High voltage XPLE cable partial discharge localization technology based on high frequency signal transmission characteristics.

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ABSTRACT

This paper is based on high frequency signal transmission characteristics, analyzing partial discharge localization of high voltage cables. The existing testing technology of partial discharge is focused on the low frequency section (less than 100MHz). Because of the long distance of low frequency signal transmission, it is difficult to determine fault location. Due to the high frequency signal transmission distance is limited, and the attenuation of the signal, the location where the high frequency signal generated could be found. For verify the method used in partial discharge localization, a representative experiment has been done, the writer created a partial discharge point in the lab. Using the method of this paper, the fault location can be determined accurately, error in centimeters.

KEYWORDS

XPLE cables; Partial discharge; Electromagnetic wave; High frequency signal

INTRODUCTION

UHF method is developed in recent years as a new method for PD detection and applied in GIS partial discharge detection at the earliest. Due to its advantages of high sensitivity, strong anti-jamming capability, enable to locate the PD and identification to the different types of defects, the method rapidly developed. And the PD localization technology for GIS has been mature and exact. There are many examples of successful application.

After its successful application in GIS and transformer, many experts and scholars tried to apply this method to the on-line PD detection of XLPE cable [1]. Researches indicated that when PD is generated in Cable ontology or glands, its pulse with a very short rising edge can inspire high frequency electromagnetic wave [2]. Although the cable is covered with good shielding layer, UHF electromagnetic waves can spread to the free space through the grounding wire of the cable or the place where shielding layer disconnects in cable terminal and glands. So it is feasible that UHF detection technology is applied in the on-line PD detection on HV cable.

Many companies and institutes have applied the method into the on-line PD detection on HV cable and develop a variety of partial discharge detectors [3-5], e.g. Italian TechImp, German OMICRON, British HVPD etc. However these instruments just focus on the signals whose frequency is under 100MHz. It should be no surprise that the frequency of electromagnetic wave generated in PD on cable with a defect ranges from several Hz to several GHz [6]. Ignoring the high frequency information could cause a great loss to discover the insulation defects on cable or properly could increase the difficulty of finding out the origin of PD. Anything else, it is difficult to determine fault location because of the long distance of low frequency signal transmission .The frequency of electromagnetic wave higher, the damping coefficient bigger. That is to say, higher frequency wave spreads shorter. This is a new field that no one sets foot in about UHF on-line PD localization technology on HV cable and it is precisely the topic we research on. Through the study of transmission characteristics for high frequency signal, a preliminary located solution is obtained. The on-line PD measuring system is just based on the located scheme and has improved the located accuracy to the distance between two cable joints measured.

In this paper, the existing transmission attenuation model of high frequency signals will be referred to. Then the on-line PD measuring system with experimental verification is discussed. On this basis, a field measurement on HV cable is introduced to explain the located scheme by transmission characteristics taking use of the system. Also the limitation and research direction will be discussed.

MODEL OF ATTENUATION

Attenuation characteristic of the amplitude and frequency for PD pulse when transferring in the cable could be expressed by the model analogous to Gaussian function [7-8]. It is related to cable structure, degree of aging of medium and frequency components. Table 1 shows signals' frequency and the corresponding theoretical distance in which the signal attenuate 3dB.

Frequency (Hz)	Distance for -3dB (m)	Frequency (Hz)	Distance for -3dB (m)
1M	43859	100M	47
5M	3958	200M	17.3
10M	1409	500M	4.7
20M	503	800M	2.5
50M	130	1G	1.9

Table 1 Attenuation characteristic in 220kV cable

Due to the effect of semi-conducting layer, the wave form distortion and attenuation happen in the transmission of