CHAPTER 7

CONCLUSION

7.1 CONCLUDING REMARKS

A study of pollution phenomena is very relevant in order to understand the behaviour of insulators and bushings when exposed to adverse environmental conditions. While studies on full length of insulators are necessary, the utility of models for such purposes is unquestionable. They have the advantages of ease of construction and mathematical tractability while retaining the significant features of the phenomena under consideration. This thesis, in the main, is concerned with the development of physical models for HVDC insulators and bushings for pollution studies.

Events leading to flashover are primarily influenced by the creation and location of dry bands. So, attention was paid to the replication of these effects by the models developed earlier. A further consideration was the necessity of maintaining controlled levels of pollution so that the essential features of dry band formation were highlighted. The use of models for these studies was shown to be particularly effective in understanding this phenomenon.

In this work new models were developed for HVDC insulators and bushings. The design features of the models permit the study of the flashover processes in these insulators. Based on the studies on these models the following conclusions were arrived at:
The Rib Effect Simulation model is an extremely close approximation of a suspension insulator. This is because of its three dimensional structure and a one to one correspondence between a point on the insulator and the model. Its mathematical tractability implied that issues such as the location and inception of dry bands can be predicted once the extent of pollution is specified.

The model can be used for HVDC as well as conventional AC insulators.

It was concluded from the studies on the model and the insulator that proper representation of the ribs and the pin is necessary in the model for the study of the flashover phenomena in suspension insulators.

Based on experiments on the model and the insulator the flashover voltage for DC voltage is less by a factor which is in the range of 0.60 to 0.85 compared to the power frequency AC voltage.

Non-uniform wetting, non-uniform pollution and the location of ribs are found to effect the flashover process and these effects were studied using the model.

The two dimensional model for a bushing is sufficient for studies pertinent to the location and pattern of dry band formation. Its simplicity from the mathematical point of view makes it particularly attractive for studies based on the extent of pollution. In the worst case, error for the initial potential distribution at any point on the bushing based on analysis of the model was found to be 15 percent for both AC and DC energisations.

The Didactically Kindred model is a three dimensional model and hence it is a close approximation to a bushing. It is useful in studying the flashover processes in bushings. Studies on the bushing and the model showed that flashover voltages under DC negative polarity are about 10 percent less when compared to AC and DC positive polarity.
The model is capable of reproducing effects of non-uniform wetting which leads to a change in the flashover voltage.

A new method to simulate a condenser bushing in a laboratory model is suggested by the use of carefully assigned external capacitors at appropriate locations in the didactically kindred model.

The flashover voltages with external capacitor connections are found to be slightly more than those compared to the ones without capacitors. The increase in the withstand voltage observed in the bushing is about 15 percent. It is about 30 percent in the case of the model.

The surface resistance measurements on the model under rainy conditions showed that the surface resistance variation with time is similar to the observations made on actual HVDC wall bushings made in other laboratories.

The mathematical model developed to estimate the time to flashover indicated that the parameters which play a dominating role in the flashover of a HVDC wall bushing are the surface resistances per unit length of the dry and the wet zones of the contaminated wall bushings.

The network model developed is useful in obtaining the voltage distribution plots across the length of the wall bushing.

It is calculated from the network model that the voltage coming across the dry zone decreases with increase in the dry zone length. About 70 percent of the total applied voltage comes across the dry zone initially under non-uniform wetting conditions. This is again dependant on the percentage of wetting and the conductivity of the rain water.

If the initial dry zone length is more than about 30 percent of the total creepage length, flashover of the bushing does not take place. If the percentage of wetting is more than 90 percent, there is a very high possibility for a total flashover to occur.
7.2 SCOPE FOR FUTURE WORK

Nonuniform voltage distribution along the bushing as well as within the dry zone itself creates the prerequisites for the initiation of the flashover process in HVDC wall bushings. Using the model described in chapters 4 and 5, further study may be done into the effect of the voltage collapse across the inter shed gaps which is a cumulative process leading to a final flashover. The effect of Room Temperature Vulcanised (RTV) silicone rubber coatings and booster sheds in reducing the danger of flashover can also be studied using the model. Further work is possible for the identification of failure modes in present HVDC wall bushings. New design specifications for bushings can be attempted using the DK model. Investigation of diagnostic techniques for existing and future wall bushings that assist in the determination of the need for preventive maintenance, can also be attempted.