USING DIAGNOSIS GAS ANALYSIS AS A TOOL FOR POWER TRANSFORMER MAINTENANCE

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ABSTRACT

The importance of Diagnosis Gas Analysis (DGA) has been recognized by electrical industry nowadays as one of the tools for power transformer maintenance to monitor the performance of transformers and provide early information about the health of a transformer. The lifespan of a transformer depends on the condition of the transformer oil. Transformer problem causes an increase in temperature of transformer components, thereby increasing the temperature of the insulating. When the oil is exposed to heat, it will result in the formation of a number of gases dissolved in transformer oil. The purpose of this research is to investigate the relationship between dissolved gases in transformer oil and its relationship to the damages suffered by the transformer. This research used oil samples taken from a number of power transformers installed in Tenaga Nasional Berhad, an electrical utility company in Malaysia. Oil samples were sent to a laboratory for analysis. This research is aimed at finding the causes and consequently identify damages to the components by using five methods of interpretation using the DGA namely Rogers Ratio Method, Doernenburg Ratio Method, IEC Method Ratio, CIGRE Ratio Method and Duval Triangle Method Ratio Method. Three actual cases are discussed in this thesis based on the investigation and repair works on 132kV and 275kV transformers. It is found that DGA can be used to locate defects in the components of the transformer.

ABSTRAK

Kepentingan *Diagnosis Gas Analysis (DGA)* telah dikenal pasti oleh industri elektrik pada masa ini sebagai salah satu alat penyelenggaraan alatubah kuasa. Ini adalah untuk meninjau prestasi alatubah tersebut dan memberi informasi awal mengenai kesihatan sesebuah alatubah. Jangka hayat sesebuah alatubah berhubungkait dengan keadaan minyak alatubah. Alatubah yang bermasalah akan menyebabkan peningkatan suhu kepada komponen alatubah, seterusnya peningkatan suhu juga akan berlaku pada minyak penebatnya. Apabila minyak penebat terdedah kepada haba, ianya akan mengakibatkan pembentukan gas yang larut di dalam minyak alatubah. Tujuan penyelidikan ini dijalankan adalah untuk mengkaji hubungan antara gas-gas yang terlarut di dalam minyak alatubah dan pertaliannya dengan kerosakan yang dialami oleh alatubah tersebut. Penyelidikan ini menggunakan sampel minyak yang diambil daripada beberapa alatubah kuasa yang dipasang di Tenaga Nasional Berhad, sebuah syarikat utiliti elektrik di Malaysia. Sample minyak ini kemudian dihantar ke makmal untuk dianalisa. Penyelidikan ini adalah bertujuan untuk mencari punca dan seterusnya mengenalpasti kerosakan pada komponen dengan menggunakan lima kaedah intepretasi menggunakan DGA iaitu kaedah nisbah Rogers, kaedah nisbah Doernenburg,, kaedah nisbah IEC, kaedah nisbah CIGRE dan kaedah Segi Tiga Duval. Tiga kes sebenar telah dibincangkan di dalam tesis ini berdasarkan kajian dan kerja-kerja pembaikan pada alatubah 132 kV dan 275 kV. Ke-kes ini telah dibincangkan secara terperinci dan adalah dididapati DGA boleh digunakan untuk mencari kerosakan komponen didalam alatubah.

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DGA	-	Dissolved Gas Analysis
TNB	-	Tenaga Nasional Berhad
MTM	-	Malaysian Transformer Manufacture
IEE	-	Institute of Electrical and Electronic Engineers
HV	-	High Voltage
Ppm	-	Part Per Million

CHAPTER 1

INTRODUCTION

1.1 Overview : Background of the research

A transformer is a static electrical device, which transform alternating current (AC) of electrical power from one voltage to another voltage keeping the frequency same involving no continuously moving parts, used in electric power systems to transfer power between circuits through the use of electromagnetic induction. Most of the power transformers are filled with a fluid that serves several purposes. The fluid acts as a dielectric media, an insulator, and as a heat transfer agent. The most common type of fluid used in transformers is of a mineral oil origin. There are insulating materials that may be superior to mineral oil with respect to both dielectric and thermal properties. However, to date, none has achieved the requisite combination of equal or better performance at an equal or better price. Consequently, mineral oil continues to serve as the major type of liquid insulation used in electrical transformer.

