

PARTIAL DISCHARGE CHARACTERISTICS OF NATURAL RUBBER BLENDS
WITH INORGANICS NANOFILLER AS ELECTRIC INSULATING MATERIAL

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Dedicated, especially to my beloved mother, father, wife, grandmother, son, relatives and my friends for their eternal support, encouragement and inspiration.

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ABSTRACT

In electrical engineering, electrical discharge can occur in gaseous, liquid or solid insulating medium. Localized dielectric breakdown that occur at a small portion of a solid or fluid electrical insulation under high voltage stress is called partial discharge (PD). This phenomenon can cause the material to breakdown if there is no action taken quickly. As such, it is important to study about PD. Usually it begins within voids, cracks, or inclusions within a solid dielectric, at conductor-dielectric interfaces within solid and in bubbles within liquid dielectrics. In order to modify electrical properties of the original structure then nanocomposite need to be introduced. Nanocomposite is the original structure that has been inserted by nano component (nanofiller) such as silicone dioxide and titanium dioxide. Nanocomposites are also found in nature, for example in the structure of the abalone shell and bone. By adding nano component inside the original component, it can change the mechanical and electric properties. In this project, partial discharge characteristics for the nanocomposites will be investigated. The sample of nanocomposite was developing by using extrusion method. The sample will be testing by using detection method. High voltage is applied at the upper of the electrode of the test sample. The signal of partial discharge will detect by CIGRE Method II and RC detector and the signal will be transferred to be display at personal computer by using LabView™ software. The result from the software will be analyst to find out the partial discharge of the nanocomposites as electric insulating material. The results revealed that the highest PD numbers come from compositions with no filler while the lowest PD numbers come from sample that use 4% SiO₂ as its nanofiller. Therefore, compositions with 4% SiO as its nanofiller is suitable as insulators material among the samples.

ABSTRAK

Di dalam kejuruteraan elektrik, nyahcas elektrik boleh berlaku melalui penebat yang menggunakan medium gas, cecair atau pepejal. Kerosakan dielektrik setempat yang berlaku pada bahagian kecil penebat elektrik pepejal atau cecair di bawah tekanan voltan tinggi dikenali sebagai nyahcas separa (PD). Fenomena ini boleh menyebabkan kerosakan terhadap sesuatu bahan sekiranya tiada tindakan yang cepat diambil. Oleh yang demikian adalah penting untuk mengkaji mengenai nyahcas elektrik (PD). Biasanya nyahcas elektrik bermula di dalam ruang kosong, rekahan atau lubang di antara dielektrik pepejal, pada antara muka dielektrik konduktor dalam pepejal dan buih-buih dalam bahan dielektrik cecair. Oleh yang demikian untuk mengubahsui sifat-sifat elektrik struktur asal nanokomposit diperkenalkan. Nanokomposit ialah struktur asal yang telah diubahsui oleh komponen nano (nanofiller) seperti silika dioksida dan titanium dioksida. Nanokomposit juga dijumpai dalam alam semulajadi, misalnya dalam struktur petala abalon dan tulang. Dengan menambah komponen nano di dalam komponen asal, ia boleh mengubah ciri-ciri sifat mekanikal dan elektrikal bahan tersebut. Dalam projek ini, ciri-ciri nyahcas separa untuk nanokomposit akan dikaji. Sampel nanokomposit dilakukan dengan menggunakan kaedah *extrusion method*. Sampel akan diuji dengan menggunakan cara pengesanan. Voltan tinggi dialirkan pada bahagian atas elektrod sampel. Nyahcas separa akan dikesan oleh *CIGRE Method II* dan pengesan RC, isyarat akan dipindahkan untuk dipaparkan pada komputer peribadi dengan menggunakan perisian LabViewTM. Hasil dari perisian ini akan dianalisis untuk mengetahui ciri-ciri nyahcas separa pada nanokomposit untuk bahan penebat elektrik. Keputusan menunjukkan bahawa bil PD yang tertinggi diperoleh daripada komposisi yang tidak diubahsui manakala bil PD terendah diperolehi daripada. Oleh itu, komposisi dengan Sio 4% sebagai komponen nano adalah sesuai sebagai bahan penebat di kalangan sampel yang dikaji.

