Verification Experiment and Analysis for Electrical Utilities Diagnosis System by HFPD Detector

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Abstract. It is important to secure the technology of electrical devices diagnosis to provide reliability of electrical power supplies in the modern society. In this paper, the electrical utilities diagnosis system is developed by the core technology for the high frequency partial discharge (HFPD) detection. The system detects the partial discharge generated in the electrical devices and analyzes the stability for operation status of the electrical utilities on uninterruptible power supply condition. In addition, we evaluate the stability and reliability for the electrical utilities diagnosis system by the experiments in the laboratory. In result, we find the partial discharge signal patterns by the trouble types of the electrical devices. In the future, we'll prevent the power failure accident through monitoring the inside strange status of the electrical devices.

Introduction

Not long ago, the accident occurred by the temporarily suspended electric power supply for 2 hours in the big semiconductor factory. Then, It causes the most damage about $9,000million. The power accident occurred in the factory that spends the large amount of electricity over 300,000 kilowatts a day usually comes to the great damage in terms of social and economical effect. Therefore, according to the request of the business customer, it is the tendency that the application of the uninterruptible technique is expanded for the inspection for the electric power facilities and safety test [1]. That is, the necessity of equipment development emerges. And for diagnosing the degraded state of the high-voltage installation. The uninterruptible diagnostic tool the high pressure water or more existence and nonexistence inspection of the substation facility and diagnose state are preferred. In addition, the existing uninterruptible diagnostic equipment is mostly the overseas. And the cost is the high price. Therefore, In our country field, the electric installation diagnosis system development by the high frequency partial discharge which can be easily usable and be supplied is desperately needed. Therefore, in this paper, the partial discharge signal generated in the electric power equipment including the power transformer, mold transformer, cable for electricity, and etc is detected. In the non-electricity failure condition, the electric installation diagnostic system in which the high frequency partial discharge technique analyze the operation state of the electric power facilities is applied was developed. In addition, in the laboratory , the stability of this system and reliability was evaluated through the partial discharge fixing simulation.

Partial Discharge Measurement and Program Development
Summary of Partial Electric Discharge
If the insulating state is not good between the transformer inner turn, if that is the insulating blazing fire is progressed, before the dielectric breakdown occurs, the partial discharge is generated. That is in the inside of insulator and external defect, the definition of the partial discharge [2] means the isolation breakdown, that is the section in which the duration generated by the formation of the high field is very short. Therefore, the partial discharge generated in the electric power equipment shows well the insulating blazing fire information according to the electric power equipment operational state and generally directly the degradation because of this is connected to the electric power facilities accident by driving. However, it is considerably difficult to detect the partial discharge generated in the electric power equipment from the field by the partial discharge signal abandoned from the surrounding environment noise problem, noise from the power and other high pressure equipment or the electromagnetic discharge source.

Partial Discharge Measurement and Analysis Program

The partial discharge is classified into 3, the inner discharge, flashover, and corona discharge. And after detecting the partial discharge signal by applying HFCT(High Frequency Current Transformer) sensor, the couple discharge signal pattern detection is made through the analysis program in which PRPDA (Phase Resolved Partial Discharge Analysis) technique [4] and neural-network algorithm [3] are applied. The partial discharge measurement and analysis program developed shown in [Figure 1].
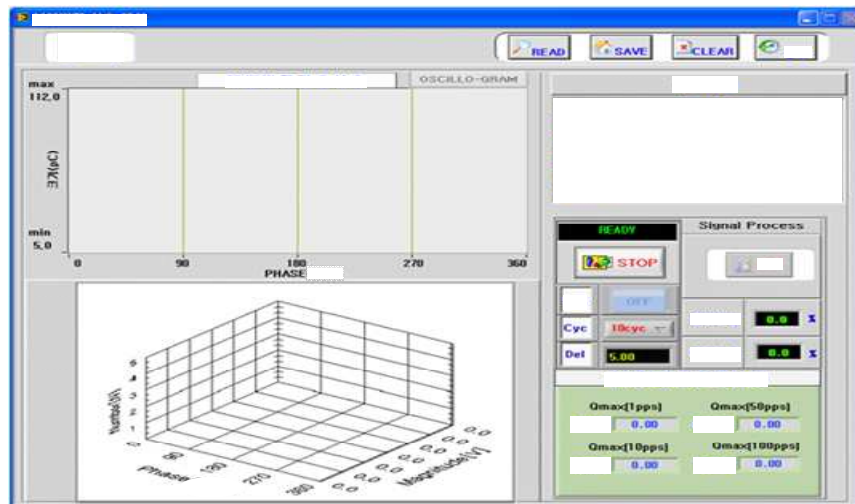

