SIMULATION OF ELECTRICAL AND THERMAL PROPERTIES PERFORMANCE OF MINERAL OIL BASED NANOFLUIDS

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DEDICATION

This project report is dedicated to my father and mother who always teach me to embrace each and every situation in life.

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ABSTRACT

Mineral oil is one of the most common oil that is being used for transformer insulation. They act as an insulator and heat dissipator in the system. Failure of transformer is a very is quite crucial as it is very costly to replace. Since it is under constant pressure of electrical stress and ageing, it degrades and loses its dielectric properties easily with course of time and when fall short of its expected lifetime. In order to demonstrate the efficacy and capabilities of transformer oil, several researchers have conducted experimental studies of due to the growing demand for the production of good insulation. For transformer applications, this is achieved by suspending the nanosized solid particles in the oil which then called as nanofluid. The purpose of this project is to investigate the electrical and thermal properties of mineral oil based nanofluids using Quickfield simulation in the presence of the different types' nanoparticle of magnesium oxide, titanium dioxide and iron oxide which were classified based on their conductivity. Different concentration for nanoparticles 1%, 5% and 10% were used to prepare the nanofluids. A test cell model and dummy three phase transformer were designed in order to investigate the electrical and thermal properties of the nanofluids. It is found that the addition of nanoparticles enhances both electrical and thermal properties the fluid. It is envisaged that the method used can be very useful in determining the properties of nanoparticles before testing in real life.

ABSTRAK

Minyak mineral adalah salah satu minyak yang paling biasa digunakan untuk penebat pengubah. Mereka bertindak sebagai penebat dan penyebar haba dalam sistem. Kegagalan pengubah adalah sangat penting kerana sangat mahal untuk diganti. Oleh kerana tekanan tekanan dan penuaan elektrik yang berterusan, ia merosot dan kehilangan sifat dielektriknya dengan mudah seiring berjalannya waktu dan ketika jatuh dari jangka hayat yang diharapkan. Untuk menunjukkan keberkesanan dan kemampuan minyak pengubah, beberapa penyelidik telah melakukan kajian eksperimen kerana permintaan yang semakin meningkat untuk pengeluaran penebat yang baik. Untuk aplikasi transformer, ini dicapai dengan menangguhkan zarah pepejal nanosized dalam minyak yang kemudian disebut sebagai nanofluid. Tujuan projek ini adalah untuk menyiasat sifat elektrik dan termal nanofluid berasaskan minyak mineral menggunakan simulasi Quickfield dengan adanya pelbagai jenis nanopartikel magnesium oksida, titanium dioksida dan besi oksida yang dikelaskan berdasarkan kekonduksiannya. Kepekatan yang berbeza untuk nanopartikel 1%, 5% dan 10% digunakan untuk menyiapkan nanofluid. Model sel ujian dan pengubah tiga fasa dummy direka untuk menyiasat sifat elektrik dan haba nanofluida. Didapati bahawa penambahan nanopartikel meningkatkan sifat elektrik dan haba cecair. Diharapkan kaedah yang digunakan dapat sangat berguna dalam menentukan sifat-sifat nanopartikel sebelum diuji dalam kehidupan nyata.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The transformer can be explained as a fixed piece of apparatus which has windings, with or without the presence of a magnetic core which is used for the purpose of transforming a system of alternating voltage and current into another system at the same frequency. A transformer collapse can cause economic losses in between the power supply interruption, higher cost of changing, and is long lasting to repair. Therefore, the safety of the transformer during its operation is the topmost priority. Study after the failure shows that the life of a transformer mainly depends on the condition of the insulation system and is the second major reason of transformer failures [1]. Important factors that could affect the life expectancy of insulation in a transformer are overloading, high operating temperature, lightning or line surges, and improper lubrication. These points require keen observation and are a very big responsibility for the person in charge for the operation and maintenance of the transformer.

Globally, there are two different types of leading transformers that are designed to carry the electrical energy from one electric circuit to another. They include oil filled type and dry type transformers. However, the oil filled type transformer is the most used in electricity distribution systems [2]. Oil filled transformers as by their name are generally filled with liquid known as transformer oil. The oil acts as an insulating system and a cooling agent, making the transformer acceptable for outer applications

while helping in preservation of the core and winding. Furthermore, the oil helps to avoid straight contact with atmospheric oxygen due to susceptibility of the transformer to oxidation. Better the performance of transformer oil, higher the efficiency of the power system and thus enhancement the power transfer capability. Hence, different approaches, preventive and spontaneous maintenance, and repair methods have been designed to eliminate or minimize the failures and breakdown probability.

1.2 Problem Statement

Most of the transformer suffer failure before their expected age with degradation of breakdown voltage and slow dissipation of heat is a major reason due to which it makes scientist think to produce a better solution for insulation which provides better efficiency to the transformer. Among all the solution one is use of nanoparticles in oil insulation which can enhance electrical as well as chemical properties. However very limited study in the field of electrical and thermal properties had been carried out due to difficulty in synthesizing of nanofluid on large scale. Before testing in real life some simulation analysis is required in order to test nanofiller performance. With the increase in demand of energy we need to find optimum concentration for of nanoparticles maximum efficiency.

1.3 Objectives

The objectives of this project are

a) To design models for thermal and electrical analysis of nanofluids using Quickfield software.

b) To model mineral oil based nanofluids in simulation at different concentrations for relative permittivity and thermal conductivity.
c) To investigate and analyze the effect of relative permittivity and thermal conductivity for different concentration on nanofluids.

1.4 Scopes of the project

a) Study and create the test cell model design for thermal and electrical analysis using Quickfield software.
b) Preparation of properties of mineral oil based nanofluids with the effect of different concentration (1-10%) of nanoparticles.
c) Investigation and analysis of the results shown in simulation for relative permittivity (2.2-3.3) and thermal conductivity (0.133-0.195) using Quickfield software.

1.5 Project Outline

1. Chapter 1: Introduction explains about the importance of insulation in the transformer. Explains objectives, scopes, problem statement etc in the later part.

2. Chapter 2: Literature Review explains about the important component such as transformer oil, nanofluids, nanoparticles, tests in the nanofluids etc.

3. Chapter 3: Research Methodology describes in detail how the Simulations were performed and the steps that were taken during conduction of simulation.

4. Chapter 4: Results and Analysis presents the results that were obtained during our simulation and analysis of those results and comparison of results for different nanofillers.

5. Chapter 5: Conclusion and Recommendation concludes our project work and gave a through briefing about the project and future works were discussed later.

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