Fibre Optic Temperature Sensor Using Intermodal Interference for Underground Cable Joints Monitoring

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ABSTRACT

Asset management for electricity transmission and distribution system operators pushes the need for intensive cable and substation monitoring to protect investments, guarantee supply in safe conditions and optimize the lifetime. In this context, this paper presents the results of a new sensing technique applied to the monitoring of underground cable joints. The validation is achieved in laboratory by comparing the conventional and optical measurement techniques when estimating the thermal behaviour of industrial electrical junctions of good and bad quality.

KEYWORDS

Optical fibre sensor, quasi-distributed thermal sensing, intermodal interference pattern, image processing.

INTRODUCTION

Asset management for electricity transmission and distribution system operators pushes the need for intensive cable and substation monitoring in order to protect investments, guarantee supply in safe conditions and optimize the lifetime. In this context, reduction of maintenance operational costs with better fault detection and localization is a prerequisite.

As an illustration, from 2005 to 2012, two major evolutions of MV cables have been achieved by ORES®, a Belgian supplier in electricity and gas [1]. On one hand, the electrical underground infrastructure has been stretched out from 15000 km long to around 16000 km long (Fig. 1). On the other hand, during this same period, the installation of polymeric cables (XLPE type) has increased gradually (Fig. 2). The number of failures recorded in the network is summarized in Fig. 3 and Fig. 4.

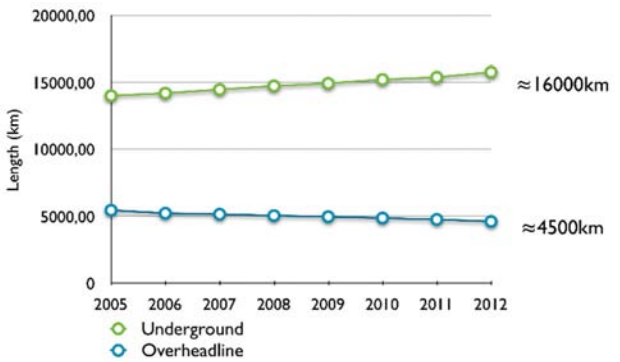

Fig. 1. Evolution of underground MV cables compared to overheadline MV cables on ORES® network [1].

Most of the problems comes from an electrical cause at a rate of 1 failure/100km/year for XLPE cables [1]. The consequences for final users and investments can be disastrous with long-term shortage and expensive repairs. Predictive maintenance can be achieved thanks to distributed monitoring of cables parameters like temperature and partial discharges. These approaches are efficient but expensive due to large geographic scale extent. The research presented here targets an affordable solution for this particular context.

Temperature monitoring plays a key role to check sizing, installing techniques effectiveness and cable power capacity in its underground environment. Two measuring approaches are already on the market to meet electricity operators' requirements at different cost level: local and distributed sensing.

The localized approaches use point sensing for strategic control like for cable joints. Its efficiency is proven but the operator will not be warned in case of a fault appearing in an unmonitored zone (between joints by example). Localized point sensing does not enable a complete awareness of the performance and state of the infrastructure. Moreover this technique implies delocalized point sensing with reliability concerns. The cost for one joint is estimated between 2 k€ and 5 k€.

On the other hand, the distributed approach offers a wide range of opportunities using distributed network of sensors (quasi-distributed approach) or a continuous sensor (fully distributed approach) but is very costly. With these techniques, the state of the whole infrastructure can be assessed and faulty conditions can be detected anywhere in the structure.

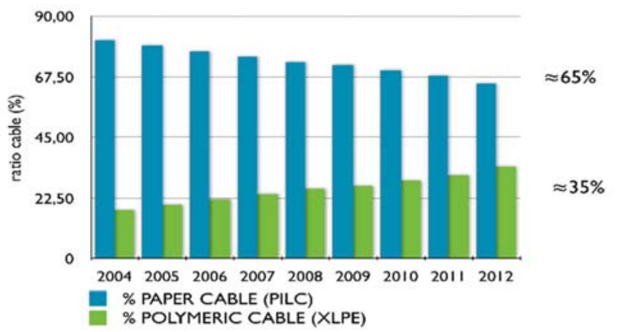

Fig. 2. Evolution of polymeric cable installations according to paper cable on ORES® network [1].