WATER TREEING AT HIGH HYDROSTATIC PRESSURES AND TEMPERATURES

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ABSTRACT

A very special application for XLPE cables has been developed for offshore use. High voltage is used in order to prevent blocking of oil transport pipes. A high voltage is used to heat the steel pipes to a moderate temperature. In this way the increased temperature melts eventual wax decomposition on the inside wall of the oil pipe. However, this use demands for not metallic water protected XLPE cables. And the use is also requiring high conductor current in order to heat the pipe. A typical water depth where such system is installed is approximately 300 m.

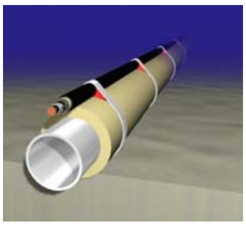
XLPE cables have been aged at temperatures up to 90 ^{0}C, different electric stresses and exposures for hydrostatic pressures up to 30 bars. Bow tie trees are initiated rapidly after the ageing is started. Breakdown strength is reduced by a factor of approximately 3 the first year. No significant vented water tree growth is observed, even after almost 2 years of ageing. This is an unexpected observation when compared to utility experiences.

KEYWORDS

XLPE cables, wet ageing, hydrostatic pressure, high temperatures, water treeing.

INTRODUCTION

Traditional methods of clearing pipelines of wax and hydrate deposits are by use of chemical inhibitors. However, these methods are expensive and represent a risk to the environment if leakage should occur and require comprehensive operational procedures.



a)

b)

Figure 1: a) Schematic drawing of the DEH cable strapped to a flowline. b) Example of paraffin blocked pipeline.

The Direct Electric Heating (DEH) system [1, 2] is based on the fact that an electric alternating current (AC) in a metallic conductor generates heat. The heating system is usually from the platform power supply, from which feeder cables provide the electric power to the heating system. One of the two single core feeder cables is connected to the near end of the pipe, and the other to the forward conductor (piggyback cable) that is connected to the utmost end of the pipe. The cable connected to the far end is mounted parallel and close to the pipe as shown in Figure 1 a) and Figure 2.

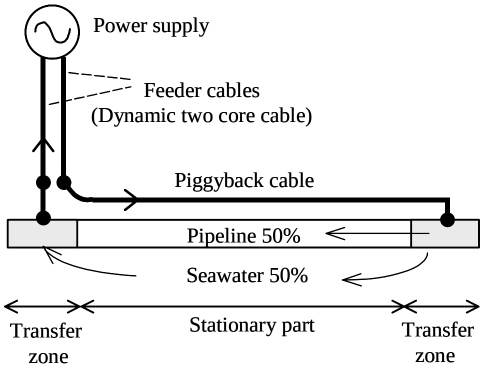


Figure 2: Schematic drawing of a DEH cable piggybacked to a pipeline.

Up to now the DEH system has been installed on flowlines of lengths up to 15 km. In this system the heated pipeline is an active conductor in a single-phase AC electric circuit, together with a single core high voltage extruded cable strapped (piggybacked) to the heated flowline. For new projects with flowlines exceeding 40 km [2], the insulating outer sheath and the metallic ground screens can be replaced by a semi-conductive outer sheath for a continuous transfer of capacitive currents to seabed, or to clay for buried sections. This can be essential to avoid high voltages subjected to the metallic ground screens. Due to the high temperatures of the crude oil, thermal insulating properties of the clay and heating of the cable conductor, relative high temperatures can be subjected to the cable materials.

However, in order to optimise the DEH system no metallic water blocking of the cable sheath can be used. A wet cable construction has to be applied at high temperatures direct installed in sea water. Hence, water tree growth has to be considered as a precursor to cable failure.

Water treeing has been studied for more than three decades. Material aspects have been evaluated with respect to electric stress, temperatures, frequencies, etc. Reference for testing regimes can be made to both international literature and standards. SINTEF Energy Research has been active ever since the middle of the seventies; both with respect to tests that investigates water tree initiation and growth dependency upon ageing regimes and performing long term tests on manufactured cables.