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Levels of Pollution to Enhance Transmission Line Model using ANN

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Abstract*: Pollution insulators are a serious problem to the safety operations of electric power networks. Leakage current sensing is often used on transmission line insulators to quantify pollution level. The present research shows the inference of pollution concentration on insulators via the simulated leakage current and voltage in a gearbox tower. The simulation parameters are fed based on the enhanced transmission line model with an insertion of leakage resistance currents between buses. Simulated leakage current and voltage between two buses are utilized at different locations in order to approximate the pollution level with the help of artificial neural network (ANN).*

Keywords*: Fuzzy logic, Neural networks, Pollution check sensors, Leakage current*

I. Introduction

Pollution has a significant impact on high-voltage transmission lines particularly in the case of outdoor insulation systems whereby contaminants/pollutants such as dust, salt, and industrial pollutants may accumulate on insulators and result in surface leakage currents, corona discharge and flashover on insulators, leading to deterioration of insulation strength and power losses and hence harming the system stability. These variations exceptionally caused by the pollution are often not well reflected in conventional models of transmission lines, and Artifice [1-4]. Through back-reading as well as present information, ANN models can attain the relationship amid electrical-performance properties and environmental contamination. Adding the data of pollution levels to the transmission line modelling with hatched neural networks (ANN) allows utilities to advance the fault prediction, planning of maintenance, and accuracy of simulation. The approach enhances the reliability and the performance of power systems operating under diverse conditions of pollution and environment.

II. Simulation Model

The environmental contamination data are included in the simulation model to enhance the transmission line performance using the Artificial Neural Networks (ANN) so as to predict the electrical behavior at different conditions. The model inputs are temperature, humidity, pollution seriousness (low, medium, heavy), and past indicators of line performance such as leakage current, insulation resistance, and flashover. The supervised learning guides the ANN grid by matching the values of pollution with the response of the transmission lines through implementation of input-output datasets derived in laboratory tests and those made in field tests. The traditional network comprises of one or many intermediate layers of pattern recognition, one output layer of predicting performance related indicators such as insulation degradation or likelihood of a fault and one input layer (environmental and electrical conditions).

The ANN model depicts the non-linear impacts of pollution on transmission lines fairly well according to simulation results [4-6]. To have a smarter and stronger power transmission network, the strategy promotes proactive maintenance, reliability predictions, and optimized line setting in polluted sectors.

