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**STUDY ON DIELECTRIC STRENGTH IMPROVEMENT OF RECLAIMED USED
TRANSFORMER OIL USING FULLER EARTH**

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**A report submitted in partial fulfilment of the requirements for the degree of
Bachelor of Electrical Engineering (Industrial Power)**

**Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

2016

“I declare that this report entitles “Study on Dielectric Strength improvement of Reclaimed Used Transformer Oil using Fuller Earth” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree

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Date :

To my beloved mother and father

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ABSTRACT

Transformer is a device which is critical, high in load and the most expensive part in generation and distribution system. Transformer oil is used as the medium for insulation to avoid the transformer produce more heat due to the process of energy transfer. Most of factor that contributes to the transformer failure is the physiochemical reactions such as heat, oxygen and moisture content had effect the transformer oil. So, there will be increment in terms of water content and total acid number for the transformer oil. Then, this will affect breakdown voltage (BdV) of the oil which make the BdV decrease. Therefore, this project was conducted in order to produce a new oil from the used oil of a transformer. In order to justify the oil is suitable for transformer operation, Karl Fischer, Total Acid Number (TAN) and BdV test will be used to observe the changes in terms of water content, acid number and breakdown voltage of the reclaim oil. Standard of ASTM D1816-84a will be used as the guidelines in the testing BdV procedure and confirmation of the finding. The result will be shown the effect of multiple stage of reclaim oil to the performance of the oil in terms of water content, total acid number and breakdown voltage. By using Karl Fischer and TAN test, total of water content and acid number which able to remove must be more than 50%. Other than that, BdV test should increase the value of breakdown voltage for multiple stage of reclaim oil more than 50%. So, it will expect to get the improvement for dielectric strength on used transformer service oil for reclaimed oil.

ABSTRAK

Pengubah adalah sebuah peranti yang kritikal, mempunyai beban yang tinggi dan peranti yang paling mahal di dalam sistem penjanaan dan pengedaran. Minyak pengubah digunakan sebagai medan untuk penebat bagi mengelakkan pengubah menghasilkan haba yang lebih tinggi kesan daripada proses pemindahan tenaga yang berlaku. Antara faktor yang menyumbang kepada kegagalan pengubah adalah tindak balas kimia seperti haba, oksigen dan kandungan air yang telah memberi kesan kepada minyak pengubah. Oleh sebab itu, terdapat kenaikan dari segi kandungan air dan jumlah asid bagi minyak pengubah tersebut. Seterusnya, keadaan ini akan memberi kesan kepada keruntuhan voltan (BdV) minyak. Oleh itu, projek ini direka bagi menghasilkan minyak baru berdasarkan minyak yang telah digunakan oleh pengubah. Bagi memastikan minyak ini sesuai untuk beroperasi di dalam pengubah, ujian Karl Fischer, Total Acid Number (TAN) dan BdV akan digunakan untuk melihat perubahan dari segi kandungan air, jumlah asid dan keruntuhan voltan minyak yang telah dikitar semula itu. Piawaian ASTM D1816-84a akan digunakan sebagai garis panduan bagi prosedur dan pengesahan keputusan di dalam ujian BdV. Keputusannya akan menunjukkan kesan kitaran semula minyak yang berganda terhadap prestasi minyak dari segi kandungan air, jumlah asid dan keruntuhan voltan. Ujian Karl Fischer dan TAN seharusnya menghapuskan jumlah kandungan air dan jumlah asid melebihi 50%. Selain daripada itu, ujian BDV perlu meningkatkan nilai keruntuhan voltan melebihi daripada 50%. Jadi,

peningkatan daya kekuatan elektrik diharap dapat dilihat melalui minyak yang telah dikitar semula ini pada penghujung eksperimen ini.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	SUPERVISOR DECLARATION	i
	PROJECT TITLE	ii
	DECLARATION	iii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
	TABLE OF CONTENTS	ix
	LIST OF ABBREVIATIONS	xiii
	LIST OF TABLES	xiv
	LIST OF FIGURES	xv
	LIST OF APPENDIX	xvii
1	INTRODUCTION	
	1.1 Research Background	1
	1.2 Problem Statement	3

