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Performance Analysis of Porcelain and Polymaric Insulator Contaminated by Dust Particals

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ABSTRACT: Several techniques have been already reported for the diagnosis of outdoor polymeric insulation. But a reasonably accurate prediction of the degradation of polymeric insulating material is yet to be identified for better preventive maintenance work. The primary goal of the present work is to identify the surface condition of the insulation structure. Leakage current (LC) measurement is being normally used in different parts of the world to determine the surface condition of the insulation structure. The overhead line conductors should be supported on the poles or towers in such a way that currents from conductor do not flow to earth through support. That is line conductors must be properly insulated from supports. This is achieved by securing line conductors to supports with help of insulator. The insulator provides necessary insulation between line conductors and supports and thus prevents any leakage current from conductors to earth. Once tracking occurs, the surface electrical insulation property is lost completely and it never recovers. The analysis of surface degradation of the polymeric insulating materials due to the formation of surface discharges is a complex process.

I. INTRODUCTION

An Electrical power system consists of generation, transmission and distribution. The transmission system supply bulk power and the distribution system transfer electric power to the ultimate consumers. The power system may be divided into Transmission and distribution. Transmission system supplies only large block power station. It interconnects the neighboring generation stations into a power pool. The component of an electrical power system connecting all the consumers in an area to the bulk power sources or transmission lines is called a distribution system. As a rule, power transmission over long distance is carried out by using overhead lines. In general, the main components of an overhead line are conductor, supports, insulators, cross arms. The overhead line conductors should be supported on the poles or towers in such a way that currents from conductor do not flow to earth through support. That is line conductors must be properly insulated from supports. This is achieved by securing line conductors to supports with help of insulator. The insulator provide necessary insulation between line conductors and supports and thus prevent any leakage current from conductors to earth. In recent times, polymeric insulating materials are widely applied in power transmission lines, because of their superior insulation performance compared with conventional ceramic insulators. When these polymeric insulating materials are used for outdoor applications, they are exposed to pollution and moisture from rain, fog and condensation which lead to the development of leakage currents on their surface. Under severe conditions, this may lead to the formation of dry band discharges and increase in probability of failure of material due to “tracking”. This is a peculiar phenomenon, occurs on the surface of the insulation structure because of the creepage discharge resulting from surface contamination. Once tracking occurs, the surface electrical insulation property is lost completely and it never recovers. The analysis of surface degradation of the polymeric insulating materials due to the formation of surface discharges is a complex process. Several techniques have been already reported for the diagnosis of outdoor polymeric insulation. But a 16 xvi reasonably accurate prediction of the degradation of polymeric insulating material is yet to be identified for better preventive maintenance work.

The primary goal of the present work is to identify the surface condition of the insulation structure. Leakage current (LC) measurement is being normally used in different parts of the world to determine the surface condition of the insulation structure. Fourier Transform based frequency domain analysis of LC is the conventional approach followed in many research papers. A proposed a methodology to classify the surface condition of the insulation structure using neural network approach by utilizing the features extracted from the FFT analysis of the leakage current during tracking test. Both time and frequency domain analysis of leakage current will lead to the development of an efficient tool. In

recent times, for the accurate analysis and classification of signals with complex characteristics, wavelet transform has been proposed as an alternative to conventional Fourier Transform technique.

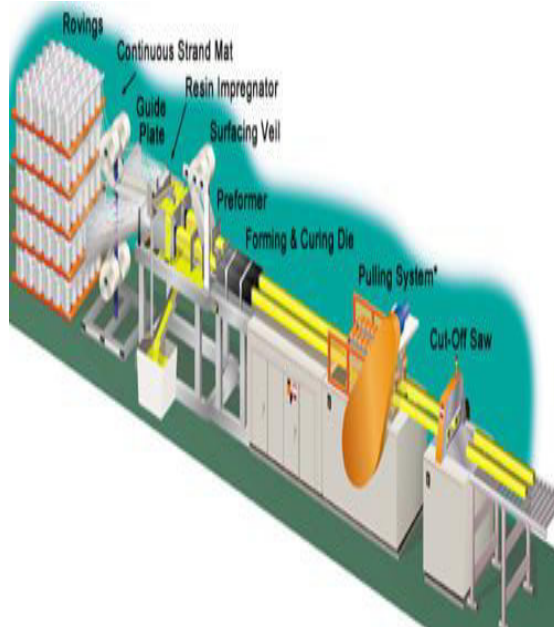


Fig 1: Wavelet Transform Architecture

Wavelet Transform has good localization in both time and frequency domain, which makes it suitable for time-frequency analysis. Having known this, in the present work a methodology to monitor the surface condition of the insulating material using discrete wavelet packet transform and S-transforms is proposed. Once tracking occurs, the surface electrical insulation property is lost completely and it never recovers. The analysis of surface degradation of the polymeric insulating materials due to the formation of surface discharges is a complex process. Several techniques have been already reported for the diagnosis of outdoor polymeric insulation. But a reasonably accurate prediction of the degradation of polymeric insulating material is yet to be identified for better preventive maintenance work.

