Degradation Mechanism of SCOF Cable due to Cable Core Movement

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ABSTRACT

Recently, SCOF cable breakdown accidents have occurred, possibly caused by cable core movement. Cable core movement under some cable conditions such as steep slope, cable curve near joint boxes, and strong binding force by semi-stop parts might have caused breakdown accidents of the SCOF cable joint boxes (over 154 kV), other than those caused by original issues (defective design, manufacturing failure, assembly failure), negligent act of a third party, and natural hazards. This paper introduces the degradation mechanism of SCOF cable due to cable core movement and its maintenance procedure.

KEYWORDS

Self-Contained Oil-Filled (SCOF) cables, cable core movement, Dissolved Gas Analysis (DGA), X-ray inspection, Partial Discharge (PD)

INTRODUCTION

According to the report [1], the total amount of the cable facilities of Japanese domestic electric companies at the end of 2010 was approximately 17,790 km/cct. Among these facilities, the amount of self-contained oil-filled (SCOF) cable facilities was approximately 3,980 km/cct, which accounts for approximately 22 % of the total amount. Many SCOF cable facilities have been operating since the 1960s and 1970s. About 3,060 km/cct of SCOF cable facilities started operating over 30 years ago, accounting for approximately 77 % of the total SCOF cable facilities. Some facilities of over 66 kV cable facilities have aged more than 50 years, and the oldest facility is aged 58 years.

Approximately 60 breakdown accidents of over 66 kV SCOF cable facilities occurred by the end of 2010. Moisture intrusion or cable core movement is considered as main factors in breakdown accidents in the case of aging SCOF cables. Recently, it has often been reported that some breakdown accidents are caused by cable core movement.

This paper introduces the degradation mechanism due to cable core movement and maintenance procedure obtained from the investigation of the joint boxes that were broken and removed.

OUTLINE OF SCOF CABLE FACILITIES

The SCOF cable system is constructed such that it maintains pressure that is higher than the atmospheric pressure from oil tanks to the inside of the cable through an oil duct in the cable. In addition, through the oil duct, the oil tanks absorb oil expansion and contraction caused by load fluctuation. This system works to prevent the introduction of voids in the insulation material and to maintain the insulation performance.

Fig. 1 shows the basic structure of SCOF cables. SCOF cables are formed using a conductor, paper insulator (kraft papers), shielding layer, metallic sheath, and anti-corrosion layer. An oil-impregnated paper is used as the insulator. The oil-impregnated insulator is a stacking structure, and is formed by winding several oil-impregnated kraft papers approximately 100 μm thick. Polypropylene laminated paper has also been used since the 1980s, which is made by bonding kraft paper and a plastic (polypropylene) film together, resulting in high anti-deterioration strength and low loss.

The cable core of a 154 kV SCOF cable is structured by approximately 100 insulating papers, and gap-wound insulating papers are used to raise the mechanical strength against bending.

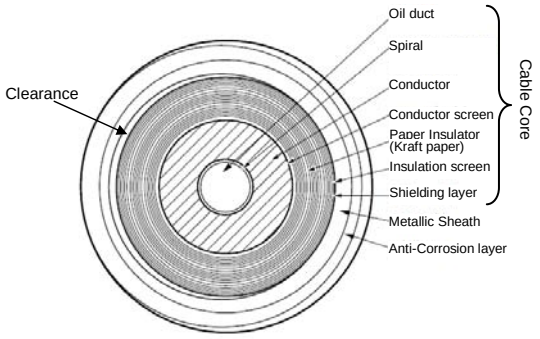
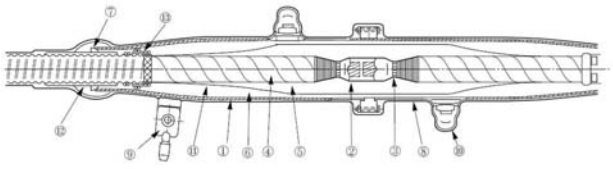


Fig. 1: Typical structure of SCOF cable

Fig. 2 shows a typical structure of an SCOF cable joint box. Two cables are electrically connected in a joint box.



(1)Copper tube (2)Conductor sleeve (3)Cable conductor (4)Cable insulator (5)Reinforced insulating layer (6)Insulating oil (7)Spacer (8)Anti-Corrosion layer (9)Ground terminal (10)Connector (11)Shielding layer (wire) (12)Wiping (13)Semi-stop parts

Fig. 2: Typical structure of SCOF cable joint box

The joint boxes have semi-stop parts ((13) in Fig. 2), which prevent the spill of oils during jointing works and keeps guaranteed pressure inside the SCOF cables when the cables are jointed.

A fault in these semi-stop parts may cause negative oil pressure by leakage of a large amount of oil during jointing works or by allowing air to enter the cables.