بسم الله الرحمن الرحيم

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

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AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electrical Power and Machines Engineering

Neural Networks Approaches to Determine Electrical and Rheological Properties of Polymer High Voltage Insulators

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

By

Sherif Hussein Haggag Ahmed
Master of Science in Electrical Engineering
(Electrical Power and Machines Engineering)
Arab Academy for Science Technology & Maritime Transport, 2013

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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 and Machines department, Aswan University, Research and Development department, EGYPLAST factory, El Sewedy Group. 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

Cables are an essential component in the power system. Cables insulation should have basic electrical parameters to give it the capability of performing its function successfully. High dielectric strength, significant resistivity, besides low permittivity and loss factors, are important electric features that should be possessed in the cable insulation materials; however, thermal and mechanical aspects such as thermal withstand capacity and adequate degree of elasticity are substantial as well.

Due to their chain structure, polymers have low dielectric constant and high electric breakdown; In addition, they are characterized with multiple valuable mechanical parameters that make them suitable for cable insulation applications.

Polymer composites and blends in dielectric applications have lately garnered significant interest from researchers. The applicability of customizing polymers features to suit particular objectives met approbation by the industrial sector.

This research introduces the changes of a comprehensive electromechanical properties bundle for low density polyethylene compounded to nano and micro scale magnesia (LDPE/MgO) to obtain electrical cables insulating material with advanced performance. Composites of various filler loading weight ratios were prepared by melt intercalation technique; multiple samples were produced in sets as they were cut with definite dimensions as per recommendations of the related testing standard then electrically and mechanically examined following the instruction dictated by the code while preserving typical test condition for all sets. Dielectric strength, volume resistivity, capacitance, and loss angle were the tests of the electrical test pack, while elongation, tensile strength, and melt flow rate were the mechanical and rheological tests applied. Water absorption is another test that has been conducted on the proposed composite.

Artificial Neural Network was designed and trained using acquired practical results in order to predict dielectric strength of composites that have typical contents but with different filler loading or impacted by other media salinity degrees.

The research findings and comparisons showed that the Low-Density Polyethylene compounded to surface characterized nano magnesia is better in most electrical and mechanical properties than the pristine host, nanocomposite with non-modified filler surface and micro composite, best results obtained with low percentages of filler loading of almost 1.5 wt%.

Keywords: Low-Density Polyethylene, Micro and Nano Fillers, Magnesium oxide, Surface modification, Dielectric Strength, Tensile Strength, Elongation at Break, Feed Forward Neural Network

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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.
FTIR	: Fourier-Transform Infrared Spectroscopy
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.
TDS	: Total Dissolved Solids
TGA	: Thermo-Gravimetric Analysis.
TiO_2	: Titanium Dioxide.
TRXLPE	: Tree Retardant Cross-Linked Polyethylene.
Wt(%)	: Weight Percentage.
XLPE	: Cross Linked Polyethylene.

XRD	: X-Ray Diffraction
Z	: Zeolite.
ZnO	: Zinc Oxide.

LIST OF ACRONYMS

P	: Pure LDPE
MN1	: Modified Nano LDPE-MgO Composite with 0.5wt%.
MN2	: Modified Nano LDPE-MgO Composite with 1wt%.
MN3	: Modified Nano LDPE-MgO Composite with 1.5wt%.
MN4	: Modified Nano LDPE-MgO Composite with 2.5wt%.
MN5	: Modified Nano LDPE-MgO Composite with 4wt%.
N1	: Nano LDPE-MgO Composite with 0.5wt%.
N2	: Nano LDPE-MgO Composite with 1wt%.
N3	: Nano LDPE-MgO Composite with 1.5wt%.
N4	: Nano LDPE-MgO Composite with 2.5wt%.
N5	: Nano LDPE-MgO Composite with 4wt%.
M1	: Micro LDPE-MgO Composite with 5wt%.
M2	: Micro LDPE-MgO Composite with 10wt%.
M3	: Micro LDPE-MgO Composite with 15wt%.
M4	: Micro LDPE-MgO Composite with 20wt%.

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