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D.2.5. Etude en grandeur réelle du comportement thermique de câbles tripôlaires MT posés en conduits

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Résumé

Le comportement thermo-mécanique de câbles tripolaires posés en conduits est analysé. Les résultats obtenus sont discutés sur la base d'un modèle simple. Des valeurs concrètes d'échauffements maximaux sont données pour différents systèmes. Ce travail est un guide dans le choix de composants pour la mise en place d'une ligne.

D.2.5. Full-scale study of thermal behaviour of MV tri-polar cables laid in conduits

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Abstract

Thermal behaviour of three phase cables laid in ducts is analysed. Obtained results are discussed on the basis of a simple model. Concrete values of maximum temperatures are given for different systems. This work helps for the choice of components when a new line has to be built.

Introduction

In Switzerland, the geographical situation and the high population density are the main reasons that the proportion of underground cables is fairly high in comparison to overhead lines. Most cables are laid directly in plastic ducts (PE) embedded in concrete or installed in cable galleries. This gives the possibility during the planning of networks to prepare for future cable additions, or in the long term, to replace rapidly and economically a defective cable or to adapt the line to a load increase.

In service conditions longitudinal thermal expansion arises due to cable heating. Specific problems are then in the hands of the project engineer for choosing components. The cable expansion is absorbed essentially by the cable displacement in curves, the axial compression of the cable and buckling inside the duct. These deformations generate, aside from the forces at the ends of the layout, efforts on the walls of ducts that can damage the cables.

Several approaches have already been proposed for the theoretical modelling of such systems (1). Indeed, such models allow to understand the influence of the different parameters on the mechanical behaviour of the cable, but they do not bring real answers to the network engineer, the number of significant parameters being too numerous (bending stiffness, cable compression and torsion modulus, linear thermal expansion coefficient, friction coefficient with the duct walls, cable weight, as well as the variation of these parameters as a function of temperature). Moreover, internal stresses that appear during the production of triple phase cables can not be included in such models.

Our 1:1 scale study of triple phase MV cables has therefore the aim to put forth the different behaviours associated to each type of cable as well as helping the network engineer in his choice of ducts and/or cables according to the desired application. The maximum possible temperature increase without mechanical deterioration for the installation has therefore been measured and is presented for different cable/duct systems.

Choice of cables and ducts

The construction of the cable being of fundamental importance, our choice has focused on different standard triple phase constructions frequently used in ducts in Switzerland. They are briefly described in the paragraph below.

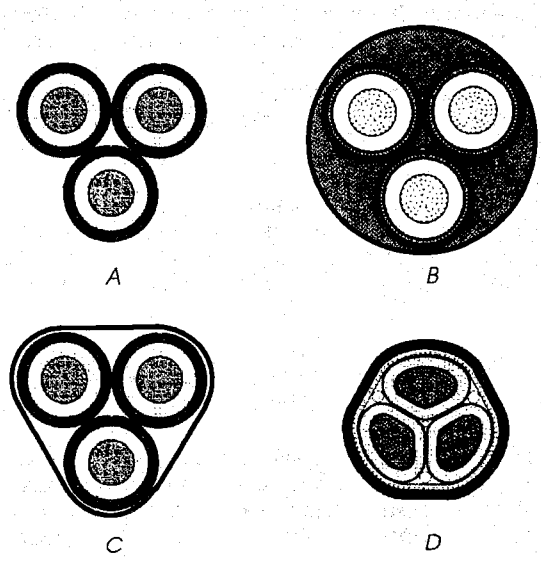

Figure 1: Cable cuts of studied designs:
A: Three single phase insulated cables placed next to each other (in a triangle).
B: Three single phase conductors assembled, a filler and a HDPE sheath.
C: Three single phase conductors assembled, PETP tape and triangular HDPE sheath.
D: Sectoral conductor, copper screen and PE sheath.

The cables are constituted of 3 single phase cables, themselves composed of a copper conductor, a conductor shield, a 5 mm thick insulation (XLPE or EPR), an insulation shield, a copper screen (Ceander) and an outer sheath