Partial Discharge Measuring Equipment

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Abstract

In electrical facilities rated equal or more than medium voltage level of high- and higher-voltage classes, phenomena like partial discharges may occur if there are conditions of insufficient maintenance such as deterioration in insulation, surface contamination, or poor contact. Detection of such discharge phenomena can result in early detection of abnormal symptoms in electrical facilities.

The measuring equipment introduced in this paper is a facility diagnostic tool to detect partial discharges in the live state of facilities (live line). Since measurements are carried out in a live state, each sensor is designed based on the non-contact method for safety. For analysis of collected data, this equipment is designed to enable noise element separation by software which makes a special processing for frequency analysis.

1 Preface

The needs for diagnostic services at electrical facilities for locating any possible deterioration of insulation performance in electric circuits and equipment (transformers, circuit-breakers, etc.) became very strong in supplying stable and highly reliable power in society. Against such background, it calls for technologies which can accurately and safely measure and evaluate the intensity of partial discharges because these partial discharges are the preceding phenomena that lead to insulation breakdown.

We developed and actively use partial discharge measuring equipment for analysis evaluation. It detects ultrasonic noise, electromagnetic waves, and pulse currents that are generated upon the occurrence of partial discharges. Fig. 1 shows how each sensor is used for the detection of partial discharges on live lines.

This paper introduces the partial discharge measuring systems: one with the ultrasonic detection method and another with the electromagnetic waves detection method. Both models are presently actively introduced for live-line diagnostic services.

2 Partial Discharge Measuring Equipment

Fig. 2 shows external appearances of each of the equipment units. The Features and outline of

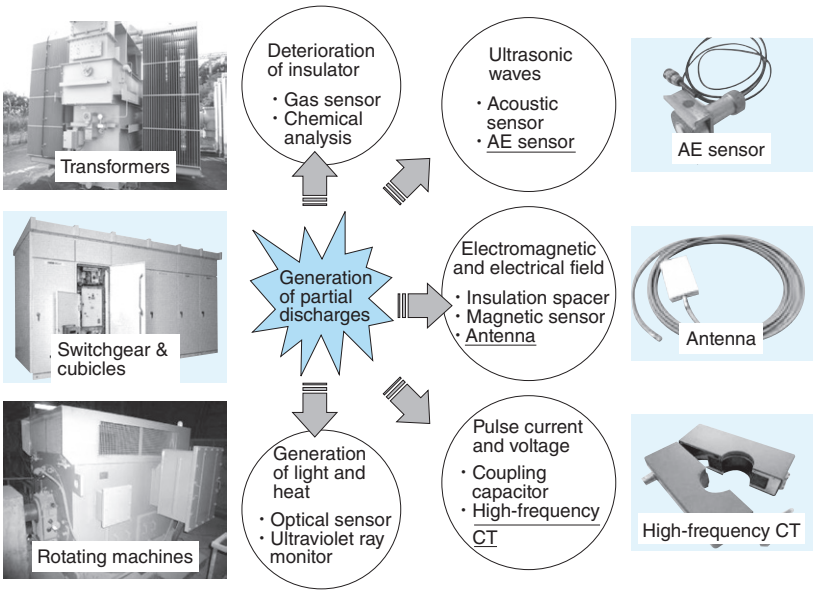
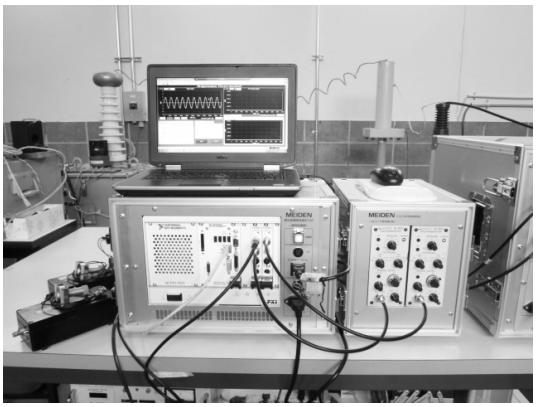
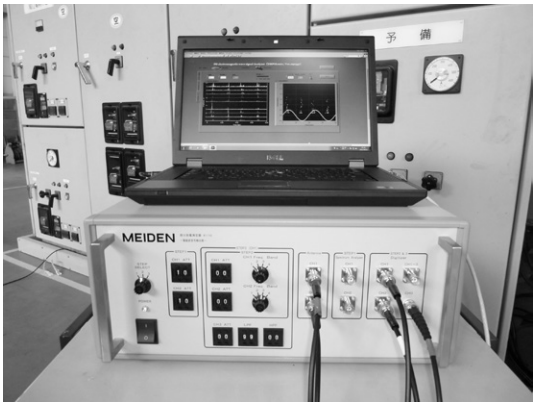


Fig. 1 Live-Line Partial Discharge Detection Approach

A workflow shows how each result adds up to the final overall evaluation. This approach is in line with the risk-based management concept.



