New Method of PD measuring on MV XLPE Cable by Using Prototype Patch Antenna

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Prototype 패치 안테나를 이용한 MV급 전력케이블의 부분방전 측정 연구

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Abstract - We studied the partial discharge detecting by sensing electromagnetic wave emitted from the partial discharge source in the MV XLPE cable with the new type of patch antenna sensor. In this study, we design new kind of patch antenna and make many experiments compare with the existing HFCT sensor on MV XLPE cable in the laboratory. According to our experimental results our new sensor can detect pure PD and wider bandwidth 20MHz to 70MHz than HFCT and can easily localized manually on the cable.

Keywords : MV XLPE cable, patch antenna, HFCT sensor, Electromagnetic wave sensing, wideband.

1. Introduction

Partial discharges are localized electrical discharges that only partially bridge the insulation between the conductors. Partial discharge is important reason to cause insulation deterioration. From the middle of 20thcentury, people start making research on partial discharge[1, 2].

During the partial discharge process, there are many form of exchanges of energy such as electrical pulse current, dielectric loss, electromagnetic radiation, sound, ultrasonic, acoustics emission, increased gas pressured, and chemical reactions[3].

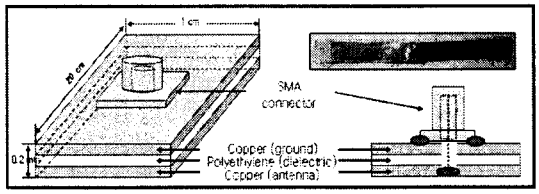
In detection partial discharge, depending on the sensing on the kinds of energy exchange different detecting methods were approached in last few decades[4]. In these methods, electromagnetic sensing is one of the best kind of partial discharge detection and localization of PD source[5].

The main advantages of this method can reduce electrical noise. In this paper, we will show some experimental results over HFCT (High Frequency Current Transformer) sensor and our patch antenna in detection partial discharge in MV XLPE cable of 22.9kV.

2. Experimental

2.1 Design and Implementation

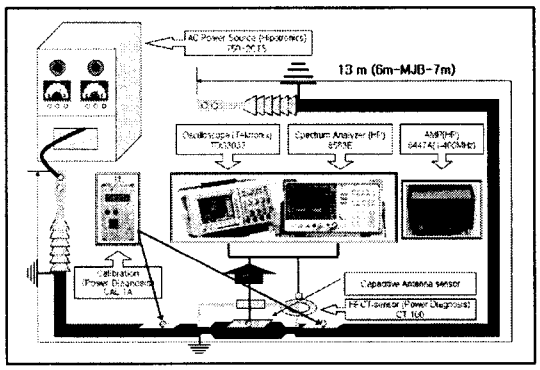
geometry of the double-sided parallel strip antenna is shown in Fig 1. he coaxial fed point is connected to the center of the patch by using 50Ω SMA connector. We used polyethylene (dielectric constant =2.25) film is sandwiched between 20cm x 0.5 com copper foil. This antenna sensor can collects the frequencies range of 5MHz and 70MHz.



<Fig 1> Structure of Prototype Patch Antenna

2.2 Measurement Methodology

The measurement system is as show in Fig 2. We used 20dB amplifier which works the frequency range of 1 to 400MHz to amplifier.

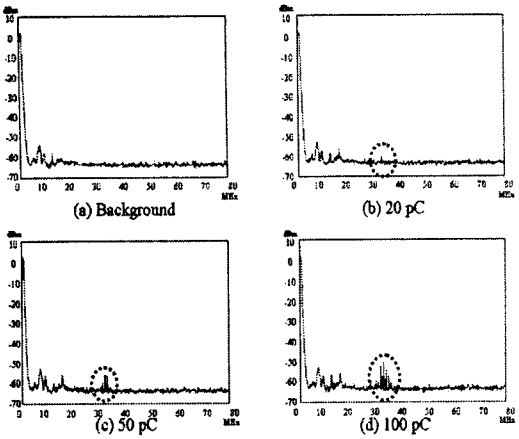


<Fig 2> Test Map for Partial Discharge Detection

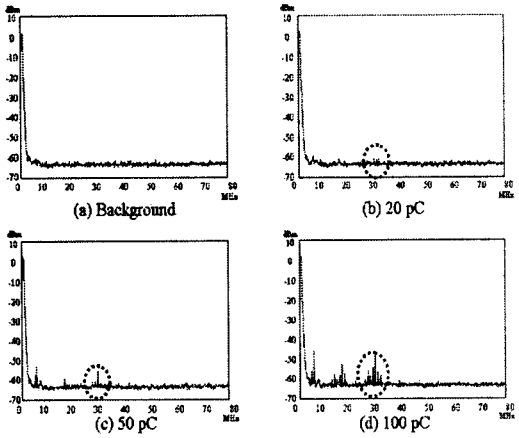
First we measured the calibration signal of 10pC, 20pC, 50pC, and 100pC increasing step by step compare between the existing HFCT sensors and capacitive patch antenna. Secondly, we measured the PD signal by injection high voltage of 19kV.

