Activities of Laboratories

Laboratory of High Voltage Engineering and Department of Power Systems at Hanoi University of Technology

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1. Introduction

The department of power systems at Hanoi University of Technology (HUT) was established in 1957, one year after the foundation of HUT. 29 faculty members of the department engage in research in wide range of areas, in order to provide superior graduate education and research in the interdisciplinary fields of power system engineering at the HUT. Being organized by five research groups including "Power Plants and Station" group; "Power System and Networks" group; "Power Distribution" group; "Relaying and Automation" group and "High Voltage Engineering" group, the activities of our department focus on:

- Power system planning and optimization
- Power system management and power quality
- Application of artificial intelligence in power systems
- Strategic directions for development of Vietnam power system networks
- Electromagnetic transients in power systems
- Insulating performance in power systems

About 200 undergraduate students, 30 Master students and 10 PhD students are enrolled in the Department every year. The department is managed by Dr. Tran Van Top, who is currently Vice-President of HUT.

2. Research activities of the Laboratory of High Voltage Engineering

High voltage engineering field is an integral part of the work of the department. The laboratory of High voltage engineering is a graduate research and undergraduate teaching laboratory. The staff involved in the laboratory comprises 5 professors and assistant professors. At present, 7 Master students and 3 PhD students are working toward their Master and Doctor degrees in high voltage engineering discipline. The main research fields in the laboratory include:

- Electromagnetic transients in Power System including lightning and switching over-voltages
- Protection of equipments in power system against direct and induced strikes, insulation coordination, grounding system in transmission line and substation
- Electromagnetic field under high voltage transmission line and its effect on human body
- Ageing process in insulating materials and prediction of life expectancy, insulator behavior and pollution flashover in different environment.
- Insulation diagnostic method and insulation condition monitoring

3. Facilities

3.1. Overvoltages in Power System

As the laboratory of High voltage engineering play as a sub-discipline for Power system engineering, the main activities of the laboratory cover most of aspects relating to overvoltages in power systems and insulation coordination. Various studies in modeling switching and lightning overvoltages by using EMTP and MATLAB in power system of Vietnam have been done in the laboratory, the influence of network structure such as the length of transmission lines, grounding system and surge arresters on the magnitude

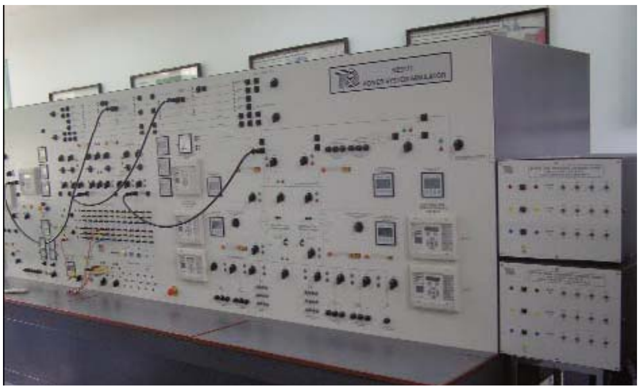

Figure 1: Power System Simulator NE 9171

and frequency of overvoltages is also considered. The modeling results could be verified in physical simulation by using Power System Simulator (PSS-NE 9171) manufactured by TQ (UK). The simulator allows simulating most of cases in switching over voltages with different structure of the power network..

3.2. Dielectric behavior of insulation under high stress

Two high voltage testing transformers of 2kVA with rectifiers provide AC and DC voltages up to 100kV in order to study potential distribution along a set of insulator and the corona effect in overhead lines. The field distribution within bulk material and along surface insulators has been modelized by using finite element method (FEM). These activities allow understanding the mechanism of pollution flashover in polluted areas in order to develop remedies method for such areas. Moreover, physical properties of liquid dielectrics can be characterized by other facilities available in the laboratory such as liquid breakdown testing kit, viscosity meter kit and flash-point measuring kit.

