

Study of comparison between Ultra-high Frequency (UHF) method and ultrasonic method on PD detection for GIS

Yanran Li^{1,a)}, Duo Chen¹⁾, Li Li¹⁾, Jiwei Zhang¹⁾, Guang Li¹⁾, Hongxia Liu¹⁾

¹Jinan Power-supply Company, Jinan, Shandong 250012, China;

^{a)}lyr0021@yeah.net

Abstract: GIS (gas insulated switchgear), is an important equipment in power system. Partial discharge plays an important role in detecting the insulation performance of GIS. UHF method and ultrasonic method frequently used in partial discharge (PD) detection for GIS. However, few studies have been conducted on comparison of this two methods. From the view point of safety, it is necessary to investigate UHF method and ultrasonic method for partial discharge in GIS. This paper presents study aimed at clarifying the effect of UHF method and ultrasonic method for partial discharge caused by free metal particles in GIS. Partial discharge tests were performed in laboratory simulated environment. Obtained results show the ability of anti-interference of signal detection and the accuracy of fault localization for UHF method and ultrasonic method. A new method based on UHF method and ultrasonic method of PD detection for GIS is proposed in order to greatly enhance the ability of anti-interference of signal detection and the accuracy of detection localization.

1. Introduction

GIS plays an important role in power system. Partial discharge is one of the important parameters to detect the insulation performance of GIS. It is recognized that partial discharge caused by free metal particles strongly harms the GIS system. The effects of UHF method and ultrasonic method on the partial discharge in GIS are currently of considerable interest. It is adopted to discriminate early insulation defects in GIS.

With the development of online PD detection, many papers have investigated the PD detection methods. S.Tenbohlen et al has reported a summary of PD measurements applying the UHF methods[1]. Simultaneously, Si et al has developed a data analyzer for ultrasonic detection system[2]. However, very few studies have been conducted on comparison and combination of this two methods.

This paper carries out with the purpose of understanding the effect of UHF method and ultrasonic method on PD detection in GIS. Accuracy, reliability, economy and PD detection ability of the two methods are compared in laboratory simulated environment[3]. On this basis, a new method based on UHF method and ultrasonic method of PD detection for GIS are proposed which can greatly enhance the ability of anti-interference of signal detection and the accuracy of fault localization.

2. Experiment

2.1 Uhf method

Partial discharge in the GIS is accompanied by a very steep current pulse and radiates electromagnetic waves to the surrounding. UHF method is using UHF antenna to detect electromagnetic waves generated by the partial discharge of GIS for the analysis of electromagnetic wave. Fig.1 shows the detection principle of the UHF method.



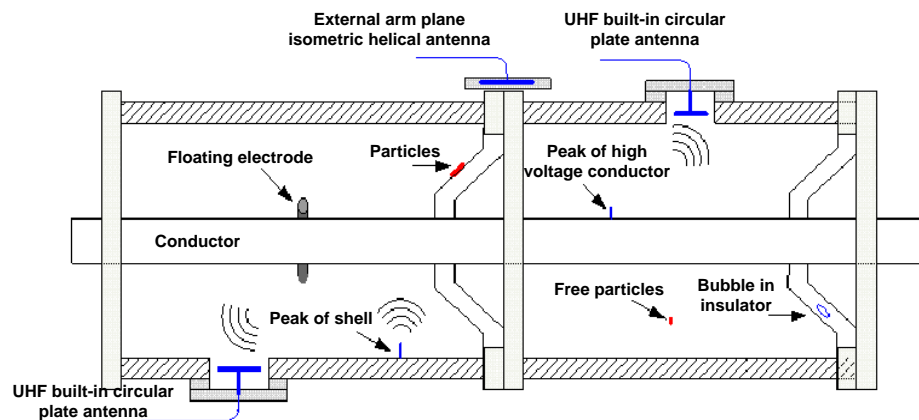


Figure 1. Schematic diagram of UHF method.

2.2 Ultrasonic method

The molecules are violently collided with each other and pressure is created in the moment when PD of GIS occurs. Longitudinal wave, shear wave and surface wave are included in ultrasonic pulses[4]. The ultrasonic signal can be collected by the installed ultrasonic sensor in the GIS wall, converted to electrical signals, and then the partial discharge level within the GIS can be measured. Fig. 2 shows the detection principle of the ultrasonic method.

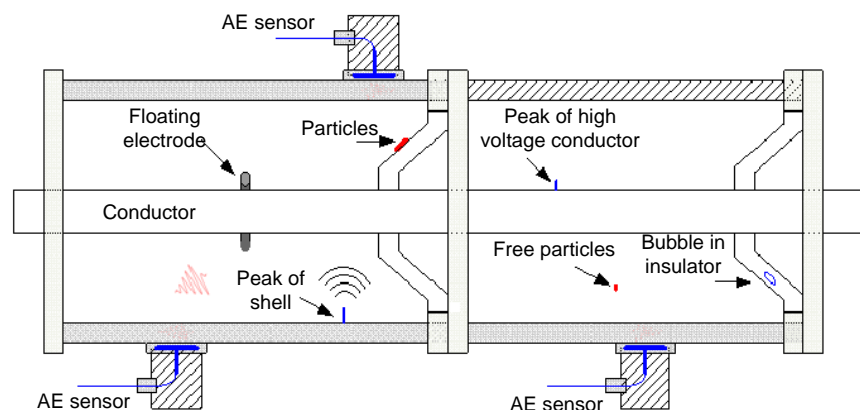


Figure 2. Schematic diagram of ultrasonic method.

