

SURFACE DISCHARGE CHARACTERISTICS OF POLYMER-
NANOCOMPOSITE MATERIAL AS ELECTRICAL INSULATION

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Dedicated to my beloved father & mother

Haji Mustam bin Haji Ibrahim & Hajah Maimunah binti Haji Saffee

My Beloved Fiancée

Husnul Hanani binti Soib

My Beloved Siblings

Muhammad Hafiz bin Mustam

Muhammad Hafizuddin bin Mustam

Afian Akhbar bin Mustam

And

My Entire friend in MEP programme

For their encouragement

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ABSTRACT

. Surface discharge is electrical discharges that normally happens on the surface of insulators and also cause the failure in electrical insulation if not taken action. On the high voltage stress, the surface discharges cause deterioration of insulating materials. The experimental was carried out to investigate the surface discharge characteristics on HDPE as insulating materials. The IEC (b) electrode configuration had been used to investigate the surface discharge phenomenon with the different type of filler under the open chamber and close chamber. In this experiment, the polymer had been selected are high density polyethylene (HDPE) with different filler which are microsilica and nanosilica. The effect of humidity will be measured inside and outside the chamber. The surface discharge characteristics observed through surface morphology which is examined by scanning electron microscopy (SEM). Moreover, it is also determined by measuring the average magnitude of surface discharges intensity on the Picoscope6 software as the digital oscilloscope. The data analysis was done to compare the surface discharge characteristics between those samples. After experiment was done, we observed the content of filler inside the sample not significantly affected on the surface discharges activities. The surface roughness that occur on the sample, might caused by the surface conductivity. When the surface conductivity of polymeric material increase the discharges magnitude intensity also increase. This lead to severe surface degradation on the sample.

ABSTRAK

Pelepasan permukaan adalah luahan elektrik yang biasanya berlaku di permukaan penebat dan juga menyebabkan kegagalan dalam penebat elektrik jika tidak diambil tindakan. Pada tegasan voltan tinggi, melepaskan permukaan menyebabkan kemerosotan bahan penebat. Eksperimen telah dijalankan untuk menyiasat ciri-ciri pelepasan permukaan HDPE sebagai bahan penebat. IEC (b) konfigurasi elektrod telah digunakan untuk menyiasat fenomena permukaan pelepasan dengan jenis yang berbeza pengisi di bawah ruang terbuka dan ruang rapat. Dalam eksperimen ini, polimer telah dipilih adalah polietilena berketumpatan tinggi (HDPE) dengan pengisi yang berbeza yang microsilica dan nanosilica. Kesan kelembapan akan diukur di dalam dan di luar bekas itu. Ciri-ciri pelepasan permukaan diperhatikan melalui morfologi permukaan yang diperiksa oleh mikroskopi pengimbasan elektron (SEM). Selain itu, ia juga ditentukan dengan mengukur magnitud purata intensiti pelepasan permukaan perisian Picoscope6 sebagai osiloskop digital. Analisis data telah dilakukan untuk membandingkan ciri-ciri pelepasan permukaan di antara kedua-dua sampel. Selepas eksperimen telah dilakukan, kita memerhatikan kandungan pengisi di dalam sampel yang tidak berubah secara ketara pada aktiviti pelepasan permukaan. Kekasaran permukaan yang berlaku ke atas sampel, mungkin disebabkan oleh kekonduksian permukaan. Apabila kekonduksian permukaan bahan polimer meningkatkan keamatan pelepasan magnitud juga ganda. Ini membawa kepada degradasi permukaan yang teruk ke atas sampel.

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LIST OF ABBREVIATION

| | | |
|-----------------|---|--|
| PD | - | Partial Discharge |
| SD | - | Surface Discharge |
| SEM | - | Scanning Electron Microscope |
| IVAT | - | Institut Voltan Arus Tinggi |
| HDPE | - | High Density Polyethylene |
| CO ₂ | - | Carbon Dioxide |
| O ₂ | - | Oxygen |
| IEC | - | International Electrotechnical Committee |

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CHAPTER 1

INTRODUCTION

1.1 Background

Insulators are devices that are used on electricity supply networks to support, separate or contain conductors at high voltage. Insulation is one of the most important parts in a high voltage apparatus. The insulator intended to support or separate electrical conductors without passing current through themselves. There are three basic types of electrical insulating, which is solid, liquid and gas. These materials are widely employed in electrical network components such as circuit breakers, transformers, cables and capacitors.

