APPROPRIATE SELECTION OF AN INSULATOR FOR 275KV TRANSMISSION LINE

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11 MARCH 2005

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Tarikh : 14/03/2005

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ACQUISITION

"Saya mengakui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya jelaskan sumbernya."

Tandatangan : .....

Nama Penulis : KHAIRUL EDZHAN ADITA B. KAMARUDIN

Tarikh : 14/03/2015

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Project Abstract

Rapid urbanization and industrization in Malaysia over last two decades has resulted in increased demand for reliable electric power. The reliability in turn is greatly influenced by the grid system and its components being properly maintained. One of the important components is the high voltage insulators used in the overhead lines, substations and power stations.

The main objective of this project is to select an appropriate insulator for 275kV Transmission Line. In order to select the appropriate insulator, the flashover mechanism, hydrophobicity characteristic and aging of various kinds of insulators that involve in 275kV transmission line will be investigated. Every insulator will be analyzed with detail observation. All the characteristics of each insulator will be recorded and the suitable one will be selected.

Design of 275kV insulator of transmission line has always been restricted by limited choice of material and closely linked to the development of manufacturing process. Introducing the new designs of insulator has often been complicated. However, the types of insulators that have been used in high voltage transmission line are porcelain, glass, non-ceramic and silicone rubber Ethylene Propylene Diene Monomer (EPDM)

Abstrak Projek

Kepesatan pembangunan dan industri di Malaysia dalam tempoh dua dekad yang lepas telah memperlihatkan peningkatan dalam permintaan untuk kuasa elektrik. Keboleh harapan ini adalah factor yang dipengaruhi dari system grid dan komponen-komponen yang diselenggarakan. Salah satu komponen yang penting di dalam talian penghantaran kuasa adalah penebat voltan tinggi yang digunapakai pada talian atasan, stesen sub dan stesen kuasa.

Matlamat utama projek ini adalah untuk memilih penebat yang bersesuaian dengan talian penghantaran 275kV. Dalam menetapkan penebat yang sesuai, mekanisme voltan lampau, karekteristik ketelapan air dan juga factor ketahanan bagi pelbagai jenis penebat yang terlibat dalam talian penghantaran 275kV akan diselidik. Setiap cirri-ciri penebat akan direkod dan penebat yang sesuai akan dipilih.

Merekabentuk penebat bagi talian penghantaran 275kV selalunya menjadi begitu terhad berikutan kekurangan pilihan terhadap bahan-bahan asasnya dan juga ketiadaan teknologi dari segi proses pembuatannya. Memperkenalkan rekabentuk penebat yang baru merupakan tugas yang sukar. Walaubagaimanapun, masih terdapat lagi jenis penebat lain yang biasa digunakan dalam talian penghantaran voltan tinggi seperti tanah liat, kaca, bahan bukan seramik dan juga getah silikon Ethylene Propylene Diene Monomer (EPDM)

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CHAPTER 1

1.1 INTRODUCTION

An insulator is a material which prevents the flow of electric current and can be used to insulate or electrically isolate two current carrying conductors from each other and from ground. There are three main types of insulators used for overhead lines that are pin type insulator, suspension type insulator, and strain or tension type insulator. The correct insulator to be used for a particular application is determined by the operating voltage, the mechanical loads to be supported and the environmental influences, such as lightning and pollution, to be accommodated.

Many materials classified as insulators, among them wood, rubber, glass and numerous plastics, and are used in the production and transfer of electrical energy. However, the types of insulators that have been used in the high voltage transmission are porcelain, non-ceramic, glass, and silicone rubber Ethylene Propylene Diene Monomer (EPDM).

CHAPTER 2

2.1 PROJECT OBJECTIVES

The main objective of this project is to select an appropriate insulator for 275kV transmission line. In order to select an appropriate insulator, the following objectives are taken into consideration:

1) Types of insulators, their characteristics and comparison of various kinds of insulators which are used in 275kV transmission line will be studied and investigated so that the most suitable insulator maybe selected for 275kV line.
2) From the selected insulator type, its data will be collected, studied and analyzed. C++ programming language will be used to process the design and come up with final design proposal.

This project can be used as a reference for the high voltage transmission line. Nevertheless, this project can also be used as a study tool for students who study about the power system transmission line course.