	1.3 Motivation	3
	1.4 Objective	4
	1.5 Scope	5
	1.6 Report Outline	5
2	LITERATURE REVIEW	
	2.1 Introduction	7
	2.2 Transformer	7
	2.3 Insulation Oil	8
	2.4 Replacing Transformer Oil	9
	2.5 Adsorbent	13
	2.6 Breakdown Voltage (BdV) Test	17
	2.7 Weibull Probability Plot	19
	2.8 Review of Previous Related Works	22
	2.8.1 The Gassing Tendency of Various Insulating Fluids under Electrical Discharge	22
	2.8.2 Aged Oils Reclamation: Facts and Argument Based on Laboratory Studies	23
3	METHODOLOGY	
	3.1 Introduction	24
	3.2 Flow Chart of Project Experiment	24
	3.3 Experimental Review	26

	3.4 Stages of Reclamation for Used Oil	26
	3.5 Oil Sampling	29
	3.6 Karl Fischer (Water Content) Test	31
	3.7 Total Acid Number (TAN Test)	34
	3.8 BdV Test	36
	3.9 Weibull Probability Plot	38
	3.10 Result Analysis	40
4	RESULT AND DISCUSSION	
	4.1 Introduction	42
	4.2 Results of Reclaimed Oil using Fuller's Earth Adsorbent	42
	4.3 Karl Fischer Test	44
	4.4 Total Acid Number (TAN) Test	47
	4.5 Breakdown Voltage (BdV) Test	50
5	CONCLUSION AND RECOMMENDATION	
	5.1 Introduction	55
	5.2 Conclusion	55
	5.3 Recommendation	57
	REFERENCES	59

APPENDIX A

Figure A.1: Nameplate of Transformer for Used Oil	62
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APPENDIX B

Table B.1: Template of BdV Test for Used	63
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Transformer Service Oil

Table B.2: BdV for Used Oil	64
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Table B.3: BdV for 5 th Stage of Reclaim Oil	65
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LIST OF ABBREVIATIONS

TNB	-	Tenaga Nasional Berhad
DDF	-	Dielectric Dissipation Factor
DDP	-	Dissolved Decay Products
kV	-	Kilovolt
KFC	-	Karl Fischer Coulometer
TAN	-	Total Acid Number
BdV	-	Breakdown Voltage
PPM	-	Part Per Million
RPM	-	Rotation Per Minute
IFT	-	Interfacial Tension
NN	-	Neutralisation Number
OQIN	-	Oil Quality Index Number
°C	-	Degree Celsius
ml	-	Milliliter
ATR	-	Attenuated Total Reflectance
FYP	-	Final Year Project

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	Classification of Transformer Oil	11
4.1	Water Content Percentage of Decrement for each Oil Samples	44
4.2	Acid Number and Percentage of Acid Decrement in each Oil Samples	48
4.3	BdV for Used Oil and 5 th Stage of Reclaim Oil	53

LIST OF FIGURES

FIGURE	TITLE	PAGE
2.1	Adsorption of Activated Attapulgite Clay	15
2.2	Preparation of BdV Test by using Megger OTS60PB	18
2.3	β Estimation for Weibull Distributions	21
3.1	Flow Chart of Project Experiment	25
3.2	Adsorbent	27
3.3	Contact Process	28
3.4	Percolation Process	29
3.5	Sampling at Each Stage	30
3.6	Sampling for Final Stage	30
3.7	Coulometer	31
3.8	Procedure to Select KFC Method	32
3.9	Illustration for Procedure Number 5	32
3.10	Taking the Value of Remaining Weight into the Sample Size	33

