

Principal Research Results

Development of High-sensitivity Detection Method for Partial Discharge in Gas Insulated Switchgear (GIS)

Background

In the situation for which the effective utilization of the existing gas insulated switchgear (GIS) is necessary, a simple and high-sensitivity maintenance method that does not reduce the reliability of the equipment is needed. Concretely, a method for assessing the condition of equipment, especially a method for observing partial discharge generation, must be established. Up to now, the decomposition gas detection method for SF₆ has been applied to the fault localization of the gas insulated switchgear, however, it has not been attempted for the detection of a small amount of decomposition gas generated by a minute partial discharge. There is an advantage in which electric field noise is unaffected because this method of detecting the decomposition gas is a chemical technique. In addition, there is a possibility that the highly sensitive detection of the partial discharge can be realized using the temporal accumulation effect of the decomposition gas.

Objectives

To verify the feasibility of a method of high-sensitivity detection for partial discharge based on adsorption gas analysis using an external adsorption unit set up outside of GIS;

Principal Results

1. Proposal of external adsorbent unit method and verification of necessary functions

In our proposed method, an adsorbent is set up outside the equipment (a typical example is shown in Fig.1). This method has the following advantages.

- (1) The decomposition gas can be analyzed by sampling the SF₆ gas before it touches the adsorbent.
- (2) The SF₆ gas passes the external adsorbent unit through the circulation system and is kept clean.
- (3) The decomposition gas accumulated in the adsorbent can be analyzed easily because it can detach the adsorbent unit without blackout of GIS.

This adsorbent unit was constructed and connected to the test tank, and the functions corresponding to the above-described list were confirmed.

2. Measurement of decomposition gas generated by partial discharge and selection of monitor gas

The partial discharge was generated in a small test tank (the volume is about 15.5 liters), and various decomposition gases were measured. SF₄, CSOF₄, CSOF₂ and SO₂F₂ were generated as decomposition gases, and the concentration of each decomposition gas increased over time. After partial discharge generation, the concentration of SO₂F₂ was steady for a long time (Fig.2). However, the concentrations of the other decomposition gases decreased. Thus, it was shown that SO₂F₂ was the best monitor gas for the detection of the partial discharge in GIS.

3. Verification using real-scale test tank

A minute partial discharge with an average charge amount of 4.6pC/pulse was generated in a real-scale test tank. The tank volume is about 900 liters and the gas pressure is 0.5MPa. SO₂F₂ of 0.029ppm was detected by the accumulation of decomposition gas for 72 hours. Also, the partial discharge could be detected from the color reaction in the gas detector tube (Table 1). Therefore, it was clarified that the external adsorbent unit method can be used as a high-sensitivity partial discharge detection method.

Future Developments

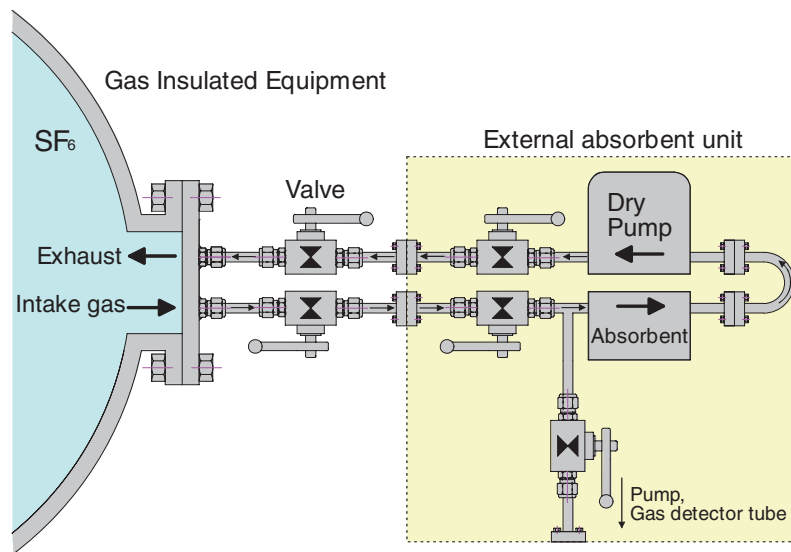
The adsorbent unit for the field test will be further developed, and a method for a more detailed condition assessment of the gas insulated switchgear will be examined.

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Reference

H. Shinkai, et.al., 2006, "Development of condition assessment method of gas-insulated switchgear - High sensitivity detection method of partial discharge by decomposition gas accumulation -", CRIEPI Report H05009 (in Japanese)



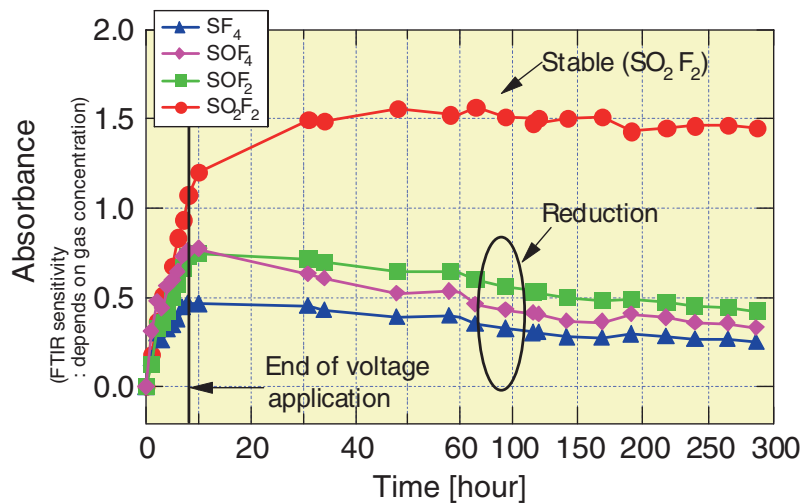
【In normal operation of GIS】

- The SF₆ gas passes the external adsorbent unit through the circulation system and is kept clean.
- When the partial discharge is generated, the decomposition gas accumulates in the adsorbent.

【Condition assessment method for GIS】

- The adsorbent unit is analyzed or SF₆ is analyzed directly before it touches the adsorbent.

Fig.1 Schematic diagram of typical external adsorbent unit



The concentration of SO₂F₂ is steady for a long time (it is the best monitor gas).

Fig.2 Relation between time passage and concentration of decomposition gas

Table 1 Parameters of partial discharge for experiment using real-scale tank and decomposition gas

Number of partial discharge [pulse/cycle]	Electric charge			SF ₆ gas moisture [ppm]	Gas detector tube		Concentration of SO ₂ F ₂ [ppm]
	Maximum Q _{max} [pC/pulse]	Average Q _{ave} [pC/pulse]	Total Q _{total} [pC/cycle]		SO ₂ [ppm]	HF [ppm]	
3.8	58	4.6	26.8	< 58	0	trace	0.029

trace : Less than minimum limit of determination, however, the gas detector tube has a color reaction.
 cycle : AC (50Hz) 1cycle = 20ms.