XLPE Cables with Aluminium Laminated Sheath

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ABSTRACT

Single-core power cables with aluminium laminate used as radial watertight need qualified solutions and instructions regarding grounding. There is often lack of information from the cable suppliers regarding the importance of proper connections and use of sufficient cross section of grounding wires. The aluminium laminate must be considered as a conducting screen together with the copper wire screen. If the copper screen and laminate are not properly connected at cable joints, end terminations, grounding points etc. cable failure can occur due to heat development caused by induced currents in the screens. Instructions in standards states that any conducting element shall be grounded.

KEYWORDS

XLPE, aluminium laminate, sheath, copper screen, grounding

INTRODUCTION

XLPE power cables with aluminium laminated sheath (laminate) was developed to improve the long term wet ageing performance of power cables and has been in use for about 25 years. The cable suppliers offer these cables in all installations and they are therefore commonly used even in indoor installations of no humid environment. Operational experiences from power utilities and producers on single core cables have not been as good as expected since several faults (insulation breakdown) have occurred. The problems have been related to overheating due to large heat development by capacitive and induced currents in the laminate and copper screen. The main reason of the fault is due to poor performance of the contact between these two elements. The faults occur mainly close to cable joints and at the end terminations, but may also occur close to cable straps where the cable is compressed and the copper screen may be in contact with the laminate. Essential information why and how to carry out the screen terminations may not always be sufficiently emphasized. Fig. 1 shows a sketch of a power cable with laminate.

Preliminary theoretical studies and laboratory tests have been carried out in order to give basis for determining the currents and generated heat in the laminate and copper screen. This is carried out on alternative configurations (trefoil and flat formation) with different cross sections of cable conductor, laminate and copper screen during normal operation and fault conditions (short circuit and ground fault). For installed cable systems where there are uncertainties whether the laminate grounding is properly implemented, analyses are required to decide if the cable systems must be replaced or could be repaired. This is due to the risk of damaged cables. Regarding planned installations it should be evaluated if the watertight design with laminated sheath is needed. Alternative solutions by use of three core cables may in some cases be more reliable if watertight cables are required. In case of repair it should be evaluated if surge arresters for protection against atmospheric and switching over voltages should be used, especially if single point grounding screens are used.

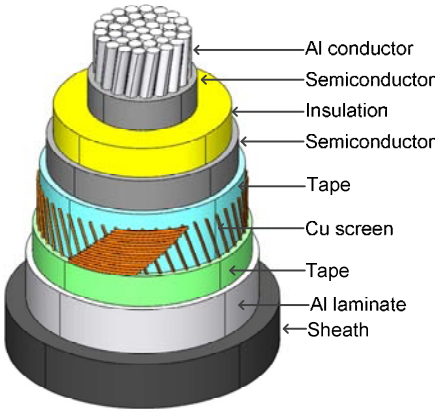

Fig. 1: XLPE power cable with aluminium laminate.

MANUFACTURER' RECOMMENDATIONS

The manufacturer' data sheets do not always give sufficient information of the laminate and cobber screen cross section. The copper screen may be specified as e.g. 35 mm^2 for a 12 kV cable with 240 mm^2 cross section, but the laminate (typical 0,2 mm thick) may also be included giving a reduced copper screen cross section. This implies that the effective equivalent copper screen cross section e.g. is 25 mm^2 and equivalent laminate copper cross section is 10 mm^2. The problem is that the manufacturers do not give any requirement of connecting the copper wire screen and laminate together where the laminate is terminated (at the joints, end terminations etc.). However, this may be very unclearly expressed as "if necessary the laminate and copper screen may be connected".

In addition the instructions of laminate termination may be insufficient as it may not contain recommended and qualified methods. Due to the confusion with the laminate, the practice has often to let the laminate be open.

INDUCED VOLTAGE AND CURRENTS IN SCREENS WITH LAMINATE OPEN

Voltage is induced in the laminates and copper screens from magnetic fields due the conductor currents. If these elements are grounded at both ends, currents are induced. The ratio between the induced voltage and the sum of the grounding and the elements resistances gives a good approximation of the induced currents. This is valid for power cables used in distribution network.

With laminate open the calculation of induced currents is