II. LITERATURE SURVEY

Literature survey is mainly carried out in order to analyze the background of the current project which helps to find out flaws in the existing system and guides on which unsolved problems we can workout. So, the following topics not only illustrate the background of the project but also uncover the problems and flaws which motivated to propose solutions and work on this project. R. Sarath, S. Chandrasekar, V. Sabarigiri, C. Venkateshah and R. Velmurugan, the paper presents analysis of surface degradation of high density polyethylene (hdpe) insulation material due to tracking. In the present work, tracking phenomena has been studied with HDPE material under ac. voltage, with ammonium chloride as the contaminant (2017). It is noticed that the tracking time depends on the conductivity and flow rate of the contaminant. The diffusion coefficient of the material was obtained. The thermal and chemical stability of the material were identified by carrying out a methodical experimental study.

V. Jayaprakash Narayanan, B. Karthik and S. Chandra sekar, the paper presents flashover prediction of polymeric insulators using pd signal time-frequency analysis and bpa neural network technique (2014). The flashover prediction of polymeric insulators used in power transmission line applications using the novel condition monitoring technique developed by PD signal time-frequency map and neural network technique. Laboratory experiments on polymeric insulators were carried out as per IEC 60507 under AC voltage, at different humidity and contamination levels using NaCl as a contaminant. Partial discharge signals were acquired using advanced ultra wide band detection system.

D. Pylarinos, S. Lazarou, G. Marmidis, E. Pyrgioti, high voltage lab., dept. Of electrical and computer engineering, University of patras 26500, rio, patra, the paper presents, investigation of leakage current on high voltage polymer (rtv sir) coated insulators (2019). Polymer coated insulators are used to suppress the pollution phenomenon on high voltage insulators. In order to investigate surface activity, which is directly linked to insulation performance and lifecycle, leakage current waveforms are used. In this paper field measurements are used in order correlate leakage current waveforms to certain surface activity directly linked with hydrophobicity.



III. METHODS

WAVELET TRANSFORMS

Wavelet analysis represents the next logical step a windowing technique with variable sized regions. Wavelet analysis allows the use of long time intervals where we want more precise low frequency information and shorter regions where we want high frequency information. Compare wavelets with sine waves, which are the basis of Fourier analysis. Sinusoids do not have limited duration they extend from minus to plus infinity. And where sinusoids are smooth and predictable, wavelets tend to be irregular and asymmetric. The Fast Fourier Transform (FFT) is an efficient algorithm for computing the DFT of a sequence. It is not a separate transform. It is particularly useful in areas such as signal and image processing, where its uses range from filtering, convolution, and frequency analysis to power spectrum estimation.

DISCRETE WAVELET TRANSFORMS

Discrete wavelet analysis is more suitable for non-stationary signals. In continuous wavelet transforms calculating wavelet coefficients at every possible scale is a fair amount of work and it generates an lot of data. If, we choose scales and positions based on powers of two, then our analysis will be much more efficient and just as accurate. We obtain such an analysis from the discrete wavelet transform (DWT). An efficient way to implement this scheme using filters was developed in 1988 by Mallat.

EXPERIMENTAL STUDIES

The tracking experiments were conducted on the silicone rubber test specimens as per IEC 60587 procedures. Fig.1 shows the schematic diagram of the experimental setup and the electrode configuration used in the study. The gap distance between the high voltage and the ground electrode was adjusted to be equal to 50 mm. 0.1N NH₄Cl was used as a contaminant. 0.02% weight non-ionic wetting agent (TritonX-100) was added to the contaminant to increase the surface wetting of the insulation material under test.

IV. RESULTS AND DISCUSSION

Time Frequency analysis of leakage current waveforms is carried out using wavelet packet transform approach. Daub 4 wavelet filter is adopted in the present work because of its usefulness in identifying any high frequency transitions. In this work, the leakage current waveform was captured with a high sampling frequency of 10 kHz. All the signals are decomposed via the WPT with Db4 filter up to 8 level of decomposition. Then best basis selection is carried out using the minimum entropy criterion as described earlier. From this figures it is clear that total energy of original signal is partitioned at different resolution levels. Standard deviation can be considered as a measure of energy content of the signal with zero mean.

Therefore, standard deviation of each node in the wavelet packet tree is calculated to understand the variations in energy content of the signal during transitions from one stage to another stage of tracking process. Standard deviation of the nth node of the signal is calculated using the formula, All the signals are decomposed via the WPT with Db4 filter up to 8 level of decomposition. Then best basis selection is carried out using the minimum entropy criterion as described earlier. A typical current waveform captured during surface discharge and corresponding approximate and detail coefficients of WPT up to level 3 respectively. From this clear that total energy of the original signal is partitioned at different resolution levels.

