PD Diagnosis on High Voltage Rotating by Using New Prototype Patch Antenna Sensor

키아우소 륀, 신동훈, 임광진, 공태식*, 김희동*, 박노준, 박대희
원광대학교, 한전전력연구원*

Prototype 패치 안테나를 이용한 고압 회전기의 부분방전 측정 연구

K-S Lwin, D-H Shin, K-J Lim, T-S Kong*, H-D Kim*, N-J Park, D-H Park
Wonkwang University, Korea Electric Power Research Institute*

Abstract - We studied the partial discharge detecting by sensing electromagnetic wave emitted from the partial discharge source in the HV Rotating Machine with the new prototype patch antenna sensor. In this study, we design new type of patch antenna based on microstrip technology and make many experiments of offline testing compare with the existing HFCT and EM probe on stator winding of HV generator in the laboratory. This paper will mention comparison of experimental results based on the three kinds of sensors.

Keywords : High Voltage Rotating Machine, New prototype patch antenna sensor, EM Probe, HFCT sensor.

1. Introduction

Now, partial discharge testing is also rapidly becoming an industry standard as a quality assurance (QA) test for newly installed stator winding insulation system. PD testing can bedone either offline (energizing the apparatus with an external transformer) and online (where the apparatus is excited by from the power system) [1]. PD testing is favorablea sudden unexpected in-service failure of the stator winding insulation of large rotating machines which would cause considerable expenses for non-availability and unplanned repair work. Therefore, PD diagnostic test are applied to assess the condition of the insulation system.

The stator winding insulation of high voltage machines is subjected to several stresses such as electrical stress, thermal stress and mechanical stress during operation that may significantly influence the performance of the performance of the insulation system and especially its long-term properties due to the various aging phenomenon. Modern insulation systems for high voltage machine are inherently resistant to the partial discharge to their inorganic mica components. The main sources of partial discharge activity in high voltage rotating machine are Voids/Delamations, Slot/Slot exit discharge and End winding discharges [3].

When partial discharge process occurs in the insulation of high voltage equipments, some of energy changes such as electrical current pulses, dielectric losses, electromagnetic radiation, sound (noise) including acoustic emitting, increase gas pressure and chemical reaction take place. Depend on sensing of those energy changes in the circumstance of insulation, there have different kinds of detecting methods and measuring system based on the noise elimination. At present there are many different techniques available for PD measurement in rotating machines for individual coils, bars or the complete stator winding. Thereby, most of the PD detecting sensors are based on capacitive coupling, inductive coupling, electromagnetic coupling and acoustic coupling compare with the visual and chemical signal of PD signal in rotating machine[3].

2. Experimental

2.1 Antenna Design

Our prototype antenna is designed on the base of microstrip line technology. A microstrip antenna consists of a dielectric substrate sandwiched between the two conducting surfaces; ground plane and patch antenna surface. The schematic diagram is shown in Fig.1.

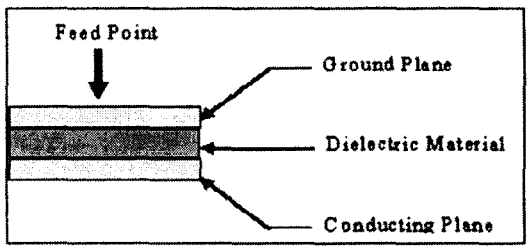

Fig.1 schematic diagram of patch antenan

By changing the width W, patch lengh and dielectric constant of substrate of the patch antenna, its resonant frequency can change.

2.2 Experimental Setup

Our experiments are madeon the 2-pole AC induction motor of 596.8kW with the rated voltage of 6.9kV in KEPRI lab. We used 3 types of measuring instruments; EM probe with PPM 97, HFCT and patch antenna sensor. This Probe was composed of a 1 m insulation rod within a multi-turn coil wound on a ferrite rod which can detect 5MHz frequency of electromagnetic pulse [4] and gives the results mA in Peak Pulse Meter.

High frequency current transformer (HFCT) is setup on the ground or neutral of the rotating

machine. Fig.2 shows the experimental setup picture. We used the spectrum analyzer and its GPIB to the PC in where we can read the PD signal in dBm on frequency domain.

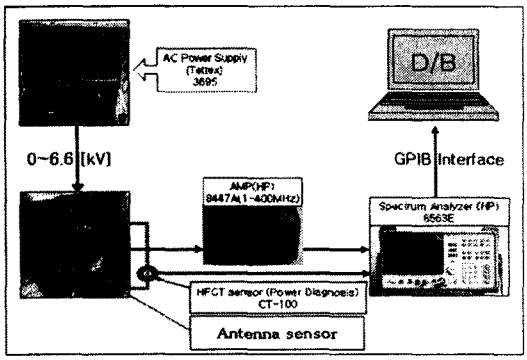

Fig.2 experimental setup diagram

We used 20dB RF amplifier to boost the received signal of antenna sensor as shown in Fig.2, measurement setup block diagram for antenna sensor.

