THE ASSESSMENT OF SWITCHGEAR SYSTEM USING CIRCUIT BRAKER PROFILER

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Bachelor of Electrical Engineering (Industrial Power)

JUNE 2013

'I hereby declare that I had read this report entitled "The Assessment of Switchgear System Using Circuit Breaker Profiler" and found that this project is comply the partial fulfilment for the purpose of awarding Bachelor in Electrical Engineering (Industrial Power)'

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Supervisor's Name: Mr. Azhar Bin Ahmad

Date: 19th June 2013

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This report is submitted with the

purpose of partial fulfilment the program requirement of awarding

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'I hereby declare that this work in this report is my own except for summaries and quotation which have been duly acknowledged'

Signature: ……..

Name: Ahmad Al-Hakim bin Shamsudin

Date: 19th June 2013

Specially for my

Beloved Mom and Dad

And Caring Siblings

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Thank You.

ABSTRACT

The application of circuit breaker in switchgear system is a common method to use as a protection system. Circuit Breaker Profiler is a circuit to be use to study the trip coil characteristic of circuit breaker. In this project, it is focused on 33kV Circuit Breaker and Circuit Breaker Profiler will be use to study several case study based on circuit breaker mechanism timing test. Based on the test held, the result of the test will be use to build a trip coil profile signature; this technique known as fingerprinting technique. Timing test will validate that a circuit breaker of the overall operation within the set limits, but it will be indicate that monitoring the current flow via the trip coil of the circuit breaker, can allocate a very dominant tool in analysing the preparedness of a circuit breaker to trip. The result of the testing specimen of DC current of circuit breaker against time will be interpreted the average or mean graph of time (millisecond) and DC Current (A) also will be developed in order to determine appropriate Trip Coil Current Profile. Upon the completion of this project, appropriate Trip Coil Current Profile and the assessment of switchgear will be known.

ABSTRAK

Penggunaan pemutus litar dalam sistem switchgear adalah kaedah yang sama untuk digunakan sebagai sistem perlindungan. Pemprofil Pemutus Litar adalah satu litar yang akan digunakan untuk mengkaji ciri-ciri Trip Coil Current Profile. Dalam projek ini, ia tertumpu kepada 33kV Pemutus Litar dan Circuit Breaker Profiler akan gunakan untuk mengkaji beberapa kajian kes berdasarkan mekanisme pemutus litar ujian masa. Berdasarkan ujian yang diadakan, keputusan ujian ini akan digunakan untuk membina Trip Coil Current Signature; teknik ini dikenali sebagai teknik cap jari. Ujian masa akan mengesahkan bahawa pemutus litar operasi keseluruhan dalam had yang ditetapkan, tetapi ia akan menunjukkan bahawa pemantauan aliran arus melalui gegelung perjalanan pemutus litar, boleh memperuntukkan alat yang sangat dominan dalam menganalisis kesediaan pemutus litar untuk perjalanan. Hasil spesimen ujian pemutus litar Arus Terus (AT) terhadap masa akan ditafsirkan purata atau min graf masa (milisaat) dan Arus Terus (A) akan dibangunkan untuk menentukan Trip Coil Current Profile yang sesuai. Diakhir projek ini, Trip Coil Current Profile yang sesuai dan penilaian terhadap sistem switchgear akan diketahui.

TABLE OF CONTENT

LIST OF FIGURE

LIST OF TABLE

LIST OF ABBREVIATION

ABBREV		NAME
DC	-	Direct Current
emf	-	electromagnetic force
PMU	-	Pencawang Masuk Utama (Transmission Main Intake)
PPU	-	Pencawang Pembahagian Utama (Main Distribution Substation)
SSU	-	Stesen Suis Utama (Main Switching Station)
ILSAS	-	TNB Integrated Learning Solution
A	-	Ampere
ms	-	Millisecond
V	-	Volts
LRT	-	Light Rail Transit
MSG	-	Malaysian Sheet Glass Sdn. Bhd.
TCCP	-	Trip Coil Current Profile

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

In power system, the equipment and devices always are evolving throughout time. The evolving process makes the needs of the maintenance program have been shove over and over again. There are other methods that can be use in assessing switchgear. According to Steward (2008), switchgear is a common term covering switching device and their combination with associated protection, measuring, and control and regulating equipment. The basic components of switchgear are load-side conductor and supply-side conductor, insulation from earth to sustain the conductor, a moving contact structured to be joined or separate and a driving mechanism and its buckled drive linkage to the moving contact.

