



# **Optical Monitoring of Pollution on Porcelain MV Transformer Bushings**

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# Abstract

This research aimed to optically monitor the dry pollution level on porcelain MV transformer bushings and determine the possible leakage current should the dry polluted surface be critically wetted. The research involved the implementation of an image capturing system with appropriate image processing. Preliminary image capture of four artificial levels of salt deposit pollution: clean, light, medium and heavy was successfully achieved. The percentage level of surface pollution was found using image binary thresholding. A Reflectance Transformation Imaging (RTI) array was designed and implemented. It facilitated the virtual reconstruction of the imaged surface, yielding 26 different processed images. Twenty trials were conducted, each with a measured leakage current and Equivalent Salt Deposit Density (ESDD) measurement. A loose exponential relation was found between ESDD and leakage current. Each trial had a minimum of 250 dry surface images associated with it. A regression model, transfer learning convolutional neural network (CNN) was implemented based upon the *AlexNet* image classification CNN. The regression model was trained using 70% of the image data acquired in the trials and validated on the remainder. Several iterations of the CNN were tested with varying data organisation in order to ascertain the highest level of accuracy. The final CNN had a relative RMSE of 0.3 mA for a predictive range of 0.1 mA to 10 mA. The standard methods used to classify pollution types and severity are presented. The dynamics governing bushing flashover under polluted conditions is discussed. The actual pollution level and type is quantified using ESDD and Non-Soluble Deposit Density (NSDD). Image segmentation and border extraction are described as a preliminary proof-of-concept. RTI is described as a more robust method of image processing. With a saliency mapping resolution of approximately 100  $\mu\text{m}$ , the feature recognition between salt deposits and bushing surface is more readily attained using RTI.