(a) Partial discharge measuring equipment by the ultrasonic detection method



(b) Partial discharge measuring equipment by the electromagnetic detection method

Fig. 2 Partial Discharge Measuring Equipment

An external appearance of the partial discharge measuring equipment is shown.

each unit are introduced below.

2.1 Measurement of Partial Discharges by Ultrasonic Detection Method

2.1.1 Features

For the measurement of partial discharges by the ultrasonic detection method, ultrasonic waves generated at the time of discharges are picked up with an Acoustic Emission (AE) sensor※1. The AE sensor can be mounted easily on equipment casing or an external wall surface of switchgear. This sensor assures safe measurements while electrical circuits are alive. Fig. 3 shows an example of AE sensor installation.

2.1.2 Outline of Equipment

Fig. 4 shows a configuration of measurement. Since signals picked up with the AE sensor are feeble, they are boosted up at the amplifier and then the specific frequency is selected at the signal detector. Analytical evaluation is carried out at the measuring PC via the signal processor block. Fig. 5 shows an example of the analyzed result obtained by detecting the partial discharge signal at the customer's facility.

Undergoing simultaneous measurements in combination with any other approach such as the

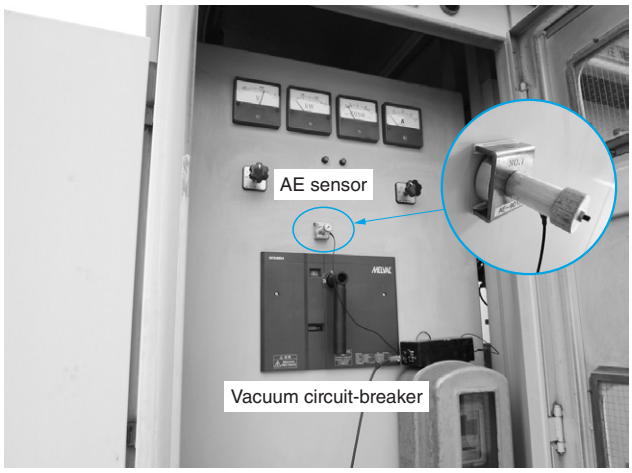


Fig. 3 Example of AE Sensor Installation

An example of diagnosis is shown for the high-voltage switchgear. The AE Sensor is fixed with the aid of magnets so that vibrations (AE waves) can be transmitted assuredly. The contact surface uses silicone grease as an acoustic coupler.

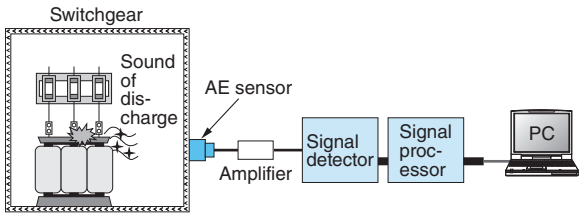


Fig. 4 Configuration of Partial Discharge Measurement with AE Sensor

A configuration is shown for partial discharge measurements.

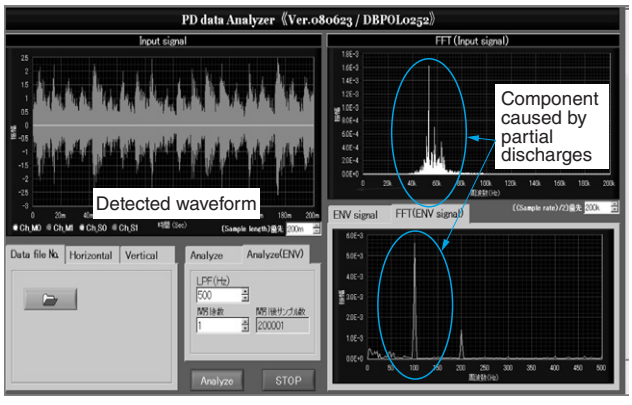


Fig. 5 Partial Discharge Signal Analysis (Example of Partial Discharge Measurement)

An example of analysis is shown where signals of partial discharges are detected.