One of the most important components in switchgear is the earthing facilities. In order to permit safe working state on the unit associated cable or busbar, the functionality of the circuit breaker rightly include a mean of earthing. Circuit breaker in switchgear is interruption techniques that use in power system fields. In order to remove traditional approach, an alternative approach to assure the reliability of the switchgear or including of whole plant. So, the method to propose is using Circuit Breaker Profiler.

1.2 Motivation

This project will become as a milestone in order to apply the condition monitoring in this country. This project is conducted due to the lack of expertise; as in power system, the manufacturing factories usually use large number of manufacturing process, operation and maintenance. So the engineer need continuously update and sublime their expertise. If the engineer is lack of expertise the hidden problem always is a hidden problem.

It is also due to no effective systems that respond to abnormalities rapidly, the prolonged absence of a system with quick respond make it difficult for hidden problem to become seen. So, this is one of the systems that will help to improve the existing system.

1.3 Problem Statement

Maintenance plan programme is time consuming and shortage of resources if the methods use is traditional approach**.** Condition monitoring technique of the trip coil profiling was developed where fingerprinting was used to emphasize any anomalies in the performance of circuit breaker.

Although fingerprinting shows diversion from the custom, it did not manifest with sufficient detail of the sources of the problem. As every type of the circuit breaker has a characteristic profile, deterioration in the circuit breaker enable to trip are indicated as unique changes of that profile. It was a proposition, that if a thorough understanding of circuit breaker of tripping mechanism was attained, the profile shall provide an assessment of its preparedness to trip.

Circuit Breaker Condition Assessment is a one way of knowing the fundamental that causing the abnormalities on circuit breaker operation delay. By investigating the characteristic of the Trip Coil Current Profile, it can be known that the flaws that implicated to the circuit breaker due to idling for a long time without tripping.

1.4 Project Objective

This project is primarily about the studies of Circuit Breaker Condition Assessment of 33kV switchgear in several substations in Malaysia throughout investigation and analysis based on Circuit Breaker Condition Assessment. This project aims to:

- Investigate the development of trip coil profile on a circuit breaker using profiler.
- Assess a circuit breaker based on it reaction to trip if faulted condition occurred.
- Determine the deterioration of operation of switchgear based on condition monitoring.

1.5 Project Scope

The analysis of this project will be conducted using MATLAB software. This project only concentrated on 33kV switchgear. The experiment of testing the specimen will use the on 33kV TAMCO Switchgear at TNB Integrated Learning Solution Institution (ILSAS), Kajang Selangor. Beside, the experiment conducted will be use as a reference of actual test specimen of several 33kV switchgears in Kuala Lumpur and Selangor area. The overall analysis will be accordingly to TNB Research standard for developing the trip coil profile of switchgear.

1.6 Thesis Outline

In chapter 1, the background of this project was included. The problem statement, the objectives and the scope of project is also discussed. This part is to show the limitation of the project.

Chapter 2 will treated about literature review. Literature review is an aggregation of studies that has been done by other researchers that have the resemblance with the field of the project. This literature review can be used as guideline in order to finish up the project. It is essential to have literature review so that the project will not diverge from the project scope.

Chapter 3 is outlining about the methodology of this project. In this chapter, it will explain on the methods system that is used for this project including all substantial modules of the system. It also discusses on software and analysis that will be used in the project.

Chapter 4 is about the analysis and discussion. In this chapter, it will be discusses all about the design system of the project. It starts with explanation on how the ideas will be applied, how to choose and apply the programming that control the system and also include the project analysis.

Last but not least, Chapter 5 which is conclusion and recommendation. In this chapter will be include the summary of the project where it will conclude overall of the project and recommendation for the future development.

CHAPTER 2

LITERATURE REVIEW

This chapter will review on Switchgear System and Condition Monitoring. The switchgear is manufactured by TAMCO Switchgear (Malaysia) Sdn. Bhd. The 33kV switchgear is using vacuum impregnate for its filler.

2.1 Switchgear System

In this project, the switchgear of 33kV is the main focus of the study. In summary, most of 33kV switchgear systems in Malaysia are using vacuum interruption techniques. This switchgear type is VH3; the circuit breaker type is VY-3OM25D. The normal current of the switchgear is 1250A. The highest voltage this switchgear can withstand is 36 kV. This switchgear is having earthing device of Rated Short Circuit Current of 79kA. This switchgear using vacuum interrupter that manufactured by EATON and the number break per pole is Single Break per Pole. Single Break per Pole can be defines as a fixed contact portion and a movable contact portion. This type of break has to carry the whole of the breaking current. The length of each break is 23mm. The material of current carrying conductor is copper. The opening time of the main contact is 25ms. For further information, the full technical data can be refers to Appendix C.

