JICABLE '99

B1.3

Moisture penetration in XLPE and PILC cables

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Résumé

Les câbles isolés au papier sous gaine de plomb peuvent subir des pénétrations d'eau sur leur longueur du fait de sous-pressions ou surpressions inattendues sous la gaine de plomb, particulièrement après une défaillance. Il est recommandé de tenir compte de cet effet lors de la réparation des câbles après cette défaillance. Autrement dit, le câble devrait être contrôlé sur la pénétration d'eau, ce parfois sur des longueurs considérables. Il est également recommandé de mettre l'accent sur la réduction des pénétrations d'eau comme un paramètre de conception pour ces câbles. Cet article décrit la pénétration d'eau comme une fonction du plomb (causée par la température du câble ou la pression sous la gaine de plomb).

Les câbles XLPE peuvent être sujets à la formation d'arbres d'eau, une raison de faire des câbles avec des constructions étanches à l'eau. Par contre, il est inattendu est que les câbles puissent être rendus étanches à l'eau à l'aide d'une gaine en polyéthylène combinée seulement à des bandes gonflantes. Une description du contexte sera donnée, tandis qu'une procédure d'essai permettant de vérifier l'étanchéité à l'eau sera indiquée.

Abstract

Paper insulated lead covered cables may suffer from water ingress over long cable lengths due to unexpected high over and under pressures under the lead sheath, especially after a failure. It is recommended to take this effect into account when repairing the cables after this failure. This means that the cable should be checked for water ingress, sometimes over considerable lengths. It is also recommended to focus on reduced water ingress as a design parameter for these cables. This paper shows the water ingress as a function of load (is cable temperature, is pressure under the lead sheath).

XLPE cables may suffer from water treeing. This is reason to make cables with watertight constructions. Not expected is, that cables can be made watertight with a polyethylene jacket in combination with swelling tapes only. The background will be described and a test procedure to verify the watertightness is given.

Introduction

PILC cables are protected against the ingress of moisture by means of a lead sheath under the steel armouring. This is a reliable method. Of course water can enter a PILC cable during mounting of accessories mainly in manholes but that can be avoided. Another way of water ingress is less known. Laboratory experiments have shown that during operation in PILC cables excessive over-pressure and under-pressure may occur with even moderate cyclic loads. These pressures result in unexpected mechanical forces in the splices. As a result of this, in particular cases a path is forced in the splice housing through which water can enter the splice and sometimes the cable. Also after a breakdown, water ingress via the breakdown side can lead to dramatic ingress of water. This paper will show the pressure variations and water ingress results of laboratory experiments. Also the relation of these effects to the cable construction will be discussed.

XLPE cables can be made watertight in order to avoid water treeing with a metal radial moisture barrier. However, it can be shown that such a metal moisture barrier is not always required in order to prevent water treeing. An MDPE sheath in combination with a swelling tape under the MDPE sheath can function as a radial moisture barrier too. This statement is apart from the fact that of course these swelling tapes also have another and well-known function: longitudinal watertightness. In this paper it is shown how such radial watertightness of an MDPE sheath in combination with swelling tapes or swelling powders can be obtained without using metal barriers. The Dutch three-phase MV XLPE cable construction is nowadays manufactured according to these principles.

Moisture in PILC cable

Introduction The relationship between water ingress on one hand and pressure effects due to load cycling, thus temperature cycling, on the other hand is not widely investigated, but very important for PILC cables. That was experienced in The Netherlands some years ago. Consequently, a research program was defined to obtain a better understanding of the dynamic pressure behaviour of