CORROSION BEHAVIOUR OF SUBMARINE POWER CABLES IN SEAWATER ENVIRONMENT

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ABSTRACT

Submarine cables placed on the seabed are susceptible of suffering corrosion processes. Damages to the different parts of the cable might happen and corrosion could be a life-limiting factor. Accelerated laboratory tests have been carried out on two single cable core designs with different metallic screens: one comprised of aluminum sheet and copper wires, and the other comprised of helicoidal copper tape. The external jacket has been intentionally damaged thus exposing the metallic screen to a synthetic seawater media. Obtained results indicate that the corrosion rate of copper in seawater decreases when coupled with aluminum due to a galvanic effect.

KEYWORDS

Submarine cable, corrosion, metallic screen, accelerated tests

INTRODUCTION

The seabed is an aggressive environment where corrosion mechanisms can take place. Submarine cables are susceptible to these processes if the external jacket is damaged during installation or service life.

This work describes the accelerated corrosion tests carried out on single core cables in order to assess the significance of certain changes in the design of the corrosion behaviour. For these tests the external high density poly-ethylene (HDPE) jacket of the cables has been intentionally damaged, thus exposing the metallic screen to a synthetic seawater media.

Impressed anodic current tests have been conducted aimed at evaluating the corrosion resistance of the metal screen. In real service conditions there is a small current passing through the metallic screens of submarine cables as a consequence of the magnetic field associated to the electrical current through the conductor. If there is an external damage in the electrical cable, a corrosion phenomenon in the exposed metallic screen is not discarded if the current leaves this area.

Corrosion degradation could also increase the electrical resistance of the metallic screen materials. One of the purposes of this screen is to provide a path for the flow of fault current. Thus measurements of the electrical resistance have been conducted on damaged samples exposed to the synthetic seawater.

Finally, leaching tests have been carried out in order to evaluate the amount of copper and aluminum that can migrate from the cable, due to the corrosion of the metal screen in contact with seawater.

EXPERIMENTAL PROCEDURE: MATERIALS AND METHODS

Cable designs

Two single core cables with different metallic screens have been studied. One cable comprised of aluminum sheet and copper wires, and the other comprised of helicoidal copper tape. In the first cable design, the cross linked polyethylene (XLPE) layer between the copper wires and the aluminum tape, is not continuous, with some areas of the aluminum and copper wires in physical contact. Therefore, a risk of galvanic corrosion is not discarded if the aluminum tape (anodic or more electronegative) is shorted to the copper wires (cathodic or more electropositive).

The two cable designs are shown in Fig. 1. .

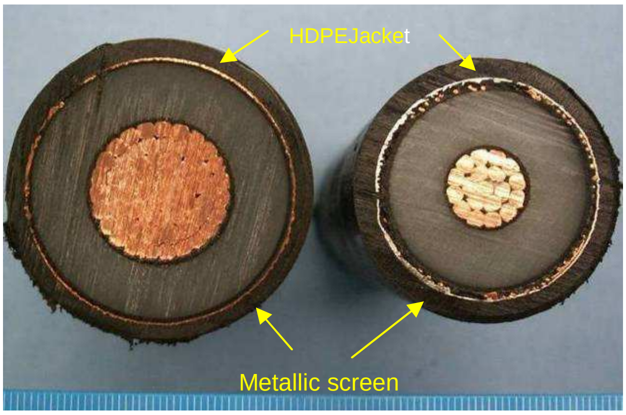

Fig. 1: Cross section of the two single-core cables with aluminum sheet and copper wires (right) and with helicoidal copper tape (left)

Corrosion evaluation under impressed anodic current

Tests under small impressed anodic current have been carried out in damaged jacket samples. The HDPE external layer was punctured in four places leaving the copper helicoidal tape or the copper wires for the aluminum + copper design uncovered. The 4 holes, each with a diameter of 10 mm, were arranged spirally at longitudinal intervals of about 50 mm and circumferential spacing of 90º. This way of producing local damage was similar to that exposed in references [1, 2].

Each cable sample was introduced in a plastic container filled with synthetic marine water Type 1, according to the ASTM D 1141 standard [3]. A small anodic current of 10mA was applied, by means of a potentiostat, between the metallic screen and a graphite counter.