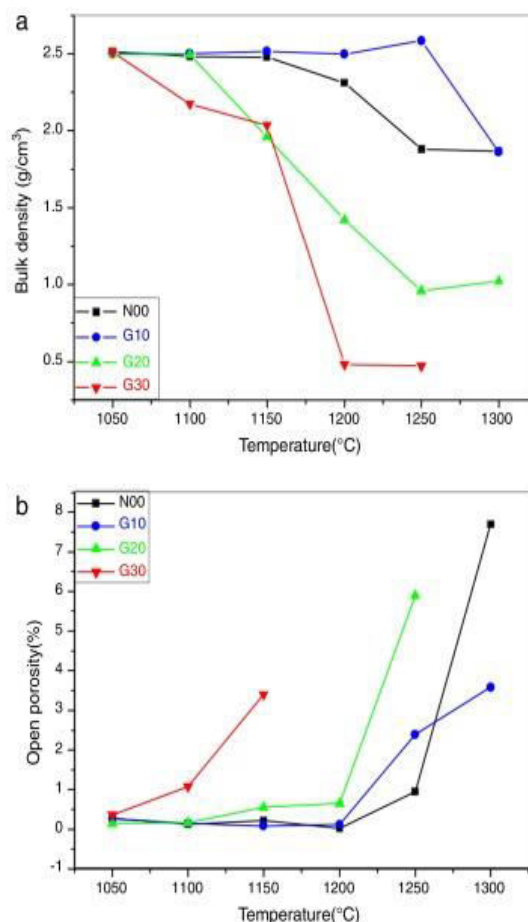


Fig 2: Clear that total energy of the original signal is partitioned at different resolution levels

The current study presents the experimental investigation of the current and conductance of polluted insulators based on the electric field under various applied voltages. In addition, the modeling approach for the distribution of electric fields and current density on insulator surfaces was performed using the FEM technique. Under a clean and wet environment, a three-dimensional structure is adequately modeled, but due to the symmetry of the insulator, the insulator was effectively described by a two-dimensional model due to axisymmetry. In the testing of insulators, fog and rain were taken into account. The insulator profile was also considered. Hence, two polymer insulators with different architectures were used in this investigation. The FEM simulation of the pollution scenario, useful in forecasting dry band development, was applied.

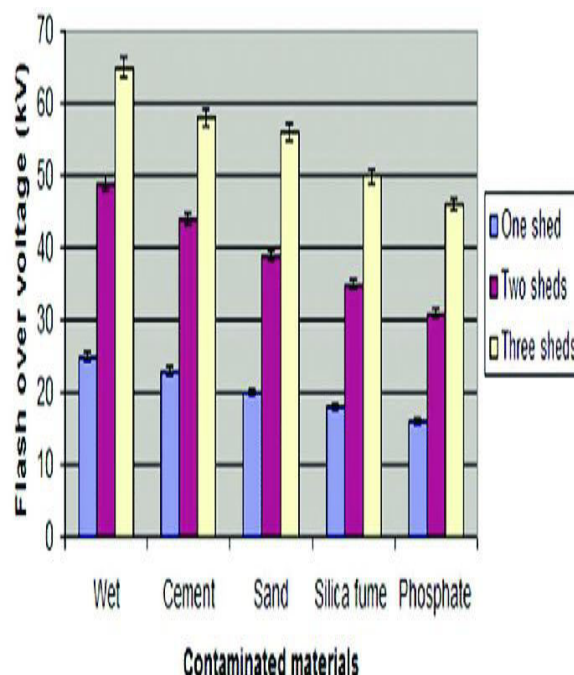


Fig 3: Electric field distribution, contour, and electric field arrows of the surface under clear

The distribution of the electric field along the surface of the polymeric insulators was investigated and calculated. Wet contaminated surfaces were simulated using experimentally observed conductivity. The electric field, current density, and pollution layer conductance are the most common modeling parameters observed in the majority of published research. However, the influences of the wetting and drying processes are not taken into consideration in most of these studies. The results of the simulation were used as a control and a comparison. The modeling results of insulators for the electric field distribution, contour, and electric field arrows of the surface under clear, fog, and high rain conditions. If the wetting (rain) increases, the variance in conductivity induces interfacial polarization. It drives charge building at the pollution border, leading to an electric field with a high value on both sides of the pollution region. According to Figures 14b and 15b, it can be seen that the electric field arrow comes out of the positive electrode (which is positively charged) and moves towards the negative electrode (negatively charged). In addition, under heavy rain circumstances, increasing the intensity arrows of the electric field indicates a rise in charge flow, which ultimately raises the field's strength. It is noteworthy that there is no appreciable variation of the numerical results if the closed geometries of the models are made larger than the ones used in the current simulation.

V. CONCLUSION

Wavelet packet transform technique for diagnosing the surface condition of an outdoor polymeric insulation structure based on the leakage current measurement has been evaluated. The selection of the best tree of the WPT is carried out using the minimum entropy criterion. Several leakage current data are used to test the validity of the proposed method. These preliminary results clearly show that accurate identification of surface condition of the polymeric insulation structure is possible from the WPT approach. The surface condition of the outdoor porcelain and polymeric insulation structure based on the leakage current measurement is carried out using recent signal processing technique. The result obtained from that is compare with other signal processing techniques.

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