INFLUENCE OF ADDITIVES ON THE WATER-TREEING IN XLPE INSULATED CABLES

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ABSTRACT

For MV cables installed in wet conditions, in order to demonstrate their durability, the main standards ask for a long term test (generally 2 years) in water and under electrical stress .

To develop new solutions more easily, small scale tests have been proposed to compare the behaviour of different materials, for example the ashcraft test. Using this laboratory scale test, trials have been made to measure the impact of different additives. The authors present the laboratory method, and the results obtained on insulations containing different natures and levels of peroxide and antioxidants.

KEYWORDS

MV cable insulation additives water-treeing.

INTRODUCTION

Depending on the used extrusion equipment, the insulation process of the MV cables can be slightly different:

- On a classic CCV extrusion line, compounds are used at delivery state. The additives, and in particular the peroxide and anti-oxidant, are dispersed properly in the polymer matrix by the supplier. In this case, the solid state of the additives is useful to avoid evaporation during delivery and storage, and the compound is just introduced in the extruder, with all cleanliness and handling precautions.

- On lines fitted with injection, the cable maker works with virgin polyethylene, and the additives are added on a liquid form, and injected in the extruder. This technology needs a proper dosing system, and is successfully used for a long time. In this case, the anti-oxidant, which can be solid or liquid, is dissolved in the liquid peroxide. Some safety rules have to be fulfilled, due to the vapour pressure of the peroxide.

The aim of this paper is to compare the behaviour regarding the water trees generation of the insulations obtained with the 2 technologies.

Water trees generation

There are two kinds of trees: the electrical tree and the electrochemical one.

The electrical trees appear when the maximum electric field at a suitable location is near the breakdown point. Generally it is admitted that partial discharges, which are not measurable individually, grow in micro-cavities and produce sharp hole at the tip, where the electric field is transferred. If micro-cavities don't exist at the beginning, they are created by an electromechanical fatigue, in points of concentration of electric field. Heating due to dielectric losses can increase this fatigue.

The electrochemical trees are less clear than the electrical ones. They consist of multitudes of micro-channels (less than 1µm in diameter) that form a kind of fog. The presence of water or a solution in the cable insulation and the application of voltage are two essential conditions for the onset of electrochemical trees. They are often called water Trees.

There are two types of electrochemical trees: the bush-type trees (Vented tree) and the bow tie trees. The bush-type trees can be either electrical or electro-chemical. They develop from defects closed to conductive screens. They present a variety of forms: algae, herbs, feathers, ferns, clouds... The general direction of growing is that of electric field.

To generate a bush like tree, it is necessary to have a conducting tip (such as a needle) down in the insulation and an electrode, generally flat and in contact with the other side of the material. The tree is now growing where the electric field is strongest, generally just at the tip.

The bow tie trees are also of electric or electro-chemical nature. They are only observed from inclusions (impurities, micro-voids) distributed in the insulation. These trees are parallel to the electric field, they are shaped bow, always oriented in the same direction, inclusion forming their center. This type of tree is less dangerous in the operation of the cable than bush-type trees. Indeed, observations have shown that some cables, still in use, have within them a large number of bow-tie trees.

Method

In our case, we will focus in particular on electrochemical trees of bush type. The parameters which must be taken into consideration are:

Solution in presence:

To produce electrochemical trees in cable insulation, it is necessary to immerse them in water or to introduce moisture into the wiring. The trees grow mainly from the internal conductive shield, and from contaminants in the insulation, but rarely from the external shield, even when the water is outside.

Water has also been found in the channels of the trees.