EFFECT OF ARC RESISTANCE IN FAULT RESISTANCE ANALYSIS

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To my beloved parents,

Baharom Bin Rejab, Kamariah Binti Sulaiman

Brothers and Sister,

Muhammad Hakimi, Muhammad Haziq, Muhammad Hasif,

Muhammad Faiz, Nor Nabiah, Nurul Juhanis

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ABSTRACT

Fault analysis is the heart of power system component which plays an important role in solving a power system problem. The abnormal condition will tend high current flow through to the network and also faulted point. The arc resistances occurred due to fault at the point of fault and rely on the length and fault current during the fault. Meanwhile, ground resistance represented the resistance that touches the live conductor to the ground. In phase to phase fault, fault is due to arc resistance. However, in case of fault involving to ground fault, it will compose both ground resistance and arc resistance. In this project, it will focus on effect of arc resistance in fault current. The simulation will be performed into two ways which are with arc resistance and without arc resistance. CAPE software will be used to conduct simulation without arc resistance, while the developed a short circuit algorithm by using the Matlab software is used to perform simulation with arc resistance. To ensure the validity in simulation without arc resistance, results from CAPE and Matlab software will be used to make a comparison. Besides that, in simulation with arc resistance, results from Matlab and open literature will be used to prove the validity. From the result, the values of fault current and arc resistance are obeyed with the theoretical concept and it can be proven by referring to the IEEE standard error and literature.

ABSTRAK

Analisis kerosakan memainkan peranan yang penting bagi menyelesaikan masalah dalam sistem kuasa. Keadaan tidak normal berlaku akan mengakibatkan arus tinggi mengalir ke dalam sistem dan tempat kerosakkan berlaku. Rintangan arker yang berlaku di tempat kerosakan bergantung pada panjang dan arus kerosakan yang berlaku semasa kerosakan. Sementara itu, rintangan bumi menunjukkan rintangan yang menyentuh pengalir ke bumi. Dalam kesalahan fasa ke fasa, ia akan melibatkan rintangan arc. Kajian ini akan menumpukan kepada kesan rintangan arker dalam arus kerosakan mengikut jenis kerosakan yang berbeza. Di sini, kaedah menganalisis boleh dibahagikan kepada dua cara iaitu dengan membina algoritma menggunakan perisian Matlab dan melaksanakan pengesahan keputusan dengan menggunakan perisian CAPE. Ini menunjukkan, perbandingan dengan menggunakan perisian CAPE hanya boleh dilaksanakan tanpa mengambil kira rintangan arker dalam analisis yang dijalankan. Di samping itu, keputusan bagi penyelidik yang terdahulu akan digunakan untuk melaksanakan perbandingan bagi algoritma Matlab dengan mengambil kira rintangan arker dalam analisis. Bagi membuktikan hasil keputusan, asas kesalahan IEEE akan digunakan sebagai rujukan. Daripada keputusan, nilai arus kerosakan dan rintangan arker adalah dipatuhi dengan konsep teori dan ia dibuktikan dengan merujuk kepada ralat IEEE.

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V	-	Volt
A	-	Ampere
MVA	-	Apparent Power
E_A	-	Voltage Source
Z_0	-	Zero Impedance
Z_1	-	Positive Impedance
Z_2	-	Negative Impedance
Z_r	-	Series Impedance
$V_{A,B,C}$	-	Phase Voltage
$I_{A,B,C}$	-	Phase Current
$I_{A0,A1,A2}$	-	Phase Sequence Current
I_f	-	Fault Current
Z_{TH}	-	Thevenin Impedance
Z_g	-	Fault Impedance
R	-	Resistance
Ra	-	Arc Resistance
R_{new}	-	New Arc Resistance
R_{old}	-	Previous Arc Resistance
P	-	Real Power
Q	-	Reactive Power
T	-	Period
L_{arc}	-	Length of Arc
Ω	-	Ohm
Y	-	Admittance

$Y_{0,1,2}$	-	Sequence Admittance
k	-	Faulted Bus
ε	-	Accuracy

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CHAPTER 1

INTRODUCTION

1.1 1ntroduction

Since the regulation of the power industry and the development of electrical energy in last decade. Power electrical system play important role in transferring power from the seller to consumer through vastly networks to ensure that the power consumed and technical goal achive the economical aspect [1,2].

Nowadays power distrubution networks are dealling with delivery power from any supplier to the customers via a large space of area under the specified market control, and it mainly complicated networks to ensure the power transfer capability and system security during the fault [3]. While the new approaches have been made to tackel the rapidly increasing power demand, it is curios to make the system to be no occurrance of faults.

The previous fault analysis studies are developed and was not considering the arc resistance values into the analysis of fault procedure. The reason is, by introducing the arc resistance in computing the value of faults, it will give the accurate values of fault because faults current depands on the arc resistance itself [1]. Recently, the hybrid compensated short circuit method is being used in developed the distribution network for cater fault analysis problems. The obvious reason in this approaches, it is used a new real-time application in distribution protection but it is not accurate enough to study of the protection needs of distribution system.

Therefore, it is still a matter of finding the iterative procedure to develop an algorithm for fault analysis studies by considering arc resistance phenomena.