2.1.1 Paschen's Law

The relationship between voltage resistance and electrode spacing is accordingly to Paschen's Law. Paschen's Law states that the breakdown voltage is the function of pressure (Torr) times by distance of gap (centimeter) [$V_{Breakdown}$ =f (P x d)]. Figure 2.1 show that Paschen's Law of helium gas, neon gas, argon gas, hydrogen gas and nitrogen gas. Based on the Paschen's Law, these recommend that the voltage resistance of a gap between electrodes is proportional to both the electrode spacing and the pressure of the gas (Stewart, 2004).

It is providential that this law only applies and true within finite limits, differently vacuum switchgear could not exist. Air pressure is reduced when starting at atmospheric pressure; the voltage resistance also reduces, satisfying Paschen's Law. Nevertheless, at very low pressure, a tremendous change is takes place. Boost decrement in pressure will result in the increment of resistance voltage. This can be graphically explained by Figure 2.2 (Naidu & Kamaraju, 2009).

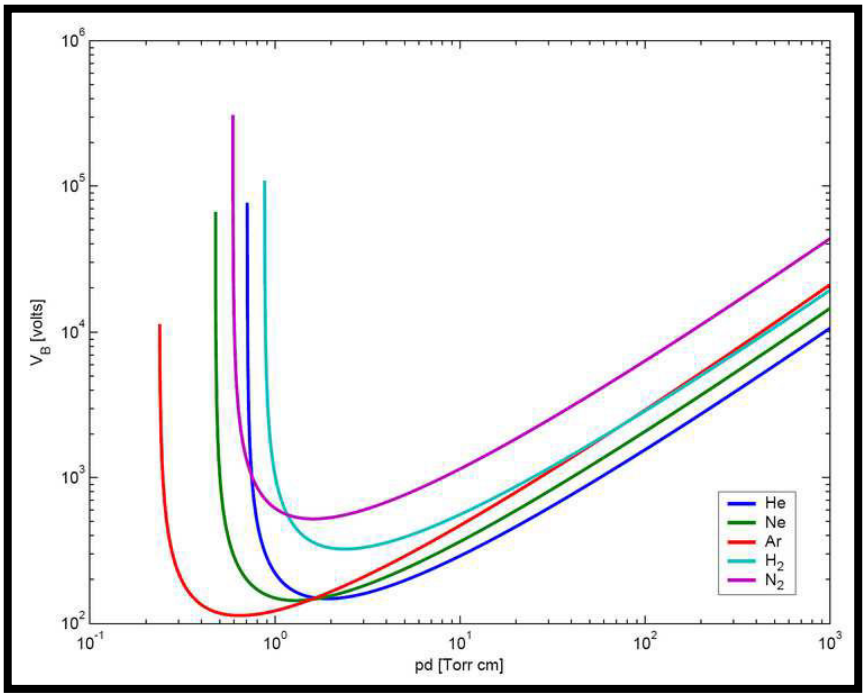

Figure 2.1: Paschen's Law graph for several types of gases (Naidu & Kamaraju, 2009)

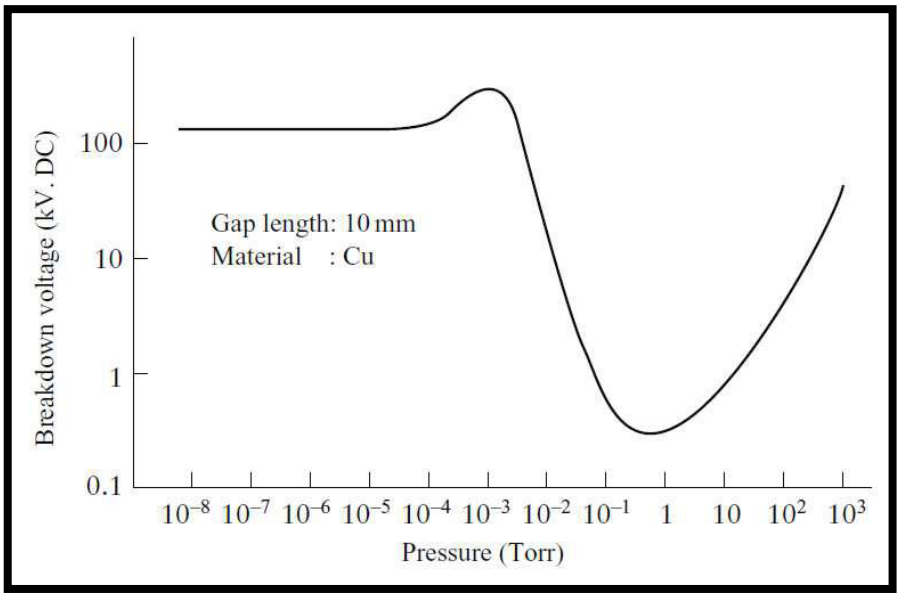

Figure 2.2: Paschen's Law at low pressure (Stewart, 2004)

