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High voltage testing : Insulation characteristic for different
types of oil / Safawati Endut.


**HIGH VOLTAGE TESTING:
INSULATION CHARACTERISTIC FOR DIFFERENT TYPES OF OIL**

SAFAWATI BINTI ENDUT

MAY 2009

To my beloved family and friend

“I hereby declare that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)”

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Date : 13 May 2009

HIGH VOLTAGE TESTING:
INSULATION CHARACTERISTIC FOR DIFFERENT TYPES OF OIL


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This Report Is submitted In Partial Fulfillment Of Requirement For The Degree of Bachelor In
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Fakulti Kejuruteraan Elektrik
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May 2009

“I hereby declare that this report is a result of my own work except for the experts that have been cited clearly in the reference.”

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Date : 13 May 2009

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ABSTRACT

Liquid is more useful as insulating material than solids and gases. This is because both liquids and solids are usually 1000 times denser than gases. Normally, liquid dielectrics are used as impregnants in high voltage cables and capacitors and also for filling up of transformers and circuit breaker. In order to conduct the study, a research work has studied the effect of dielectric and breakdown voltage for HVAC, HVDC and Impulse voltage on the characteristic of difference manufacturer of engine oil against high voltage stress. The value of breakdown voltage can used in application to reduces damage of equipment and electrical system. The breakdown voltage also depends on the nature of the voltage. At the end of this project, the difference nature of HVAC, HVDC and impulse voltage against high voltage stress of engine oil can be determined.

ABSTRAK

Cecair adalah lebih berguna sebagai bahan penebat daripada pepejal dan gas. Ini adalah kerana kedua-dua pepejal dan cecair biasanya 1000 kali lebih padat daripada gas. Biasanya, penebat cecair digunakan sebagai jejalan dalam kabel voltan tinggi dan kapasitor dan juga untuk di isi dalam transformer dan circuit breaker. Dalam memahami kes belajar ini, satu kerja penyelidikan dijalankan ke atas kesan elektrik mati dan voltan kerosakan untuk Arus Ulangalik Voltan Tinggi, Arus Terus Voltan Tinggi dan voltan dedenyut (Impulse) ke atas ciri-ciri minyak enjin terhadap pengilang yang berbeza tetapi menggunakan parameter yang sama melawan tekanan voltan tinggi. Nilai voltan runtuh boleh digunakan dalam penggunaan untuk mengurangkan kerosakan peralatan dan sistem elektrik. Voltan runtuh juga bergantung pada sifat voltan. Di akhir projek ini, sifat perbezaan HVAC, HVDC dan voltan dedenyut menentang tekanan voltan tinggi terhadap minyak enjin boleh ditentukan.

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CHAPTER 1

INTRODUCTION

1.0 Project Background

In modern time, high voltages are used for a wide variety of application covering the power system, industry and research laboratories. One of high voltage test that used in the laboratories is insulation. The voltage 1 kV and above is called high voltage.

Insulation is very important especially in our industry. The type of insulation that used in industry nowadays is solid, liquid and gas. For this project, liquid is used for testing high voltage with difference configurations. Liquid is useful in any insulation as insulating material than solids and gases. The insulation of liquid that used in industry are high voltage cables and capacitor, and for filling up of transformers and circuit breakers. It used as heat transfer agents in transformer and as arc quenching media in circuit breakers.

For this project, three types of engine oil with same parameter but difference in manufacturer is used to find the good insulator. In practice, the choice of a liquid dielectric is made mainly on the basis of its chemical stability. In order to conduct the study, this project has studied the effect of dielectric and breakdown voltage for High Voltage nature on the characteristic of difference types of oil against high voltage stress. The value of breakdown voltage can use in application to reduces damage of equipment and electrical system. The breakdown voltage also depends on the nature of the voltage.

At the end of this project, the difference nature of HVAC, HVDC and impulse voltage against high voltage stress of oil can be determined.

1.1 Objectives

The objectives of this project are:

- (a) To determine the performance of engine oils from three different parameter against three different configuration of HVAC, HVDC and impulse voltage.
- (b) To make the comparison and conclusion between each engine oil performance against HVAC, HVDC and impulse test.

1.2 Scope of the project

This project has been confined to three relatively simple aspects which they are:

- (a) The nature of high voltage applied for engine oil as test samples are HVDC, HVAC and impulse voltage.
- (b) To studied the breakdown voltage for electrical characteristic of engine oil.
- (c) Use 3 types of particular engine oil. Three types of engine oil is same manufacturer but different parameter.

1.3 Problem Statement

Nowadays, nobody knows the electrical strength of engine oil available in market. These studies could be determining to performance this engine oil against high voltage. Therefore, the aim of this project is to present experimentally obtained

results on the breakdown characteristic on various type of oil. With this project, the new insulator can be developing in this country.

