Lifetime extension of medium voltage cables

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ABSTRACT

In many Austrian distribution grids PE-insulated medium voltage cables installed in the 1980's are still in service. Failures caused by water-trees in the insulation are well known and reported. For grid operators this raises the question of whether to replace the cables to maintain the reliability of the grid.
Another possibility instead of replacing the cables is to extend the service life of PE-insulated cables using a treatment to refit the insulation. This treatment uses a silicon based fluid which is pressed into the insulation of the cable to inactivate existing water trees. Initially cables were treated using a fluid containing phenylmethyl-dimethyloxysilane components. These components often caused accelerated corrosion of aluminium conductors because of chemical reactions in the past. Due to this fact a couple of years ago the fluid was improved using alkoxylane to prevent corrosion. The effectiveness of this improved method for life time extension of medium voltage cables has been investigated in a cooperation of the Austrian Netz Burgenland Strom GmbH, the German UtilX Europe GmbH and the Institute of High Voltage Engineering and System Performance, Graz University of Technology. Sections of 20 kV cables were used for investigating this insulation refit. An impulse voltage step test has been carried out on these and on refitted samples to evaluate the effect of the treatment.

KEYWORDS

Medium voltage cables, PE-insulated cables, life time, refitting of PE-cables, impulse voltage step test, water trees.

DESCRIPTION OF THE CABLECURE® PROCESS

The process for the rejuvenation of water-tree damaged medium voltage cables by silicone injection is named CableCURE®. The process can be divided into the following stages [1]:

Step 1: TDR Measurement. By applying a TDR measurement existing known or unknown joints get identified and located.
Step 2: Handling of joints. Based on the TDR results old joints are replaced by the latest types of flow-through joints, especially designed to carry the pressure required for silicone fluid injection.
Step 3: Handling of terminations and cable ends. Existing terminations and SF_6-elbows are modified or replaced by pressure resistant types. Alternatively special cable injection adapters are installed.
If required, the existing connector remains on the conductor end.
Step 4: Flow test. After the cable has been mechanically prepared for injection a flow test is applied to confirm the pressure resistance of cable accessories and the flow through capability of the conductor.
Step 5: Injection: By using different types of pressurized injection tanks strand desiccant and silicone fluid are injected into the cable's conductor.
A pressure of 0,5 MPa/75 psi is usually sufficient to fill the cable. However, depending on the circumstances (joints/no joints) higher pressures can also be applied to accelerate the process.
A vacuum system connected to the far end of the cable supports the injection process and assures a fluid injection free from gas or air pockets.

Fig. 01: Pressurized injection tanks (left) and the vacuum system (right)

Step 6: Polymerization. The CableCURE® fluid rapidly diffuses from the strands into the insulation, where it polymerizes with the water in the micro voids and fills them with this highly dielectric fluid. Since the molecules of the resulting dielectric fluid are much larger than water molecules, they lock into place, retarding the growth of future water trees.

QUALITY ASSESSMENT OF PE CABLES BY MEANS OF IMPULSE VOLTAGE STEP TEST

By examining cable samples with an impulse voltage step test it is possible to discover protrusions or impurities in the insulation of the PE-cable. Defective areas strongly reduce withstand voltage level. Although this test is not part of the usual standards it can be carried out for selected cable samples in the course of prequalification or quality tests on an agreement between cable manufacturer and customer. Experiments show withstand voltage levels of at least 600 kV in 20 kV cables of an acceptable quality [2].

Five prepared samples of 20 meters length each are required (Fig. 02) for testing the cables.
No terminations are required for the test procedure. The