Fig. 1. The partial discharge measurement and analysis program

Particularly, in this research, the back propagation algorithm (Back Propagation Algorithm, BPA) [5] was used among the neural-network algorithm. BPA has the defect that it fails often in the exaction of heavy taxes and is faced with the local minima. However, is the algorithm which is suitable for the non-linear signal prediction like the partial discharge diagnostic system. BPA is comprised of 1 input layer, 1 hidden layer, 1 output layer for the partial discharge measurement and the node of the input layer, for 500 node of the hidden layer, 30 and output layer are made over the protrusion (electrical wire) and insulator in the normal condition 3 nodes by applying 6 patterns according to the trouble condition, the learning pattern number used the total of 18s.
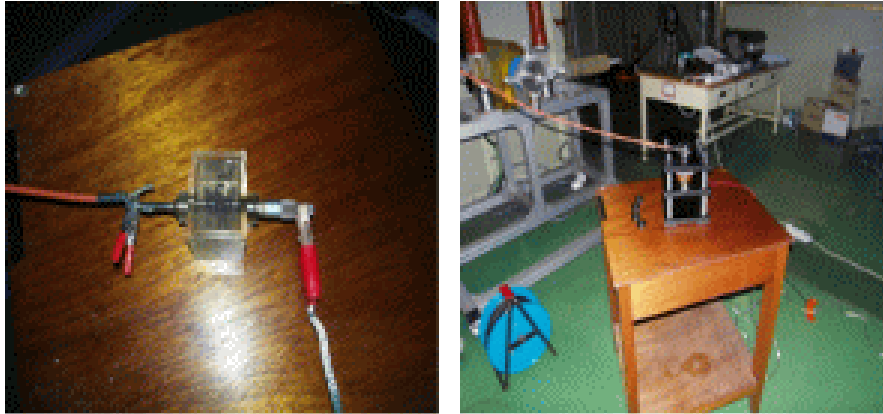
Simulation

Partial discharge of this Section 3 describes how to simulate faults and fault conditions on the result of each detection pattern according to the partial discharge signals are compared. First, the simulate structure was made for the simulation   test bed building. The internal which carried out each trouble condition experiment and which it is generated over the inside of electric power equipment in order to analyze the detecting pattern of the partial discharge signal which can be shown up according to the trouble condition including the production inferiority of the electric power equipment or foreign material, and etc. failure phenomenon was compared by the detecting pattern of the partial discharge signal. At this time, the applied voltage is 1 φ 60Hz 100 kV. The fault condition assumed in this simulation shows up in the table 1.

The figure 2-(a) is the experiment environment which it comprises in order to analyze the partial discharge characteristic of the case that the condition, including, field concentration condition, and etc. was generated to rotate inside the flow-in instrument, and etc. The figure 2-(b) is the photo which comprises the experiment environment in case of plotting void inside XLPE (Cross Linking-Polyethylene) insulator, that is the power cable used in the extra high voltage, in order to detect the partial discharge signal pattern.

Table 1 Partial Electric Discharge Fault simulated failure conditions

| Num.	Fault conditions	Details
1	General	In case there is no fault condition
2	Protrusion	The protrusion condition simulate in the insulator
3	Void	Insulation inside the voids simulated

(A) Protrusion for insulation condition (B) voids within the insulation condition

Fig. 2. When a fault condition within the power unit for the analysis of partial discharge characteristics simulated field (inside the lab)

