REVIEW: PARTIAL DISCHARGE TEST FOR INSULATOR

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ABSTRACT

The insulation quality plays a significant role in high voltage grid instrumentality. It's been seen by power engineers that one in every of the foremost issues in high voltage (HV) grid is breakdown of insulators or degradation of insulators. Modeling of the partial discharge (PD) method permits a stronger understanding of the phenomena. Partial discharge breakdown (BD) characteristics underneath ac voltage application were obtained and mentioned at part and pressurized conditions. So it's necessary to watch the condition of the insulation property .Modeling of the partial discharge method permits a stronger understanding of the phenomena. In this paper the varied strategies for stuff testing introduced and comparative analysis for every methodology bestowed here.

Keyword: - *Insulator testing, partial discharge*

1. INTRODUCTION

Rapid growth in electrical power system has given the chance to guard the equipment's for reliable operation throughout their in operation life. The insulation quality plays a significant role in high voltage installation instrumentation. It's been seen by power engineers that one in every of the key issues in high voltage (HV) installation is breakdown of insulators or degradation of insulators. Because of the degradation of insulators in installation engineering alternative equipment's tends to present less potency. Insulators area unit the key equipment's in installation. For the aim of safety and higher potency, it's necessary to stay the insulators in a very healthy condition throughout its operation. Because the insulators area unit perpetually in impure kind because of presence of air bubbles/other impurities within the insulators, the native electrical breakdown therefore known as partial discharge (PD) is takes place because of the high voltage tresses. The failure of insulation arises because of the presence of partial discharges. Due to PD, the properties of such insulators deteriorate tremendously. Finally, the breakdown is takes place and full installation is folded. Therefore, continuous observance and detection that the one in every of the vital task for engineer to stay the high voltage power instrumentation in healthy condition. During this work, epoxy glue (i.e., Associate in Nursing dielectric) with a cuboid void (air bubble) as associate in impurity is taken for realization of actual PD activity within the insulator with the applying of high voltage oppression MATLAB Simulink atmosphere.

2. PARTIAL DISCHARGE METHODS

Transients associated with partial discharges in voids can be described in terms of the charges induced on the terminal electrodes of the system. The relationship between the induced charge and the properties which are usually measured is discussed. The method [1] is illustrated by applying it to a spheroidal void located in a simple disk-type GIS spacer. The correct explanation of partial-discharge transients can be attained only through the concept of induced charge. The application of this concept has enabled a partial-discharge theory to be developed through which the influence of all relevant void parameters can be correctly assessed.

This paper reports on the development of ICT enabled remotely operated high voltage laboratory (ICTRHVL) for on-line measurement of partial discharges (PDs) of a model transformer. The remotely operated high voltage

laboratory includes the partial discharge assessment facilities with ICT enabled technology will help the users to perform partial discharge tests and assessment on-line, in real time on real equipment, by sitting at their own place by local area network (LAN) as well as through the internet.

Fig.1:- A photograph of the schematic experimental setup of partial discharge measurement.

The most of the PDs occurred in the first (0-90°) and third (180°-270°) quadrant of positive and negative half cycle of the applied voltage, respectively, which indicates that the PDs present in the model transformer is 'floating partial discharge type'.

In some method [3], a simulation model for spherical cavities within a homogeneous dielectric material has been developed. The model is implemented using Finite Element Analysis (FEA) software in parallel with a mathematical package. This method provides many advantages over previous PD models because discharge events can be simulated dynamically and the electric field in the cavity can be calculated numerically.

It is found that certain model parameters are dependent on the applied stress and parameters that clearly affect PD activity can be readily identified, these parameters include; the electron de-trapping time constant, the cavity surface conductivity, the initial electron generation rate and the extinction voltage. The influence of surface charge decay through conduction along the cavity wall on PD activity has also been studied.

The established model [4] of the flashover of an insulator, whose surface is covered with a moist, conducting layer of pollution, envisages that it develops from the formation and bridging of a dry band by a partial-arc pre-discharge. This pre-discharge is assumed to possess arc characteristics, so that the electric field across the dry band will fall as the partial arc current increases. Observations of insulators which are only lightly polluted, however, show that pre-discharges are of low luminosity and rich in ultraviolet, and resemble the spark leader inception and extension sequence in air gaps. This is because the current limitation by low values of surface-layer conductance can inhibit the transition to an arc at the pre-discharge stage. An alternative model using simplified voltage-current equations is developed to represent these spark properties rather than an arc characteristic. The predictions of the partial-arc model and this new approach are both tested here, using published experimental data from light-pollution fog tests in the authors' laboratory. For this purpose, the partial-arc theory is further developed in order to reveal its implied prediction for the increase of pre-discharge length with applied voltage before flashover. A corresponding relationship is obtained for the increase of spark leader length using the new model. It is found that for light pollution, the dry-band spark model better represents the test data than the partial-arc model. Consequent predictions are made for the variation of flashover voltage with pollution severity in this regime, which may account for anomalous insulation failures.