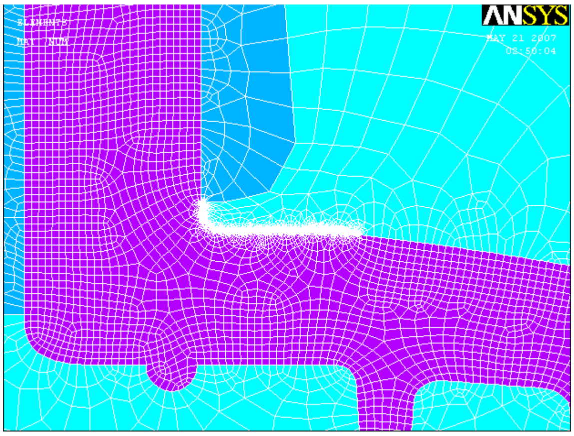

Figure 2: Simulation of polluted surface of insulator by FEM

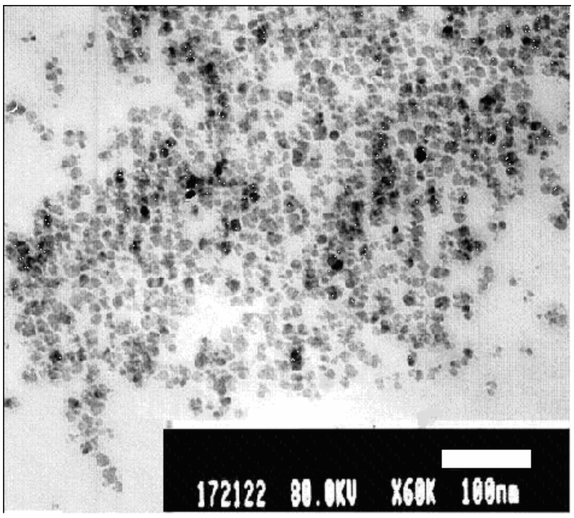

Figure 3: TEM image of magnetic nano-particle using for mixture with transformer oil

4. Current research project

4.1. New generation of transformer oil using magnetic nano-particle

In order to improve the cooling capability of transformer oil in electrical equipment, a collaborative research has been carried out with the cooperation of researchers from International Training Institute for Material Science (ITIMS) at HUT. Mineral oil has been mixed with appropriate ratio of magnetic nano-particles, which are displaced in induced magnetic field inside the equipment. Oil particle surrounding the magnetic particle moves with the magnetic particle, and results in auto-cooling effect.

4.2. Conception and realization of optimal multi-layered electromagnetic shielding of conducting composite in the microwave band

The project is funded by VLIR-HUT institutional Program with the grant of 15 000 E and lasts for 2 years (from 2007-2009). Objective of the project is to make a Polyaniline based conducting composite for electromagnetic shielding application in microwave band (8-18GHz). The project is a collaborative research between the staffs of the Laboratory, the staffs of the department of instrumentation and industrial informatics at HUT, researcher of electric power university (EPU) and professors from Ecole de Mines at Douai (France).

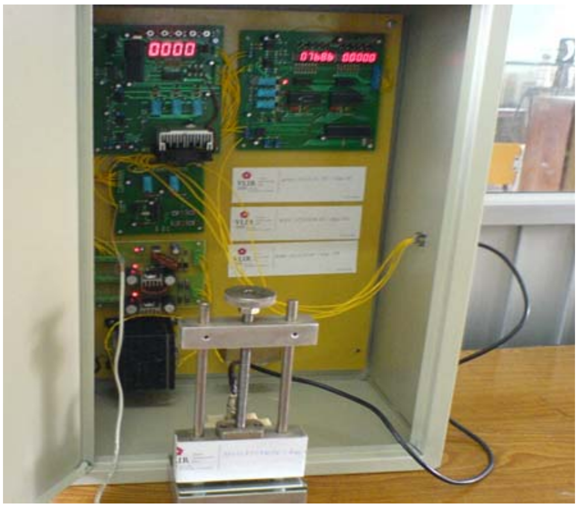

Figure 4: Conductivity measuring device for conducting composite

4.3. Development of insulation diagnostic tools

Insulating failure diagnostic tools are currently developed in the laboratory include partial discharge measurement and leakage current measurement (polarization and depolarization current). With the neuron network simulation, we are trying to sketch out criteria for predicting life expectancy of the insulation in transformer, cable and generator.

5. International cooperation

Besides the relation of the department of power system with traditional partners such as Department of Power System at Moscow Institute of Energy (MEI), Grenoble Electrical Engineering Laboratory (G2E Lab), AUF (Organization for French-speaking universities), the Laboratory have very close cooperation with other foreign institutions in preparing and realizing various common research projects such as Systems and Applications of Information Technologies and Energy Laboratory (SATIE, France), Centre for Plasmas-Material- Nanostructure Research (CRPMN, France), Korea Electrotechnology Research Institute at Changwon (KERI, Korea).