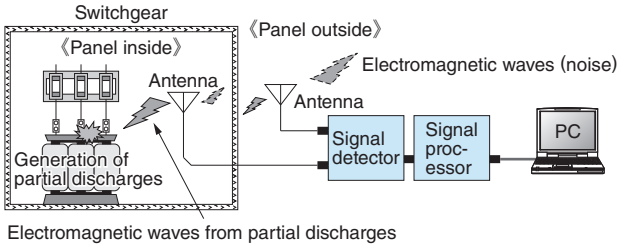


Fig. 6 Configuration of Partial Discharge Measurement by Electromagnetic Detection

utilization of an electromagnetic detection method to be related in **2.2** herein, presence of partial discharges can be grasped more definitely.

2.2 Measurement of Partial Discharges by Electromagnetic Wave Detection Method

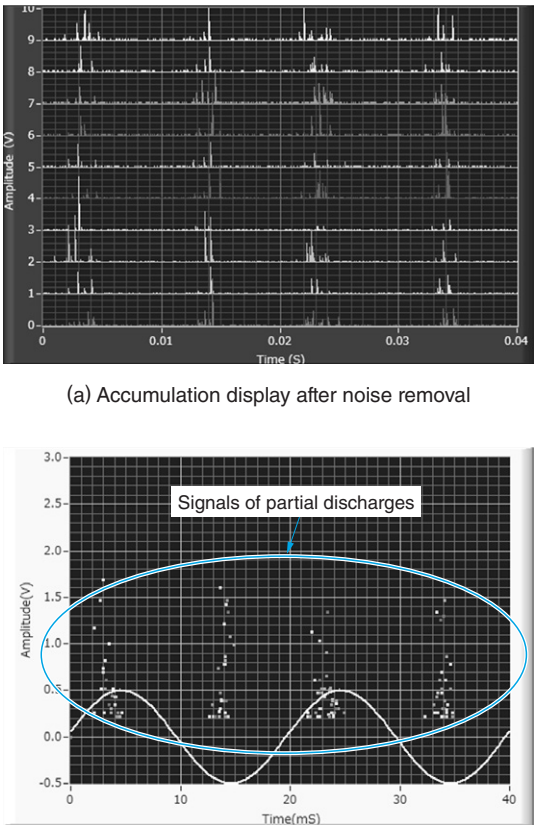
2.2.1 Features

Measurement of partial discharges by the electromagnetic wave detection method is performed in such a manner that electromagnetic waves generated at the time of discharges are picked up by an antenna. If there is no shielding such as an iron plate or the like, electromagnetic waves are propagated as far as the antenna that is installed near the target equipment. Accordingly, safe measurements are possible in non-contact mode even though power circuits are alive.

2.2.2 Outline of Equipment

Fig. 6 shows a configuration of partial discharge measurement by the electromagnetic detection. Antennas are installed inside and outside the switchgear so that signals from electromagnetic waves can be analyzed.

In the case of field measurements, a variety of electromagnetic waves (noise) are measured together with signals from partial discharges. Therefore the discrimination of signals is a standing problem to be solved. In the case of switchgear, the panel wall can function as a shield. Utilizing the panel wall surface, analytical evaluation is carried out for the extraction of electromagnetic signals from partial discharges, noise discrimination by software, and determination of the presence of signals from partial discharges. Fig. 7 shows an example of electromagnetic signal analysis for partial discharges.



(a) Accumulation display after noise removal

(b) Accumulation display of peak values

Fig. 7 Example of Electromagnetic Signal Analysis for Partial Discharges

An example of signal analysis is shown.

3 Postscript

In the case of field measurements, there is a mixture of field noise. Improvement of techniques is essential, particularly for the discrimination of noise components and signals. If an optimal detection system is selected according to the type of measuring equipment and environmental conditions in the measuring field, it is possible to improve measuring accuracy.

We will seek further improvements of diagnostic techniques through the accumulation of measuring records in practical fields and the accumulation of competencies by identifying our challenges for the solution and realizing the solutions.

Note：※1. AE sensor: A sensor consisting of a piezoelectric element such as PZT (Lead Zirconate Titanate), to be used for the conversion of mechanical vibrations to electrical signals