AIN SHAMS UNIVERSITY
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ELECTRICAL POWER AND MACHINES DEPT.

Study on Electrical Characteristics for High Voltage Insulators Polymer Composite using Hybrid Fillers

A Thesis
Submitted in partial fulfillment of the requirement for the
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STATEMENT

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

The work included in this thesis was carried out by the author. No part of this thesis has been submitted for a degree or a qualification.

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ABSTRACT

The rubber and epoxy are polymeric materials widely-used as insulating materials for many reasons such as; economy, strength and ease fabrication to good tolerance. As a result of the development which has taken place recently; these materials can be produced with various designs and shapes for outdoor applications with suitable electrical and mechanical properties according to their intended purpose.

Composite material has electrical properties such as dielectric strength and electric resistivity which are measured by different tests and compared with different composite materials according to the added filler. The (Micro – Nano – hybrid) filler is inserted in manufacturing the composite material to improve its electrical and mechanical properties.

Epoxy composites are one of the polymeric composite insulators which are used in outdoor insulation. In order to study the electrical behavior of epoxy composites as outdoor applications insulators for overhead transmission lines at different conditions, inorganic fillers such as titanium dioxide and silica with different sizes are inserted into the epoxy to modify its electrical and physical properties in addition to maximize surface flashover voltage and decrease tracking phenomena at dry and contaminated weather conditions. Surface flashover voltage for composite insulators is calculated using neural-network based on mathematical model at any weather condition.

The objective of this research is to study electrical properties of epoxy composites for overhead transmission lines under contaminated weather conditions. The composites include inorganic filler of different types, sizes and concentrations. It is used as insulators. This is aimed at selecting the suitable polymer composite insulator which achieves the maximum surface flashover voltage.

Finally the main salient points of the chosen polymeric insulator for this work have been summarized and presented.

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LIST OF ABBREVIATIONS

TiO_2	Titanium dioxide
SiO_2	Silicon dioxide composite or Silica
$Ti_{M0.1}$	Micro titanium dioxide composite loaded with 0.1%
$Ti_{M0.25}$	Micro titanium dioxide composite loaded with 0.25%
$Ti_{M0.5}$	Micro titanium dioxide composite loaded with 0.5%
$Ti_{M0.75}$	Micro titanium dioxide composite loaded with 0.75%
Ti_{M1}	Micro titanium dioxide composite loaded with 1%
Ti_{M3}	Micro titanium dioxide composite loaded with 3%
Ti_{M5}	Micro titanium dioxide composite loaded with 5%
Ti_{M7}	Micro titanium dioxide composite loaded with 7%
$Ti_{N0.1}$	Nano titanium dioxide composite loaded with 0.1%
$Ti_{N0.25}$	Nano titanium dioxide composite loaded with 0.25%
$Ti_{N0.5}$	Nano titanium dioxide composite loaded with 0.5%
$Ti_{N0.75}$	Nano titanium dioxide composite loaded with 0.75%
Ti_{N1}	Nano titanium dioxide composite loaded with 1%
Ti_{N3}	Nano titanium dioxide composite loaded with 3%
Ti_{N5}	Nano titanium dioxide composite loaded with 5%
Ti_{N7}	Nano titanium dioxide loaded with 7%
$Si_{M0.1}$	Micro silica composite loaded with 0.1%

$Si_{M0.25}$	Micro silica composite loaded with 0.25%
$Si_{M0.5}$	Micro silica composite loaded with 0.5%
$Si_{M0.75}$	Micro silica composite loaded with 0.75%
Si_{M1}	Micro silica composite loaded with 1%
Si_{M3}	Micro silica composite loaded with 3%
Si_{M5}	Micro silica composite loaded with 5%
Si_{M7}	Micro silica composite loaded with 7%
$Si_{N0.1}$	Nano silica composite loaded with 0.1%
$Si_{N0.25}$	Nano silica composite loaded with 0.25%
$Si_{N0.5}$	Nano silica composite loaded with 0.5%
$Si_{N0.75}$	Nano silica composite loaded with 0.75%
Si_{N1}	Nano silica composite loaded with 1%
Si_{N3}	Nano silica composite loaded with 3%
Si_{N5}	Nano silica composite loaded with 5%
Si_{N7}	Nano silica composite loaded with 7%
$Ti_N/Si_{N\ (0.1)}$	Hybrid nano titanium dioxide and nano silica with 0.1%
$Ti_N/Si_{N\ (0.75)}$	Hybrid nano titanium dioxide and nano silica with 0.75%
$Ti_M/Si_{N\ (0.1)}$	Hybrid micro titanium dioxide and nano silica with 0.1%
$Ti_M/Si_{N\ (0.75)}$	Hybrid micro titanium dioxide and nano silica with 0.75%
$Ti_N/Si_{M\ (0.1)}$	Hybrid nano titanium dioxide and micro silica with 0.1%
$Ti_N/Si_{M\ (0.75)}$	Hybrid nano titanium dioxide and micro silica with 0.75%
$Ti_M/Si_{M\ (0.1)}$	Hybrid micro titanium dioxide and micro silica with 0.1%

$Ti_M/Si_{M\ (0.75)}$	Hybrid micro titanium dioxide and micro silica with 0.1%
$Ti_{M/N\ (0.1)}$	Hybrid titanium dioxide composite loaded with 0.1% micro and nano
$Ti_{M/N\ (0.75)}$	Hybrid titanium dioxide composite loaded with 0.75% micro and nano
$Si_{M/N\ (0.1)}$	Hybrid silica composite loaded with 0.1% micro and nano
$Si_{M/N\ (0.75)}$	Hybrid silica composite loaded with 0.75% micro and nano
ESDD	Equivalent salt deposit density (mg/cm^2).
kV	kilo Volt
V	Volt
KVA	Kilo Volt Ampere
BDV	Breakdown Voltage
ρ	Volume resistivity (Ω.cm)
σ	Volume conductivity (S/m).
U	Expanded uncertainty %
S	Siemens
M.S. Error	Mean square error