MATLAB Based Digital Analysis of Partial Discharges in Power System

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ABSTRACT

This paper presents topics in power capacitor advancement, Partial Discharge developments of dielectric materials and their applications including improvement of insulating oils, development of new insulating oils, and introduction of polypropylene films. A technical overview of capacitors used this simulation model for MATLAB based Digital analysis of partial discharges (PDs) in power apparatus. This work serves as a basis for future investigations, to provide a guide for those attempting to set acceptances levels to parameters of PD measured using digital techniques, and to present methods for the graphical representation of these parameters commercially available partial discharge (PD) detectors are described, along with their important characteristics.

Key Words: Partial discharge detector, Simulink Model

1. INTRODUCTION

material of high voltage power equipment is studied with the MATLAB simulink platform. In most of the high voltage (HV) power equipments are made of with different type of high quality insulation to protect against the high voltage tress. A variety of In high voltage (HV) electrical power system, variety of solid, liquid and gaseous materials are used for insulation purpose to protect the incipient failure inside the HV power equipment. Among these the solid insulation is widely used for high voltage power equipment HV electrical power system. Most of insulating materials are not perfect in all respect and contains always some impurities. The presence of air bubble is one of such impurities in insulating materials and highly undesirable for such type of insulation which causes a local weak zone inside the insulator. Insulation of the HV power equipment gradually degrades inside the insulator due to cumulative effect of electrical, chemical and thermal stress. Due to the high voltage stress the weak zone inside the insulator causes the partial discharge (PD) which is known as local electrical breakdown As a result the insulation properties of such materials are enormously degrades its quality due to the PD. In this work, the simulation of PD activity due to presence of a small cylindrical void inside the solid insulation

solid, gaseous, liquid and combination of these materials are used as insulation in high voltage power equipment [1-5]. Among those the solid insulation like epoxy resin is widely used, not only as a component of complex insulating system such as HV rotating machine insulation but also in indoor insulators, in transformers and in many different high voltage power equipments[1-2]. To access the quality of such insulation is a challenging task to the power engineers while the same power equipment is under operating with high voltage stress for a long period. The quality of such insulation plays an important role on HV power equipment in view of quality assessment. Large numbers of installed Medium Voltage or High Voltage power (MV/HV) cables are now of advanced age and have gradual insulation deterioration problems. Electrical supply industries have shown a strong interest to extend those cables in service with longer period than they were designed for. Based on the present replacement rate of installed MV/HV power cables, it would take a few hundred years to replace the entire network. The only option available to maintain the cables in good condition is to improve asset management methods. Asset management in a modern power system is focused on what is termed life cycle management of the equipment, which is critical to understanding the ageing process of the equipment components and the consequent impact on the equipment performance [1]. Many breakdowns in MV power cables are caused by damage due to digging activities [2], but are still more than half of the breakdowns in the cable network caused by internal faults in the insulation system of the cable network [3]. The appearance of PDs is a problem for insulation failure of high voltage equipment used in power plants. As the insulation of equipment is a sensitive zone therefore quality of insulation plays an important role in high voltage (HV) power equipment. It is found that most of the insulators are manufactured without avoided a small amount of impurity inside the insulator. The impurity of such insulating material is in the form of solid, gas or liquid. During the manufacturing process it is found that most of the solid insulation has impurity in the form of air bubbles (void) which creates a small weak zone inside the insulator. It weakens the insulation region and responsible for appearance of PDs with application of the high voltage.

2 ANALYSIS AND CLASSIFICATION OF PARTIAL DISCHARGE

The analysis and classification of partial discharge (PD) data of different origins. The data considered are simulated and experimental; both were generated by discharges in a gaseous dielectric under sinusoidal electric field. Following our analysis, we conclude that a nonlinear deterministic model can be more suitable than a linear stochastic model in application to PD data. Using the deterministic model, we demonstrate the results of classification of PD data on the basis of the error of prediction. Finally, we present the recovery of dynamics of two nonlinear interacting systems. This investigation is related to the problem of identifying dynamics of several different partial discharge sources.

