

**TRANSFORMER DISSOLVED GAS ANALYSIS  
USING DUVAL TRIANGLE METHOD  
VIA ANDROID**

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**TRANSFORMER DISSOLVED GAS ANALYSIS USING DUVAL TRIANGLE  
METHOD VIA ANDROID**

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

**Faculty of Electrical Engineering**

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**JUNE 2014**

" I declare that this report entitle " **Transformer Dissolved Gas Analysis Using Duval Triangle Method via Android** " 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 candidate of any other degree.

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Date :.....

Specially dedicated, in thankful appreciation for the support, encouragement and understandings for my beloved father, mother, siblings, and supervisor's

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## ABSTRACT

It is difficult to classify the incipient fault that caused by filling oil in power transformer if there is no suitable analysis being used. Deep studies about DGA found that Duval triangle method and another techniques can be used to analyze the fault that will occur in the power transformer. Nowadays, Tenaga Nasional Berhad (TNB) is using a computer software related to Duval Triangle method to diagnose the power transformer. Research found that the Duval triangle method of DGA has 88% consistent of giving accurate analysis in determining the incipient fault that will occur in the power transformer. Applying a portable software implementation via Android application would be a good innovation in analyzing the incipient fault of the power transformer. In this project, Java programming in Eclipse software which is widely used around the world is used to design the Android application. Hence, by using this Android application, the process of analyzing the fault of the power transformer is much easier and faster.

## ABSTRAK

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 Analisis Gas Terlarut mendapati Kaedah Segitiga Duval dan beberapa kaedah lain boleh digunakan untuk menganalisis permasalahan yang akan terjadi dalam alat ubah kuasa. Pada masa kini, Tenaga Nasional Berhad (TNB) menggunakan satu perisian komputer berkaitan dengan Kaedah Segitiga Duval untuk menganalisis permasalahan yang akan berlaku dalam alat ubah kuasa. Kajian mendapati Kaedah Segitiga Duval 88% konsisten memberi analisis yang tepat dalam menentukan permasalahan yang akan berlaku dalam alat ubah kuasa. Pelaksanaan perisian mudah alih melalui aplikasi Android akan menjadi satu inovasi yang baik dalam kerja menganalisis permasalahan yang akan berlaku dalam alat ubah kuasa. Dalam projek ini, pengaturcaraan Java dalam perisian Eclipse yang digunakan secara meluas di seluruh dunia boleh digunakan untuk mereka bentuk aplikasi Android. Oleh itu, dengan menggunakan aplikasi Android ini, proses menganalisis permasalahan alat ubah kuasa adalah lebih mudah dan lebih cepat.



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**LIST OF ABBREVIATIONS**

DGA - Dissolve gas analysis	PPM - Part per million
H <sub>2</sub> - Hydrogen	AWT - Abstract window toolkit
O <sub>2</sub> - Oxygen	OS - operating system
CO - Carbon monoxide	
CO <sub>2</sub> - Carbon dioxide	
CH <sub>4</sub> - Methane	
C <sub>2</sub> H <sub>2</sub> - Acetylene	
C <sub>2</sub> H <sub>4</sub> - Ethylene	
C <sub>2</sub> H <sub>6</sub> - Ethane	
TNB - Tenaga Nasional Berhad	
FYP - Final year project	
IEEE - Institute of Electrical and Electronics Engineers	
PD - Partial discharge	
PDC - Polarization and depolarization current	
FRA - Frequency response analysis	
LTC - Load tap changer	

## CHAPTER 1

### INTRODUCTION

#### 1.1 Project Background

In electric power system, power transformer is one of the most valuable and important equipment. It plays a major role to step up or step down the voltage either in low voltage system or in the high voltage system. So, condition monitoring, analyzing and diagnostics of the power transformer are really important to prevent any disturbance in the electric power system [1]. Thus, these elements are beneficial to the power transformer as they can extend the transformer lifespan, reducing the risk of expensive failures and allow several maintenance strategies.

Power transformer failure occurs because of many factors such as line surge, insulation, overloading, and etc. It is important for power utilities to avoid all the abnormalities and ensure the power transformer continually operate in good condition. So, most industries need something for better monitoring, analyzing or diagnostics, which can help to extend the life of the transformer. Currently, there are many types of testing and monitoring for the power transformer which can be classified into chemical, electrical, thermal and mechanical diagnostics [2]. The power transformer is a reliable electrical equipment that can operate between 20 to 35 years [3]. Research has been done and found that 70% of the most oil filled transformer fault can be detected by using Dissolve Gas Analysis (DGA) [4].

DGA is a well-known method to detect the incipient fault in the power transformer. This type of analysis classifies cases based on the following key gases, hydrogen ( $H_2$ ), oxygen ( $O_2$ ), carbon monoxide (CO), carbon dioxide ( $CO_2$ ), methane ( $CH_4$ ), acetylene ( $C_2H_2$ ), ethylene ( $C_2H_4$ ) and ethane ( $C_2H_6$ ). These hydrocarbon gases are formed because of hydrocarbon chain molecules break in mineral oil that is being used in power transformer. Gases of  $O_2$ , CO and  $CO_2$  were released by cellulose paper degradation. The gases in oil tests usually evaluate the concentration of hydrogen, methane, ethylene, ethane, carbon monoxide, carbon dioxide, nitrogen and oxygen [3].