3 Results and Discussion

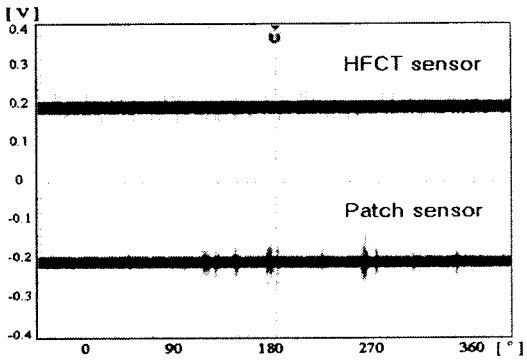
Our experiment includes tow kinds: calibration signal injection and high voltage of 22kV injection to the cable. We used measured instruments of Oscilloscope for time domain reading and Spectrum Analyzer to check frequency domain using with GPIB intereface to Computer. In calbration testing, 20pC, 50pC and 100pC calbration signals are injected and detect the by patch antenna and commerical HFCT sensor. The calibration signal detecting results are shown in Fig 3 and Fig. 4 in coomparison of HFCT and patach antenna in time domain.



<Fig 3> Each calibration signals using by Patch Antenna

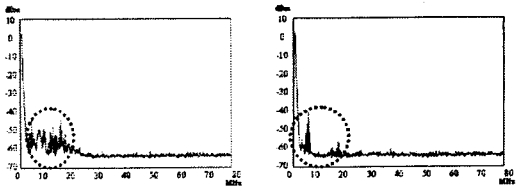


<Fig 4> Each calibration signals using by HFCT Sensor

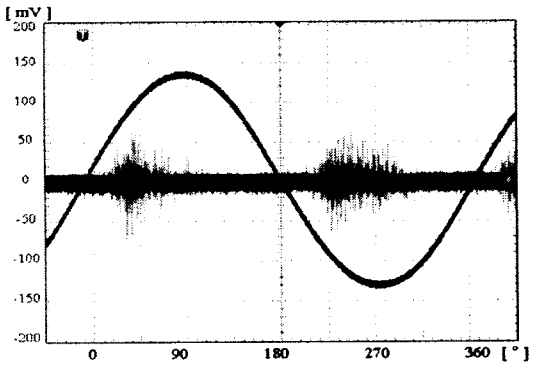


<Fig 5> Comparison calibration signals of HFCT and Antenna

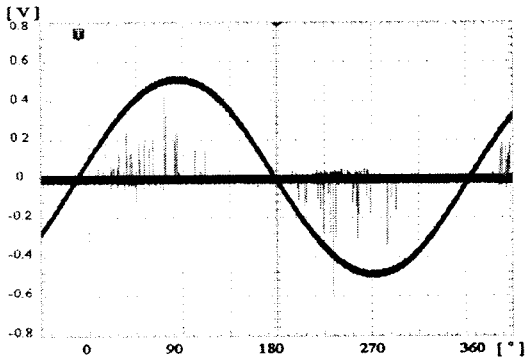
For phase resolve partial discharge analysis, we use oscilloscope to see in time domain. Sometime noise surges are occurred from the HFCT output but we found that Capacitive patch antenna sensor gives only pure calibration signal. The calibration signal results measuing in oscilloscope is shown in Fig 5.



<Fig 6> PD signals of 22kV inject time



(a) Oscilloscope results of PD signals detecting by HFCT sensor in 22kV injection



(b) Oscilloscope results of PD signal detecting by patch antenna in 22kV injection

<Fig 7> Time domain measurement in 22kV

In offline real power injection experiment, MV cable is supplied step by step raising voltage by the external HV source in the laboratory. We found PDIV at 19kV. and detect by both sensor.

Fig 6 shows the wideband confirmation of Capacitive antenna sensor compare to the HFCT sensor from the Spectrum analyzer output. This results is obtained by injecting High Voltage of 19kV to the cable. Capacitive antenna can sense the frequency range of 5MHz to 70MHz.

Fig 7 shows the Oscilloscope results of PD when 22kV is applied to the cable. This results show our antenna sensor can separate positive PDIV (Partial Discharge Inspection Voltage) and negative PDIV by giving different polarities out put in 1st quadrant of positive rise time and 3rd Quadrant of negative rise time.

4. Conclusion

In contrast, the detection PD by patch antenna sensor can reduce the electrical distrubances or interferences and PD signal can be separately seen in positive and negative cycle. Moreover, patch antenna is easy to fabricate and cost effective compare with the other types of PD sensors.

Acknowledgment

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