Partial discharge detection system simulation model was established [5], including partial discharge model, measuring system for ultrasonic signals. Numerous figures of domain and frequency about ultrasonic signals are obtained and analyzed. Two ultrasonic bands of 20k~40kHz and 80k~140kHz for the partial discharge detection are chosen as characteristic parameters and input of support vector machine (SVM). SVM is used to recognize the discharge models and the recognition rate can reach up to 100%. The results prove that this method can recognize partial discharge effectively, which provides a new arithmetic for detecting ultrasonic signals.

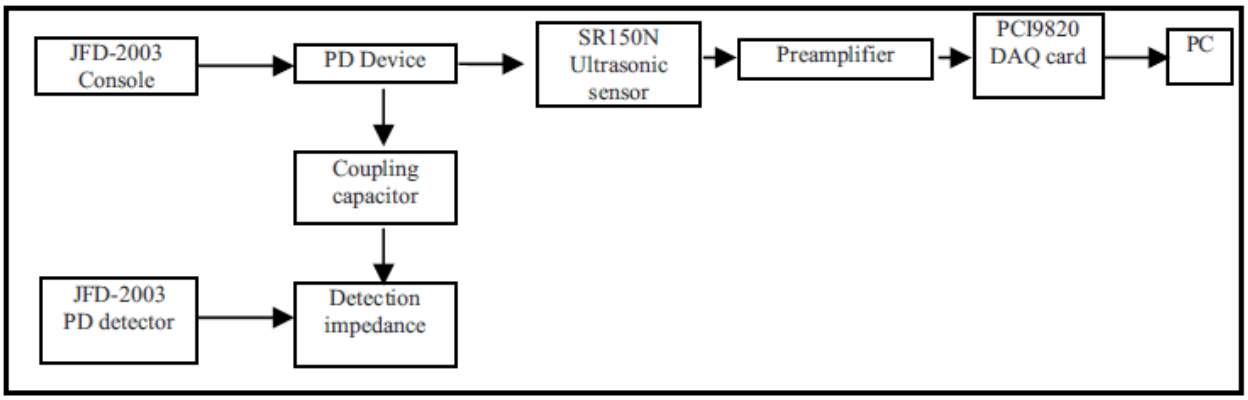

Fig.2:- The principle diagram of PD experimental device [5]

The challenges of partial discharges (PD) detection in high voltage cables using signal processing techniques based on time frequency methods combined with Recurrence Plot Analysis (RPA) and high order spectrum analysis (HOSA) was presented [6]. Detection of PD poses many problems in terms of speed of calculation and selection criteria, due to the nature of PD spectrum (frequency varying from a few hundreds of kilohertz up to hundreds of megahertz) and multitude of causes which lead to the occurrence of PD. These challenges take a great toll on the computing capability of today's PD detection systems. In order to overcome these drawbacks, author developed an algorithm which uses the spectrogram to perform a fast detection of parts from the signal which are susceptible of partial discharge (PD) activity. The second stage calculates for each zone a detection curve using the HOS concept of bi-spectrum and RPA. The latter has been applied in many non-linear systems in order to characterize the process on the basis of the recurrence matrix obtained from a time series given by the system.

Design and simulate the PD activity inside the cavity of various solid dielectric materials namely, Polycarbonate, Silicone Rubber and Silicon Carbide insulation exposed to high electric fields in various shapes of cavities (cylindrical, spherical and unsymmetrical) using a industrial simulation tool named COMSOL (Communication Solution) Multi-physics, and interface it with MATLAB was presented [8]. In this work, the simulations of PD activity within cavities in the insulation have been performed for different shapes and position of voids present in various insulating materials.

