TESTING OF METAL OXIDE SURGE ARRESTER MONITORING (MOSAM)

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Dedicate to my beloved family:

Mohammad Jailani bin A Jamil (husband)

Zainol bin Ahmad (father)

Zabidah binti Wahab (mother)

Zakiah binti Zainol (sister)

Zanariah binti Zainol (sister)

You are all my inspiration and my strength

What I have been through, you were there all the time.

and

All my friends in MEP programme

for their support and encouragement

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ABSTRACT

Surge arrester is a device used to protect the transmission lines and substations. It protects the power systems from lightning impulses and very fast transient over voltage. The degradation of a metal oxide surge arrester can be accomplished by using the measurement of its leakage current in particular, the third harmonic resistive component. A significant change in the third harmonic level may indicate a severe ageing of the arrester. Metal Oxide Surge Arrester Monitoring (MOSAM) is a new smartphone based device capable of assessing the current status of gapless MO arresters. This project aims to test and verify the MOSAM previously developed in Institute of High Voltage and High Current (IVAT). Low voltage and high voltage calibration were carried out. It is shown that the obtained calibration results using the low voltage are consistent with those using the high voltage. Three types of clamp meters were used. MOSAM is proven to work as designed for at least one type of clamp meter.

ABSTRAK

Penangkap pusuan ialah alat yang digunakan biasanya untuk melindungi talian penghantaran dan pencawang. Ia melindungi sistem kuasa dari *impuls* kilat dan voltan fana yang sangat cepat. Degredasi penangkap pusuan oksida logam boleh dicapai dengan menggunakan pengukuran arus bocor khususnya komponen rintangan harmonik ketiga. Perubahan ketara dalam tahap harmonik ketiga mungkin menunjukkan penuaan yang teruk ke atas penangkap. Pemantauan Penangkap Pusuan Oksida Logam (MOSAM) adalah peranti baru berasaskan telefon pintar yang mampu menilai status semasa penangkap pusuan oksida logam tanpa sela. Projek ini bertujuan untuk menguji dan mengesahkan MOSAM yang sebelum ini dibangunkan di Institut Voltan Tinggi dan Arus Tinggi (IVAT). Penentukuran voltan rendah dan voltan tinggi telah dijalankan. Ia menunjukkan bahawa keputusan penentukuran diperolehi dengan menggunakan voltan rendah adalah sejajar dengan menggunakan voltan tinggi. Tiga jenis meter pengapit digunakan untuk ujian ini. MOSAM terbukti mampu beroperasi seperti yang direka bentuk untuk sekurang-kurangnya satu jenis meter pengapit.

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LIST OF ABBREVIATIONS

MO	-	Metal oxide
RMS	-	Root Mean Square
MOSAM		Metal Oxide Surge Arrester
MOSA		Metal Oxide Surge Arrester
TOV		Temporary Over Voltage
Si		Switching Impulse
VFTOs		Very Fast Transient Over Voltage
ZnO		Zinc Oxide
Hz		Hertz
Ref		Reference
IRMS		Current Root Mean Square
3^{rd}		Third
IVAT		Institute of High Voltage and High Current
Min		Minimum
Max		Maximum

LIST OF SYMBOLS

V	Voltage
I	Current
kV	kilo volt
k	constant
α	coefficient
μ	micro
A	Ampere
m	mili
C1	Clamp 1
C2	Clamp 2
C3	Clamp 3
vs	versus

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CHAPTER 1

INTRODUCTION

1.1 Project background

Surge arresters are widely used to help damage of apparatus due to high voltage. It has been used in service since 1970's. It protects the power systems from temporary over voltage, switching impulses, lightning impulses and very fast transient over voltage as shown in Figure 1.1. This arrester has two functions which are to provide a point in the circuit where an over voltage pulse can pass to ground and to prevent any follow up current from flowing to ground. It's provides a low impedance path to ground for the current from a lightning strike or transient voltage and then restore to a normal operating condition.

