an assessment of the global aging. However, if one cable or joint is plagued with a local defect that "shunts" the insulation, the resulting quasi-conduction current measured in the polarization mode will completely overshadow the contribution of the global losses. In such a case, the TDS method allowing measurements in depolarization mode offers a clear advantage over the FDS method, since only the global aging contributes to the depolarization losses.

When dielectric spectroscopy is used for the diagnostic testing of underground lines, the total losses measured are the result of the combined contributions of cable sections, joints and terminations on each phase [4]. It is thus fundamental to determine the respective contribution of each component in order to assess the water-tree aging of the XLPE cable insulation.

This paper presents TDS results obtained on 71 joints recuperated from service together with TDS results on new joints, for reference. From the analysis of the results obtained by the systematic characterization of joints by TDS, two aging mechanisms are proposed. The results of a line simulation with cables and joints recuperated from service, in order to assess the respective contribution of the components to the dielectric losses, are also presented.

EXPERIMENTAL

TDS is a non destructive and efficient method for measuring dielectric losses of polymeric insulation; the principle is shown in Figure 1. Dielectric losses are calculated in the low-frequency range between 10^{-1} Hz and 10^{-4} Hz from the measured polarization and depolarization current values.

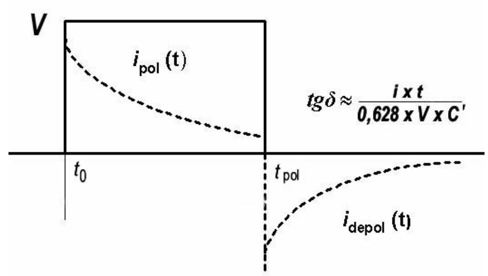

Figure 1: Principle of the Time Domain Spectroscopy measurements

The computer-controlled laboratory version of the TDS device developed at IREQ can measure currents as low as 1×10^{-12} A both in polarization and depolarization. The sensitivity of this laboratory version is better than the TDS field device in the polarization mode, since the samples are grounded through the electrometer. A schematic of the TDS circuit and a photo of the set-up used to characterize all joints are shown in Figures 2 and 3 respectively.

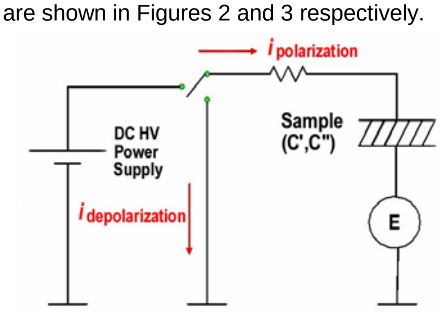

Figure 2: Schematic of the TDS measurements in ungrounded mode: E = electrometer