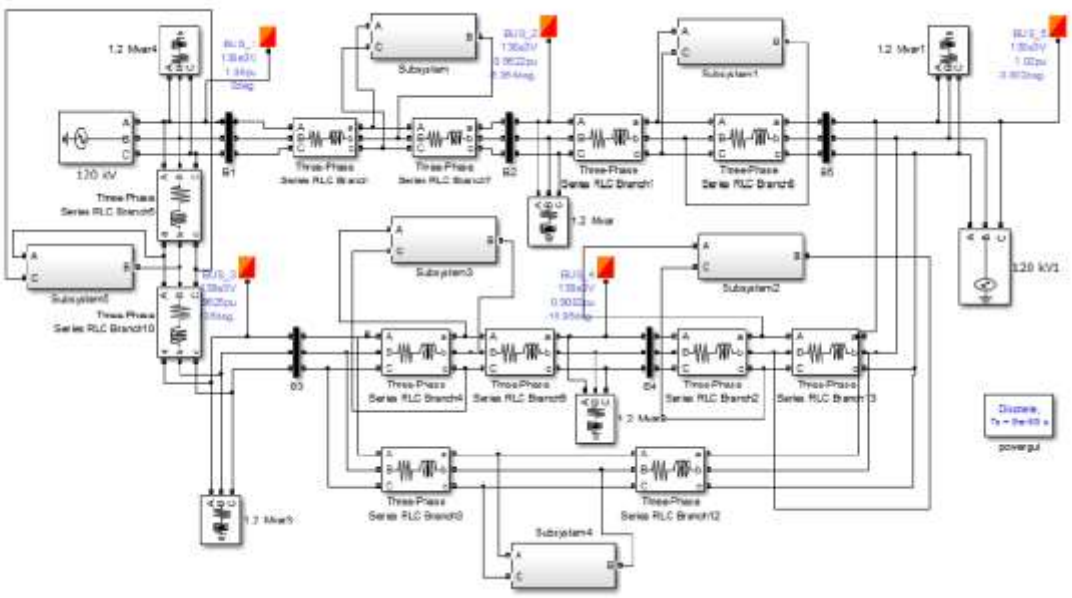

Fig 1: Test System Simulink model

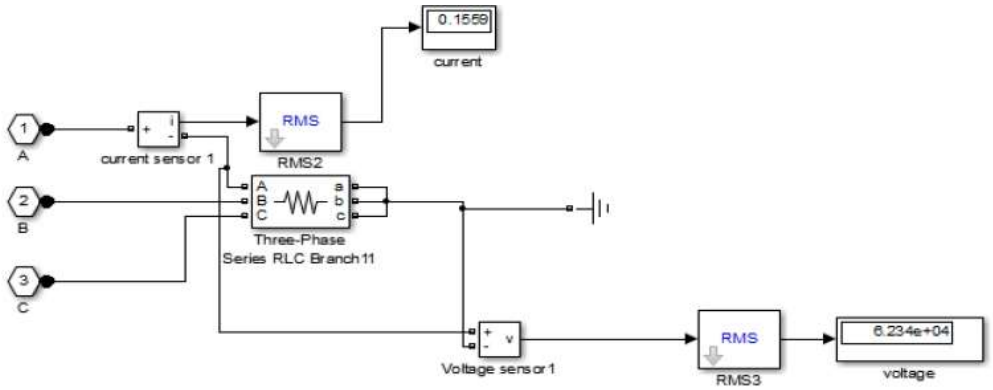

Fig 2: Measuring Leakage Current for sensor system

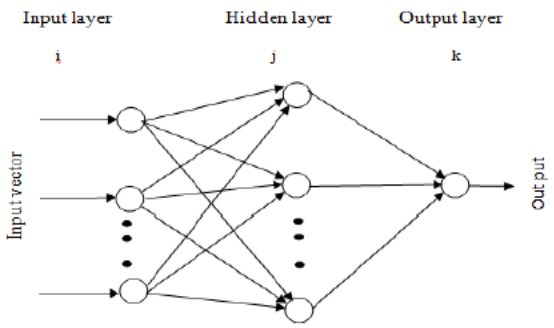

Fig 3: FFBP Neural Network

III. Results and Discussion

A clear correlation between expected and actual performance data means that a simulation shows that ANN model perfectly predicts transmission line behavior in different pollution levels. With an increase in the level of pollution, non-linear interactions are well represented by the model that shows a reduction in the insulation resistance and an increase in the leakage current. The accuracy and reactivity are improved compared to the conventional models. These findings establish the ability of incorporating pollution variables in ANN based models to enhance the diagnostic functionality of the model and as such enables the gearbox systems in the polluted regions to be operated more reliably and be taken in proactive manners [2].

