

# Monitoring the electrical properties and modified insulation of enhancing XLPE high voltage cables

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**Abstract**— Electrical treeing is the dominating failure phenomena in solid insulating material. Treeing occurs due to voids, dust and impurities present in the insulation material, change in the crystalline structure, stress occurring in the semi-crystalline structure and environmental factors. The growth characteristics of electrical tree is analyzed by injecting high voltage continuously using transformer in XLPE sample

**Keywords**—XLPE, high voltage, treeing, nano particles

## I. INTRODUCTION

The solid high-voltage cable insulation's treeing can be a frequent breakdown method and electrical faults are occurred in underground high voltage cables. Treeing occurs due to voids, dust and impurities present in the insulation material, change in the crystalline structure, stress occurring in the semi-crystalline structure and environmental factors. In this work, the inception and propagation of the tree is monitored at regular interval of time. The length of the tree, the partial discharge and leakage current at the time of propagation of the tree is also monitored.

## II. EVERY DAY WITH METALS

### A. Different other forms of metals

In everyday life, the pure fundamental silver can be the exceptional electrical conductor meet. Steel, Copper, aluminum, brass and gold can be acted. The electricity is conducted by a few metals better than any recognized material at room temperature having low temperatures. This kind of occurrence can be known as superconductivity, and a material that can behave that method can be known as a superconductor.

### B. The surface ligands or the nano particles

In general, the interfacial layer can be an essential element of nanoscale substance. The interfacial layer includes the ions, organic and inorganic molecules. The Organic molecules outside layer inorganic nanoparticles are called as surface ligands, capping, stabilizers or passivating agents. A particle has been described as a little object that can act as an entire unit with respect to it's conveyed and elements. These particles are categorized depending on the

## III. IMPACT OF NANO PARTICLES

A. Typically, the unexpected optical properties are possessed by the nanoparticles as they can be little adequate to detain their electrons and generate effects of quantum. In substances composed of nanoparticles, the inclusion of solar radiation can be much higher than it can be in thin films of incessant substance's sheets. The shape, size, and substance of the particles are controlled and it can be probable to manage solar inclusion in both solar PV (photovoltaic) and solar thermal purposes. At present, the core nanoparticle was established a zero backward scattering with improved onward scattering on Si (Silicon) substrate while plasmon of surface can be placed in solar cell's front.

### B. High Voltage and XLPE Cables

- A high-voltage (HV) cable is one type of electrical cables that can be utilized for electric power transfer at high level of voltage. This cable contains a conductor and insulator and it can be appropriate for underwater or underground running. The high voltage can take a voltage over 1000 volts. These cables for 3000 and 6000 volts subsist, other than the most of cables have been utilized from 10 kV and rising. These high voltage cables are over 50 kV high voltage cables. For example, the XLPE (Cross-Linked Polyethylene) cable is a one kind of high voltage cables.
- XLPE cables are in the range from 6.6 kV and above that having the semiconducting screens over the every insulated core and conductor. The XLPE cable cannot struggled inexpensively for underground distribution at the voltage level of 11kV with the paper-insulated aluminum- enclosed cable, other than effort can be in the development on regulate and evaluate the design of XLPE cable contains trial fitting, in training for some alter in the condition. The circumstances can be varied for XLPE and it can be the sort in main demand.
- Partial discharge can be acted as localized dielectric breakdown of a little piece of a fluid or solid electrical insulation scheme under the pressure of high voltage, in which space is not linked between the two conductors. The PDs within solid insulation method cannot be observable as a corona discharge can be exposed by a comparatively stable glow or clash discharge in the air.

- The Partial Discharge has also been happened all along the solid insulating substance surface when the surface tangential electric field can be high sufficient to reason a breakdown beside the surface of insulator. These kinds of occurrence marked itself on transparency line insulators, mainly on contaminated insulators in the days of high moisture. Overhead lines can utilize the air as their insulation intermediate.

### C. Voltage Gradient

In initial approximation, the main insulation of a high voltage XLPE cable can be regarded as a homogenous cylinder. Its field distribution or voltage gradient is therefore represented by a homogenous radial field. The value of the voltage gradient at a point x within the insulation can therefore be calculated as:

$$E_x = \frac{U_o}{r_x \cdot \ln\left(\frac{r_a}{r_i}\right)} \quad (1)$$

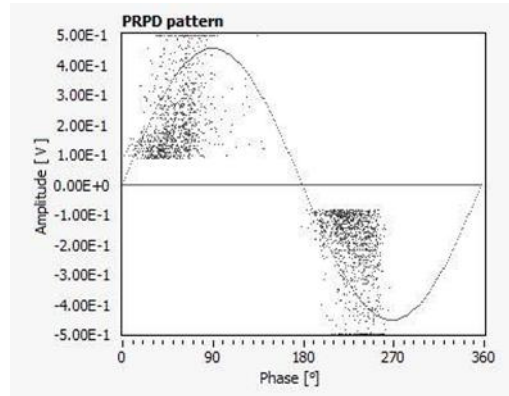
### D. Nano Technology techniques

- Cross-linked polyethylene (XLPE) has been created by thermochemical action; the benefit of cross-linking is to inhibit the movement of molecules with respect to each other for enhancing stability at various temperatures compared with the thermoplastic materials. This action permits higher operating temperatures and current rating than polyvinyl chloride. Nanotechnology science gives polymer matrix a reduction in the values of effective permittivity as nanocomposites materials. Nowadays, electric and dielectric properties of power cables insulation materials can be controlled using nanotechnology techniques under various thermal conditions.

$$E_{max} = \frac{2Ud}{r \cdot \ln\left(1 + \frac{4d}{r}\right)} \quad (2)$$

- Electrical trees initiate when there are deterioration caused by partial discharge in gas void or gas crack, or high electric field caused by impurities. It is observed a bush type of tree and branch type tree is observed. The certain length is 20µm. The initiation time, which is the time used for the tree to grow over 20µm in length after it is subject to the electrical stress, have been calculated and analyzed. As the voltage increases, the dispersion of initiation time decreases. This may be because the influences of material microstructure near the needle tip on the initiation of electrical trees are larger when the voltage is lower.

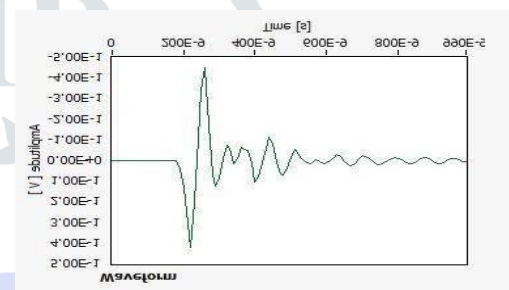
### E. Result Analysis



Partial discharge pattern (a)

### F. Leakage current waveform

“Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes



Leakage current waveform(a)

### G. Conclusion

In this research, the electrical properties have been monitored and modified insulation of enhancing XLPE high voltage cables was improved. A technique of remote sensing of stress and monitoring of partial discharge in High Voltage XLPE cable system has also been discussed. The Monitoring and detection of voltage stress in HV cables was executed I2C protocol by applying the embedded technology. I2C protocol was implemented successfully in this system. Master and slave operations have been controlled by PIC microcontroller. Abnormal voltage stress across the HV cable was corrected by using step up and step down transformer. To implement this proposed method in real-time XLPE cable insulation using some electrical properties. The nano particles SiO<sub>2</sub>, TiO<sub>2</sub> can be added to XLPE cable insulation to the more extension. To examine the improved performance at low computational cost.

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