PD SIGNAL COMPENSATION IN CABLE TERMINALS FOR CLASSIFICATION IN HV CABLE INSULATION ASSESSMENT

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ABSTRACT

The goal of this paper is insulation assessment of HV cables based on investigating the void size, while the void is considered as the partial discharge source in the cable. In this paper, PD signals and their embedded features are affected by the void size and depth, location of void in the cable length, cable aging, cable temperature and also environment noise, i.e. the proposed classifier should perform its task under all different conditions. In addition, in this paper, a compensation procedure is employed in order to diminish the effect of PD pulses propagation along the cable on the features used for classification. Decision tree (J48) is used as the classifier and the pre-requisite task of denoising is performed by a filter based on mathematical morphology (MMF). Results have shown high accuracy of the proposed insulation assessment method.

KEYWORDS

Void size Estimation; Decision tree; Mathematical Morphology; Partial Discharge; Insulation assessment; High Voltage Power Cables.

INTRODUCTION

The voids are an important source for partial discharge occurrence in the cable insulation. By repeatedly occurrence of partial discharges in cable insulation, voids become larger and finally results in break down. Therefore, by estimation of void's size and, consequently, the remained thickness of cable insulation, a suitable assessment of insulation condition can be performed.

The measured PD severity in HV cables insulation is principally dependent upon the size, depth and type of the discharge source [1]. Furthermore, ambient condition of the cable can affect PD intensity. Moreover, wave propagation through cables is involved with attenuation and distortion of the wave's shape. Therefore, even if the sizes of two cavities within a cable are similar, the recorded PD pulses at the terminals under various conditions are different. As an illustration, two typical PD pulses for two cavities with similar sizes under dissimilar conditions are shown in Fig. 1. In other words, the characteristics of PD pulses such as the peak value, rise time, fall time and area of the pulses are different on various conditions even for a void with a defined size. In addition to above problems, environment noise distorts the shape of the PD pulses and this make the feature extraction from PD pulses more difficult. Consequently, performing the classification of void's size on the basis of the features generated from PD pulses is not straight-forward and should be handled by applying some powerful classifiers with applying effective features. Meanwhile, a powerful algorithm should be used for noise reduction.

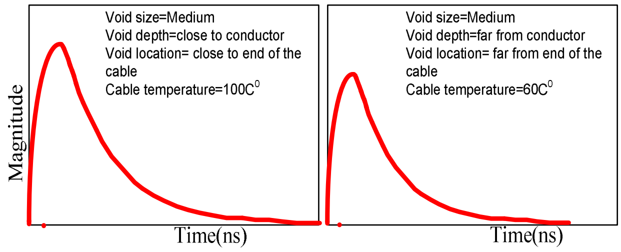

Figure 1. Two typical PD pulses for two cavities with similar size but under dissimilar conditions.

In the last decade, many efforts are done on PD classification for void's size estimation. In [1], a comparison is carried out on the partial discharge pulse shape recognition capabilities of neural networks, using the nearest neighbor classifier, learning vector quantization and multilayer perceptron paradigms, while the PD pattern recognition capabilities are assessed on artificial cylindrical cavities of different sizes. In [2], a procedure is described for the application of fuzzy logic systems to the classification of partial discharge pulse patterns in term of void's size, the features employed in the pattern recognition task are those related to the form or shape of the partial discharge pulses and their associated apparent charge transfer. An inductive inference algorithm is employed upon time dependent partial discharge pulse pattern recognition in [3]. In [4] PD signal classification is performed for voids size estimation by using decision tree algorithm. In [5], PD signals classification for void's size estimation is presented through fuzzy decision tree approach. Generally, these papers have not considered the effect of all different conditions of void and/or cable. But, in this paper, PD signals and their embedded features are affected by the void size and depth, the location of void in the cable length, cable aging, cable temperature and also the environment noise, i.e. the proposed classifier should perform its task under all these conditions.

In addition, in this paper, a compensation procedure is introduced in order to diminish the effect of propagation on the features which are used for classification, whenever PD pulses are measured at the cable terminals.

Moreover, a filter based on MM (mathematical morphology) is proposed for noise reduction from PD pulses.

The remainder of this paper is organized as follows. First, data acquisition procedure and feature generation are introduced. Next, feature compensation algorithm is detailed. Afterwards, a paradigm based on mathematical morphology is introduced for noise reduction. The decision trees (J48), as the classifier employed in this paper, is presented in the next section. The classification results are discussed, and, finally, the conclusions are given.