SUBMARINE CABLE METALLIC SHEATH DIAGNOSTIC

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ABSTRACT

After many years of reliable service, a decision whether to replace a submarine cable or to extend its service life must be based upon sound and non-destructive diagnostic technologies. This would require assessing the condition of all cable components including the metallic sheaths without jeopardizing the integrity of the cable. This paper presents the application of an eddy current diagnostic to evaluate the condition of copper tapes in an in-service submarine cable. Laboratory development and the in-situ application of the eddy current diagnostic are discussed along with a case study that highlights the location and extent of cracking in the copper tape sheathing.

KEYWORDS

Submarine cable, copper tape sheathing, cracks, non-destructive testing, eddy current inspection.

INTRODUCTION

A submarine cable of 15 kV XLPE 250 mm^2 has prematurely failed at the termination. A failed cable was replaced with a new section of the original cable that had been stored as a spare cable. The replacement termination also failed within a short time. The cable was made of copper conductor with successive layers of the conductor screen, cross-linked polyethylene (XLPE) insulation, semiconducting tape, copper tape sheathing, polyethylene (PE) jacket, copper armor wire and jute wrapping. The cross section of the submarine cable is shown in Figure 1.

Fig. 1: Cross-section of the submarine cable

A failure investigation of the cable concluded that it failed due to cracks in the copper tape sheathing. The condition of the copper tape sheathing in the in-service cable as well as in the spare cable was unknown. Hence, there is a need to develop a non-destructive diagnostic technique to assess the condition of the copper tape sheathing of the existing cable.

EDDY CURRENT INSPECTION METHOD

Eddy current inspection is a non-destructive testing (NDT) method used to identify or differentiate a wide variety of surface, physical, structural and metallurgical conditions in electrically conducting ferromagnetic and non-ferromagnetic metals and metal parts. The method is based on based on the principles of electromagnetic induction and the concept is similar to that of alternating current (ac) circuit analysis.

An eddy current inspection system consists of the following components:

- Oscillator
- Coil assembly (Probe)
- Bridge circuit
- Signal processing unit
- Readout or a display unit

The oscillator provides an alternating current of one or more frequencies to the coil. Frequencies used for eddy current inspection range from 50 Hz to 6 MHz

The coil assembly induces an eddy current into the part being inspected and detects changes in the eddy current flow. Depending on the application, a single coil or multiples coils are employed in an assembly. A common configuration has one coil inducing the eddy current flow and separate coils used as detectors. Another configuration uses one coil as both an inducer and a detector on the test part.

The bridge circuit converts changes in eddy current magnitude and distribution into signals that are ultimately processed and displayed.

The signals from the bridge circuit are processed in the signal processing circuit unit. Some units detect and amplify the signal or convert the signal into digital format. More sophisticated systems can process the electromagnetic signal into single amplitude and signal phase and provide filtering to suppress unwanted signals.

The eddy current test data are presented in the readout unit either in the form of an analog or digital readout.

The data are displayed in a cathode ray oscilloscope or a video screen. Eddy current instruments with a two dimensional graphical display are used where both the eddy current signal amplitude and phase must be measured.