In this research, the topic of discussion will be limited to those transformers that utilize the mineral oil type fluids. As human being can detect the abnormality and diseases in the body by doing blood test sampling, transformer's oil sampling can also be used to find information to knowing the health's condition of the transformer. This technique is called Diagnosis Gas Analysis (DGA). According to scientific finding, fluid or transformer oil contains over 70% of diagnostic information and the assessment during the transformer on load is the most effective. [1]

In the utility business sector nowadays, it is vital to use prediction based maintenance for monitoring the performance of the power transformer in order to avoid system failure. It is not only because the replacement will incur highly cost but also interruption of power supply to consumers is no longer accepted.

This research study will discuss the advantages of using information from oil itself to monitor transformer condition by analyzing the slowly changes of gas pattern concentrated in the oil and relate it with the deterioration of transformer's health. Rectification work can be done before it reaches the danger zone. Maintenance people are also having more convenient time to prepare for the remedial. The DGA for selected power transformers were analyzed. The analysis will be then to be used to validate potential incipient fault in power transformers under investigation and to recommend preventive actions that can be carried out to avoid these faults from occurring.

1.2 Objective

There were three objectives had to be achieved for this project. Firstly was to identify the problematic power transformer based on the DGA results by studying the relationship of gas concentration in the mineral oil and correlating it with the health condition of the transformer. Secondly was using the five (5) interpretation methods of DGA and did the comparison of the result. The methods used were Rogers Ratio Method, Doernenburg Ratio Method, IEC Ratio Method, CIGRE Ratio Method and Duval Triangle Method. Finally, to locate the defective components in the transformer based on the density of gas produced and use the best interpretation method to investigate the problem and hence repair the transformer.

1.3 Problem Statement

DGA is becoming popular and widely used in preventative maintenance technique today to monitor condition of the transformers. It can be used as pre-fault analysis because of its ability to tell what is happening based on the indication of information gathered earlier before actual fault happen (prevention is better than cure). Rogers Ratio Method, Doernenburg Ratio Method, IEC Ratio Method, CIGRE Ratio Method and Duval Triangle Method were used during the research project. The problem arises when different methods used giving different results, make it difficult to do prediction and identifying the root cause of the defect. The results from different methods will be analysis and compared in order to get the best method in identifying the defective components in the transformer.

1.4 Project Scope

In this research, the project's scope was seeking damages in the transformer based on the results obtained using five (5) DGA interpretation method namely Rogers Ratio Method, Doernenburg Ratio Method, IEC Ratio Method, CIGRE Ratio Method and Duval Triangle Method. The research was done in the transmission system installation in electrical utility company in Malaysia namely Tenaga National Berhad (TNB). The levels of transformer voltage involved in this thesis were 132kV and 275kV. There are various types of transformers installed from different manufactures such as ABB, MTM, AEG, Shenbian, Fuji, Osaka, Shenyang, Hyundai, Xian, Bharat and Crompton Greaves.

1.5 Project Report Outline

Generally this project report is divided into five chapters, where it consists:

Chapter 1: Introduction

Chapter 2: Literature Review

Chapter 3: Research Methodology

Chapter 4: Results and Discussions

Chapter 5: Conclusion and Recommendation

Chapter 1 is an overview of the research project, objective, problem statement and project scope. The research project that will be done are based on the objectives and scopes that been stated earlier.

Chapter 2 presents the literature review and theory background. In this chapter the principle of gas generation in transformer oil will be discussed. Various DGA interpretation techniques are explored for a better understanding.

Chapter 3 will focus on oil sampling procedures that one need to strictly follow in order to get a reliable dissolved gas analysis data. In addition, methodology and process flows of the overall condition monitoring process are explained.

Chapter 4 will presents the results and analysis done on the DGA data. First, power transformers condition assessment is determined based on the collection of the DGA test results. The trending will then be studied based on this. Comparative of study also is done on the various interpretation methods available. Finally, the finding and repair works taken will be presented.

Chapter 5 will summarized all the works that had been presented in previous chapters and all the results of the research project. This is followed by recommendations for future works.

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