## 1.2 Project Motivation

In the recent years, there are many researches about the power transformer. One of the researches is DGA which analyzing the key gases that found in the power transformer. Under the DGA, there are Duval Triangle, Key gases, IEC, Roger and Doernenburg method. By using DGA analysis, it is possible to distinguish some faults such as partial discharge, overheating, and arcing in a great variety of oil filled equipment [5]. In this project, Duval Triangle method is given more attention for analyzing the power transformer compared to other methods.

Nowadays, the Duval Triangle method is implemented using Microsoft Excel by TNB. Sometimes, computer system could be attacked by virus or malware and give problems in the analysis process. Besides that, this Microsoft Excel Duval Triangle can only display the result analysis in Excel spreadsheet, which is troublesome to the user to find the result analysis. Duval Triangle portable software would be created and the result analysis can be converted into PDF file. Currently, Android operating system is widely used in our country, so user will have no worries about the corrupt of Duval Triangle software. This is because the user can download and play the Duval Triangle software via open source in Playstore and directly install in other Android devices. Hence, this situation has been the inspiration to create a product in the form of Android application to be used in

the power transformer fault analysis. This project has successfully designed a Duval Triangle portable software for Android application.

### 1.3 Problem Statement

It is difficult to classify the fault that caused by filling oil in power transformer if there is no suitable analysis being used. DGA is an important tool in determining the fault condition within oil-immersed in the power transformer. There are some methods can be used in DGA such as Roger's ratio, IEC, Doernenburg, Key Gases and Duval Triangle. The Duval Triangle has been published by Michel Duval for oil-filled LTC's [4]. Duval Triangle method does not have the problem of cannot interpret some DGA results, which do not match the ratio codes [6], so this method is more reliable compared to other methods in DGA. The Microsoft Excel Duval Triangle that is used by TNB run slowly during start of the program as the program needs a good computer specification. Moreover, the major problem is the computer can be attacked by virus malware or spyware which can affect the analysis of the transformer. The Duval Triangle portable software which is smaller installer size and simple to be used can be design to overcome these problems. Hence, the portable software implementation for Duval Triangle can be done via computer software by using the triangular map method.

## 1.4 Objectives

The objectives of this project are:

1. To study various DGA method applied for power transformer especially Duval Triangle method.
2. To develop a new portable software via Android application for the simplification of Duval Triangle analysis.
3. To validate the new developed portable software via Android application with the existing software (Microsoft Excel Duval Triangle calculator) for the simplification of Duval Triangle analysis by using real data from TNB .

## 1.5 Scope

The scope of this project is to study, understand and investigate the methods that are used in DGA to diagnose the types of faults that occurred in power transformers. Hence, the investigation is focusing on the Duval Triangle method via portable software implementation to visualize the different type of faults that occurred inside power transformers. There are some stages and processes involved in designing this portable software. The processes involved are the usage of AutoCAD software to find coordinates of Duval Triangle and the usage of Eclipse software to implement the Java language in designing the Duval Triangle portable software. The Java programming will be run in Android emulator, which functions as a real Android portable device. After the design process completed, the Java programming will be converted into Android installer and ready to be installed in any Android device. In addition, this new developed portable 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 ; existing software using Microsoft Excel and new developed portable software using Android application. Hence, the results from the new developed portable software will be compared with the results from the

existing software in order to proof that the new developed Duval Triangle portable software is valid to be used.

## **1.6 Outline of Report**

This report consists of five chapters. Chapter 1 discusses the research background, problem statement, objectives and expected project outcome. Chapter 2 describes the literature review on power transformer diagnosis using DGA. The literature review is much focused about the Duval Triangle method which obtained from IEEE journals, articles, newspapers and others. Chapter 3 is the methodology of the project which covers the flowchart of the project, techniques that had been used, and work that had been taken. Chapter 4 shows the project achievement for the whole project design in FYP 1 and FYP 2 involving the real data obtained from TNB. Under this chapter, there is also the validation result of the new developed portable software. In the final chapter, Chapter 5 describes the conclusion and recommendation of the project.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

This chapter discusses on the power transformer diagnostic methods, Java theories, and Android application. Section 2.2, Section 2.3, and Section 2.4 discuss deeply about power transformer diagnostic methods. Section 2.5 describes the Java theories involved while Section 2.6 elaborates the Android application software that currently present in the market. Lastly, Section 2.7 reviews the previous related works to this topic while Section 2.8 is the summary of Chapter 2.

#### 2.2 Diagnostic Fault in Power Transformer

Power transformer breakdown can be classified as a big problem in the electrical distribution system. The transmission of electrical power will be interrupted as no equipment to step up and step down the voltage in a system. All the problems either small or big matter should be addressed seriously as it can lead to the breakdown of the power transformer. Hence, diagnostic methods either electrical, mechanical, optical/thermal or