1.1.1 Fault Recognition

Fault analysis has been done in so many years to discuss the issues of disturbances that happen in the electrical network system. As a results, 80% or 90% fault occupied in the system can be happen in anywhere and any time [1,5]. The unpredictable fault will lead to uncountable of damage involve, and the failure problems will cause interuppted of supply. In so many cases, fault can be classified in several types :

Type of fault that generally occurs in all over the world:[4,5,8]

i. Single Line to ground fault
ii. Line to line fault
iii. Three phase fault
iv. Double line to ground fault

Note that the common fault happen is single line to ground fault and the worst fault is three phase to ground fault [4]. Type of fault must be known to ensure the

differents between each fault can be used to conduct the simulation which is discussed in Chapter 3.

Tendency of faults will cause the damages depands on the network configuration of the system. Differents network will produce different level of studies during and after the fault occur. Therefore, it is important to study the network configration to figure out the path of impedance during faults as well as currents and voltages. In this analysis, it will focus on the distribution network configuration which is radial system type. This will be discussed further in Chapter 3 as well.

1.1.2 Arc resistance Formula

Concern about the accuracy, it will help to find the accurate value of studies in fault analysis method. The previous literature was not include the arc resistance value in their analysis of fault, so it will give unaccurate results. By considering the arc resistance value in computing fault current, it will induce the path of fault impedance and decrease fault current in the point of fault location happen. Since the arc resistance is directly propotional to the fault current, the typical values for arc resistance are based on the type and location of fault. In the other word, the arc resistance is important thing to be concerned in analyzing the fault current in overall system indeed. This issue will be discussed in Chapter 3.

1.2 Short circuit analysis

Short circuit analysis is needed to calculate the fault current. During and after a fault occurs in power system, it provides currents and voltages which can be used to design a protective relay system. In order to develop an efficient and reliable relay system, the fault currents and voltages must be calculated under various types of faults in every location of the power system. Normally , there are thousands of buses in a system. So, it is difficult to calculate them without a computer. The early short circuit analysis program is proposed in 1949 [9]. Gradually, a formal calculation method is developed to handle the classical faults with high accuracy.

The traditional fault analysis approach of unbalanced power systems entirely on the symmetrical components. Furthemore, this following steps will gives the solution to calculate the fault current [7,8]:

i. Draw the network as described in the problem showing in all data
ii. Convert all the equipment data to one per unit base.
iii. Draw the positive, negative and zero sequence networks. Note that only the positive sequence network contains sources. The negative sequence network is similar to the positive network but without sources. The zero sequence networks are influenced by the way machines and transformers are connected and their grounding practices.
iv. Calculate the Thevenin's equivalent sequence networks at the point of the fault. This step involves network reduction techniques. Three reduced networks result from this step: positive, negative and zero sequence networks.
v. Apply the network connections according to the fault type:
    a. Symmetrical Three Phase Fault
    b. Line- Ground
    c. Line- Line
    d. Line-line-Ground
vi. Assume the voltage at the point of the fault to be 1.0 per unit

vii. Calculate the sequence currents and voltages.
viii. Convert the sequence voltages and currents to their phase quantities.
ix. Calculate the corresponding fault current.

This project presents a short circuit algorithm to calculate fault in CAPE and MATLAB software. The results will be verified by considering the arc resistance and without it into fault analysis.

1.3 Problem Statement

Most of the low voltage installation works had not used arc resistance formula techniques especially in analysing the fault [10]. As a result, it had caused inherent tripping, inadequate over current protection, inactivated earth fault and high cost of installation. Thus, a proper selection of arc resistance for a specific application and realizing the time, current and voltage characteristic during fault are very important.

1.4 Objective

There are three objectives for this project which are:

i. To review short circuit and arc resistance formula in fault analysis studies.
ii. To develop a short circuit algorithm for fault analysis by considering arc resistance in Matlab software.
iii. To verify the results of fault analysis methods by using CAPE software.

1.5 Scope

The scope of the project are:

i. Studies the components of fault and calculate the fault currents, fault levels at each point by with or without considering the arc resistance.
ii. Use Matlab Software to develop an algorithm for short circuit analysis
iii. Study about CAPE Software to model the selected network system
iv. Comparison between the algorithms with the short circuit classical method CAPE.

1.6 Report Outline

This report is divided into five Chapters. These Chapters include the basic principles, theories, literature review, simulation result and discussion based on each Chapter's requirement of contents.

Chapter 1 is an introduction Chapter which covers several parts including overview, objectives,and scope. Chapter 2 will introduce the literature review of journals and papers related to this project. A brief discussion about the journals and papers is presented in this Chapter.

Chapter 3 will explain the methodology of the project. In this Chapter, the author discussed about the steps taken in developing the algorithm to calculate fault current at the same time calculated arc resistance, and also how simulation will be carried out to prove the result. Result and discussion will be covered in Chapter 4. This Chapter will discuss about the performance of the arc resistance method.

Finally the report will close with conclusion and suggestion covered in Chapter 5. Some recommendations and contributions also will be mentioned in this Chapter.

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