2.1 ANALYSES OF THE PARTIAL DISCHARGE

The analysis and modeling of the partial discharge (PD) process is important in providing the means for quantification, classification and, ultimately, better understanding of the process and its effects on insulation degradation and the reliability of the insulation system. There have been attempts to model the PD process based on physical principles, for example, the algorithmic model of Patsch and Hoof [3] or the stochastic model of Heitz [2]. Instead of attempting to describe the process on the basis of the 'first principles' and for purposes important in engineering applications it is often sufficient and also interesting to model the observed data.

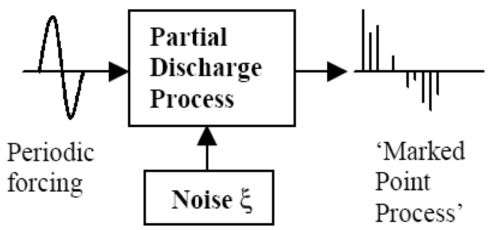


Fig. 1. Input-output representation of the PD process

The process of partial discharges can approximately be isolated from the environment and analyzed in this way as demonstrated an experimental setting, the PD event is observed by recording the current induced in the high voltage electrode. The peak value of the current and its time relative to the phase of the applied 50 Hz voltage are normally stored. Consequently, the information about the PD events is available as a series of 'magnitudes' and 'phases. Commonly, a static stochastic description is adopted for such a series and the PD process is presented on a phase-magnitude plot such as Subsequently, statistical measures are used to characterize the process. In our work, we are interested in time relationships or 'dynamics' in the sequences of PD events. In particular, we are inspired by the theory of processes which are nonlinear, deterministic and sensitive to initial conditions.

It was initially surprising that a process which is irregular in appearance can be generated variable. This phenomenon was first demonstrated by Ulam and von Neumann [4]. Later, it has become evident that for a deterministic process to generate 'apparently stochastic data' its rules of motion should be nonlinear and sensitive to initial conditions.

3. PARTIAL DISCHARGE SITE LOCATION IN POWER CABLES

Partial discharges are caused by various defects such as voids, shield protrusions, contaminants, advanced stages of water tree, etc and known the main cause of breakdown in insulation materials. Partial discharge (PD) location is a powerful and useful tool for the maintenance and operation of electrical power distribution cables. Power outages due to failure of cables or their accessories during operation could cause the forced interruption of critical processes, but in the current climate of electricity de-regulation; it is not acceptable anymore due to outage cost. It is therefore important to know the state of health of the cable network (as one of the asset) in an electricity supply system. Owing to faulty manufacturing processes or, to aging after several years of service, shielded high voltage power cables may develop various defects such as electrical tree or water tree within their insulation layer[1]. If the electric stress applied is high enough, these defects may cause PD. Locating PD sites in underground power cables is a powerful and useful tool for evaluating their conditions [2-3]. The incipient defects, which can lead to failure of the cable in service, are thus located. It is also possible to identify high-risk sections of circuits in advance and to replace just the few defective meters [4]. Thus one can prioritize different problem feeders and replace or repair them in according to asset management programs [4]. As a result, The reliability of a plant can be substantially improved if potential cable failure sites could be identified and corrected after their installation.

