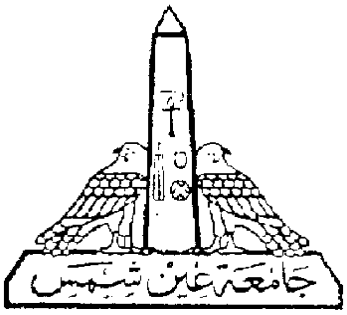

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
ELECTRICAL POWER AND MACHINES DEPT.

INVESTIGATION OF SURFACE PHENOMENA ON POLYMER COMPOSITE INSULATORS DUE TO WATER DROPLETS UNDER HIGH VOLTAGE.

A Thesis
Submitted in Partial Fulfillment for the Requirement of the Degree of
Master of Science in Electrical Engineering

By
Ahmed Mohamed Husieny Abo-se'da
B.Sc. Electrical Engineering, Ain Shams University, 2006

Supervised By

Prof. Dr. Mahmoud Abd El-Hamed
Electrical Power & Machines Dept.
Faculty of Engineering
Ain Shams University

Prof. Dr. Loai Saad El-deen Nasrat
Electrical Power & Machines Dept.
Faculty of Engineering
Aswan University

Prof. Dr. Samia Habib Mansour
Polymers & Pigments Dept.
National Research Center

Cairo – 2013

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 and Polymers and Pigments department in National Research Center (N.R.C). No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

Acknowledgement

My greatest thanks to the God Almighty for giving me the will power and strength to make it this far when I did not see a light

I am grateful to **Professor Dr. Mahmoud Abd El-Hamed** for his able guidance and support throughout the research work.

I would like to extend my sincere thanks to my supervisor **Professor Dr. Loai Saad El-deen Nasrat** for his continuous support and encouragement. His experience and research interest in the area of polymeric insulators encouraged me to select this topic. His uninterrupted guidance and continuous help rather push to move forward greatly assisted me in developing the research skills and achieving the target.

I am grateful to **Professor Dr. Samia Habib Mansour** , Polymers & Pigments Dept., National Research Center, who has been a constant source of inspiration for me.

Sincere thanks are extended to the staff of High Voltage Laboratory, electrical engineering department and National Research Center, Polymers & Pigments Dept. where most of the samples preparation and experimental work was carried out.

Finally, but most important, I thank God almighty again on all things in my life

ABSTRACT

High voltage power transmission lines have acquired considerable prominence in the recent times. It has become essential to design and develop compact cost-effective and reliable insulation structures

Traditionally, line insulators have been produced using high quality glazed porcelain and pre-stressed or toughened glass. Extensive research and service experience has shown that these materials are very reliable and cost effective for a majority of outdoor applications. However, since early sixties, alternative materials namely polymers have emerged and presently are being used extensively for a variety of outdoor insulator applications because of their lightweight, high mechanical strength, less cost, reliability and superior contamination performance.

Water droplets on a polymeric surface may cause corona under the influence of an electric field and can cause deterioration to the insulation surface even in conditions of a low pollution level. The droplets increase locally the applied electric field. Local field intensifications lead to partial discharges (PD) and/or localized arcs, which may render possibly dry bands on the polymeric surface. Local arcing will eventually bridge the dry bands and a complete flashover will finally ensue.

This study investigates the influence of various parameters on the behavior of water droplets on PVC/EPDM composite material surface under electric fields. Parameters, such as polymer content, water droplet conductivity, droplet volume, and number of droplets were studied. The flashover voltage is affected by all aforementioned parameters.

Results showed that PVC material without any additions gives the best electrical performance with respect to blends of PVC / EPDM and EPDM only, increased conductivity, number of droplets and increased droplet volume cause a reduction of the flashover voltage.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

PD **:** Partial Discharges

EPDM **:** Ethylene Propylene Diene Monomer

EPR : Ethylene Propylene Rubber

UV : Ultra Violet

SR : Silicone Rubber

PVC : Polyvinyl Chloride

CFO : Critical Flashover

EPM : Ethylene Propylene Monomer

DSC : Differential Scanning Calorimetry

TGA : Thermogravimetrical Analysis

ETFE : Ethylene-Tetrafluorethylene

PPNCE: Plasticized Polymer nanocomposite electrolytes

XRD : X-Ray Diffraction

SEM **:** Scanning Electron Microscope

Tg **:** Glass Transition Temperature

DBS : Dielectric Breakdown Strength

IEC : International Electrotechnical Commission

LMW : low-molecular-weight

ASTM : American Standard Test Method

TPE **:** Thermoplastic Elastomer

DCPD **:** Dicyclopentadiene

ENB : Ethylidene norbornene

VNB : Vinyl Norbornene

kVA : Kilo Volt-Ampere

IEEE : Institute of Electrical and Electronics Engineers

NaCl **:** Sodium Chloride

DOP **:** Dioctyl Phthalate

LIST OF TABLES

LIST OF FIGURES