CHAPTER 7

CONCLUSION

The research work is based on two salient parameters namely the leakage current and the surface temperature variation to study the phenomenon of polluted insulator and its performance.

Polluted insulator samples collected from the Mettur region are investigated in the laboratory to assess the pollution severity that is characterized by the ESDD. From the investigations, it was observed that the prediction of flashover is mainly based on the magnitude and shape of leakage current and the surface temperature variation.

The contributions made in this research work are summarized in this chapter.

Using equivalent insulator trough model, artificial contaminations tests were conducted for the measurement and analysis of leakage current. The leakage current for a withstand (non-flashover) has intermittently large peaks whereas the flashover case exhibits a continuous train of large peaks. The higher the ESDD value (conductivity) of the pollution layer, the more likelihood of a flashover and lower the value, the better chances for an insulator to withstand.

Based on the International Standards, tests have been conducted to measure the emitted harmonic currents on the insulator equivalent trough model determine the worst conditions. These experimental results of the
leakage current waveforms, which were found to be distorted from sinusoidal were recorded and analyzed with their magnitudes, harmonic components and THD. It is inferred that the emitted harmonic currents depend strongly on the leakage current waveforms. The 3rd and 4th harmonic components are dominant prior to flashover which is strongly correlated with the dry band activity.

The extracted leakage currents are fed to ANN and trained. In ANN1, the overall testing accuracy equals to 99.73%, with 99.88% accuracy for no flashover, 99.91% for flashover case and 99.41% for forecasting which represents the arcing and no flashover. This ANN1 model also extended to predict the levels of contamination and to identify the occurrence of flashover in ANN2. The trained ANN shows an accuracy of 99.84% for prediction of flashover to distinguish security, forecast and critical level of assessing situations of approaching flashover of contaminated trough and 99.74% for estimation of ESDD to distinguish very light, light, medium and heavy level of pollutions. The estimation of ESDD for various level of pollution along the variation of leakage current changes the flashover mechanism which results either in flashover or withheld was determined accurately.

An offline LabVIEW GUI to simulate Wavelet MRA was designed and implemented to classify the surface condition of insulator trough model. The signal is decomposed into nine levels and the waveforms of the detailed coefficients and the standard deviation plots are analyzed. For low contamination there is not much deviation in the leakage current. For medium and heavy contamination case the magnitude of high frequency band increases. The standard deviation curve shows the transient energy present during the surface discharge from the deviation of distorted leakage current signal. The STD-MRA curves showed different patterns to classify the different phenomena at various levels of contamination to identify the surface condition of the insulator trough model effectively and accurately.
Simultaneous and continuous temperature measurement and thermal imaging of the polluted insulator trough model were conducted to study the initiation and the instant of dry band formation. The results are obtained for various contamination levels. Visual observation of a complete time-domain record of temperature shows significant variation during the dry band formation. This technique precisely locates the dry band formation from the surface conduction.

For medium contamination, the maximum temperature rise is at T4 and it is 54.3°C after 9.20 minutes at the instant of initiation of dry-band formation. The simultaneous non-contact type infrared thermal imager captured the thermal image and shows 55.8°C at T4. Similarly, when the leakage current reaches zero, the temperature at T4 is 50.5°C after 16 minutes the dry-band just got formed. The simultaneous non-contact type infrared thermal imager captured the thermal image and shows 52.5°C at T4.

For heavy contamination, the maximum temperature is at T4 and it is 62.6°C after 220 seconds at the instant of initiation of dry-band formation. The simultaneous non-contact type infrared thermal imager captured the thermal image and shows 65.6°C at T4. Similarly, when the leakage current reaches zero, the temperature at T4 is 53.2°C after 9 minutes the dry-band just got formed. The simultaneous non-contact type infrared thermal imager captured the thermal image and shows 60.6°C at T4.

It is inferred that for temperature distribution, higher the conductivity, the higher the final temperature reached by the layer and for the lower the value, the time taken for dry band formation probability decreases.

The uniqueness of this thesis is the introduction of using simultaneous and continuous measurement by thermocouples and Infrared thermal imaging technique is used for the first time for the measurement of
surface temperature of polluted insulator trough model. This new experimental investigation is well correlated with leakage current measurement recording for the initiation and the instant of dry band formation.

FDR based ANN identification model was first proposed as a general class of identification in polluted insulator surface temperature identification problems. The FDR ratio is calculated for all the seven features extracted from seven channels and are ranked accordingly. The extracted seven channels are fed to ANN and trained. Next, the input channels are reduced, the first 3 top-ranked input channels are selected for medium contamination case and first 4 top-ranked input channels are selected for heavy level contamination case and given as input data to the neural network and trained.

It was inferred that the neural network developed for the medium contamination with channel reduction using mean feature of 4 rows has better classification accuracy, maximum mean sensitivity and specificity compared to other models.

It was also inferred that the neural network developed for the heavy contamination with seven input channel using geometric mean feature of 2 rows has better classification accuracy and geometric mean of 3 rows has maximum mean sensitivity and specificity compared to other models.

The validity of the above research work contributions are supported with publications.

Further, this research work can be extended by implementing advanced computation methods like, particle swarm optimization and differential evolution for analysis.