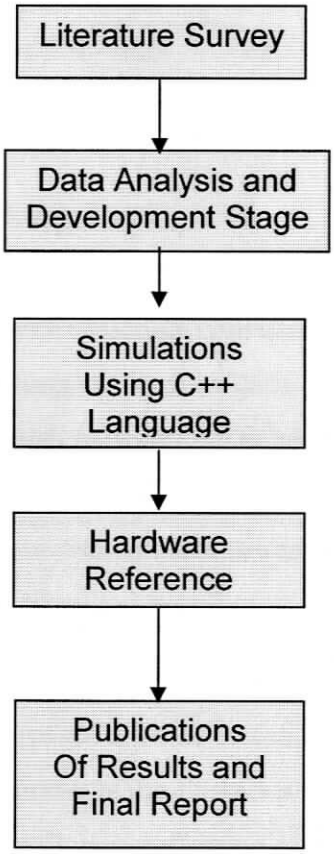
2.2 PROBLEMS STATEMENT

There are many types of insulators in high voltage transmission line. Each type of insulator used in the high voltage transmission line has different characteristics from the others. Overhead line insulators are used to separate line conductors from each other and also from supporting structure electrically. While selecting for suitable insulator, the following points are taken into consideration:

1) The insulator should be able to withstand the over voltage due to lighting, switching or other causes under severe weather conditions in addition to the normal working voltages.
2) It should posses high mechanical strength to bear the conductor load under worst loading conditions.
3) It should have a high resistance to temperature changes to reduce damage from power flashovers.
4) The leakage of current to earth should be minimum to keep the corona loss and radio-interference within responsible limits.

All of the points above must be considered otherwise there will be a problem in making a selection of insulation design. Besides that, the different components of insulators have to be studied. Every collected data must be categorized to ensure a high accuracy degree of accuracy in line with the related insulation type and its characteristics. This project will concentrate on proper selection of 275kV Line insulator.

2.3 PROJECT PLANNING



2.4 SCOPE OF THE PROJECT

The scope of this project is to study how to select an appropriate insulator for 275kV transmission line.

CHAPTER 3

3.1 LITERATURE REVIEW

There are plenty of research materials consisting of research papers presented in both local and international conferences such as IEEE proceedings. There are also other resources of literature material such as books, CDs, websites and electrical engineering manuals. Some of these literature materials have been reviewed and referenced during the on-going of this project. These related literature resources have been studied and reviewed and some of them are discussed below.

George G. Karady[1] proposed a paper on the ***Flashover Mechanism Of Non-ceramic Insulators.*** This paper presents the flashover mechanism of non-ceramic insulator and also describes the pollution collection mechanism and concludes that silicone rubber insulators collect more pollution than porcelain insulators.

All Non-ceramic insulators have a fiberglass rod with metal end-fittings, which provides the mechanical strength. Silicone rubber or ethylene propylene diene monomer (EPDM) weather sheds cover the fiberglass rod. The weather sheds provide a long leakage distance and high electrical strength [1].

The aim of this paper is to improve the flashover mechanism of non-ceramic insulator. The typical problem with non-ceramic insulators is the aging and deterioration oh the shed material but no flashover [5]. Most of the flashovers reported in the literature occurred in extremely bad weather, during storms. A survey indicates better contamination performance for non-ceramic insulators than porcelain [6]. Particularly

important is the better performance in contaminated conditions. However, flashover of non-ceramic insulators has been observed in extreme condition [4], which gives importance to the study of the flashover phenomenon.

Koji Kato, Hideyo Asaoka, Takuma Ikedia, Masato Oki, Masaaki Sakaguchi and Ryosuke Matsuoka. [2] have proposed a paper on ***The Wetting Characteristics of Various Kinds of Insulators.*** This paper presents the wetting characteristics of various kinds of insulators. There are two types of methods that have been used to obtain the surface resistance of specimen insulators that is the artificial fog chamber and outdoors test.

In general, continuous water films are not formed on hydrophobic silicone rubber surface, and so higher flashover voltages are expected of heavily contaminated polymer insulators. Under heavy wetting conditions, however flashover voltages may be reduced even on hydrophobic surface due to the water streams running down along the surface [2]. In addition, hydrophobicity on silicone rubber surface may be temporarily reduced or even lost under some wetting conditions. Low molecular weight silicone rubber components, which are considered to give the hydrophobicity, may be washed away from surface under heavy wetting conditions.

The aim of this paper is to establish design and application guidelines for Semiconducting Glaze (SG) insulators. The wetting characteristics of these insulators have to be investigated and compared to the porcelain insulators. This paper also focusing on the effect of wetting on the insulation performances of semiconductor glaze insulators [2].

Ahmad S. Ahmad, Hussein Ahmad, Razali B. Jidin, T.Tamsir, S.Shahnawaz Ahmed and Z. Buntat [3] are the group of researchers from Faculty of Electrical Engineering, University Teknologi Malaysia, 81310 Skudai, Johor Darul Takzim, Malaysia proposed a paper on the ***Contamination of High Voltage Insulators in the East Coast of Peninsular Malaysia***

The paper presents the effect of the salt contamination on high voltage insulators due to the salty wind that coming from the South China Sea. Power system lines, which are passing near the sea, are subjected to contamination deposit. Near the sea the constitution of the contamination layers is mainly due to salt[3]. High failure rate of polluted insulator due to the flashover has been found near the coastal areas [9].

