INVESTIGATION ON RELATIONSHIP BETWEEN ULTRASOUND FAULTS WITH HOT SPOTS ON INCOMING CABLE AT DISTRIBUTION TRANSFORMER

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MAY 2009

"I hereby declared 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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DEDICATION

Special dedicated to my beloved parents and family

For my supervisor, Mr. Hidayat bin Zainuddin
Universiti Teknikal Malaysia Melaka

And lastly to my beloved friends and who have encouraged, guided and inspired me throughout my journey in education

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First and foremost, I would like to take this opportunity to express my highest gratitude to my supervisor, Mr Hidayat bin Zainuddin who has helped me a lot in sharing his knowledge and experiences and giving me useful advised in doing this project. During the duration of this final year project, Mr Hidayat bin Zainuddin has helped to guide me in order to write a good report and develop the project.

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ABSTRACT

Condition monitoring is among the most important component in vast of engineering and exacting demand are made upon their carrying capacity and reliability. Consequently, by examining fault, it is possible, in majority of cases, to form an opinion on the cause of the fault and to take the requisite action to prevent a recurrence. Ultrasound and infrared thermography is one of the condition monitoring. It has been known for some time that ultrasound and infrared technologies complement each other when conducting inspections of transformer over 1000 volts. Fortunately, the combined use of ultrasound and infrared can improve a transformer inspection program by providing early detection of both heating and non-heating problems. Hence, this study will fine the condition that cause ultrasound and hot spot problems. The main purpose of this study is to fine the relationship between ultrasound faults and hot spot on distribution transformer incoming cable. Thermograms and ultrasound audio files will be integrated into this research to show their relationship to problems that occur in this type of electrical equipment.

ABSTRAK

Kaedah pemantauan keadaan adalah menjadi kepentingan dalam kejuteraan pada masa kini. Tidak hairanlah permintaan yang tinggi dalam kaedah pemantauan ini menjadikannya satu benda yang penting bagi menjadikan lebih berkuliti dan dinamik. Sebagai contoh, sesuatu masalah pada peralatan elektrik dapat di kesan dengan cepat sebelum peralatan elektrik itu gagal untuk berfungsi. Kaedah ultrabunyi dan suhu inframerah adalah contoh kaedah pemantauan keadaan pada peralatan elektrik. Pada sesuatu masa teknologi ultrabunyi dan inframerah digunakan bersama ketika melakukan pemeriksaan pada transformer 1000V ke atas. Penggunaan kedua-dua kaedah ini secara serentak pada sesuatu masa mempu mengesan lebih awal masalah panas dan tidak panas pada pengubah. Oleh itu kajian ini akan mencari faktor yang menyebabkan masalah ultrabunyi dan titik panas. Tujuan sebenar kajian ini adalah untuk mencari perhubungan antara kerosakan jenis titik panas pada kabel masukan pengubah pengagihan. Segala data dalam bentuk foto inframerah dan graf ultrabunyi akan di gunakan bagi mendapatkan kesahihan perhubungan antara masalah bunyi dan titik panas.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

TNB	-	Tenaga Nasional Berhad
TNBD	-	Tenaga Nasional Berhad Distribution
IR	-	Infrared Thermography
dB	-	Decibel
PD	-	Partial Discharge
PDA	-	Partial Discharge Analysis
XLPE	-	Polyethylene
UTeM	-	Universiti Teknikal Malaysia Melaka
PPE	-	Personal Protective Equipment
°C	-	Degree Celcius
PE	-	Electrical Substation

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Project overview

It has been known for some time that ultrasound and infrared technologies complement each other when conducting inspections of transformer over 1000 volts. At this voltage and higher, the electrical potential field is such that corona and tracking conditions can occur. Electrical discharge in the form of corona and tracking has caused many failures in transformer with little advanced warning or understanding of the cause. This is especially furs treating for the end-user when infrared technology is being utilized as a predictive tool to prevent such occurrences. Because corona and tracking conditions are voltage problems that not produce heat, it goes undetected during an infrared thermography inspection. Fortunately, the combined use of ultrasound and infrared can enhance a transformer inspection program by providing early detection of both heating and non-heating problems.

Otherwise, this study will find the condition that cause ultrasound and thermography problems from the physically shape. The presence of ultrasound and thermography in transformer is a serious problem that should be addressed as soon as possible. Therefore, this research is carried out to study what condition that more to cause ultrasound and infrared thermography effect.

1.2 Problem Statement

Generally, Tenaga National Berhad (TNB) has to face problem in their equipment like switchgear, transformers, cable compartment and etc. Therefore, TNB conducts inspection to their equipment according to a certain time. From this inspection like ultrasound and infrared thermograpyh inspection they find the problem at their equipments. Example of ultrasound problems are corona and tracking while infrared thermography problem like heating on transformers bushing.

After examining fault at their equipments, TNB forms an opinion on the cause of the fault and take the requisite action to prevent a recurrence. Sadly, some of the task could not be solved after the action taken. Therefore, this study is done to learn the relationship between ultrasound faults with infrared thermography effect on power transformers so that a better appropriate preventive action can be taken. However, this project is only focused on the incoming cable of distributions transformer.

