Name of the Research Scholar	**:**	Md. Danish Equbal
Supervisor	**:**	Prof. Shakeb A. Khan
Co-Supervisor	**:**	Prof. Tarikul Islam
Department	**:**	Electrical Engineering Department, Faculty of Engineering and Technology, Jamia Millia Islamia.
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ABSTRACT

Power transformers are vital components of the power system. They are normally considered as stable components of power system, yet faults in them can result in significant financial loss and can severely deter the power system functioning. Hence, fault in transformers need to be identified and tended to at the incipient stage.

Dissolved gas analysis (DGA) is one of the proven tools to identify the incipient faults in the transformer from the decomposed fault gases dissolved in oil. A number of standards have been developed that serve as the guidelines for interpreting the incipient faults. Some of the commonly used standard incipient fault interpreting methods includes the IEC standard, Rogers ratio method (RRM), Doernenberg ratio method (DRM) and the Duval’s triangle method (DTM). The standard specifies the range of input gas ratios for a particular incipient fault condition to exist. The problem encountered with the usage of ratio based diagnostic standards is that some fault cases may be wrongly interpreted and many result in unresolved diagnosis.

In this research work, the interpreting standards have been implemented using softcomputing techniques viz. fuzzy logic (FL) and ANFIS with the objective to circumvent the limitations and improve their diagnostic reliability. Furthermore, an ANFIS model has also been

developed for the DTM method. A comparative diagnostic study of the developed models for a common fault database of 100 fault cases, has revealed the superiority of the softcomputing models over the direct application of the standards. It has further been identified that the ANFIS models based on the IEC-599 and DTM give more efficient diagnosis as compared to other fuzzy and ANFIS models. Hence, these models are suitable candidates for online fault studies.

Another approach adopted in this research for transformer incipient fault diagnosis is through the use of Artificial Neural Network (ANN), taking into account the difference in the energy required to produce the different fault gases. In this work, a weighing factor has been used, to take into account this relative difference in energy requirement for various fault gas formation. The fault gas concentrations have been suitably weighted by their respective weighing factors before being used in the incipient fault diagnosis process. A back propagation ANN has been appropriately trained using the weighted fault gas concentration for transformer incipient fault identification. The comparative diagnosis results presented here show clear improvement in the diagnosis of transformer internal faults using the energy weighted ANN model over the unweighted ANN model.

This research also explores the feasibility of using an E-Nose along with the converged ANFIS models of IEC and DTM to diagnose incipient faults in the transformer. The E-Nose which is essentially an array of sensors is realized as a prototype developed using actual gas sensor characteristics rather than gas sensors. The actual sensor characteristics are used to calibrate variable resistances. The output voltages due to the resistance change are fed to a computer through an Arduino interface where it is converted back to gas concentration in ppm. The E-Nose model has been tested using a reduced fault database and the preliminary model has shown an encouraging trend towards a reliable online diagnostic model.