AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
ELECTRICAL POWER AND MACHINES DEPT.

CALCULATION OF ELECTRIC FIELD BY CHARGE SIMULATION METHOD

A Thesis
Submitted in Partial Fulfillment for
the Requirement of the Degree of Master
of Science in Electrical Engineering

By

Samah Mohamed Taha El Safty
B.Sc. Electrical Engineering, Ain Shams University, 1988

Supervised By

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Dr. M. M. Awad
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بسم الله الرحمن الرحيم

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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master in Electrical Engineering.

The work included in this thesis was carried out by the author. No part of this thesis has been submitted for a degree or a qualification.

Sanah El Safty

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ABSTRACT

Gas insulated substations (GIS) have been developed with the view of utilizing the high reliability, compactness and economization achieved by gas insulation. The basic insulation components in GIS are SF_6 gas and solid spacers which are necessary for the physical support of conductors.

The working performance of compressed gas insulated system (GIS) to a great extent depends on the electric performance of spacers. Therefore the knowledge of the potential and electric field distributions in the vicinity of the spacer and on its surface is of great significance for the optimum design of spacers.

In the present work a computer program has been developed for the calculation of the potential and electric field distributions in the vicinity of the spacer and on its surface by using the charge simulation technique (CST). Lotus spread sheet and Harvard Graphics have been used for plotting the results.

The effects of using metal insert at one or both ends have been studied. Also the dependence of the electric field on the depth and width of the metal insert has been investigated. The effect of varying the spacer length and material on the electric field has also been studied. Moreover, the optimal design of a spacer having metal inserts is discussed. A significant reduction in the electric field has been achieved by using suitable metal inserts at both ends.

The effect of accumulation of surface charges on the potential and electric field distributions at the interfacial boundary between the solid insulator and SF_6 has been studied in two cases ; namely with and without metal inserts.

Also in this work analytical study has been carried out in order to calculate the electric field at measured values of the flashover voltages and for different values of gas pressure.

The development and relevant sizes of the discharge electron avalanches have been calculated. Hence, the criteria of electric breakdown are investigated.

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LIST OF ABBREVIATIONS

GIS : Gas Insulated Switchgear.

SF_6 : Sulphur Hexaflouride.

CSM : Charge Simulation Method.

FDM : Finite Difference Method.

FEM : Finite Element Method.

E_n : Normalized normal field component.

E_t : Normalized tangential field component.

E_T : Normalized total field component.

E_{nc} : Normalized normal field component at the cathode junction.

E_{tc} : Normalized tangential field component at the cathode junction.

E_{Tc} : Normalized total field component at the cathode junction.

E_{nm} : Normalized maximum normal field component.

E_{tm} : Normalized maximum tangential field component.

E_{Tm} : Normalized maximum total field component.

E_a : Applied electric field.

E_s : Space charge field.

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