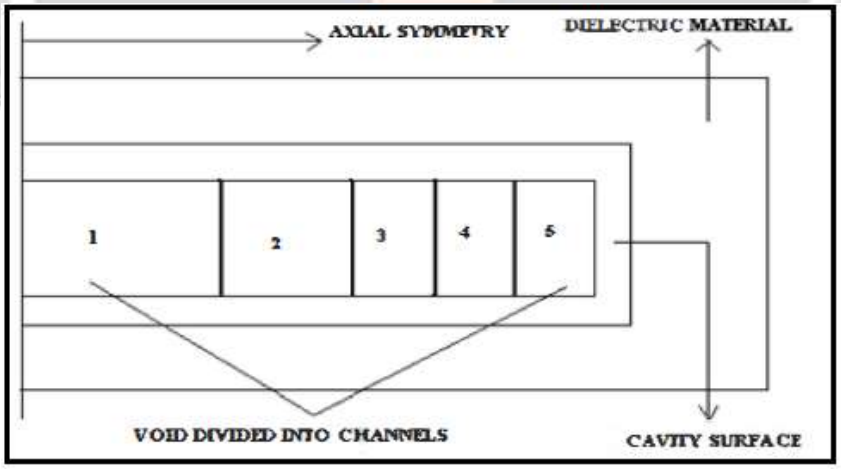

Fig.3:- Partial discharge model in COMSOL software.

Insulation of the power equipment gradually degrades inside the insulator due to collective 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. The simulation of PD activity due to presence of a small cylindrical and cubical void inside the solid insulation material of high voltage power equipment is studied with the MATLAB Simulink platform was presented [9].

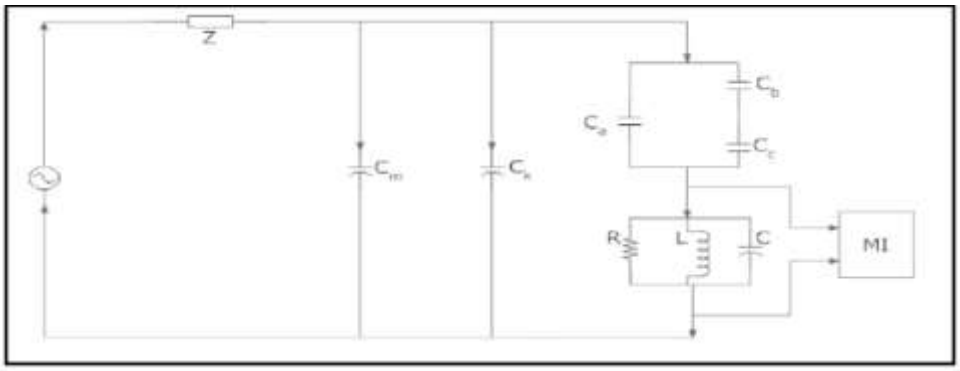

Fig. 4:- Electrical equivalent circuit model of void (test object) in solid insulation.

Table 1:- Different methods for partial discharge test on insulator or underground cable.

Sr. No.	Name of Author & Year	Title of paper	Methodology	Claim by Author
1.	G. C. Crichton, P. W. Karlsson and A. Pedersen (1989)	Partial Discharges in Ellipsoidal and Spheroidal Voids	Transients associated with partial discharges in voids can be described in terms of the charges induced on the terminal electrodes of the system. The relationship between the induced charge and the properties which are usually measured is discussed. The method is illustrated by applying it to a spheroidal void located in a simple disk-type GIS spacer.	The application of this concept has enabled a partial-discharge theory to be developed through which the influence of all relevant void parameters can be correctly assessed.
2.	R. J. Van Brunt (1994)	Physics and Chemistry of Partial Discharge and Corona	Results of recent research on physical and chemical processes in partial discharge (PD) phenomena are reviewed in which influence of memory propagation effects in controlling the stochastic behavior of PD is shown.	(1) Extend computer simulations of discharge growth to include the modifications of the local environment by residuals from prior discharge activity; (2) develop models that can predict the transition from a pulsating corona to a glow discharge; (3) develop models that predict the size of constricted glows in highly non-uniform fields.
3.	M. Farzaneh, T. Baker, A. Bernstorf (2005)	Selection of Station Insulators With Respect to Ice and Snow—Part II: Methods of Selection and Options for	Paper describes the selection process and mitigation options, based on the environmental parameters. These include insulator size, shape, surface material, surface quality, electric field improvement, and	The Task Force encourages further laboratory and field experiments on flashover data to improve the existing mathematical models.

