MODELLING SINGLE GROUNDING ELECTRODE USING COMSOL

ABDULMANAN MEMON

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To My Parents

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ABSTRACT

In electrical engineering, the necessity of grounding system refers to a system where conductor is grounded and intended or may cause the current to flow under normal operations. Grounding system is designed for appropriate of the clearing the grounding faults and dissipates the lightning energy. Most commonly used material for the grounding system is copper. However the increasing price and theft issue of copper has led to research materials other than copper with additive filler to overcome problem as well as maintaining the efficiency of an electrical system. The current project analyses the mixture of copper and graphite along with silica glass and amorphous carbon used as an additive material for the analysis of the system. The analysis was done using COMSOL multi-physics software. The voltage distribution and current density was analysed which showed that graphite rod can be used instead of copper.

ABSTRAK

Dalam bidang kejuruteraan elektrik, keperluan sistem pembumian merujuk kepada satu sistem di mana konduktor dibumikan dan bertujuan atau boleh menyebabkan arus mengalir di bawah operasi normal. Sistem pembumian direka untuk sesuai bagi penjelasan kesalahan asas dan membebaskan tenaga kilat. Bahan yang paling biasa digunakan untuk sistem pembumian adalah tembaga. Walau bagaimanapun harga dan isu kecurian tembaga yang semakin meningkat telah membawa kepada penyelidikan bahan-bahan lain daripada tembaga dengan bahan tambahan lain untuk mengatasi masalah serta mengekalkan kecekapan sistem elektrik. Jika dilihat projek semasa di mana mereka menganalisis campuran tembaga dan grafit bersama-sama dengan kaca silika dan karbon amorfus yang digunakan sebagai bahan tambahan untuk menganalisis sesuatu sistem. Bagi projek ini, analisis dijalankan menggunakan COMSOL perisian multi-fizik. Pengagihan voltan dan ketumpatan arus dianalisis yang menunjukkan bahawa batang grafit boleh digunakan selain daripada tembaga.

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LIST OF ABBREVIATIONS

EPN	-	Electrical Power Network
AC	-	Alternating Current
GEM	-	Ground Enhancing Material
GAM	-	Ground Additive Material
HCBM	-	High Conductivity Backfill Material
ZP	-	Zero Potential
SV	-	Stray Voltage
ECH	-	Electric Shock Hazard
FC	-	Fault Condition
VS	-	Voltage Stabilization
GA	-	Grounding Agent
VD	-	Voltage Distribution
CD	-	Current Density
SG	-	Silica Glass
CA	-	Corban Amorphous
NES	-	National Electrical Safety
EAM	-	Earth Enhancing Material
VG	-	Voltage Gradient
AT	-	Artificial Treatment
LPS	-	Lightning Protection System
EMI	-	Electromagnetic Interference
CM	-	COMSOL Multiphyscis
SD	-	Soil Design
PDE	-	Partial Differential Equation
CDE	-	COMSOL Desktop Environment
ECS	-	Electric Current shells

ES	-	Electrostatic
MSM	-	Material Selection Modules
MW	-	Model Wizard
RF	-	Radio Frequency
EF	-	Electric Filed
SEP	-	Scalar Electric Potential

LIST OF SYMBOLS

D_h	-	Demarcation for Holes
D_e	-	Demarcation for Electrons
nm	-	Nanometer
°C	-	Celsius
T_m	-	Melting Temperature
T_g	-	Transition Temperature
BO_3	-	Triangular Units
BO_4	-	Tetrahedral Unit
n	-	Refractive Index
a	-	absorption coefficient
Z	-	Atomic Number
E_g	-	Energy Band Gap
T_o	-	Irradiation Temperature
T_m	-	Maximum Peak Temperature
E	-	Trap Depth or Activation Energy
m	-	Concentration of Holes
s	-	Frequency Factor
b	-	Kinetics Order
eV	-	Electron Volt
k	-	Boltzmann Constant
A	-	Area Under Glow Curve
μ_g	-	Geometric Factor
β	-	Linear Heating Rate
min	-	Minute
P	-	Transition Probability
$f(D)$	-	Linearity Index