6. Conclusion

As a home of nationwide renowned of researcher and graduate student in Vietnam, the Department of Power System and Laboratory of High Voltage Engineering at HUT is pleased to share the experience and facilities with the researchers and people in the community of power system engineering and high voltage engineering. Therefore, we welcome enquiries and interest of professors from over the world, and warmly invite them to visit our department and laboratory in order to enhance our scientific collaboration.

7. Acknowledgment

The author wish to thank Professor Masayuki Nagao, Toyohashi University of Technology, for giving the opportunity to introduce about the department of Power System and High Voltage Engineering Laboratory at Hanoi University of Technology.

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Activities of High Voltage Research Laboratory at Hoseo University

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The High Voltage Research Laboratory is a part of Department of Electrical Engineering, Hoseo University, which is located about 60km south-east of Seoul. Its activities started from 1994. The activities can be categorized as follows;

The optical fiber sensor application for power equipment monitoring, high voltage impulse application for water treatment used in power plant, partial discharge measurement, research on water treeing in polymeric cable, development of educational program of business administration for undergraduate student of engineering college.

1. Optical fiber sensor application

A precise information on spatial distributions of temperature are important for diagnosing power transformers and evaluating its life because a power system failure will result in an enormous loss in tangible as well as social. The optical fiber Bragg grating (FBG) sensors, which have been studied intensively for last decade, can be very efficient tools for applications to above mentioned purpose because these are immune to EMI and can be highly multiplexed, which enables efficient quasi-distributed temperature sensing along tens of km range.

Since the first observation of photosensitivity in fiber, the use of FBGs in both communications and sensing applications has been intensively studied in the last two decades, because it has many important advantages. First, a FBG only reflects Bragg wavelength and transforms the sensed physical quantities to shifts in reflected Bragg wavelengths. Because of this wavelength-encoding characteristic, the sensed information is independent of source power fluctuations, total light level, losses in the connecting fibers and couplers and the other environmental noise sources. Secondly, FBGs can be easily multiplexed in a serial fashion, allowing many of them to be used on a single fiber, which enables efficient quasi-distributed sensing. In addition, the reflected Bragg wavelength shifts show linear response to the change of fiber grating's properties, which means any external physical quantities applied to the gratings such as strain, pressure, temperature or vibration can be recovered from the measured Bragg wavelength shifts. By this features, the FBGs have been intensively studied as an optical sensor for various sensing applications used in the health monitoring of civil structures, nondestructive testing of composite materials, smart structures, and traditional strain, pressure and temperature sensing.

Fig. 1 The 3000kVA mold transformer with the 10 FBG sensors to monitor temperature distributions for 2 months in operation.

The developed FBG sensor system has been applied to 3000kVA mold transformer which was in operation on the real distribution network for 2 months. The performance of FBG sensor has been proven to be stable enough for real scale application.

2. High voltage impulse application for water treatment used in power plant

Water used in power plants must always be kept in high purity. Recently, the trend of producing water for power generation is likely to be changed from the conventional water treatment process to the process utilizing the membrane technology, such as reverse osmosis, nanofiltration and ultrafiltration. This is because the membrane technology has the advantage of not only providing superior process efficiency but also stably producing water. In the membrane process, however, the contamination phenomenon of membrane is always noted as a problem, requiring to imminently make it sure for the technology to control membrane contamination.

The membrane contamination may lower performance of membrane and thereby cause the reduction of water production as well as power generation efficiency, imposing the burden of facility costs because of frequent replacement cycle. Hence, the necessity to procure technologies for the control of membrane contamination is being raised. While several methods including chemical cleaning are currently being implemented to solve the membrane contamination phenomenon, those have not provided fundamental solution measures, like a second

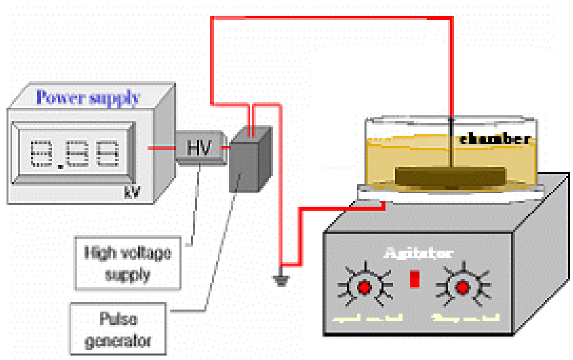

Fig. 2 Schematic diagram of the High voltage impulse system for water treatment used in power plant.