3. Analyzation

3.1 Uhf method

UHF method for partial source detection is mainly based on the statistical characteristics of the signal and phase analysis. In the laboratory simulation environment, the typical UHF signal waveforms produced by various typical defects are measured. Due to the limitation of space, the author only selects the UHF signal waveform caused by the discharge of the metal protrusion on the conductor. Waveform characteristics is extracted to establish a defect database and provide the basic data for the application of the expert system, as is shown in Fig.3.

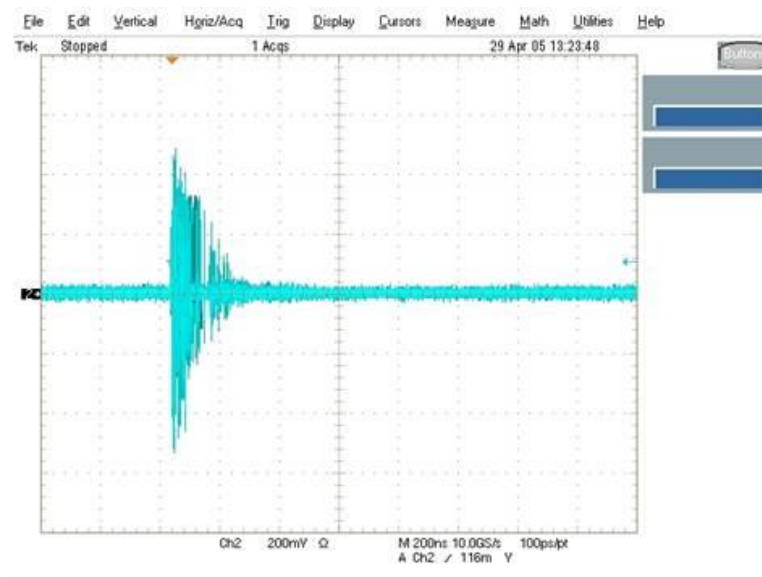


Figure3.UHF signal waveform caused by free particles

3.2 Ultrasonic method

The pattern recognition method based on the artificial neural network is used in the pattern recognition of the acoustic emission signal[5]. It is focused on the feature extraction (the acquisition of the discharge fingerprint). The extracted feature is used as the network input, and the known discharge samples are used to change the neural Meta-weight and finally fix weight. BP network, self-organizing feature mapping network, LVQ network and ART network are commonly used in discharge identification[6].

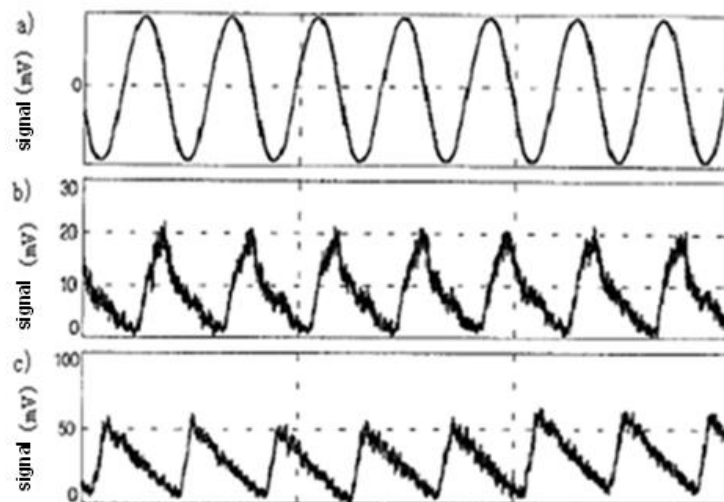


Figure4. a)Test voltage b) protrusion on the conductor
c) protrusion on the shell

4. Conclusion

Based on the analysis of the previous part of this paper, we can get the partial discharge monitoring and fault location of the UHF monitoring and ultrasonic monitoring of the two methods, as shown in Table 1.

Table 1. Comparison of two methods

PD Detection method	UHF method	Ultrasonic method
Advantage	High sensitivity	Anti-electromagnetic interference ability
Disadvantage	High cost	Complex structure
Accuracy	Very high (0.5~0.8pC)	High (<2pC)
Applicable discharge source	All discharge source	Free particles; Suspended matter
Detection localization ability	Applicable	Applicable for harsh condition
Detection type determination	Applicable	Applicable

Considering the advantages and disadvantages of UHF method and ultrasonic method, a new method combined UHF method and ultrasonic method is proposed. In the future, It is applied in the partial discharge detection. Advantages of UHF method and ultrasonic method are mixed in this new method. It has mixed distributed sensor technology, strong anti - interference ability, high positioning accuracy and high reliability.

References

- [1] S. Tenbohlen et al, Partial discharge measurement in the ultra high frequency (UHF) range[J]. IEEE Transactions on Dielectrics and Electrical Insulation, 2008. 15(6): 1544-1552.
- [2] W. R. Si et al, Investigation of a comprehensive Identification Method used in acoustic detection system for GIS[J].IEEE Transactions on Dielectrics and Electrical Insulation, 2009. 17(3): 721-732.
- [3] Kawada M.Fundamental study on location of a partial dischargesource with a VHF-UHF radio interferometer system[J]. ElectricalEngineering in Japan, 2003, 144(1): 32-41.
- [4] Kim, C.-S., T. Kondo,T. Mizutani. Change in PD Pattern with Aging. IEEE Transactions on Dielectrics and Electrical Insulation, 2004. 11(1): 13-18.
- [5] Gulski, E. Discharge pattern recognition in high voltage equipment. IEE Proceedings: Science, Measurement and Technology, 1995.142(1): 51-61.
- [6] B. X. Du, "Discharge Energy and dc Tracking Resistance of Organic Insulating Material", IEEE Trans. Dielectr. Electr. Insul., Vol. 8, No. 6, pp. 897-901, 2001.