Surface discharges can occur in a gas, liquid, or a vacuum in close to a solid dielectric surface. Even though the magnitude of such discharges is usually small, they can cause progressive deterioration and leads to failure. So, it is important to investigate these surface discharge characteristics to find the solutions for the problem occurs in application of the solid dielectrics. Solid dielectric materials are used in all kinds of electrical apparatus and devices to insulate one current carrying part from another when they operate at different voltages. A good dielectric should have low dielectric loss, high mechanical strength, should be free from gaseous inclusions, and moisture, and be resistant to thermal and chemical deterioration. Solid dielectrics have higher breakdown strength compared to liquids and gases.

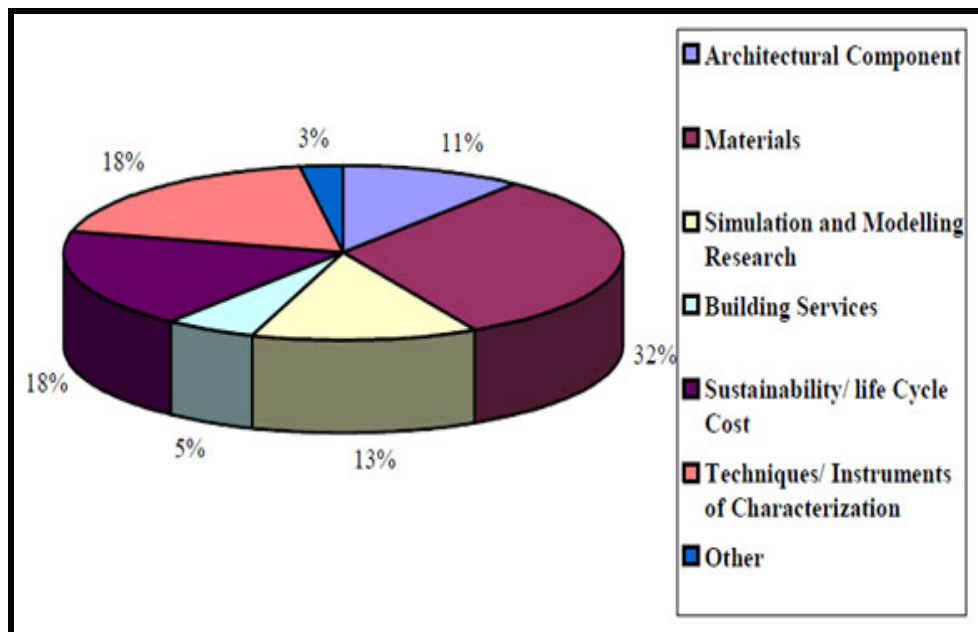


Figure 1.1: Breakdown of Research Area[2].

Figure 1.1 have state that the major affected to the occurring the breakdown phenomenon is causes by material. Follow by technique of characterization, sustainability, simulation and modeling, architectural component, and building services. The (eLCOSH) The Electronic Library of Construction Occupational Safety and Health was developed and is maintained by CPWR - Center for Construction Research and Training (CPWR) with support from cooperative the National Institute for Occupational Safety and Health (NIOSH). eLCOSH is intended to provide accurate, user-friendly information about safety and health for construction workers from a wide range of sources worldwide.

1.2 Problem Statement

Such of discharge also known as surface discharge (SD). Although the magnitude of such discharges is usually small, they can cause progressive deterioration and ultimate failure [1]. So, it is essential to study its phenomenon and characteristics to the polymer as an insulating material.

Three Mechanisms of slow deterioration caused by discharge [1]:

- a) Slow erosion by ionic bombardment of ions in the spark
- b) Chemical degradation of the insulation material
- c) Carbonization of the materials surface

As the result, this can lead to electrical failure and therefore it shows why the study of surface discharge phenomena is very important nowadays.

1.3 Objective

1. To investigate the surface discharge characteristics of micro composite and nanocomposite materials using IEC(b) electrode test according to IEC 60343 .
2. To investigate the effect of humidity against discharge characteristic
3. To investigate the effect of ageing time characteristic on surface discharge of micro composite and nanocomposite.

1.4 Scope of the Project

The scopes of the project are as the following:

- i. Material Sample
 - High Density Polyethylene (HDPE) pure
 - HDPE added 1%, 3%, 5%, 7% nanosilica
 - HDPE added 1%, 3%, 5%, 7% microsilica

- ii. Investigation
 - Discharge intensity
 - Degradation of polymer-nanocomposite material
 - The physical morphology of polymeric material
 - Dielectric strength

- iii. Experimental Area

Test is conducted at High Voltage lab to analyze the result based on electrical characteristics and compare result with the standard.

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