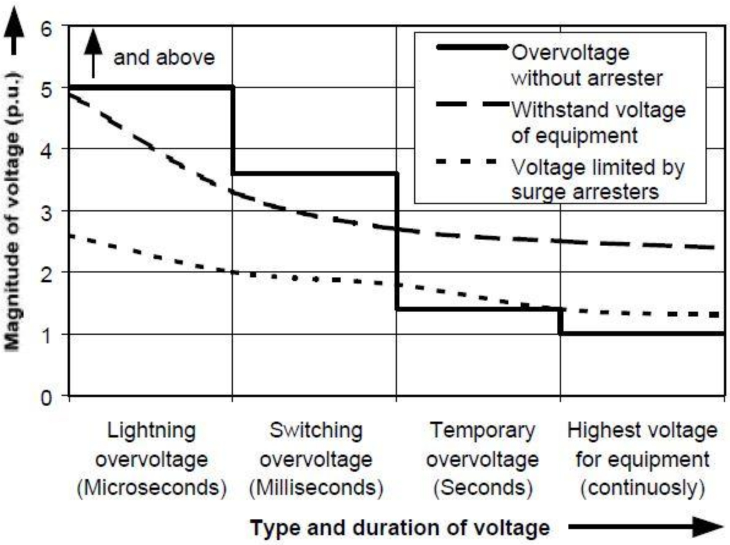
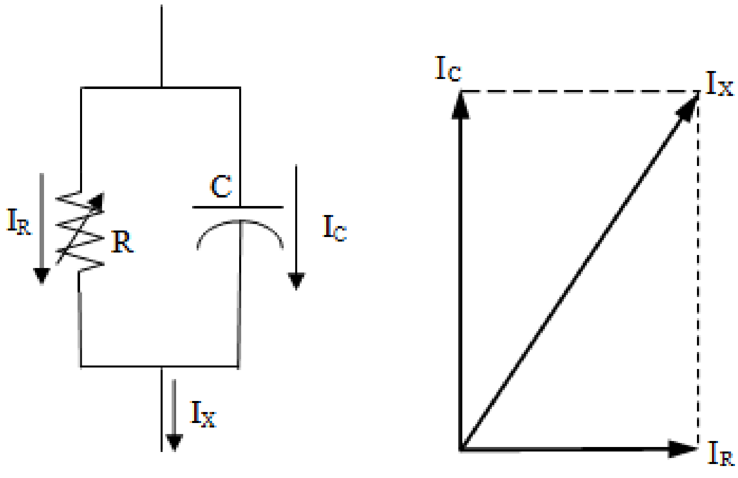


Figure 1.1 Voltages and overvoltages in electric power system

The Metal Oxide (MO) was based on metal block and not require series gap and hence is referred as a gapless metal oxide arrester. The metal oxide surge arrester is a non linear resistor. It consists of disc of metal oxide arranged in a stack inside in suitable insulator. The construction of metal oxide blocks with a highly non-uniform current voltage (*I*-*V*) is appropriate for over voltage suppression.

Many researchers have been done to study the performance and monitor the condition of the metal oxide surge arrester. One of that is measurement on leakage current. Metal Oxide Surge arrester has small leakage current mainly comprises the capacitive current and the resistive part of the current flowing through it due to its gapless construction. The surge arrester performance is evaluated by measuring the resistive part of the leakage current, which is proportional to the watt loss of the arrester. The increase of in watt loss is a direct measure of deterioration.

The total leakage current mainly comprises of the capacitive component and resistive component. The capacitive and resistive component leakage current differs in phase by 90°. Therefore, a large increase in the resistive current of the non-linear metal oxide resistor is needed to observe a significant change in the total leakage current level. Online measurement of the leakage current are extremely used in practice to show the root means square (r.m.s), mean or peak value of the leakage current.



(a) (b)

Figure.1.2 (a) Simplified model representation of surge arrester and (b) Vector diagram of I_X, I_C and I_R

The surge arrester performance is evaluated by measuring the resistive component of the leakage current, which is proportional to the watt loss of the arrester (Figure 1.2). The increase the watt loss means the increase of deterioration. The resistive component consists of third harmonic leakage current when the waveform shown not purely sinusoidal. These harmonics increase with the increase of resistive leakage current.

Metal Oxide Surge Arrester Monitoring (MOSAM) is a new smart phone based device capable of assessing the current status of gapless MO arrester. However, being developed within the institute, the device lacks data from field testing. This project requires data measurement from low voltage testing and high voltage testing to calibrate the MOSAM. The correlation between the measurement parameter and age or condition of arrester can be established. Accurate reading of the arrester leakage current is required in order to obtain real physical condition of the MOSA insulation.

1.2 Problem statement

There are several available metal oxide surge arrester condition monitoring device. An example of these devices is the SCAR-10 manufactured by ISA ITALY. However, there are still a lot of implements that can be made on these devices. This project aims to test and verify a new device previously developed in Institute of High Voltage and Current (IVAT). The device is named is named is Metal Oxide Surge Arrester (MOSAM).

Among the tasks need to be carried out are the calibration of MOSAM and the performance checking against electromagnetic and high voltage interferences.

1.3 Objectives of Project

There are three main objectives that have been achieved in this project:

a) To do calibration on MOSAM

b) To carry out testing of MOSAM

c) To finalize the MOSAM configuration based on the testing data.

1.4 Scope of Project

This scope will cover to 132kV system MO gapless polymeric housed arresters.

1.5 Thesis Outline

This thesis has been divided into five chapters. All contents about some basic or generally principles, theories, formula, previous studies references, methodology of the project, experimental results and discussions are included based on contents requirement.

Chapter 1 contains of projects overview and the objectives of conducting the project. Chapter 2 is discussing about the background information of the project such as the history of the surge arrester, and design of MOSA. This chapter discussed briefly on cause of the surge arrester failure and the degradation of MOSA.

In chapter 3, presents the methodology of calibration and testing on MOSAM. The process and the experimental procedure to carry out the MOSAM were explained in this chapter. Then, the results and discussion are covered in Chapter 4.

Summarize of all the studies and procedures of works from previous four chapters discussed in Chapter 5. Besides, future works and recommendation are recommended at the end of the chapter.

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