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LIST OF ABBREVIATIONS

PD	=	Partial Discharge
LabVIEW™	=	Laboratory Virtual Instrument Engineering Workbench
NI	=	National Instrument
NR	=	Natural Rubber
HPF	=	High pass filter
LDPE	=	Low Density Polyethylene
NBR	=	Acrylonitrile – Butadiene Rubber
EDPM	=	Ethylene propylene diene monomer rubber
EVA	=	Ethylene-co-vinyl acetate
PVC	=	Polyvinyl Chloride
TiO ₂	=	Titanium Dioxide
SiO ₂	=	Silicone Dioxide
SEM	=	Scanning Electron Microscope
EDX	=	Energy Dispersive X-ray
pph	=	part per hundred

LIST OF SYMBOLS

V	= Voltage
q	= Charge
C	= Capacitance
R	= Resistance
I	= Current
Ω	= ohm
δ	= delta
G	= Giga

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CHAPTER 1

INTRODUCTION

1.1 General Introduction

Partial Discharge (PD), as its name is an electrical discharge that occurs across a portion of the insulation between two conducting electrodes, without completely bridging the gap. Partial Discharges can occur at voids in solid insulation, gas bubbles in liquid insulation or around an electrode in a gas (corona).

. Partial Discharge activity can initiate under normal working conditions in high voltage equipment where the insulation condition has deteriorated with age and has been aged prematurely by thermal over-stressing. Partial discharge is generally accepted as predominate cause of long term degradation and eventual failure of electrical insulation.

PD can also be observed, on occasion, with the commissioning of new equipment due to improper installation, poor design or workmanship (this is seen particularly in cable joints and terminations which are made-up on site). After initiation, the PD can propagate and develop into electrical trees until the insulation is so weakened

that it fails completely with breakdown to earth or between the phases of a 3-phase system. In order to prevent and reduce partial discharge from occur in the electrical appatuses, then the new material need to be developed. This new material is called nanocomposite

Nanocomposite is the original structure that has been inserted by nano component or nanofiller such as nano silica and nano titanium. By adding nano component inside the original component, it can change the mechanical and electric properties. In this project the nanocomposites will be develop using natural rubber, LLDPE and nanofiller.

The samples of the nanocomposites will be produce using extrusion method and will be reshaping using moulding machine. After that, the sample will be testing using detection method by apply high voltage to the sample. The signal of partial discharge will detect by CIGRE method II and RC detector and the signal will be transferred to be display at personal computer by using LabView software. LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a powerfull graphical programming language and being used in lots of industry and application and create by National Instrument (NI). The result from the software will be analyst to find out the partial discharge characteristics of the nanocomposites as electric insulating material

1.2 Problem statements

Rubber is very important in our daily life to make many things. In electrical engineering, rubber is used to make coating of the insulator. But the surface of the natural rubber are easy to damage and breakdown.

This will cause technical life of the coating decrease. As a result, the cost of maintenance will increase because we have to replace the damaged coating regularly.

As such, natural rubber blend with inorganics nanofiller was develop to improve the technical life of the coating and other apparatus based on rubber because by adding the nanofiller, it can increase the dielectric properties and mechanical properties such as strength and stiffness. That means, the insulator will less fractured and damage against changing weather. So, it can minimize the cost of changing the insulator.

The invention of natural rubber with inorganics nanofiller is intended to enhance the technology and human way of life. Therefore, this nanocomposite is very important in need.

The partial discharge characteristics of natural rubber blends with inorganics nanofiller as electric insulating material is not clear reported yet. Therefore, the investigation on this project is necessary in order to find the characteristic of the nanocomposites as electrical insulator

1.3 Objective of Project

The main objective of this project is to develop a nanocomposite-natural rubber blends with inorganics nanofiller for investigation of partial discharge for electrical insulation material. Second objective is to investigate partial discharge characteristics of natural rubber blends with inorganics nanofillers that has been choose in this project. Then the nanocomposites will be comparing to find out the best bending formulation between natural rubber blends with different inorganics nanofiller that can withstand against PD. The characteristic that will be find in the nanocomposites is important in order to know either the nanofiller that has been used is suitable or not for electrical insulation.

1.4 Scopes of Project

In order to complete the project, there are several scopes should be follow. This project is to develop a nanocomposite – natural rubber blend with specified inorganics nanofiller. After the sample is developing using extrusion method, the experiment will be conducted by using detection method to detect signal of PD. High voltage will be applied to the sample and the partial discharge signal will detected and transfer to the PC. Te signal will be develop at PC by using LabVIEW software. Then, the observation at the sample is on electrical parameter such as voltage and number of PD in order to study and analysis the partial discharge (PD) characteristics at the sample.

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