3.11	Titrimo Plus	34
3.12	Potassium Hydrogen Phthalate (KOH)	35
3.13	Sample Oil inside Megger OTS60PB for BdV Test	37
3.14	50 th reading of BdV fill in Worksheet	38
3.15	Dialog Box for Procedure Number 4	39
3.16	Dialog Box for Graph Variables	39
3.17	Approximate Value of Weibull Probability Plot	40
4.1	Colour Different between Used Oil and Multiple Stage of Reclaimed Oil	43
4.2	Graph of Water Content in PPM against Multiple Stage of Reclamation Process	45
4.3	Graph of Decrement Percentage of Water Content against Multiple Stage of Reclamation Process	46
4.4	Trend of Total Acid Number for each Oil Sample	49
4.5	Graph of Decrement Percentage of Acid Number against Multiple Stage of Reclamation Process	49
4.6	Weibull Probability Plot for Used Oil	51
4.7	Weibull Probability Plot for 5 th Stage of Reclaim Oil	52

LIST OF APPENDIX

APPENDIX	TITLE	PAGE
A	Nameplate of Transformer for Used Oil taken	62
B.1	Template of BdV Test for Used Transformer Service Oil	63
B.2	BdV for Used Oil	64
B.3	BdV for 5 th Stage of Reclaim Oil	65

CHAPTER 1

INTRODUCTION

1.1 Research Background

In electrical energy supply, power transformer is one of the important assets in order to make sure that the voltage can step up and step down well to the desired value. Power transformer works so that the consumers receive enough energy for their daily use. So that, it is very important to make sure that the transformer is in good condition so that the operation performed by the transformer is always in good condition.

There are many types of transformer that always use in industry such as dry type transformer and liquid oil type transformer. In Malaysia, liquid oil type transformer is widely used nowadays. This type of transformer contains oil which will be functioning as electrical insulator and the medium to decrease the heat generated by the windings. Basically, there are two types of insulation oil which always use in Malaysia such as mineral based oil and

vegetable based oil. From day to day, the age of the transformer's oil increase and this factor indirectly give effect to the performance of the transformer's oil.

In Tenaga Nasional Berhad (TNB), there will be a team which will do their routine to check the condition of the transformer. Basically, this team will check whether there is oil leakage at the transformer, the input and output voltage of the transformer and clean the area around the transformer. In a certain range of month, this team also will make a shutdown process to change the transformer's oil. The aim of this precaution is to make sure that the transformer can operate continuously without having any massive problem.

Power transformer basically is a critical, highly loaded and the most expensive component in electricity generation and distribution network. This appliance needs extra surveillance. By comparing new transformer's oil and used transformer's oil, their differences will be clearly seen by seeing their colour and viscosity. In order to know the content inside the used transformer's oil, various techniques can be implementing to check the properties of the transformer's oil such as Karl Fischer, Total Acid Number, Breakdown Voltage (BdV), Dielectric Dissipation Factor (DDF), Dissolved Decay Products (DDP), Turbidity, Interfacial Tension, Water Content and Ultraviolet-Visible Spectrophotometer (UV-Vis). Karl Fischer is one of the techniques that can be used to check the amount of water content inside the oil. These techniques will give the value of water content inside the oil in Part Per Million (PPM) unit. This experiment was done by using used transformers oil with a type of adsorbent in multiple stage. At the end of the experiment, the result will show the effect of adsorbent on the reclaim oil by using Breakdown Voltage (BdV) test, moisture test and total acid number (TAN) test.