		Mitigation	orientation.	
4.	S. Karmakar, N. K. Roy, P. Kumbhakar (2009)	Partial Discharge Measurement of Transformer with ICT Facilities	Development of ICT enabled remotely operated high voltage laboratory (ICTRHVL) for on-line measurement of partial discharges (PDs) of a model transformer. The remotely operated high voltage laboratory includes the partial discharge assessment facilities with ICT enabled technology will help the users to perform partial discharge tests and assessment on-line, in real time on real equipment's, by sitting at their own place by local area network (LAN) as well as through the internet.	With the inclusion of ICT facilities, PDs can be measured, monitored and analyzed from anywhere in the world by using the Local area network (LAN) as well as through the internet.
5.	R. T. Waters, A.Haddad, H. Griffiths, N. Harid and P. Sarkar (2010)	Partial-arc and Spark Models of the Flashover of Lightly Polluted Insulators	The partial-arc theory is further developed in order to reveal its implied prediction for the increase of pre-discharge length with applied voltage before flashover. A corresponding relationship is obtained for the increase of spark leader length using the new model.	The electric gradients normally associated with spark channels, on the other hand, are more in line with the measured values. The electric gradients normally associated with spark channels, on the other hand, are more in line with the measured values. It is possible that dry band spark-over can cause anomalous insulation failure in lightly polluted insulators.
6.	Hazlee Illias, George Chen and Paul L. Lewin (2011)	Partial Discharge Behavior within a Spherical Cavity in a Solid Dielectric Material as a Function of Frequency and Amplitude of the Applied Voltage	Discharge events can be simulated dynamically and the electric field in the cavity can be calculated numerically. The model has been used to study the effect of different amplitudes and frequencies of the applied voltage and simulation results have been compared with experimental measurement results.	When the applied frequency is increased, the total electron generation rate is higher, which causes higher number of PDs per cycle. The charge decay between two consecutive PDs is also less significant as the applied frequency is increased due to the shorter period of the applied voltage. When the applied voltage amplitude is increased, the total electron generation rate increases. Consequently, the number of PDs per cycle increase with increasing applied voltage amplitude.
7.	Rencheng Zhang, Erli Liu, Li Xie, Jianhong Yang	Arithmetic and Experiment Research on Ultrasonic Detection of Partial	Partial discharge detection system simulation model is established, including partial discharge model, measuring system for ultrasonic signals.	Ultrasonic signal is an early characteristic signal of PD, and the experiment shows that adopting ultrasonic testing method to detect PD is

	(2011)	Discharge for Switchboard	SVM is used to recognize the discharge models and the recognition rate can reach up to 100%.	feasible. The results shows that choosing the normalized value of power spectrum areas of 20k~40kHz and 80k~140kHz frequency bands as feature vector can represent the characteristics of PD. On the basis of detecting ultrasonic and choosing two feature vectors, least squares support vector machines (LSSVM) is supplied as a pattern recognition algorithm which can be successful used in PD pattern recognition.
8.	Qing Yang, Rui Wang, Wenxia Sima, Chilong Jiang, Xing Lan and Markus Zahn (2012)	Electrical Circuit Flashover Model of Polluted Insulators under AC Voltage Based on the Arc Root Voltage Gradient Criterion	This criterion can explain the variation of the arc root voltage gradient in the arc propagation process. Based on this criterion, a new distributed parameter electrical circuit flashover model of polluted insulators is presented. The arc channel is considered as an equivalent distributed parameter circuit model instead of using the arc voltage-gradient equation.	The calculation results are in good agreement with existing models and artificial AC pollution flashover tests, which verifies the electrical field concentration at the arc root in the process of arc propagation. In other words, the voltage gradient near the arc root increases.
9.	I. Candel, A. Digulescu, A. ¸Serb anescu and E. Sofron (2012)	Partial Discharge Detection in High Voltage Cables using Polyspectra and Recurrence Plot Analysis	Partial discharges (PD) detection in high voltage cables using signal processing techniques based on time frequency methods combined with Recurrence Plot Analysis (RPA) and high order spectrum analysis (HOSA).	A fast preliminary detection was made using the spectrogram in order to follow changes of the spectrum content in time
10.	L. Seenivasagam, R. VMaheswari, Dr.P.Subburaj (2013)	Modelling 01 Partial Discharge Behaviour in a Cavity within the Solid Dielectrics	The simulations of PD activity within cavities in the insulation have been performed for different shapes and position of voids present in various insulating materials.	The magnitude of electric field distribution is high for polycarbonate insulation and is less for silicone rubber insulation and silicon carbide insulation has the lowest value of electric field distribution. Thus polycarbonate insulation is less affected by the Partial discharge activity compared to other types of insulation system.
11.	Pragati Sharma, Arti Bhanddakkar	Simulation Model of Partial Discharge in Power Equipment	The simulation of PD activity due to presence of a small cylindrical and cubical void inside the solid insulation material of high voltage power	Based on the SIMULINK model partial discharge characteristics are plotted.

	(2015)		equipment is studied with the MATLAB Simulink platform.	

3. CONCLUSION

Partial discharge is the main problem in high voltage power equipment system. Therefore, finding and measurement of partial discharge is necessary to maintain the power equipment's in healthy condition during their operation. This paper review different methods for partial discharge methods. This paper useful for researcher and student those interested or doing research and study in insulator design, protection system design and magnetic tool deign in electrical engineering.

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