1.4 Report Outline

Basically, this report consists of 6 chapters. Each of chapter can be describe in the following term:

(a) Chapter 1 : Introduction

This chapter is representing the introduction that consists of project background and problem statement. The scope of this project will be focus on breakdown voltage and types of oil.

(b) Chapter 2 : Literature Review

On this chapter will overview the theory and research about this case study. It will more understand about this study and can help in represent the best of case study.

(c) Chapter 3 : Research Methodology

This chapter will be cover about methodology of this research. The step from starting and ending of this research will be described in this subtopic.

(d) Chapter 4 : Experimental Work

This chapter represents the part of experimental work. This research will conduct the breakdown voltage depend on the flow chart of experimental work.

(e) Chapter 5 : Result and Analysis

In this chapter will cover all part of result that we get from the experiment. The result takes in 5 times for each sample. This result will help in prepared the report and analysis of the research.

(f) Chapter 6 : Conclusion and Recommendation

This chapter concludes all of experimental result and the end of report. This is the important part of this report that wills recommendation for future study work.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Generally, the case study about high voltage test of this research accordingly characteristic of engine oil, their configuration of HVDC, HVAC and impulse voltage and conducting and breakdown voltage of pure oil. This configuration is important in our industry and usually used.

The definitions for this research is about to find the best insulation of the engine oil with the different configuration. The best insulation of the object is depends to the value of breakdown voltage when high voltage is supplied. When the object can't withstand the voltage supplied, it means the dielectric strength of the material is fail.

Liquid is more useful and good dielectric properties. Liquid dielectrics normally are used mainly as impregnants in High Voltage cables and capacitor. Beside that, it also used for filling up of transformers and circuit breakers. Oil is useful for filling up of transformer not only as heat transfer but as insulator. In practice, the choice of a liquid dielectric is made mainly on the basis of its chemical stability. Liquid dielectrics normally are mixtures of hydrocarbons and are weakly polarized and its breakdown of influence the hydrocarbon is shown in Figure 2.1.

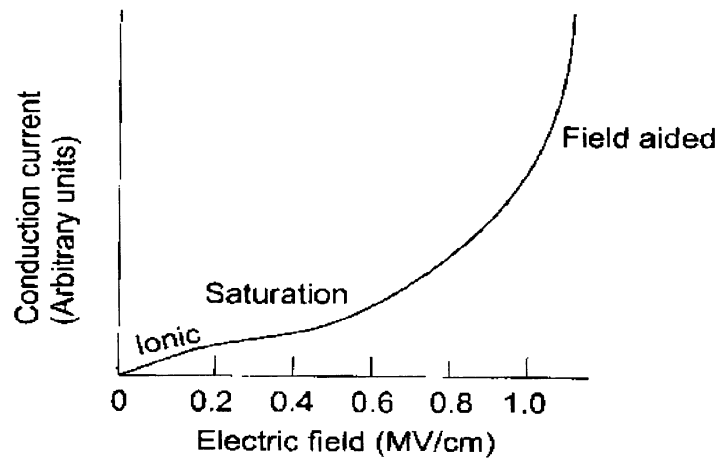


Fig 2.1 Characteristic of conduction current-electric field in a hydrocarbon liquid

The characteristic of the good dielectric of the object not only depends on the chemical strength of that object but its impurities may reduce or enhance the electrical strength.

The breakdown voltage depends on the field, gap separation, cathode work-function and the temperature of the cathode. In addition, the liquid viscosity, liquid temperature, the density and the molecular structure of liquid also influence the breakdown strength of liquid.

Typical maximum breakdown strength of some highly purified liquids and liquefied gases are given in Table 2.1 below.

Table 2.1 Maximum breakdown strengths of some liquids

Liquid	Maximum breakdown strength (MV/cm)
Hexane	1.1 – 1.3
Benzene	1.1
Transformer oil	1.0
Silicone	1.0 – 1.2
Liquid Oxygen	2.4
Liquid Nitrogen	1.6 – 1.9
Liquid Hydrogen	1.0
Liquid Helium	0.7
Liquid Argon	1.10 – 1.42

Liquid dielectrics normally are mixtures of hydrocarbons and are weakly polarized. When used for electrical insulation purposes they should be free from moisture, products of oxidation and other contaminants. The most important factor that affects the electrical strength of an insulating oil is the presence of water in the form of fine droplets suspended in the oil. The presence of even 0.01% water in transformer oil reduces its electrical strength to 20% of the dry oil value. The dielectric strength of oil reduces more sharply, if it contains fibrous impurities in addition to water.

