بسم الله الرحمن الرحيم

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تم رفع هذه الرسالة بواسطة / حسام الدين محمد مغربي

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات : لا يوجد

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
ELECTRCICAL POWER AND MACHINE DEPT.

Effect of Nano Fillers on Dielectric Properties for the Crosslinked Polyethylene High Voltage Cables

A Thesis Submitted in Partial Fulfillment of the Requirements of the Degree of Doctor Philosophy in Electrical Engineering
(Electrical Power and Machines Dept.)

By

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Master of Science in Electrical Engineering
Faculty of Engineering, Ain Shams University, 2012

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Cairo – (2022)

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Date: 17/ 02/ 2022

STATEMENT

This thesis is submitted as a partial fulfilment of Doctor of Philosophy in Electrical Engineering Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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 Centre (NRC) and National Institute of Standards (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 play a key role in every electrical power system (sub-stations, distribution and transmission lines). Theoretically, an electrical insulator provides very high resistance and protection for the electrical equipment so that no current can flow through it.

Polymer insulators are used for both distribution and transmission lines. Since 1970, the use of such insulators increased rapidly because of their advantages of light weight, high mechanical strength, easy handling, maintenance free, and considerably low cost. Insulators are required in the power system network to provide ground isolation and mechanical support for line conductors. Different kinds of insulators are being utilized in the transmission lines and substations. Many power utilities are now using non-ceramic insulators like XLPE composite insulators.

Crosslinked polyethylene XLPE is widely used in medium and high voltage cables insulation due to its low dielectric losses and its ability to improve cable properties in high temperatures. Also, XLPE has an excellent chemical resistance. Due to the various advantages, the XLPE-insulation type has vastly displaced the traditional classic paper-insulated types in many sectors for cables. Many studies and researches have been conducted to improve XLPE characteristics.

This thesis aims to develop XLPE nanocomposites for usage as power cables insulations in the industrial applications. To attain this, XLPE polymer were blended with different fillers of Titanium Dioxide (TiO_2) and Zeolite (Z) nanoparticles: 0, 1, 3, 5 and 7 weight percentages (wt%). The dielectric properties of these developed XLPE nanocomposites were studied by measuring the AC breakdown strength with a regulated high voltage testing transformer (50Hz). The breakdown strength of the nanocomposites is tested in several conditions such as: different temperatures ranges (30℃ and 250℃), nanocomposites were thermally stressed for 24 hrs aging in high temperatures (120℃ and 160℃), low saline water and high saline water conditions. The mechanical properties such as tensile strength and elongation at break were also assessed. The thermal properties of nanocomposites were examined using Thermo Gravimetric Analysis (TGA).

Addition of nano TiO_2 with 5 wt% showed the optimum results to improve the electrical, mechanical and thermal characteristics of XLPE nanocomposites compared to Z nanofiller.

The laboratory results were utilized to build a machine learning software using Python ; which comprises mostly of diverse circumstances, fillers type, and filler concentrations as input and experimental outcomes as output such as the AC breakdown strength . The machine learning model has been used to estimate and predict the other values of breakdown strength and tensile strength for XLPE nanocomposite samples that were not tested in the laboratory. This software can help to choose the optimum filler type and concentration to enhance the high

Keywords: XLPE, Nano Fillers, Titanium Dioxide, Zeolite, Breakdown Strength, Tensile Strength, Elongation at Break, Thermogravimetric Analysis, Machine Learning

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LIST OF ABBREVIATION

Al_2O_3	: Aluminum Oxide.
ASTM	: American Society for Testing and Materials.
EPR	: Ethylene Propylene Rubber.
EVA	: Ethyl Vinyl Acetate.
EPDM	: Ethylene Propylene Diene Monomer.
HDPE	: High Density Polyethylene.
HMWPE	: High Molecular Weight Polyethylene.
IEC	: International Electro Technical Commission.
LDPE	: Low Density Polyethylene.
MgO	: Magnesium Oxide.
MPa	: Mega Pascal.
PE	: Polyethylene.
SEM	: Scanning Electron Microscope.
SiO_2	: Silica.
TGA	: Thermo-Gravimetric Analysis.
TiO_2	: Titanium Dioxide.
TRXLPE	: Tree Retardant Cross Linked Polyethylene.
wt(%)	: Weight Percentage.
XLPE	: Cross Linked Polyethylene.
Z	: Zeolite.
ZnO	: Zinc Oxide.

LIST OF ACRONYM

B	: XLPE with no fillers.
T1	: Nano Titanium Dioxide Composite filled with 1wt%.
T3	: Nano Titanium Dioxide Composite filled with 3wt%.
T5	: Nano Titanium Dioxide Composite filled with 5wt%.
T7	: Nano Titanium Dioxide Composite filled with 7wt%.
Z1	: Nano Zeolite Composite filled with 1wt%.
Z3	: Nano Zeolite Composite filled with 3wt%.
Z5	: Nano Zeolite Composite filled with 5wt%.
Z7	: Nano Zeolite Composite filled with 7%.

TABLE OF CONTENTS

LIST OF TABLES