1.2 Problem Statement

Nowadays, transformer is one of the important electrical devices in electrical system. This device is the most expensive devices for electrical generation and distribution network. So it is important to keep the transformer in well condition for a long term. For transformer with oil insulation type, there will be a lot of problem will be face by using this type of transformer. Begin with the new transformer oil, the oxidation process of the transformer will make the transformer oil darken and high viscosity. Other than that, the sludge will be formed and it will trap inside the porous structure of the insulation paper. In order to keep the transformer in well condition, the transformers will have maintenance proves for a fixed duration. This process takes high cost. It is because the cost of transformer oil is already high and the process of changing the transformer oil is also high. So, there will be another alternative that can be used to decrease the cost of transformer's maintenance. By using reclaimed oil, cost for buying new oil can be reducing and reclamation method can be used for 2 or 3 times for the same used oil.

1.3 Motivation

This project was created based on past year research which approve that used oil such as Synthetic Ester, Natural Ester, Mineral Oil, Silicone Fluid and Transformer Oil can be used again after a few process take place [1]. There will be a lot of methods introduced by the researcher to recycle the used oil such as Percolation Method and Mechanical Agitation. These methods can remove the unused particles which these particles will make the oil become more acidity and increase in term of viscosity [3]. This process can be illustrating

same as the dialysis process for the human's kidney. This process begins by observing the effects of adsorbent used on breakdown of valence bonds in unstable hydrocarbon and volatile molecules. Therefore, it is motivated to observe the effect of moisture, acid number and breakdown voltage on the oil that has been reclaimed. The flow of current inside the transformer will produce heat inside the transformer. The heat will be steam and will produce water that will give effect to the value of the breakdown voltage and chemical bonding of the oil. After the oil having reclamation process in five stages, the oil will be having the moisture test and TAN test at each stage and also BdV test for the final stage oil. As a result, this project will contribute to give more information on the effect of multiple stages of reclamation to the total moisture, acid number and breakdown voltage of the reclaim oil.

1.4 Objective

The objectives of this experiment are listed below;

1. To perform reclamation process on used transformer service oil using Fuller's Earth adsorbent.
2. To determine the total acid number, water content and breakdown voltage of the reclaimed transformer service oil.
3. To analyse the performance of reclaimed transformer service oil in term of its total acid number, water content and breakdown voltage.

1.5 Scope

The scopes for this experiment are listed below;

1. Used oil is obtained from the 29 years age of ACEC type transformer at the electrical substation in Batu Pahat, Johor.
2. Fuller's earth was used as the adsorbent.
3. Contact process and percolation process will be used for oil reclamation process.
4. In contact process, adsorbent will be mixed with used oil for four hours with speed of 750 rotations per minute (rpm).
5. Standard used for BdV test is ASTM D1816-84a.
6. Karl Fischer method will be used by using 899KF Coulometer to determine the amount of water in oil sample.
7. 848 Titrino Plus produce by Metrohm will be used for Total Acid Number (TAN) test.

1.6 Report Outline

This report contains five chapters which include Chapter 1, Chapter 2, Chapter 3, Chapter 4 and Chapter 5. Chapter 1 will cover the introduction of the project which includes project background, project motivation, problem statement, project objectives and scope of the project. Chapter 2 is the chapter for literature review which includes the theory and basic idea that related to the project based on the previous research. This chapter will be focusing on the effect of contaminants on the transformer oil. After that, Chapter 3 will review the method that has been used to complete the project. Chapter 4 will explain more about the

result that have been obtained through the experiment. The result that have been obtained will be discussed and analyse in this chapter. In the last chapter which is Chapter 5 will create a conclusion for overall project that have been take place. This chapter will conclude whether the objectives for the project have been achieved or vice versa. There will be suggestion that can be used for further research of the study in the future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, there will be summary and synthesize of the article that have been used as the references for this project. All of the useful information will be cited and the cited can be referring in the references part.

2.2 Transformer

In an electrical system, transformers are critical, high in load and the most expensive part in electrical generation and distribution network [1]. Basically, transformer can be used to increase or decrease voltage to the desired value of voltage. Transformer usually builds up by core, winding and insulation material. There are five types of transformer which include pole mounted transformer, house hold transformer, dry type transformer, current transformer