분리된 6.6kV급 고정자 권선의 부분방전 측정을 위한 Spiral 패치 안테나 센서 적용 연구

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Dismantled PD diagnosis on 6.6kV Stator Winding by Using Spiral Patch Antenna Sensor

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Abstract : There have three kinds of partial discharge diagnosis testing: online, offline and dismantled testing on high voltage rotating machine. Our lab testing is dismantled testing, taking off pieces into individual parts of stator coil of high voltage rotating machine in laboratory. We investigate internal discharge, slot discharge, corona discharge and normal state on pre-made stator winding by using spiral patch antenna sensor. In this lab test we compare the experimental results of our spiral patch antenna sensor and reference commercial HFCT sensor.

Key Words : PD diagnosis, Spiral patch antenna sensor, HFCT(high frequency current transformer), HV rotating machine

1. Introduction

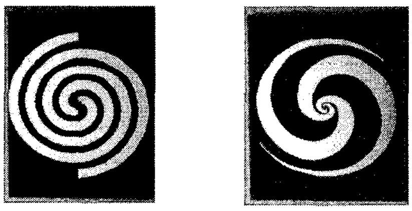
Partial discharge(PD) testing of the condition of the stator winding insulation on high voltage motors and generators has been a practical technology since early 1950's[1]. By measuring the PD level, the condition of high voltage insultion can be assessed. The electromagnetic(EM) wave emitted from PD includes broadband signal of VHF/UHF (Very High Frequency: 30MHz to 300MHz/ Ultra High frequency: 300MHz to 3000MHz)[2]. There have three kinds of PD measuring method on high voltage machine: online, offline and dismantled diagnosis[3]. We will investigate dismantled diagnosis on various kinds of discharge in stator winding insulation. In our laboratory testing, pre-made stator coils for particular discharge are used. These are shown in Fig. 1.

Fig. 1 Pre made stator slot to use laboratory test

2. Experiments

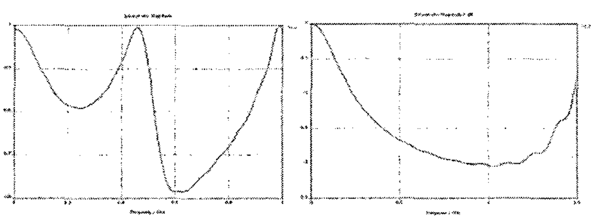
2.1 Antenna Fabrication

In this paper two types of the spiral antenna sensor where designed, fabricate and tested A FR-4 PC-board (with dielectric constand 4.6 and thickeness 1.6mm) is used as the substrate for the antenna[4].



(a) (b)

Fig. 2 (a) Traditional spiral patch antenna sensor (b) modified spiral patch antenna sensor.



(a) (b)

Fig. 3 CST simulation S11 results of (a) traditional spiral patch antenna (b) modified spiral patch antenna

A traditional spiral antenna is shown in Fig.2(a) and modified sprial antenna sensor is shown in Fig2(b). The dimension of spiral antenna are 9cmx6.5cm and 12cmx9cm. We use the CST microwave studio simulation software for design. The simulation S11 parameter of these antenna are shown in Fig.3(a) and Fig3(b).

2.2 Experimental setup

The experimental setup is as shown in Fig4. We used Midas computer control high voltage source to energize the stator coil. 20dB radio amplifier is used to amplify the antenna received signal. Tektronix TDS 3032 digital oscilloscope is used to measure PD signal in time domain analysis which can see PD signal in positive rise time and negative rise time of applied voltage by phase resolved method. To analyse frequencies of PD signal Hewlett Packard 8563E Spectrum Analyzer is used. Commerical PD sensor, high frequency current transformer(HFCT) is setup at the ground to comepare the results of our antenna sensors.

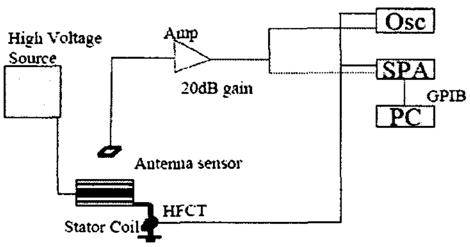


Fig. 4 Experimental Setup Diagram

3. Experimental Results and Discussion

The Stator coil is energized by 6.6kV external High Voltage Power Source. The experimental results are recorded by GBIP interface in computer via spectrum analyzer.

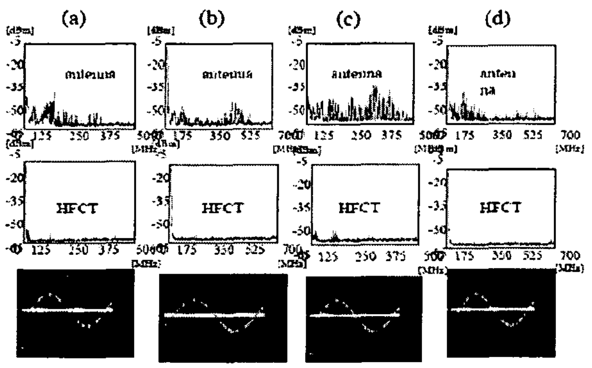


Fig. 5 Traditional spiral patch antenna and HFCT detecting results in frequency domain and antenna detecting results in time domain for (a) internal discharge (b) slot discharge (c) corona discharge (d) normal condition.

Fig 5 shows the comparison results of our traditional spiral patch antenna sensor and HFCT sensor in frequency domain for each discharge type and partial discharge confirmation of phase resolve, time domain analysis oscilloscope results of antenna sensor. we can see that different discharges have different frequency characteristic in antenna analysis. This antenna sensor can detect frequency of up to 700MHz. Fig.6 shows the comparison results for our modified spiral patch antenna sensor in frequency domain for each discharge type and Oscilloscope results of antenna sensor. We found that this modified type can detect wider range up to 1GHz of frequencies than the previous traditional spiral antenna and detection sensitivity is better than previous one. This also show different discharge type in different frequencies. We found that HFCT can detect very low frequency range of up to 30 MHz.

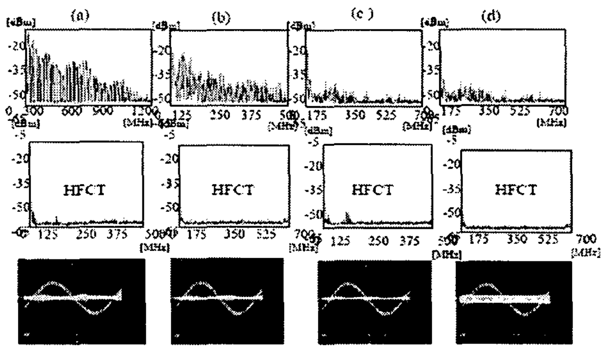


Fig.6 Modified spiral patch antenna and HFCT detecting results in frequency domain and antenna detecting results in time domain and antenna detecting results in time domain for (a) internal discharge (b) slot discharge (c) corona discharge (d) normal condition

4. Conclusion

Our experiment shows our antenna sensors can detect wide range of frequency up to 1.2GHz and we found that different discharge type have different frequencies characteristics.

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