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Development of XLPE cable under DC voltage

SATORU M., TANAKA T., MUTO H., The Furukawa Electric Co. Ltd., Chiba, Japan
TERASHIMA K., WATANABE C., Electric Power Development, Tokyo, Japan

Résumé

Cette publication présente la mise au point d'un câble PR pour le transport de courant continu sous haute tension.

Nous avons mis au point un isolant de câble PR pour CC possédant une haute résistivité et peu d'accumulation de charges spatiales.

Nous avons estimé les caractéristiques de solidité à la rupture et d'accumulation de charges d'espaces. Nous avons trouvé que ce modèle de câble présente d'excellentes propriétés grâce à l'utilisation du matériau PR CC mis au point.

Les câbles PR CC pour tension de +/- 500kV ont été conçus et fabriqués. A la suite d'un essai électrique à court terme et d'un essai de résistance mécanique, nous avons pu confirmer les propriétés isolantes du câble PR CC pour tension de +/- 500kV mis au point, en conformité au cahier des charges.

Abstract

This paper describes the development of the HVDC cable which is insulated using XLPE with special functional group. (DC-XLPE)

We have developed the insulation material, which have high resistivity and few space charge accumulations, an XLPE cable for HVDC.

The breakdown characteristics and space charge accumulation properties were evaluated using model cables insulated with DC-XLPE. As the results, it was found that breakdown characteristics was higher and space charge accumulation was few under DC voltage, compared with the ordinary XLPE cable.

The DC XLPE cables were designed and have been manufactured for ±500kV DC use. And they have been subjected to electrical tests and mechanical tests. As the results, it was found that the developed DC XLPE cable satisfy the insulating properties for ±500kV DC cable.

1. Introduction

In recent year, as the demand for electric power has been increasing, high-capacity and long-distance transmissions have been required. In most long-distance transmission lines, DC power transmission is adopted, because AC power transmission is not suitable for long-distance transmission to entail the problem of charging current, and dielectric loss. As cables for DC power transmission, paper-oil insulation has been used, such as OF (oil-filled) cables and MIND (mass impregnated non-drain) cables. However, OF cable cannot transmit electricity over long distance because of the limitation of oil supply, MIND cable cannot transmit electricity in high-capacity because of the limitation of maximum conductor temperature.

For AC power transmission, on the other hand, low-maintenance XLPE (crosslinked polyethylene) insulated cable is widely used from low-voltage to high-voltage applications. And its reliability has been getting better year by year. The application of XLPE cable, which uses no oil in its insulation, is also expected for DC power transmission.

This paper is a report on the development of cable insulated by XLPE with special functional group for operating under ±500kV DC.

2. Characteristics of insulating materials for DC XLPE cable

Studies have previously been carried out for using XLPE cable for AC transmission as DC cable. (heareafter, XLPE for AC cable called AC-XLPE.) But using AC-XLPE cable under DC voltage, it is known that the space charge accumulates within the insulation. Accordingly, local high electric field is forming in insulation and is reduced the insulation properties. Therefore the properties which are required for insulating material for XLPE cable under DC voltage is few accumulation of space charge in the insulation.

The following are thought to be factors relevant to reducing dielectric breakdown characteristics when a DC voltage is applied.

- generation of heat in the insulating material due to Joule heat.
- formation of local high electric fields in the insulating material due to the accumulation of space charge.

Therefore what is required for the insulation