PARTIAL DISCHARGE PATTERN CHARACTERISTICS OF 220KV XLPE POWER CABLE JOINTS WITH ARTIFICIAL DEFECT

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ABSTRACT

Partial discharge measurement has been widely accepted as a useful method to detect insulation defect or deterioration of power cables. In order to research insulation defect due to on-site poor workmanship, this paper presents a laboratory partial discharge experiment on 220kV XLPE cable joint with Metallic Powder defect on XLPE Insulation surface. Research results show that this defect can easily lead to electric field concentration, showing obvious characteristic. At the same time, Pattern recognition method based on fingerprint and 2-D wavelet analysis is designed to identify the defect after several accelerating age cycles. The research result shows that partial discharge patterns of the defect and this identification method are helpful for us to evaluate the insulation quality of HV cable joints based on on-line partial discharge detection.

KEYWORDS

Power cable; Partial Discharge; Insulation Defect; Pattern Recognition

INTRODUCTION

Partial discharge (PD) experiment is a necessary test method for quality evaluation of power cables and accessories at factory. As it is well-acknowledged by laboratory research and long time delivery test experience that partial discharge (PD) has a relationship with the insulation condition, the trend of PD level may be used to predict insulation defect threating the safe, reliable and efficient operation of power cables. Therefore, many researchers and scholars at home and abroad and some international electric authoritative organizations such as IEC, IEEE and CIGRE certainly recommend partial discharge experiment as the best method to evaluate the insulation health of XLPE power cable and its accessories. In well shielded laboratory conjugating with “clean” power supply, the PD detection sensitivity can reach 1pC, and the measurement frequency band is general selected at 30 kHz -500kHz range.

However, at present, the on-line PD detection technology is less mature than that in laboratory, many issues needing to be resolved: (1) Because of the serious electromagnetic interference and background noise, it is hard to distinguish partial discharge signal and interference for on-site measurement personnel. Moreover, although confirmed, partial discharge signals or patterns are seldom attributed to some type of insulation defect, i.e., the criterion is lacking in distinguishing the difference between the partial discharge pattern and interference, and also, it is lacking to make a relationship between partial discharge and insulation defect. (2) The insulation deterioration evaluation basis is insufficient; (3) The condition criterion and operation experience need to be accumulated and perfected to give a accurate advice on insulation condition of power cable. In conclusion, for on-site power cable, “is there PD?” and “is it PD?” are the two problems in front of the development and application of partial discharge on-line detection technology.

It is well-known that the defect style and its location would be predicted and confirmed easily if we knew the PD pulse signal character. But how to design the mathematic model of PD pulse signal character, how to set up the mathematic relationship between the PD characteristics and the defects or deterioration of HV and EHV power cable insulation has been very difficult until now. Although many mathematic methods such as FFT, wavelet, fractal theory, etc. have been studied and developed continually from 1980’s, PD pattern analysis and identify are still the difficult problems.

In order to research insulation defect due to on-site poor workmanship, this paper presents a laboratory partial discharge experiment on 220kV XLPE cable joint with Metallic Powder on XLPE Insulation surface by the method of internal capacitive coupling sensor. Research results show that Metallic Powder on XLPE Insulation defect can easily lead to electric field concentration, PD patterns of different applied voltage shows obvious characteristic. Pattern recognition method based on fingerprint and 2-D wavelet analysis is designed to identify the unknown partial discharge pattern. At the same time, partial discharge tests of some artificial insulation defects after several accelerating age cycles have been taken to verify the validity of this identification method. The research result shows that partial discharge patterns of typical defects and this identification method are useful for partial discharge on-line detection and insulation diagnosis of HV cable system.

DESIGN OF ARTIFICILA DEFECT IN JOINT

The basic principle of typical defects construction is that the defects must be representative; covering main hidden trouble caused by installation in field and the defect grade may excite PD at rated voltage U_0. The artificial defects were constructed to simulate practical installation and operation of power cable lines according to finite element method (FEM) calculation and statistic results of operation faults during 2001-2008 in China.

In order to extract the PD pattern Characteristics of Metallic Powder defect, cable and its terminations are confirmed no PD before artificial defects construction. The PD tests of cable sample were carried out in well-shielded laboratory. The cable joint with Metallic Powder defect is shown in Fig.1.