UNIVERSITI TEKNOLOGI MARA

ARTIFICIAL INTELLIGENCE BASED TECHNIQUE FOR PREDICTION OF PARTIAL DISCHARGE INCEPTION VOLTAGE IN A VOID OF SOLID DIELECTRIC

SITI SALWANI BINTI SAMAT

Thesis submitted in fulfilment
of the requirements for the degree of
Master of Science

Faculty of Electrical Engineering

October 2014

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Siti Salwani Binti Samat
Student I.D. No.	:	2010442182
Programme	:	Master of Sciences (EE 780)
Faculty	:	Faculty of Electrical Engineering
Title	:	Artificial Intelligence Based Technique for Prediction of Partial Discharge Inception Voltage in a Void of Solid Dielectric
Signature of Student	:	.....
Date	:	October 2014

ABSTRACT

Partial discharge (PD) is an important issue since it is considered as one of the greatest threats to insulation system of high voltage equipment. Existence of PD signifies that there is a weak point in an electrical insulation system and the existence of PD not only indicates that electrical aging is occurring, but also mechanical, thermal or environmental aging processes may be present. Materials such as solid, liquid and gaseous that are used for insulation purpose are imperfect and always contaminated. Most of the solid insulation has impurity in the form of air bubbles (void) which created a small fragile zone in the insulator during the manufacturing process and is a common source of PD. Due to the void, the insulation region is weakens resulting in the appearance of PDs with the application of high voltage. On the other hand, partial discharge inception voltage (PDIV) or also known as the breakdown voltage is the lowest voltage at which the PD events are detected. The PDIV due to PD in a void is a random phenomenon. The designing of an insulation system depends critically on the magnitude of this voltage. It is crucial to comprehend the property of the insulating materials for optimal solution in terms of insulating ability and costing. Therefore, accurate PD and PDIV models with the presence of void are highly needed to develop solid insulating materials with high breakdown strength. Lacking of these PD models will lead to difficulties in understanding the PD behavior and characteristics. As a result, assessing the insulation condition becomes a complicated process. In addition to that, an accurate artificial neural network (ANN) PD prediction system shall be the solution to help the electrical engineers in general and high voltage engineers particularly to develop a high quality insulation material that is more reliable and cost effective. This thesis presents an artificial intelligence based technique for partial discharge inception voltage (PDIV) prediction in a void of solid dielectric. This study involves the development of a MATLAB Simulink model for single void of solid dielectric for PD characterization. It also involves the development of hybrid ANN evolutionary programming (EP) for the prediction of PDIV of solid dielectric of different sizes of void. This study has also implemented an optimization technique using EP to improve the accuracy of the prediction system by finding an optimal number of learning rate and momentum constant. EP is an express search technique that is widely chosen to simplify the calculation process and also to fine tuning the result. The result of simulations has proven that the input signals such as supply voltage and supply voltage frequency are important for PD characterization. Comparative studies were done in term of the accuracy of the prediction system that was evaluated by the value of correlation coefficient, R. The result showed that the optimized ANN has able to produce a high value of R near to unity and the error was reduced tremendously. The convergence and generalization ability of the combined ANN-EP has improved outstandingly with the optimization process.

TABLE OF CONTENTS