Long Term Qualification of XLPE Electrical Insulation Systems for Offshore Deep Water Cables

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ABSTRACT

There is an increasing demand for subsea electrical power transmission in the oil- and gas industry. Electrical power is mainly required for subsea pumps, compressors and for direct electrical heating of flowlines. The majority of subsea processing equipment is installed at water depths less than 1000 meters. However, projects located offshore Africa, Brazil and in the Gulf of Mexico water depths of 3000 meters are reported.

Hence, Nexans and SINTEF Energy Research initiated a long term development program to qualify deep water XLPE power cable. The long term test program was mainly based on ANSI / ICEA S-97-682-2007. Some adjustments related to the high hydrostatic test pressure (300 bars) were; however, required.

A 7.2 kV XLPE test cable was manufactured and installed in a large hydrostatic test vessel at 45 °C and 310 bars. The cable samples were stressed with an electrical test voltage of 17 kV; corresponding to an average electrical stress of 5.9 kV/mm.

Evaluations are performed after 120, 180, 360 and 900 days of hyperbaric ageing.

Nexans has a long and proven experience of delivering wet designed power cables i.e. without a metallic water barrier. After the hydrostatic ageing of the model cable at 310 bar hydrostatic pressure the cables were tested in order to determine the electrical properties of the insulation system. In addition, water tree analyses were performed after the hydrostatic ageing.

KEYWORDS

XLPE cable, Residual breakdown strength, partial discharges, dielectric losses, water treeing.

INTRODUCTION

There is an increasing demand for subsea electrical power transmission in the oil- and gas industry. Electrical power is mainly required for subsea pumps, compressors and for direct electrical heating of flowlines. The majority of subsea processing equipment is installed at water depths less than 1000 meters. However, projects located offshore Africa, Brazil and in the Gulf of Mexico water depths of 3000 meters are reported. The deepest high voltage XLPE cable manufactured by Nexans is a power umbilical installed at 2400 m water depts for the Jack and St. Malo installation in 2014. This cable included 35 kV 95 mm^2 power cores of wet design.

In this project long term testing procedure according to [1] was used as the basis for the test parameters. Some adjustments due to the available test vessel had to done due to practical reasons.

The aim of this paper is to verify that standard homopolymer XLPE cables will survive long term service at high pressures (approx. 310 bars) without detrimental ageing performance.

DESCRIPTION OF THE TEST SAMPLES

A 3.6/6 (7.2) kV triple extruded XLPE cable core with 50 mm^2 compound filled copper conductor was used. The cable design is shown in Figure 1.

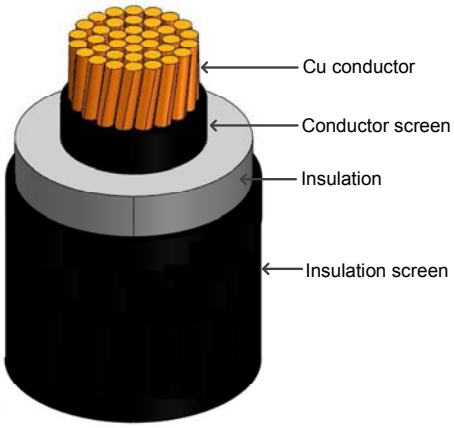

Fig 1: Cable design; 3.6/6 (7.2) kV, used in the pressurized long term ageing tests.

Minimum insulation thickness: 2.5 mm
Minimum screen thicknesses: 0.4 mm

The ageing tests were performed in a 250 liter pressure vessel designed for 1000 bars. The coiled cable just before installation in the pressure vessel is shown in Figure 2.

At the start of the ageing, 200 m cable core was installed in the pressure vessel.

At each sampling time approximately 30 m cable was removed from the pressure vessel. The 30 m cable length was divided into three test samples for the evaluations as indicated in [1].

Initially the three test samples (à 8 m active test length) were prepared for the loss factor (tan δ) and partial discharge (PD) tests. The test sample for these tests is shown in Figure 3.