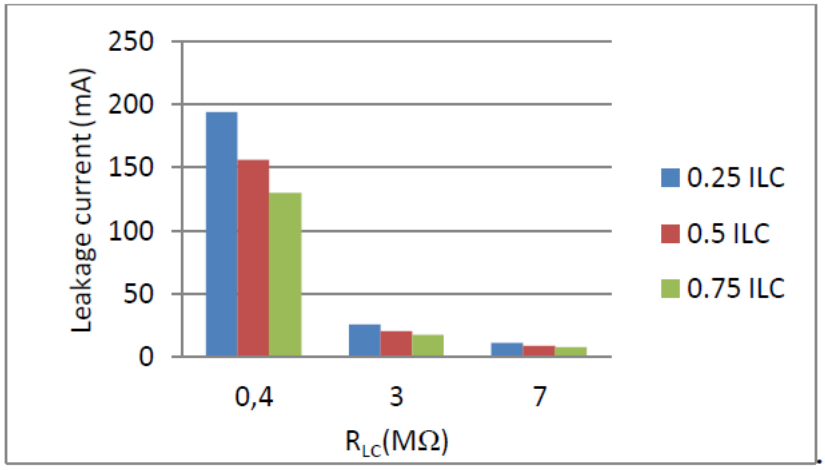

Fig 4: Short Length Transmission Lines

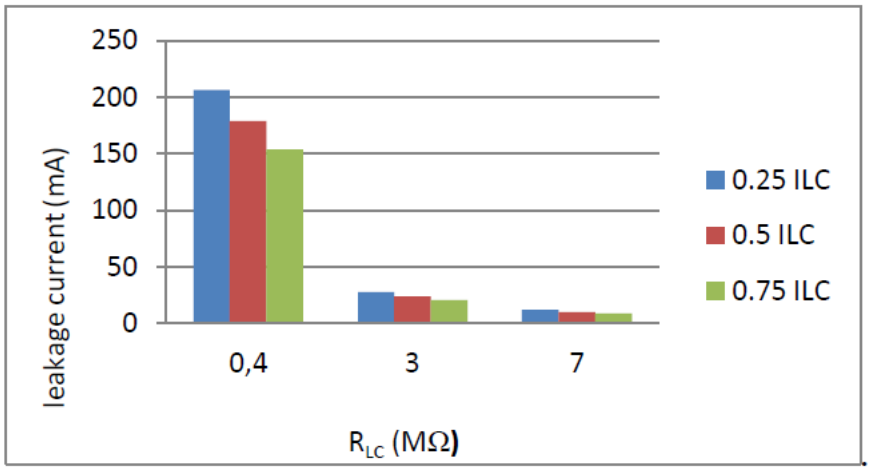

Fig 5: RLC at 0.25, 0.5 and 0.75 in Medium Length Transmission Lines

IV. Short Distance Transmission Line Neural Network

Short transmission lines are modelled to find the impact of pollution by the use of Feed-Forward Backpropagation (FFBP) Neural Network. Input parameters include measured electrical parameters such as insulation resistance and leakage current, and the level of pollution and temperature and humidity of the surrounding environment. The FFBP network trained on historical and experimental data maps these inputs to parameters of output volt-drop, power loss and flashover hazard. The model absorbs non-linear and complex interrelationships among transmission behavior and pollution levels. Its application makes the functioning of short gearbox lines in the diverse

environmental contamination conditions safer in terms of its overall reliability, inclines to conditions-based maintenance, and enhances the precision of its prediction [3-6].

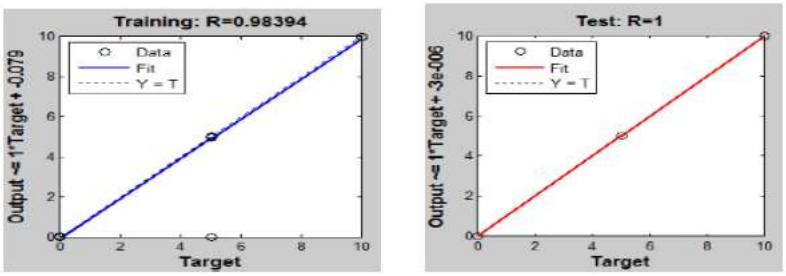

Fig 6: Neural Network Regression Results

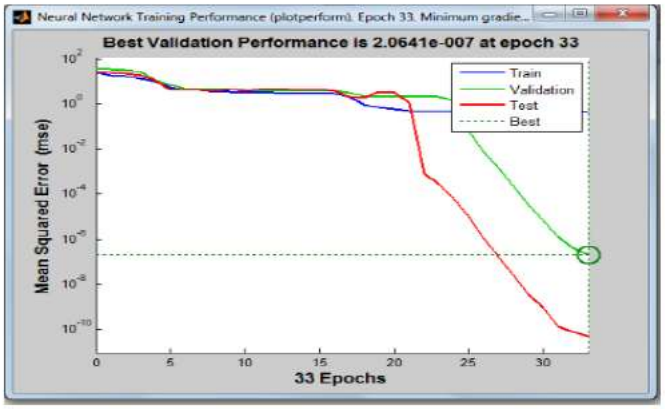

Fig 7: ANN Training

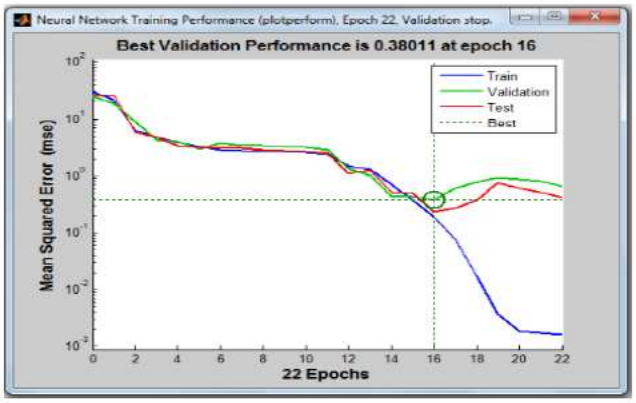

Fig 8: ANN Training for Medium Transmission Line

V. Conclusion

A significant advance to accurate line performance prediction/ tracking is the inclusion of the data of pollutant level into transmission line simulation models which is achieved by Artificial Neural Networks (ANN). Environmental factors which tend to influence insulating behavior in a large way include: dust, salt and industrial pollutants especially in the short transmission lines. The dynamic non-linear effects of these pollutants are often neglected by the classic

models. Feed-Forward Backpropagation (FFBP) networks, specifically, are an effective means to train into highly complex patterns via historical data and in real-time. The simulation and results confirm enhanced accuracy of forecasting the risk of faults, voltage dips, as well as leakage currents. This approach will ensure efficient application of energy under difficult environmental conditions, enhance reliability of operations, and allow more smart condition-based maintenance approaches.

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