Comparison of losses in an armoured and unarmoured three phase cable

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As an increasing number of wind farms are placed offshore, the energy harvested from the wind turbines must be brought to shore. This is done by using submarine cables from the offshore collector platform, which is collecting all the power from the wind turbines, to a suitable onshore substation. For practical and economic reasons it is preferred to use three core submarine power cables.

Three core submarine cables are armoured in order to provide mechanical protection of the cable and to achieve the tensile strength needed when the cable is installed. The existing IEC 60287-1-1 standard is used to determine the current rating of armoured three-phase submarine cables. The formulas in the standard are based on work done back in the 1920's and 1930's, and in the cable industry, the method used in IEC 60287-1-1 is known to overestimate the losses of three phase armoured cables. Overestimation of the cable losses can result in core cross-sections too large and thereby a more costly cable installation. Therefore, further research is needed in order to develop new analytical equations capable of a more accurate estimation of the losses in three-phase armoured cables.

This paper presents several measurements performed on both an armoured and unarmoured submarine cable of the same type and length. The AC resistance of both cables is presented and compared. For the armoured cable the AC resistance, as a function of the power conductor current, is presented. The induced currents in the lead screens of both the armoured and unarmoured cable is presented and compared. The circulating currents in the armour are investigated for different connections (e.g. armour short circuited, armour open in both ends) in both balanced and unbalanced operation. It is also investigated if the different armor connections have any influence on the AC resistance. Furthermore the influence of the semiconducting layers covering the lead screens is addressed.

The measurements presented in this paper will help understand the effect of the armour and thereby contribute to the understanding of losses in armoured submarine cables. The measurements will also help identifying the areas that need more attention in order to develop accurate, easy to use, analytical formulas for estimating the ampacity of three phase armoured submarine cables.

This paper is one in a series of papers that will focus on developing more accurate formulas for calculating the ampacity of three phase armoured submarine cables. The papers will be based on reaches done in the project "Modelling of long armoured three phase submarine power cables" the project is a collaboration between Aalborg university, the Danish TSO Energinet.dk and Dong Energy.