EQUIPMENT FOR FAST WATER TREES RESISTANCE MEASUREMENT OF POWER CABLE INSULATIONS

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ABSTRACT

In this paper novel equipment for fast water trees resistance measurement using high frequency test (3 – 5 kHz) is presented. This is composed of a power source with variable voltage and frequency, a sample holder, a system for separating and protecting the samples from breakdowns and a data acquisition system connected to a host computer. The software installed on the host computer allows the adjustment of all the test parameters (applied voltage, frequency, reading speed, current etc.), as well as advanced online and after test data processing. Using high frequency electric fields of 4 kV/mm and 3 – 5 kHz, 200 – 300 µm long water trees could develop in 3-4 days.

KEYWORDS

Water treeing, accelerated ageing, computerized set-up, cable insulations, water treeing resistance measurements.

INTRODUCTION

Under the influence of the electric field and in the presence of water, in polymeric insulations water trees develop [1-2].

Water trees are water filled micro - cavities linked by very thin channels (of microns order). They appear in regions with high electric fields, like the interface insulation/conductor (vented trees) or in the vicinity of cavities and impurities (bow tie trees) and start to develop from the areas where the electric field is more intense towards the areas where the electrical field is less intense [3 - 4].

The growth of water trees causes an increase of the electric conductivity, permittivity and dielectric losses in insulations, a local intensification in the electric field, a decrease in the partial discharges inception voltage, a decrease of the dielectric strength and of the breakdown voltage, respectively a premature breakdown of the insulations [4-8]. For this reason it is necessary to determine the resistance to water treeing of polymers and cables insulation.

To investigate the water treeing phenomenon, the reproducibility under controlled conditions is required. As the experiments under normal operating parameters (rated voltage, 50 Hz) implies a long time period, accelerated ageing tests are necessary. For these last tests strong and/or high frequency electrical fields are necessary.

Many researchers report laboratory tests concerning accelerated water trees development in samples subjected to electric fields of high frequencies [9 - 13]. Setups used in these tests implied high voltage and frequency power supplies [8 - 9] or various generators followed by power amplifiers and step-up transformers for the task [10-11]. As tests are performed simultaneously on several insulation samples, a permanent control of samples condition is required. Also is advisable to shut off test for samples having reached a current above a certain admissible upper bound due to initial manufacturing faults in insulation, large tree formation development or breakdown occurrence.

In this paper a completely automated test equipment for fast water trees development (AEWTD) is presented.

EQUIPMENT

The test system used for water tree development in polymeric insulations is presented in the block scheme from Figure 1. The measurement chain starts with a direct digital synthesizer generator (DDS) providing sin-wave signals with frequency in the range of 10 Hz to 20 kHz, 0.01 Hz resolution.

The output voltage level of the generator is controlled by a digital potentiometer, which, among the PID loop of the system, provides a 0.1 V voltage resolution on the insulation probes.

The power amplifier, following the generator, performs a voltage and power gain of the signal providing the necessary energy to the step-up voltage transformer.

Current and voltage in amplifier output are measured with appropriate sensors of the data acquisition system. The current is monitored and actions are taken to limit the power on amplifier output for protection reasons.

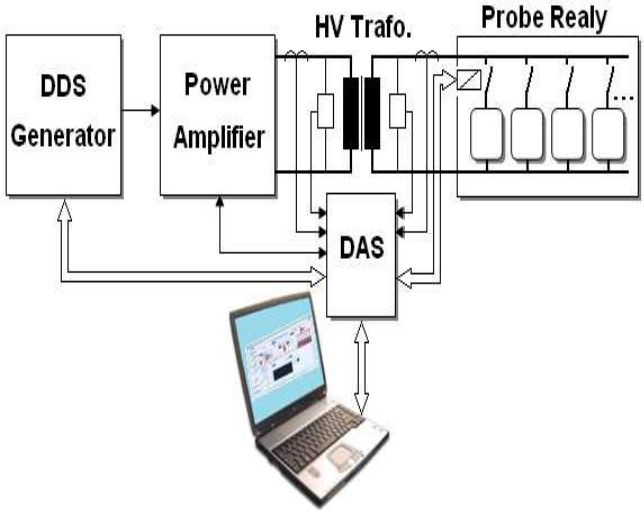

Fig. 1: Block scheme of the ageing test system