Some of materials have their breakdown that depends to their properties that contain in their material. Nowadays, many research about insulation characteristic is be done to find the good insulation that can be used in industry.

2.1 Construction Kit

The construction kit is build for test the object using high voltage. This construction is prepare at laboratories at FKE, UTeM is equipped with 3 stages of HVAC, HVDC and impulse voltage. The generation system for all configurations can generate up to 300 kV. The configuration kit is new equipment for T & L (Teacher and Learning) of high voltage subject as well as for R&D (Research and Development) at the university. The basic procedure manual (user manual) has been provided by the manufacturer for user reference to operate the equipment. However, the steps on handling the equipment are not elaborated in experimental format. This construction kit is within the software simulation equipment to handle all of construction kit. The capture of waveform and the supply of generator are doing here.

2.2 HVDC configuration

2.2.1 Generation of HVDC

Generation of High Voltage Direct Current (HVDC) is mainly used in research work in the areas of pure and applied physics. Besides, the high voltages are sometimes needed in insulation tests on cable and capacitors. The rectifier valves require special construction for cathode and filaments since a high electrostatic field of several kV/ cm exists between the anode and the cathode in the non-conduction period. The rectifier circuits for producing high D.C voltages from A.C sources maybe:

- a) Half wave rectifier
- b) Full wave rectifier
- c) Voltage double type rectifiers

2.2.1.1 HVDC 1 stage configuration

For the construction for 1 stage, the maximum voltage for one stage is 100kV. An ideal HVDC voltage without ripple is generated under no load conditions (i.e. no test object and no ohmic divider for the voltage measurement).

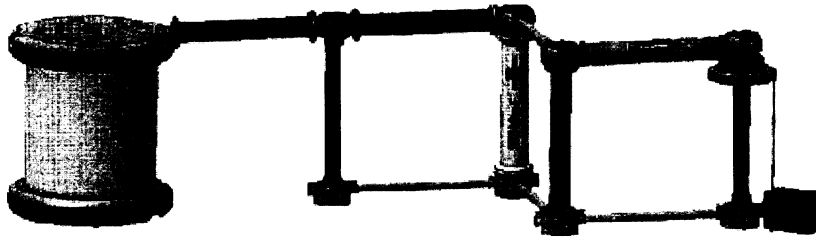


Figure 2.2: Construction kit for HVDC 1 stage

This construction depends on the circuit below.

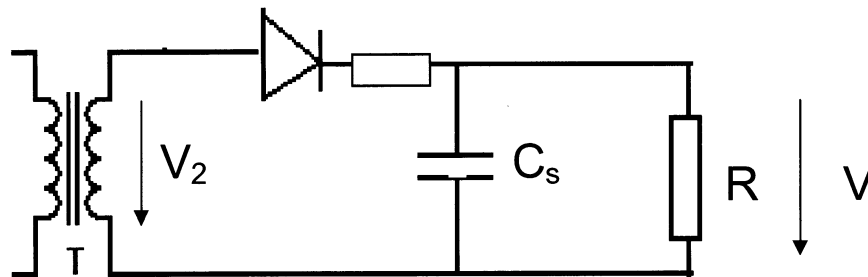


Figure 2.3 : Circuit for HVDC 1 stage.

2.3 HVAC configuration

The test for HVAC is more simple compare to HVDC test. So, their build up of construction kit is more simple. That is because the supply is from alternating current is directly to the test object. Thus, testing is used directly without any equipment changes supply.

2.3.1 HVAC 1-stages

Figure 2.4 shows the construction kit that produces the supply up to 100 kV maximum. That called 1 stages and figure 2.5 shows the circuit that used to build the construction kit as a reference.

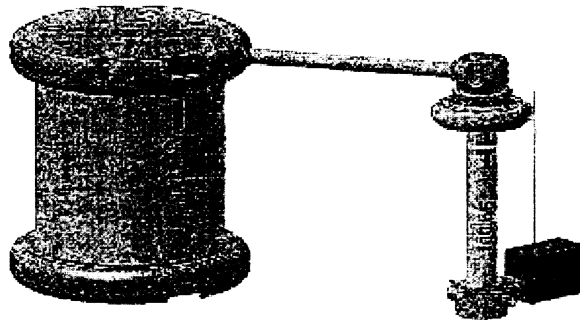


Figure 2.4: Build-up AC configuration for 1 stages

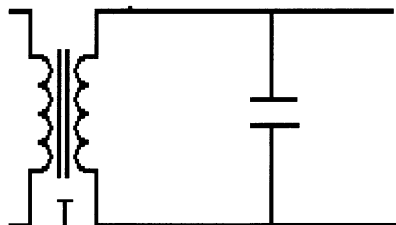


Figure 2.5: Circuit for 1 stages