By using the partial electric discharge measurement and analysis program, the result of performance the partial discharge fault malfunction simulation is shown in [figure 3]. when protrusion Conditions on the insulation , Partial discharge signal pattern 50 ° - 90 ° in the phase part, we can see that the cluster has formed a characteristic pattern. on the other hand ,Void condition inside the insulator 90°-180°, 270°-360° at the formation of clusters is a characteristic pattern. In this case [Figure 3(e)] no fault condition in the total phase belt, we can know that pattern shows evenly. Utilize the results of experiments in the field, we can see partial discharge analysis in the field of electrical equipment installed inside the state can do more.
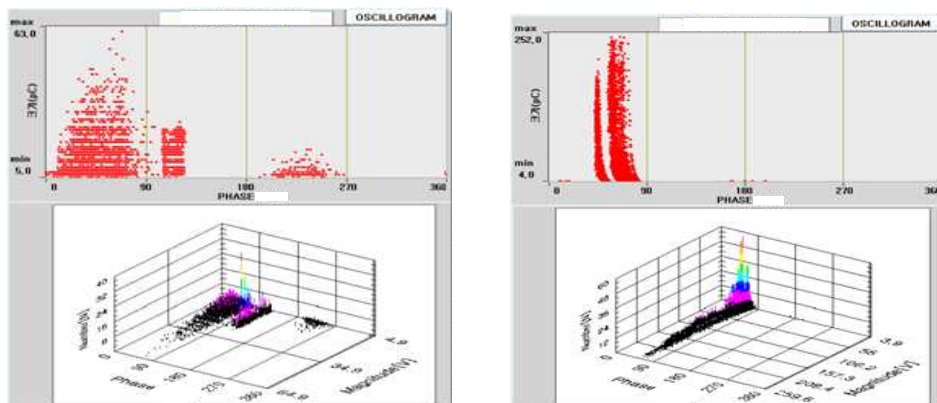
(a) insulator protruding condition Ⅰ (b) insulator protruding condition Ⅱ
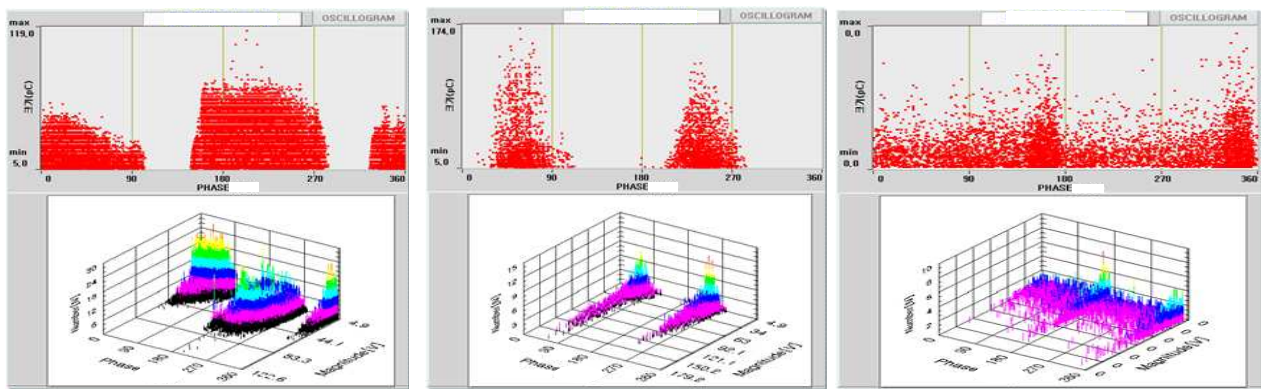
(c) insulation inside the voids Ⅰ (d) insulation inside the voids Ⅱ (e) Under normal conditions

Fig. 3. Power equipment Fault simulation Result of partial discharge signal detection pattern

Conclusions and Future Research Directions

In this paper, electrical equipment arising from the partial discharge signal is detected by the HFCT sensor to the state uninterruptible power equipment that can analyze the operation status of the high-frequency partial discharge technique was applied to the development of electrical equipment diagnostic systems. In addition, the proposed system in the laboratory using a simulated failure to perform partial discharge was obtained by the analysis result of equipment failure by the power characteristics of partial discharge signal patterns are discussed. Consequently, according to the failure mode of the electric power equipment, the respectively different partial discharge signal pattern could be detected. The possibility which can be developed into the system which it utilized this and sensed the internal tooth phase state of the electric power equipment in the prior and can previously prevent the power off accident was confirmed. This paper will contribute to the safety test increase of benefit as the diversification of the electric power equipment diagnostic warning and high-quality conversion. And it will be able to enhance the import substitution effect, externally, the status of state by developing the existing partial discharge equipment depending on import with the owned technology.

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