

Condition Monitoring of High Voltage Outdoor Insulators under Acid Rain Pollution

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The Problem

- Industrial activities result in presence of various pollutants in the air, one of which is sulphur dioxide (SO_2).
- In the presence of rain, SO_2 dissolves in water to form sulphuric acid (H_2SO_4) which is deposited on nearby insulators in the form of acid rain.
- This causes a decrease in insulator surface resistivity, increased leakage current, formation of dryband, initiation of partial discharges (PD) and possible power failure.
- Detection and analysis of PD can provide warning of incipient equipment failure; hence the need for an efficient monitoring system for PD activities.

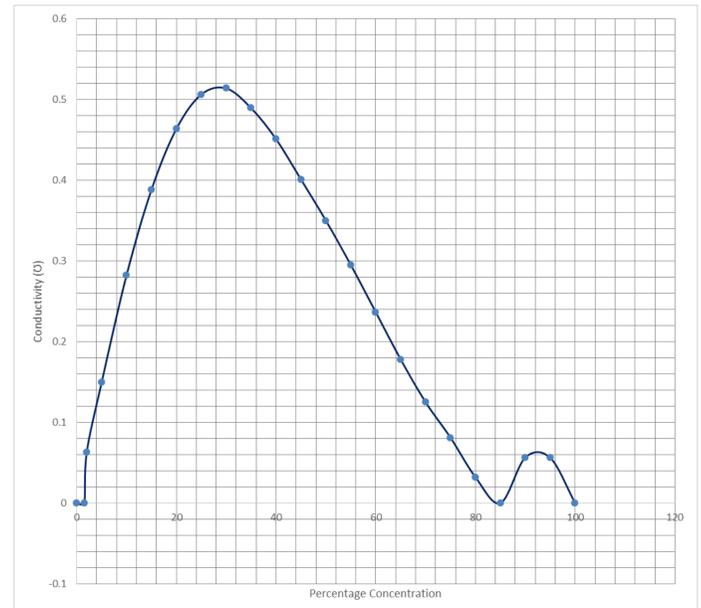


Figure 1: Conductivity of sulphuric acid vs. percentage concentration at -1deg C

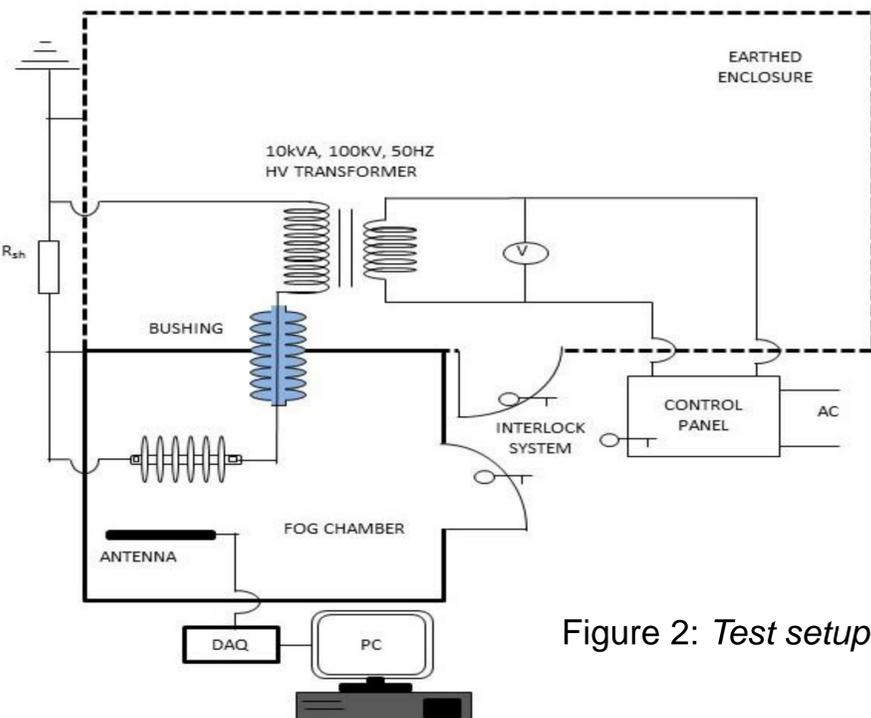


Figure 2: Test setup

A Solution

- PD activities generate wideband Radio Frequency Interference (RFI) which falls into the Ultra High Frequency band of the electromagnetic spectrum and detectable by a wideband antenna.
- The antenna measurement method offers numerous advantages over most other methods including its ability to perform non-disruptive measurements over long distances.
- A solution is to develop an online monitoring system using RFI technique to monitor PD activities on HV insulators exposed to acid rain deposition, using a combination of laboratory experiments and software simulations.

Simulation and Results

- Comsol multiphysics is used to simulate the effects of contamination accumulation on the power dissipation and electric field distribution of a uniformly contaminated cap and pin glass insulator disc.
- It was observed that the electric field stress is higher at the narrow edges of the insulator and highest at the region of "sandwich" of cement, glass and metal components as compared to other regions of the insulator.
- The power dissipation is higher in these regions implying higher temperatures, which may cause cement expansion and contraction and possible failure due to thermal stress.

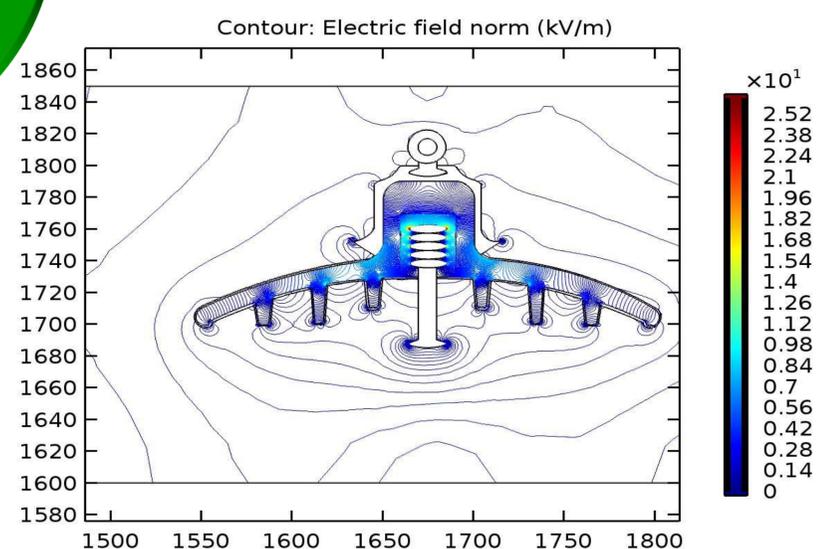


Figure 3: Electric Field Distribution along a uniformly polluted insulator

Conclusion and Future Work

- Finite Element Analysis method has been used to study the effects of contamination on a glass insulator and results obtained confirm results of previous studies.
- Future work will include experimental investigation of acid rain activities on energized ceramic insulators in a laboratory environment and monitoring of PD activities on the insulator using a directional antenna. Data acquisition system programs will be developed in LabVIEW platform to interface with the test equipment that will be used for experiments.

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