3.1 PARTIAL DISCHARGE MEASUREMENTS ON TURBINE GENERATOR

Partial discharge measurements are an important tool to assess the quality of the stator insulation of turbine generators. This work presents results of a study on the propagation of discharge signals in a stator winding. The results provide more insight into the complex electrical structure of a winding, and are used to explain measurements on generators during regular operation A novel PD (partial discharge) sensor has been developed which is able to unequivocally differentiate between PD in the winding and all types of electrical interference. This sensor, known as the stator slot coupler (SSC), is a wide-bandwidth directional electromagnetic coupler. The sensor requires no high voltage connection to the winding, and is easily installed in the stator slot, underneath the wedges. Using the inherent low-pass filter characteristic of the stator winding and the wide bandwidth of the SSC, noise is differentiated from PD by the shapes of the electrical pulses from the sensor. Experiments on operating turbine generators on which SSCs are installed have validated the theory of SSC. In addition, these installations have shown that the SSC does not degrade the overall reliability of the host generatorPower and Light Company decided that a program todetermine the remaining life of a coal-fired power plant's major components would help the company toplan its outages and avoid on-line failure of equipment. As a result, the Life Assessment & ManagementProgram (LAMP) was started with the help of an external consultant company. A part of this programrequired that Turbine Generators would be tested on each major outage to determine the quality of theinsulation material. The external consultant recommends stator rewind based on physical inspection, aninsulation resistance test and DC high potential (hipot) test. In addition, KCPL decided to undertake onlinepartial discharge testing [1]. As a result of these efforts, the rewind of Montrose Unit 2 stator was delayed for 9 years. This paper describes our experience on PD activities on Montrose Unit 2 from the installation of the bus couplers to the time of the stator rewind in the fall1) In 1991, the OEM recommended that the unit have a stator rewind recommendations was based on the OEM's inspection of the physical condition the stator slot and the end winding. The unit was then subjected to DC hipot test @1.25 X rated AC maintenance hipot (49 kV dc). The unit passed the DC hipot test and KCPL decided not to rewind the unit.2) In 1994, again the OEM recommended a generator stator rewind based on visual inspection. Again, the unit passed DC hipot @ 1.25 X rated, and the plant decided the unit is suitable forservice.3) In 1994 KCPL reliability engineers installed IRIS 80 pF 'bus' couplers to monitor the partial discharge of the stator windings.

