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FACULTY OF ENGINEERING
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Electrical Improvement For Cross-Linked Polyethylene High Voltage Cables

A Thesis
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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master in Electrical Engineering.

The work included in this thesis was carried out by the author at high voltage laboratory in Electrical Power & Machines department, Polymers and Pigments department in National Research Center (N.R.C) and Laboratory safety and fire protection in National Institute for standard (NIS). No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

Electrical insulators are a very important component in the electrical power systems such as stations, sub-stations, distribution and transmission lines.

Polymer insulators are heavily used for both distribution and transmission lines because of their advantages of light weight, high mechanical strength ,easy handling ,maintenance free, and considerably low cost.

Since about 1970, the cross-linked Polyethylene (XLPE) insulated power cables have been used worldwide. This insulation possesses very good electrical, mechanical and thermal characteristics in medium and high voltage networks. This type of insulation has excellent chemical resistance and is also resistant to cold temperatures. Due to various advantages, the XLPE-insulated type has vastly displaced the traditional classic paper-insulated types in many sectors for cables. Many studies and researches have been evaluated to improve XLPE characteristics

This study aims to improve electrical properties of Cross-linked polyethylene in respect of thermal and mechanical characteristics by adding inorganic fillers. Blends of XLPE with various

inorganic fillers such as: $CaCO_3$, Kaolin and Silica are prepared with 20%,30 % and 50 % concentration percentages.

The dielectric strength of the blends is tested in several thermal conditions such as :

- Different temperatures ranges (0 °C , 30 °C ,100°C) .
- Blends thermally stressed for 24 hrs aging in high temperatures (120 °C , 160 °C ,200°C) .

Thermogravimetric analysis,tensile strength and elongation at break tests are applied to check the thermal and mechanical properties of the blends. The results obtained are plotted and compared to each other to select most suitable filler and its concentration.

LIST OF ABBREVIATIONS

H.V : High Voltage

k V : Kilo Volt

XLPE **:** Cross-linked polyethylene

$CaCO_3$ **:** Calcium Carbonate

Wt% **:** weight percentage

$CaCO_3$(20) : Cross-linked polyethylene sample loaded with 20 wt% of Calcium Carbonate by weight.

$CaCO_3$(30) : Cross-linked polyethylene sample loaded with 30 wt% of Calcium Carbonate by weight.

$CaCO_3$(50) : Cross-linked polyethylene sample loaded with 50 wt% of Calcium Carbonate by weight.

Kaolin(20) : Cross-linked polyethylene sample loaded with 20 wt% of Kaolin by weight.

Kaolin(30) : Cross-linked polyethylene sample loaded with 30 wt% of Kaolin by weight.

Kaolin(50) : Cross-linked polyethylene sample loaded with 50 wt% of Kaolin by weight.

Silica(20) : Cross-linked polyethylene sample loaded with 20 wt% of Silica by weight.

Silica(30) : Cross-linked polyethylene sample loaded with 30 wt% of Silica by weight.

Silica(50) : Cross-linked polyethylene sample loaded with 50 wt% of Silica by weight.

IEC : International Electrotechnical Commission

IEEE : Institute of Electrical and Electronics Engineers

ASTM : American Standard Test Method

TGA : Thermogravimetric Analysis

$\mathbf{T}_{maximum}$: Maximum Tensile Stress

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