Identification of cable local thermal stress with time domain reflectometry

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ABSTRACT

The study gives information in order to provide a causal interpretation of impedance change due to local heating on a MV cable. Laboratory experiments on long cable sections have been combined with accurate dielectric characterisation on shorter ones. Evolution of parameters under thermal constraint helps to assume that the impedance variation is partly due to cable dilatation. EMTP simulation gives convergent results. Combination of analyses needed to reach application for onsite thermal constraint detection is presented.

KEYWORDS

TDR, time, domain, MV, cable, local, thermal, constraint, dielectric, spectroscopy.

INTRODUCTION

Studies on insulation resistance decrease, observed on some MV single core PVC insulated cable, showed a behavior closely related to the thermal history of the cables. Ageing test showed that, even after a long period of application, steady constraints led to very low evolution of the resistivity [1]. As considered cables are operated in very stable condition, no preventive replacement is needed.

Nevertheless, as cable insulation characteristics appeared very thermo sensitive, the hypothesis of a local thermal constraint has been considered. So, possibility for identifying such a constraint with onsite electrical measurements is presented.

Laboratory tests were performed on MV single core cables removed from network after more than 20 years of operation. Samples of cables with low resistivity values were selected as follows:

- 2 different types of cable for heating tests on long cable section
- 6 short samples for thermal and electrical characterization.

EXPERIMENTAL RESULTS

Test performed of long cable section

The two cables chosen were respectively 49,5 m long (cable#1) and 33,5 m long (cable#2) and both were 400 mm² aluminum single core PVC 6/6 kV cables. Cable#2 has a second external PVC layer separating an armoring metallic screen (Figure 9).

Global heating of long cable section

Only for cable#2, a global heating was performed at 12 kV. The aim was to detect eventual local auto heating due to dielectric losses. No specific hot spot was revealed by IR thermography (Figure 1). Temperature and voltage (3 times U0) was not increased in order to preserve the cable, so this goal was no longer reached.

Figure 1 Heating is quite homogeneous when temperature is stabilised

As illustrated in Figure 2, TDR measurements show that propagation time could increase by 20% when temperature increases from ambient to 50°C. Signal attenuation could increase about 100% at the same time.

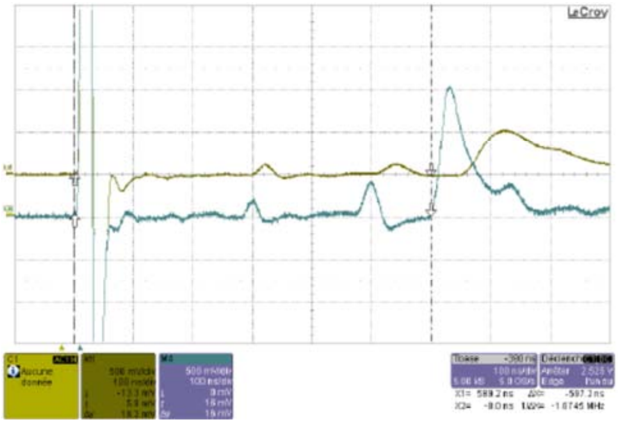

Figure 2 : Propagation time and signal attenuation at 50°C (green) compared to ambient (blue) when the whole length of cable is heated.

Local Heating

Both cables were heated locally with a special flex around the cable and thermal covering. Cable#1 was heated over a 1,7m length zone at 12 m from termination. Cable#2 was heated over 1,45 m length zone in the middle of the cable. Despite insulation, heat losses take place and temperature in the heated zone decreases from the center