On the other hand, at very low pressure, the distortions from the Paschen's Law are observed when the breakdown mechanism is not affected by the characteristics of the gas but it is reckon on the purity and the property of the electrodes (Naidu & Kamaraju, 2009).

2.1.2 Vacuum Interruption Technique

In early of 1970s, first introduction and commercialization of vacuum interrupter is being made. The vigorous development and tremendous reduced size of vacuum interrupter makes the increment size of short-circuit rating. An arc needs metal vapour from the metal contacts to prolong itself and it cannot exist in a vacuum, ideally until a natural current zero is attained. At this specified point, the metal vapour should distil back toward the contact, refusing conductivity so that current lay off to flow. In contrast, the contact materials are all essential to the interruption process. Besides, the material utilized for the contacts must have the compensate characteristics for the conduction of normal current and they must minify the natural tendency of metal to cold unify when urged together under high-vacuum condition. In advance, they must not liberate gas when interrupting current; as this would detonate the high-vacuum essential for the entire process to be repeated much time over throughout the life of the vacuum interrupter. Figure 2.3 shows an example of vacuum interrupter (Stewart, 2004).

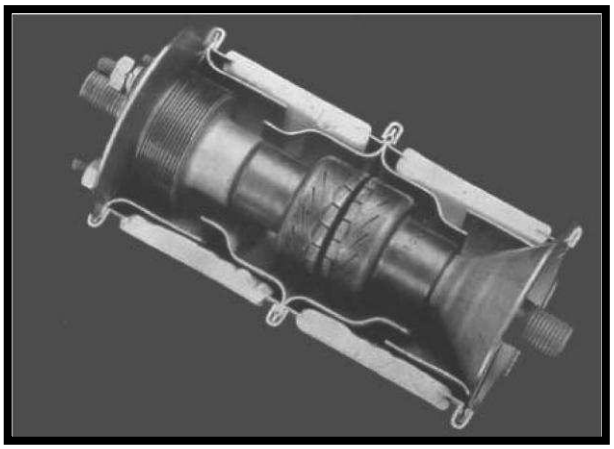

Figure 2.3: A sectioned type V801 vacuum interrupter (courtesy of ALSTOM T&D Ltd)

It follows as the voltage will be imprint crosswise an interrupter comply current interruption, insulating materials have to be considered in the design of the vacuum interrupter envelope. These insulating materials must be isolated from condensing metal vapour from the contacts which would differently deteriorate their insulating characteristics (Stewart, 2004).

2.1.3 Construction of Vacuum Interrupter

In vacuum interrupter, the protection from the internal surface of isolating envelopes is prepared by three metal shields, known as spatter shields or arching shields. It is brazed to the centre band and end caps of the interrupter. A substitute method of protecting the isolating envelope is to have both of the fixed and moving contact set up to have their contact faces placed within the central canister. Figure 2.4 showing a basic construction of vacuum interrupter (Stewart, 2004).

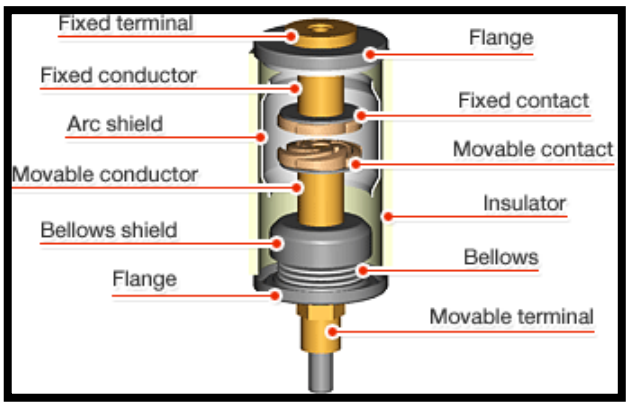

Figure 2.4: Basic construction of vacuum interrupter (Stewart, 2004)