On-line monitoring and relative trending of dielectric loss in cross-linked HV cable systems.

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Worldwide, to meet growth in electricity consumption and ensure power supply security, increasing volumes of cross-linked polyethylene (XLPE) high voltage (HV) cables are adopted in transmission and distribution networks. So it is of increasing significance to improve the reliability and operational safety in HV cable system which mainly consists of three-phase, cross-bonded when circuit length exceeds one Kilometers, single-core XLPE HV cables. Meanwhile, on-line monitoring provided an advanced way to achieve condition monitoring (CM), which reflects equipment operating status in real time effectively and realistically.

As a characteristic factor reflecting the general state of cable insulation, Dielectric Loss (DL) has been studied and reported widely throughout the world. Although DL is acknowledged as an important indicator of cable deterioration, it is necessary to take the cable off-line to carry out the test. There is no published work indicating achievement of on-line monitoring of DL in a cross-bonded single-core XLPE HV cable system. Cross-bonded single-core HV cable system, a good solution to the problem of induced voltage in metal shields, brings additional challenges to on-line monitoring, e.g. in measurement of Partial Discharge (PD) and DL, because the electrical connection of the three phase shields makes it is difficult to extract the useful signals from the detected signals. A new method, Leakage Current Separation Method (LCSM), is proposed to separate the insulation leakage current from the detected signals which contain circulating current.

Clamp-type power frequency current transformers (CT), selected as measuring devices, were installed at the four cable link boxes (shown in Figure 1). Analyzing the synchronously acquired current signals of twelve CTs installed at the connection boxes allows LCSM to distinguish leakage current of each cable section. A comprehensive DL trend analysis was proposed, without detection of a reference voltage signal, a factor widely applied in the computing DL.

DL trend analysis gives a new way to describe the three-phase cable system deterioration by judging the relative DL between phases. As the three cables are affected by the same environmental and operational stresses, detecting difference in leakage current is an effective method to compare the relative dielectric loss. If degradation or a fault occurs in one phase of the system, the DL of this phase would change relative to the other phases in a short time. Deterioration of the cable system could be judged without a reference voltage, which is a challenge in practical detection systems.

A model of a three-phase single-core XLPE HV cable system will be studied and deterioration criterion will be shown. In addition, error analysis of the measurement and inflection factors will be discussed.

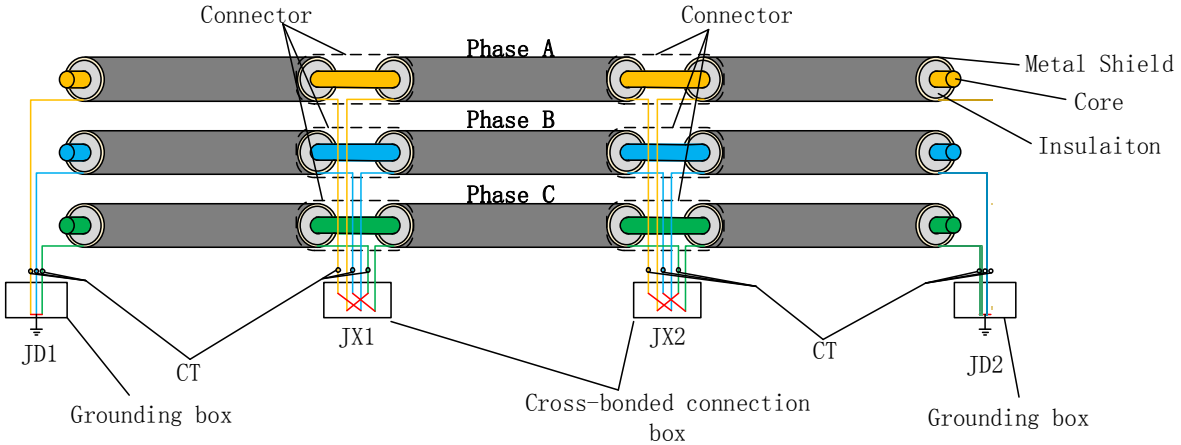

Fig. 1: CT location in cross-bonded XLPE HV cable system