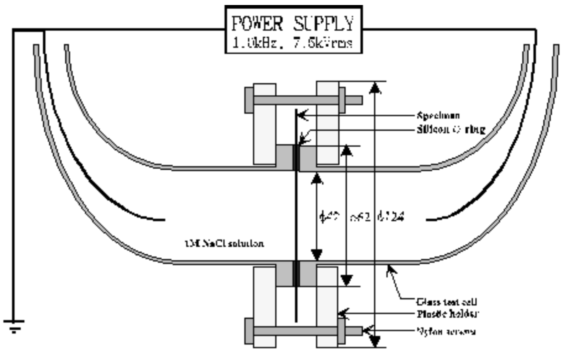

Fig. 3 Water tree accelerated aging cell for double sided water trees

contamination matter, yet.

Accordingly, the purpose of this research is to control the fundamental problem of membrane contamination by utilizing high-voltage pulsed electric fields, not chemicals or physical cleaning that cause a second environmental contamination problem by the use of chemical substances, and this research activities also have analyzed the death rate of microbes processed by electric fields as well as changes in ingredients before and after inducing electric fields.

The actual experimental results demonstrated that the death of microbes is proportional to the magnitude of electric fields. However, since sterilization in microbes means 99.99% complete death, it is expected that better results could be obtained, if experimented with higher magnitude of electric fields and the adjustment of processing time, frequency and pulse duty ratio, based on the above results. We are going to continue these experiments to demonstrate that the experimental system of this high-voltage pulsed electric fields can be effective not only in water treatment facilities but also in various fields requiring high sterilization systems, including food sterilization field.

3. Research on water treeing in polymeric cable

We have investigated the change of AC breakdown(ACBD) strength of water tree degraded XLPE specimens. The spacecharge distributions in the specimens were also measured by pulsed electroacoustic(PEA) method in order to study the correlation between the ACBD strengths and space charge distributions in the water tree degraded XLPE.

The specimens of 700 μm thickness and 85 mm diameter were prepared by hot press molding of XLPE pellet, which is commercially used for 22.9 kV underground cable insulator. For the specimens with one side water trees, opposite surface was painted by silver paste for electrode contact. Figure 3 shows the water tree accelerated aging cell for two sided water tree. In the cell 1 M NaCl solution was applied to the scratched side of the specimens. The water trees were grown at 7.5 kVrms, 1.0 kHz frequency and at room temperature. In order to make a good contact between the NaCl solution and surfaces, the cells were degassed in a vacuum chamber at 10-20 Torr before the test voltage was applied.

Figure 4 shows the spacecharge distributions in double sided water tree degraded XLPE specimens. We increased DC voltage of 0, 6, 9 and 12 kV, and finally removed applied voltage again. The homocharges are concentrated at the water tree tip regions. The correlation between the ACBD strength and spacecharge distribution of water tree aged XLPE was investigated using PEA method. It was found that the ACDB strength was reduced as the water tree grew, and the space charge with same polarity of electrode was distributed along water treed region, especially concentrated near the tree tip. Through the electric field calculation, the local field enhancement at the tip of water tree path was also verified. Based on these results, it could be said that the water tree reduced the breakdown strength of XLPE because of the homo-charge concentration at the tip of water tree path, which resulted in the reduction of effective insulating thickness.

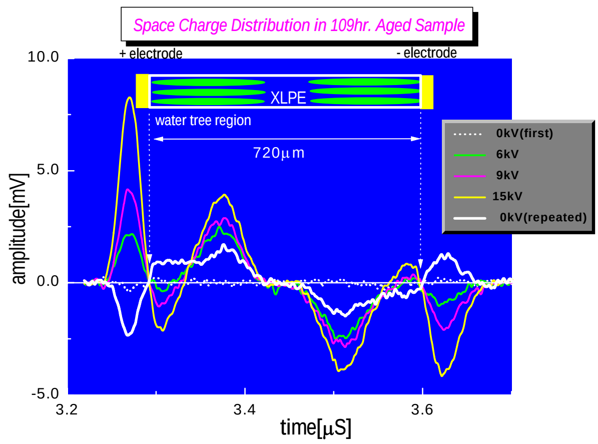

Fig. 4 Spacecharge distributions in double sided water tree sample as a function of applied voltages.

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