1.3 Project Objectives

1. To carry out a research on relationship between ultrasound faults effect on infrared thermography at transformers in order to understand what condition that cause it.
2. To determine the suitable value of temperature that can cause ultrasound from the sample of infrared thermograph image and ultrasound respond collected under loading transformers
3. To propose the possible solution to be used in over coming the problems.

1.4 Project Scope

The target for this study is on 11kV incoming cable of TNB's distribution transformer. This study will go to find out the amount of ultrasound fault in power distribution transformer that related with infrared thermography by presents on case studies. The physical condition at incoming cable of distributions transformer can be seen via infrared thermogrphy image and photo image. On the other hand ultrasound can detect electrical discharges from the cable insulator.

1.5 Thesis Outline

Chapter 1 briefly summarizes the project background and problem statements as well as elaborates the objectives and scope of the project. This chapter describe for the hole of the project.

In Chapter 2, the literature review includes condition monitoring technique, likes ultrasound and infrared thermography application to power distributions transformer inspection.

Chapter 3 is a project operation or project methodology. For this project there are several steps should be taken in order to achieve the project objectives scope.

Chapter 4 details the results and the analysis of the project. All the data from the field is collected and analyzed by using chosen software. The problem from data is related to the theoretical.

Finally, the Chapter 5 discusses the conclusion of the project and necessary recommendations are stated early.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will discuss in detail about the literature review that related to this case study. Several concepts of cases will be explained. This is because the understanding of all concepts is necessarily important to conduct this research. This work is a part of ongoing project that focuses on relationship between ultrasound faults with infrared thermography effect using data from field study.

Therefore in the following section, a brief overview about condition monitoring, ultrasound and infrared thermography situation that can be used on power transformer inspection. The researches that have been done in developing this project involve research on transformer incoming cable, faults that always occur on transformer cable, and effectiveness in using ultrasound and infrared thermography on transformer cable inspection.

2.2 Transformer Failures

Manufacture fault, short circuit faults, abnormal transient fault, premature insulation fault, and aging of the insulation materials are major causes of transformer failures [3]. There are two major classes of transformer failures, it is internal faults and external faults [2]. Internal faults could be faults between two adjacent turns, between a segment of turns, parts of coils, or between a turn and a grouped part of the transformer. External faults include overloads, over-current, over-voltage, reduced system frequency, and external short circuits such as a short circuit created on the secondary windings [2],[4]. Recent record suggests about 70% to 80% of transformer failures are due to internal faults [5]. The internal faults of transformers can be divided into loose connection or contact of internal conductors and poor quality insulation [10]. Thus insulation failure comes from the internal faults.

Among internal faults, incipient fault is caused by gradual deterioration of insulating materials, so they develop slowly, and they require a relative long time for the incipient behaviors to develop into a short circuit which will lead to a catastrophic failure [6]. Therefore, in the following section will discuss on several factors that contribute to gradual deterioration of insulating materials.

2.3 Factors on cable insulating material deterioration

2.3.1 Treeing

Treeing at the dielectric cable insulation is the term of a type of electrical pre-breakdown deterioration that path through the wall of cable insulation [11]. Treeing has been demonstrated as one of the most important factors involved in loss of life for medium voltage cables. There are two types of treeing ie; water trees and electrical trees. Figure 2.1 shows example of shape of treeing.

Figure 2.1: Example of shape of treeing

2.3.1.1 History of treeing

The phenomenon known as treeing in dielectrics was first described by Raymer in 1921 [1]. He had been investigating electrical breakdown in the presence of discharges in paper-insulated cables. The tree-like appearance of Lichtenberg figures was well known during 1920s. These "trees" are totally different from what is seen in extruded dielectric cables because those older trees were carbon paths burned into the paper insulation that proceed concentrically around the insulating wall.

Treeing in extruded dielectric cables was described by Whitehead [24] in 1932 in his work on electrical breakdown. The development of corona detection equipment in 1933 b Tykociner, Brown, and Paine [25] made quantitative studies possible. Kreuger [25] thoroughly described methods for detection methods for detection and measurement of discharges in 1965. Previous reported results, especially by the Japanese [26] that they called sulfide trees, now become required reading.

2.3.1.2 Water Trees

Water trees form at a slow rate that may take many years to propagate and grow. Water trees can occur in all solid dielectric materials [3]. It is also known to be associated with reduction of dielectric strength and eventual failure of polyethylene insulated cable which does not incorporate an effective moisture barrier [1, 2]. However, past studies of this phenomenon often correlated poorly with data gathered from field-aged cable [3, 4].

Water trees are initiated and grow at much lower electric fields than do electrical trees. They can extend from one electrode to the other without a service failure. They can be so large that they extend from shield to shield without resulting in breakdown. Some moisture is required. If partial discharge is present, we are not able to detect it at this time. They disappear when allowed to dry unless stained. They reappear when placed in boiled water. They have some method to minimize water treeing. The most effective method to avoid the formation of water trees is to keep the insulation absolutely dry. The shape of water trees is illustrates in Figure 2.2.

Figure 2.2: Water trees

2.3.1.3 Electrical Trees

Electrical trees in extruded dielectric cables are the result of internal electrical discharges that decompose the organic materials. No moisture is needed for this process. Partial discharges that decompose the organic material in insulations are generally