3 Results and Discussion

In our experiment, firstly, we energized to the stator winding of machine by the external high voltage controllable transformer as a PD offline testing. The injection voltage is raised step by step. We found PD inception voltage (PDIV) of 4kV and then the voltage is raised 0.5kV steps from 4kV to 6.5kV.

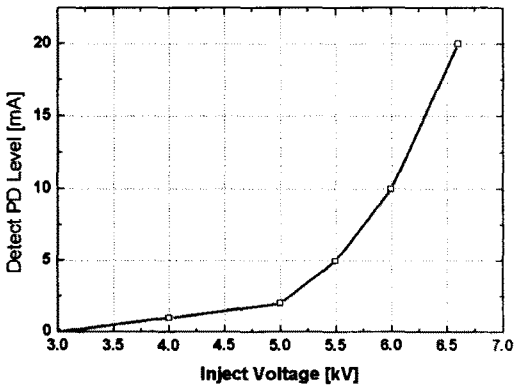

Fig 3. Injection voltage Versus detecting PD level in each voltage step

The EM probe with PPM97 reading in each step is shown in Fig. 3 By moving the probe manually over the stator winding, we can localize the source of PD at maximum meter reading results.

The testing results with commercial HFCT are also made in each step and its output is can be read by spectrum analyzer and then to the PC via GPIB *interface software. The PD signal results can be read* in dBm in the frequency domain shown in Fig.4. This sensor is fixed on the ground, so it is difficult to determine the PD source.

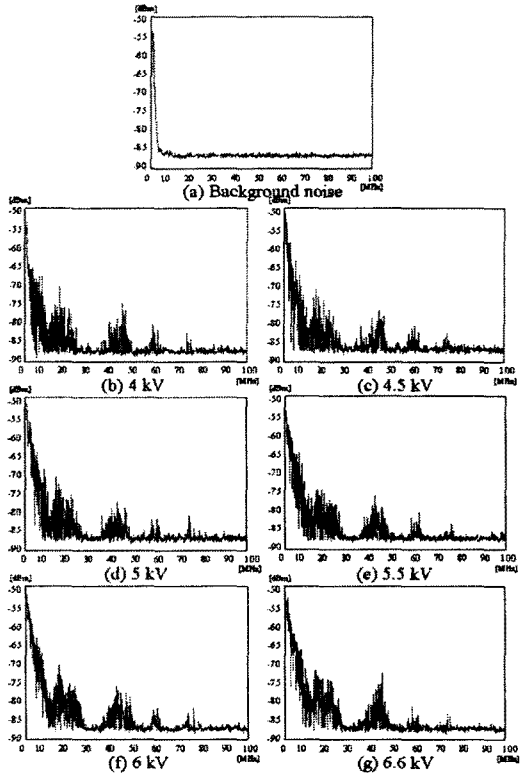

Fig. 4 PD measuring results in frequency domain by HFCT sensor

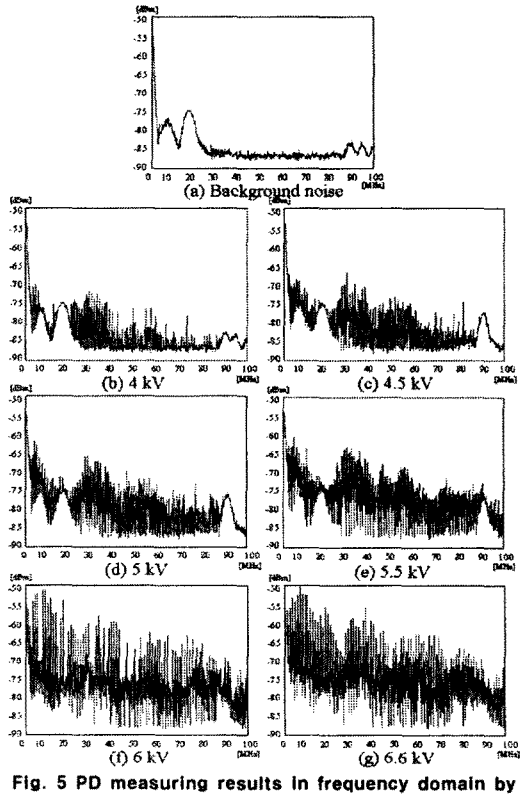

Fig. 5 PD measuring results in frequency domain by Patch Antenna sensor

In Fig 5, the testing results of the patch antenna sensor are shown. It's also seen the signal magnitude of dBm in frequency domain. We can detect wide bandwidth than HFCT. We can know the location of PD by manual moving over the stator winding like EM probe.

4. Conclusion and future work

Patch antenna can give wider bandwidth, so we can get different frequencies of PD signal from different PD sources. By knowing peak of certain frequency, we can determine the location, activity, other characteristic of PD signal at that frequency by using with narrow band tunable filter in future. More over it is easy to fabricate and cost effective.

Acknowledgment

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