



**FAKULTI KEJURUTERAAN ELEKTRIK
UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**LAPORAN PROJEK
SARJANA MUDA**

**THE CREATION OF DUVAL TRIANGLE BY SOFTWARE IMPLEMENTATION FOR
DISSOLVED GAS ANALYSIS**

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Bachelor of Electrical Engineering (Industrial Power)

June 2014

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“ I hereby declare that I have read through this report entitle “The Creation of Duval Triangle by Software Implementation for Dissolved Gas Analysis” and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power) ”

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**THE CREATION OF DUVAL TRIANGLE BY SOFTWARE IMPLEMENTATION
FOR DISSOLVED GAS ANALYSIS**

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

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

JUNE 2014

I declare that this report entitle “*The Creation of Duval Triangle by Software Implementation for Dissolved Gas Analysis*” 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.

Signature : _____

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Date : 18 June 2014

Special dedicated to my beloved father, mother, brothers, sisters and friends who always give me strength guided, encouraged throughout my journey of education.

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ABSTRACT

The transformer is one of the most important and expensive components of the electric power system network. The major faults can cause damage to the power transformer, which are not only disturbing the electrical network, but also resulting in large losses. It is difficult to classify the incipient faults that occur in the power transformer if there is no suitable analysis being used. Deep studies about Dissolved Gas Analysis (DGA) found that Duval Triangle method and other techniques can be used to analyse the fault that will occur in the power transformer. Nowadays, Tenaga Nasional Berhad (TNB) is using Microsoft Excel software related to Duval Triangle method to analyze the power transformer. Research found that the Duval Triangle method of DGA gives the accurate result more than 88% compared to other techniques. Microsoft Excel is licensed software and the users need to buy at a high price to get the full licensed software. Java programming is used in the developing new Duval Triangle in Eclipse software. As the Eclipse software is open-source software and the licensed is free, therefore the license issue can be solved. The results from the new developed Duval Triangle software will be compared with the results from the existing software in order to proof that the new developed Duval Triangle software is valid to be used.

ABSTRAK

Alat ubah adalah salah satu komponen yang paling penting dan mahal dalam rangkaian sistem kuasa elektrik. Permasalahan utama boleh menyebabkan kerosakan kepada alat ubah, bukan sahaja mengganggu rangkaian elektrik, tetapi juga mengakibatkan kerugian besar. Situasi akan menjadi sukar untuk mengelaskan permasalahan yang akan berlaku dalam alat ubah kuasa jika tiada analisis sesuai yang boleh digunakan. Kajian yang mendalam berkaitan “Dissolved Gas Analysis” (DGA) mendapati “Duval Triangle” dan teknik-teknik lain boleh digunakan untuk menganalisis permasalahan yang akan berlaku di dalam alat ubah kuasa. Pada masa kini, Tenaga Nasional Berhad (TNB) menggunakan perisian “Microsoft Excel” yang berkaitan dengan kaedah “Duval Triangle” untuk menganalisa alat ubah kuasa. Kajian mendapati bahawa kaedah “Duval Segitiga” memberikan keputusan 88% lebih tepat berbanding dengan teknik-teknik lain. “Microsoft Excel” adalah perisian berlesen dan pengguna perlu membeli pada harga yang tinggi untuk mendapatkan perisian berlesen penuh. Pengaturcaraan Java digunakan dalam membangunkan “Duval Triangle” baru dalam perisian Eclipse. Perisian Eclipse adalah perisian sumber terbuka dan lesen adalah percuma, maka isu lesen boleh diselesaikan. Keputusan daripada perisian “Duval Triangle” baru akan dibandingkan dengan keputusan daripada perisian yang sedia ada bagi membuktikan bahawa “Duval Triangle” perisian baru adalah sah untuk digunakan.

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LIST OF ABBREVIATIONS

DGA	Dissolved Gas Analysis
TNB	Tenaga Nasional Berhad
FYP	Final Year Project
O ₂	Oxygen
H ₂	Hydrogen
NO ₂	Nitrogen
CH ₄	Methane
C ₂ H ₆	Ethane
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
FRA	Frequency Response Analysis
PDC	Polarization and Depolarization Current
RVM	Recovery Voltage Methods
FDS	Frequency Dielectric Spectroscopy
PD	Partial Discharge
DAC	Digital to Analog
C ₂ H ₄	Ethylene
C ₂ H ₂	Acetylene

ppm	parts per million
JVM	Java Virtual Machine
LTC	Load Tap Changer
IEEE	Institute of Electrical and Electronics Engineers
IBM	International Business Machines
IDE	Integrated Development Environment
UI	User Interface
ADT	Android Development Tools
AVD	Android Virtual Device

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Transformer is one of the most important and critical components in the electric power system network. The main function is to transfer the electric power from the power station to the consumer center by step up or step down the voltage value. For many years, the power transformer has been in maintenance under different environmental, electrical and mechanical condition. As it is the most important and critical component in the electric power system network, the predicting diagnosis method analyzing and condition monitoring system are focused on the power transformer [1]. Nowadays, electric utilities from all around the world make efforts on the power transformer for extended transformer lifespan, prevent tripping due to breakdown of the transformer, prevent or reduce damage on the equipment and lastly demand for a higher productivity increase.