4. SIMULINK MODEL

The simulink model of the proposed work is given below

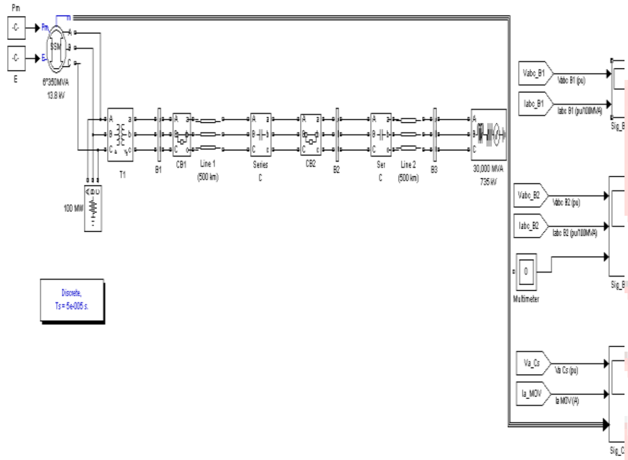


Figure 1. Simulink model of system

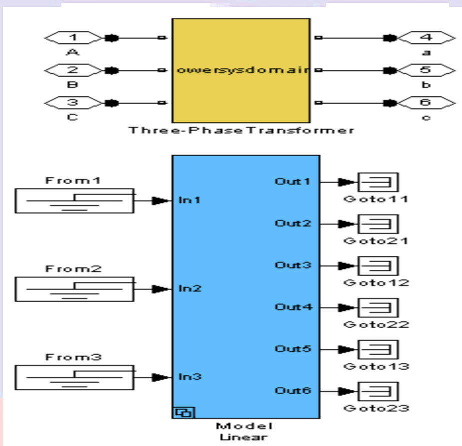


Figure 2. Three phase V-I measurement

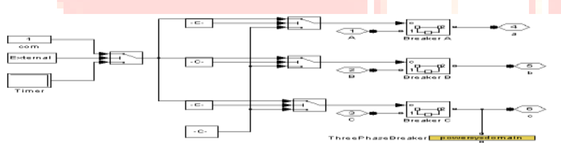


Figure 3. Three phase breaker

4. RESULTS

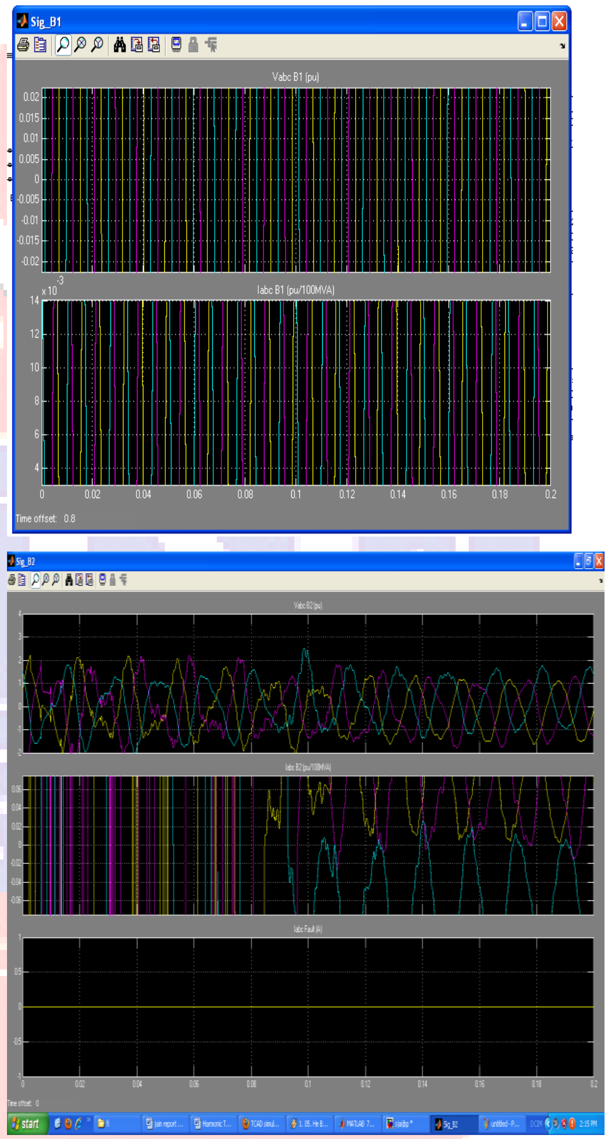
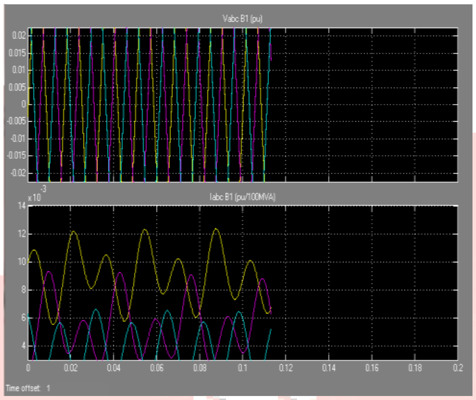
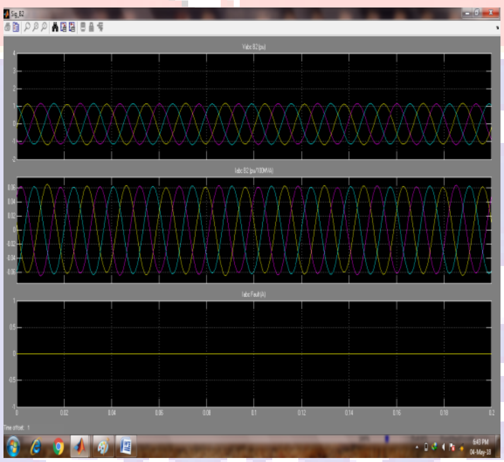


Figure 4. PD Total harmonic distortion





The results shown in the graph indicates the partial discharge as mentioned in Table 1 given below

S.No	VOLTAGE	PD AMPLITUDE
1	100	.2061
2	200	.2199
3	500	.2421
4	600	.2497
5	700	.2574

This chart clearly shows that partial discharge varies with respect to applied voltage

5. Conclusions

Partial discharges are a major source of insulation failure in high voltage power system which needs to be monitor continuously to avoid the incipient failure in the power systemNetwork. To understand the PD activity inside the solid insulation a MATLAB based simulink model has been developed in this work.

1. In this PD is increases with the increase of applied voltage in the form of Harmonic distortion inside the solid insulation.
2. In this study an efforts have been made to investigate the maximum PD magnitude with the help of harmonic distortion.

6. REFERENCES

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