σ_B	-	Standard Deviation of Background
F	-	Conversion Factor
B^*	-	Background Signal
Z_{eff}	-	Effective Atomic Number
$S(E)$	-	Energy Response
(μ_{en}/ρ)	-	Mass Energy Absorption Coefficient
Gy	-	Gray
ρ	-	Density
V_m	-	Molar Volume
M	-	Molecular Weight
N_A	-	Avogadro's Number
X_B	-	Mole Fraction
N	-	Ion Concentration
r_p	-	Polaron Radius
r_i	-	Inter-nuclear distance
Å	-	Angstrom
T_c	-	Crystalline Temperature
cm	-	Centimeter
Mv	-	Megavolt
MeV	-	Mega Electron Volt
T_{rg}	-	Glass Forming Ability
H_R	-	Glass Stability
f_{exp}	-	Oscillator Strength
$[O_V]^-$	-	Oxygen Vacancy
h	-	Hole
nC	-	Nanocolumbs
w	-	Fractional Weight
σ_T/D	-	Relative Total Standard Deviation

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Grounding basically originally began as the safety measure to help prevent people from accidently coming in contact with electrical Hazards. In the electrical system the grounding system or earthing system are the circuits used to connect electrical devices to the ground. Grounding of electrical installation is primarily concerned when safety aspect of equipment and user are concern. In the electrical system grounding is important provide a reference voltage (zero potential ground potential) against which all other voltages in a system are established and measured. An effective ground connection also minimize the susceptibility of equipment to interface reduce the risk of equipment damage due to lightning.

In electrical power network grounding system help to maintain the voltage of any part of electrical network within a predetermined range of with respect to earth under safety and fault condition. Electrical ground system have an appropriate current carrying capabilities. Ground also consider as idealized as infinite source or sink for charge which can absorb unlimited amount of current without changing its potential. For the real grounding connection has significant resistance the approximation voltage is no longer valid stray voltage and earth potential rise occurs which may create the noise in signal if large noise produce that cause the electric shock hazard.

If grounding system installed correctly it should allow the enough current to flow under fault condition. To operate the protective device installed correctly the rise in potential during fault condition combined with fault clearance should be minimize the both risk of electrocution to individual near the site of damage to equipment. Widespread usage of electrical appliance used in industries as well as used in homes also introduces many situation where efficient grounding is paramount importance especially to prevent from electrical shock under fault condition.

1.2 Grounding System

The necessity of grounding system is refers to a system where conductor is grounded and intended or may cause to current flow in normal operation. Grounding system is very important. It is not only expensive to build an appropriate ground system during initial construction of any electrical system but it can also expensive to add it enhance it or replace it. After the completion of the electrical network, for the design of grounding system point taken in to consideration for the appropriate of clearing ground faults and dissipating lighting energy.

In term of grounding and earthing most of the people can quite confused. Earthing is common word used in outside in United States of America. Earthing is the connection of the equipment and facilities to mother Earth and in the lighting protection system the earthing terminal is the point where lighting current discharge to earth. The word grounding is used in the northern America both word has nearly same meaning but difference is that different term used by different countries.
As discussed there are several important reasons why grounding system should be installed. The most important reason is to protect people other to protection of electrical device from unintentional contact with energized electrical lines. Grounding system provide the maximum electrical safety from the electrical system faults and lighting.

A good grounding system should have periodic inspection and maintenance program to ensure its effectiveness continued. The periodic maintenance is added

through adequate design choice of material (for the electrodes) and proper installation techniques to ensure that the grounding system resist deterioration or inadvertent destruction the performance of such electrode depend on the soil type composition conductivity moisture content soil temperature and etc.

1.3 Problem Statement

The mostly using material for grounding system is copper but due to increasing price and theft problem of copper it is important to analyse the different material other than copper with additive grounding material also be analysed. To overcome the problem of cost as well as theft issues, reduce the cost of system, reduce the losses and increase the efficiency of an electrical system.

1.4 Objectives of the Project

The objective of this research is as follows:

i) To review and investigate grounding- agent's performance.
ii) To simulate and analyze the different behaviors of the several grounding rod material mixed with grounding agent materials

1.5 Scope of Project

This project will cover the work on the analysing the grounding rod materials. Study of the replacement of copper graphite, and the usage of additive grounding material for the decreasing the grounding resistance and corrosion reduction. As for the methodology concern the simulation will be performed on by using COMSOL Software.

1.6 Report Outline

This report is composed of five chapters. The first chapter discusses the background of this research, problem statement, objective and Scope. Chapter 2 contains the literature review of the grounding materials used for the grounding system design. Chapter 3 describe the methodology how to use the Comsol Multiphyscis 4.4 for the grounding system. Chapter 4 will present the results and discussion about the grounding system in electrical terms. The problem and challenges faced during simulation and design also discussed in this chapter. Chapter 5 discussed the conclusion of the whole project and some recommendation of improvement is presented.

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