The particles are brought to the insulator surfaces by some forces such as electrostatics, aerodynamics and gravity [1]. Salt sticks to the insulator and makes it more vulnerable to further contamination which in turn severely decreases flashover voltage [10].

The aim of this paper is all to develop a mathematical model correlating Equivalent Salt Deposit Density (ESDD) with the hydrometeorological variables. The data collected at one of the plants in the east coast during the dry season has been used to develop the model by using multiple regression analysis [9].

CHAPTER 4

INSULATORS

4.1 INSULATORS

There are three main types of insulators that are used for the overhead transmission lines, they are:

i) Pin type insulators.

ii) Suspension type insulator

iii) Strain or Tension type insulator

4.1.1 Pin type insulator.

The pin insulator is supported on a forged steel pin or bolt which is secured to the cross-arm of supporting structure. The conductor is tied to the insulator on the groove on straight line position and side groove in angle position by annealed binding wire of same material as conductor. A lead thimble is cemented into the insulator body to receive the pin.

4.1.2 Suspension type insulator

A suspension insulator consists of number of separate insulator units connected with each other by metal links to form a flexible chain or a string. The insulator string is suspended from the cross-arm of the support. The conductor is attached to the lowest unit. Suspension insulator offers the following advantages:

i) Each unit is designed for operating voltage of about 6.5kV, so that a string can be assembled by connecting several units to suit the service voltage and weather conditions.

ii) In case of failure of one of units in the string only that particular units need replacement rather than whole string.

iii) Since the power conductor and string swing together in case of wind pressure, the mechanical stresses at the point of attachment are reduced as compared with pin type of insulator because of rigid nature of the attachment fatigue and ultimate brittleness of the wire.

iv) The operating voltage of the existing transmission line can be increased by adding suitable number of disc in the string instead of replacing the whole string.

v) There is a decreased liability to lighting disturbances if the string is suspended from the metallic supporting structure which works as a lightening shield for conductor.

Since the string is hung from the support the tower height is to increased. Greater spacing between the conductors is to be provided to allow for swinging. The suspension insulator is suitable for 275kV transmission line

The type of suspension insulator in use is:

i) Cap-and-pin type

ii) Hewlett or Inter link type.

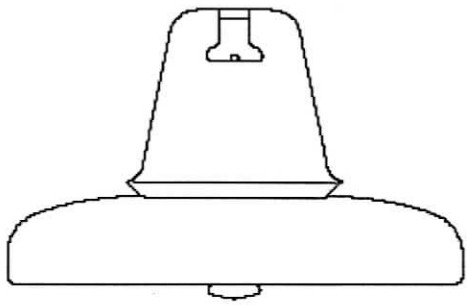


Figure 1: Disc Insulator

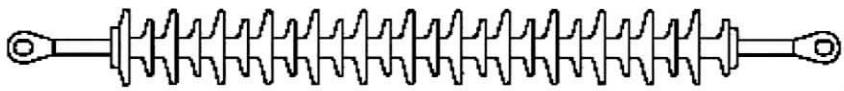


Figure 2: Suspension Insulator

4.1.3 Strain or tension Insulator

Strain or tension insulators are designed for handling mechanical stress at angle positions where there is a change in the direction of the line or at the termination end of the line. Shackle and pin insulators serve the purpose for low voltage lines. For high voltage line having longer spans and greater mechanical loading, suspension strings are arranged in a horizontal position. In case a single string is not sufficient to take the load, two or more strings in parallel may be employed for higher conductor tension.

4.2 DEFINITIONS

4.2.1 Contamination

Contamination is a dirty elements accumulated on the insulator surface at the overhead transmission line. It is believed that the weather is the main factor for contamination on the transmission line. There are some other sources that cause a contamination such as aging, salt fog from the sea, dust, and bird drops. Contamination is one of the factors that can cause a flashover voltage [3].

4.2.2 Anti-contamination

One of the biggest enemies of insulators is contamination. Transmission lines and substations in regions of extreme salt, dust, and smoke have sea salt and dust adhering to the surface of the insulators. [3] When moistened by mist, fog, etc., these contaminants drastically lower the insulation of the insulator surface. When ordinary insulators are used in these situations, the prevention of flashover is extremely difficult.

Typical design principles are as follows:

(1) Increased leakage distance

(2) Streamlined shaping

(3) Anti-dust accumulation contouring

(4) Rain-washing effect utilization

(5) Insulation oil utilization

(6) Water-repellent coatings

(7) Relaxing of the electrical field around the insulator

(8) Self-healing