There are few general reasons of power transformer failures such as overheating, lightning surges, overload, line surges, etc. One of the main reason breakdowns in the power transformer is overheated, which are caused by some factors such as overload, copper losses, core losses, hysteresis, Eddy current, cooling system failure, etc. Overheating in a power transformer gives the bad effects that reduce the function and character of a good insulation system either oil or paper insulator [2]. It is a very important issue for electric utilities to prevent the failures and to keep the power transformer in best-performing condition. Hence, a better monitoring and analyzing life assessment or

diagnostics will help to increase the lifespan of the power transformers. There are many types of diagnostic techniques have been used by electric utilities. The methods that usually used are chemical, electrical, mechanical, optical and thermal diagnostics [3, 4]. Dissolved Gas Analysis (DGA) has been found that to be the best method of the diagnostic amount of gases dissolved in the power transformers [5-7].

1.2 Project Motivation

The analysis of oil sample from the power transformer is very effective, predictive and efficient for determining the health of the transformer. By using DGA, the oil sample will be tested to assess the health of the power transformer. The failure of the function electrical insulation and other related parts inside a power transformer will generate gases inside the transformer. DGA methods are available for identification of the faults such as arcing, corona or hot spot. The gases that generated are identified and will give useful information on the preventive maintenance program. Moreover, DGA can provide advance warning of the existence of faults and monitor the rate of fault development [8]. Therefore, DGA method can minimize the risk of the power transformer from damage.

Java language is now the most popular programming in all around the world. Besides, Java language is easier to understand and usually used in developing graphical method. Moreover, Java language can be run on the various of open-source software such as Eclipse software. As the Eclipse software is open-source software and the licensed is free, therefore the users no longer need to worry about the licensed issues. In addition, the installer size of Eclipse software is smaller compared to MATLAB and Microsoft Office software. Apart from that, this Java language also can be used in developing new Android application. A hundred million of mobile devices are powered by the Android platform in more than 190 countries. The applications available for the Android seem to grow faster in the Play Store. The lack of problems, more friendly and being an open-source platform is making it number one in the industry. Furthermore, Android gives developers to create

new application and games for Android users everywhere. Android devices come in all kinds of sizes and with all sorts of features and prices [9].

Nowadays, with the evolution of growth and development throughout the world, DGA diagnostic system should be built more impressions and fast way. DGA diagnostic systems developer must be developed this system in line with characteristic of the local power transformer to achieve the best performance. However, countries that have the same environmental conditions and characteristics of the power transformer may find this diagnostic system very useful to them and suitable with a minor modification. Hence, it can help local manufacturers by developed diagnostic system as to save on maintenance costs of the power transformer [10].

1.3 Problem Statement

The power transformer is a major part and a highly expensive component of an electric power system network. There are more than one thousand of the power transformers serviced under Tenaga Nasional Berhad (TNB). The failure in these power transformers may give interruption of the power supply to industries and residents. Hence, preventive maintenance technique for detection of faults in these power transformers is introduced. DGA is the most important tool in determining the fault condition within the oil-filled power transformer. The most frequent technique that has used in DGA is a Duval Triangle method. This method has satisfied the fault diagnosis more than 88% accurate than any other method of diagnosis [6]. Moreover, the types of hydrocarbon gases that filled in the power transformer are difficult to be categorizing to produce the results. Duval Triangle will use three hydrocarbon gases to calculate and identified the types of faults occur in power transformers.

The latest software of Duval Triangle that being used for diagnostic in the power transformer is Microsoft Excel Duval Triangle Calculator. This file will be run using

Microsoft Office software. Besides, Microsoft Office is licensed software and the users need to buy at a high price to get the full license software. Java language is easier to understand and usually used in developing graphical method. Moreover, Java language can be run on the various of open-source software such as Eclipse software. As the Eclipse software is open-source software and the licensed is free, hence the users no longer need to worry about the licensed issues. In addition, the installer size of Eclipse software is smaller compared to Microsoft Office software.

1.4 Objectives

The objectives of this project are:

- i. To analyze various DGA methods applied for power transformer specifically Duval Triangle method.
- ii. To develop new software via Eclipse software for the simplification of Duval Triangle analysis.
- iii. To verify the new developed software via Eclipse software with the existing hardware (Microsoft Excel Duval Triangle Calculator) for the simplification of Duval Triangle analysis by using the actual data from TNB.

1.5 Scope of Research

The scope of this project is study, understand and investigate the methods that are used in DGA to diagnose the types of faults that occurred in the power transformers. Hence, the investigation is focusing on the Duval Triangle method via implementation of AutoCAD and Eclipse software to visualize the difference types of faults that occurred inside the power transformers. Once the process completed, the development of new

software will be implemented. In addition, this new developed software will be based on the characteristics according to the different fault classifications on triangular map using Java language. Lastly, the validation process will take place. A real DGA data from TNB will be inserted into both of software; existing software using Microsoft Excel and new developed Duval Triangle software. Hence, the results from the new developed software will be compared with the results from the existing software in order to prove that the new developed software is valid to be used.

1.6 Outline of Report

This report consists of five chapters. Chapter 1 describes the overview of project, motivation of project, problem statements, objectives, scope and outline of a report. Furthermore, Chapter 2 explains the literature review related for this project, including theory of the transformer, DGA analysis, Java language, Eclipse software, etc. Chapter 3 explains the methodology of the project starting from finding information, study and understanding until procedure to develop Duval Triangle software using Eclipse software. Chapter 4 discusses of final results and an analysis. Lastly, in Chapter 5 is conclusion and recommendation from the finding research that have been made.