Mistakes During Partial Discharge Measurements of High Voltage Capacitors

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Abstract: This paper presents some common mistakes which should appear during partial discharge measurements in ca se of high voltage capacitors. The partial discharge measurements are a very sensitive measurement type, which have to be done in a shielded chamber. This kind of measurement should be disturbed by conducted low frequencies electromagnetic noises. For example the switching power supply of a Computerized Numerical Control machine, produce a high level electromagnetic noises, which some times is higher than the partial discharge produced by high voltage capacitors. Another kind of mistakes which should appear is the poor cable connections in the measurement system, which determines some discharges which appear at poor cable connections. This kind of mistake determine a very high amount of partial discharge measurement results. This kind of mistakes determine false measurement result or make impossible the measurement process, which affect the credibility of the measurement laboratory.

Keywords: coupling capacitor; partial discharge; high voltage;calibration

1 Introduction

The high –voltage capacitors are very important components for electrical devices, as capacitive voltage dividers and coupling capacitors. From power supply networks point of view, the high voltage capacitors are used in electrical substations, protection and monitoring systems, circuit breakers. Its can be divided in six groups: high-voltage capacitors, high-power capacitors, starting capacitors, energy storage capacitors, filter capacitors and discharge capacitors [1].

Before 1970s in high voltage capacitors manufacturing the most important dielectric was the impregnated kraft paper [2]. One of the most important advantage of the transition from impregnated paper to polymer film was represented by reducing of drying time before impregnation [3-4]. There are two manufacturing methods for high voltage film capacitors, one is the coil technology, which are using capacitor winding machine, and the second is the stacking technique, which stack the dielectric films [5-6].

2. Testing of high voltage capacitors

2.1. Partial discharge test

The partial discharge is a dielectric breakdown which appear in small portions of dielectrics. The partial discharge appear, when the strength of the electric field is higher that the insulation of the dielectric material in that point [7]. Tis situation appear when the dielectric contains an inner impurity like an air void for example. In Fig 1a is presented an energized dielectric material without any impurity or structural defect. The electric field inside of dielectric is homogenous. In Fig 1b there is an air void impurity. Typically, the electrical permittivity of air is lower than electrical permittivity of a dielectric material, this is the reason why the electric field will be higher in air void. That is mean in this place should appear first an electric discharge phenomenon if the level of electric field reach the necessary strength. Another result of this impurity is that the electric field is non homogeneous.

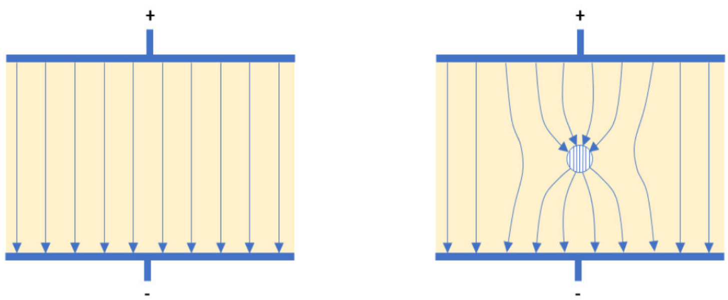

Figure 1a Figure 1b

Fig. 1. Two energized solid dielectrics [8]

In Fig. 2. is presented the partial discharge measurement system. It contains next components:

- voltage regulator from 0V to 400V
- step up transformer up to 200kV

- Coupling capacitor 200kV 1nF
- PD detector and measuring impedance

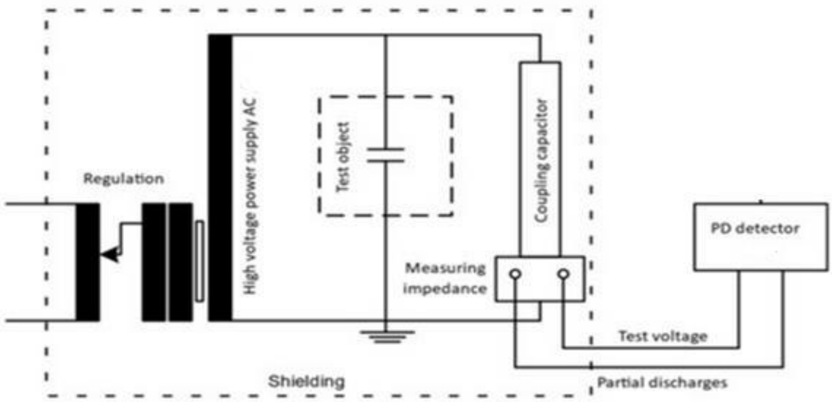

Fig. 2. Partial discharge measurement system

Because the measurements are very sensitives to electromagnetic noises, all the measurement system is located in a shielded room. An important step in measurements of partial discharge test is the calibration of the system. The partial discharge appears inside of the capacitor. The measurement system does not have direct access to inside of the capacitor only indirect access through capacitor body. This is the reason why before measurement of a capacitor type, the measurement system, have to be "teaching". The calibration has to be done with measurement setup from Fig. 2 and the system has to be not switch on. The calibrator, which is a known impulse generator have to be connected in parallel with the capacitor. The level of impulse depend, by capacitance of the capacitor. For example in case of 1nF capacitor it is enough 20 pC impulse, but for an 33 nF capacitor a 100 pC impulse has to be used. During the calibration test the measurement system gives information about background noises too. The background noise is influenced by the capacitance of measured capacitor. In Fig. 3 is presented the calibration and measured background noise in case of 1nF 100kV capacitor. The influence of the capacitor is low, and the background noise is under 1pC. In Fig. 4 is presented the calibration and the measured background noise in case of 33nF 30kV capacitor. From figure should be seen that in this case the background noise is influenced by the capacitor. The noise is around of 20pC. In Fig. 5. is presented a measurement results of a capacitor free from partial discharge. In Fig. 6. is presented a measurement results of a capacitor with partial discharges.

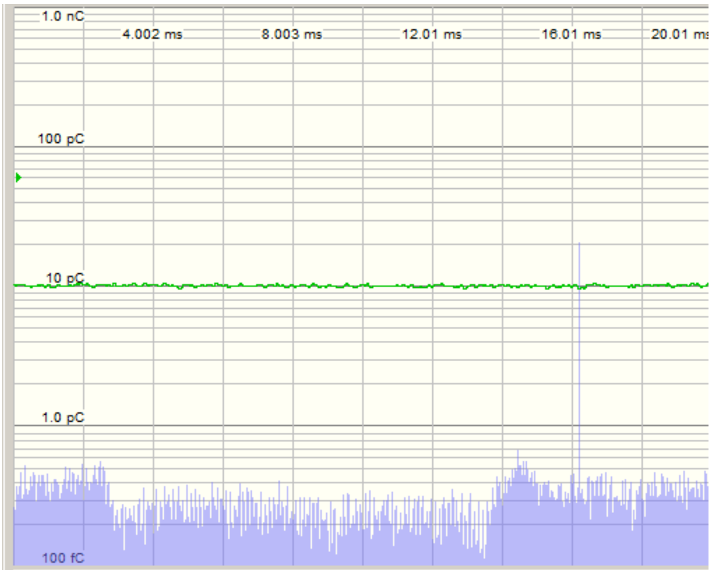

Fig. 3. Calibration and background noise of a 1nF 100kV capacitor

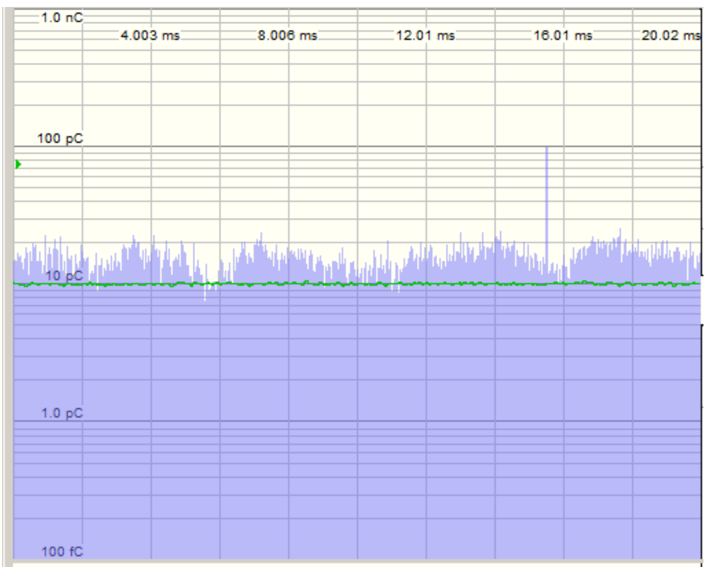

Fig. 4. Background noise of a 33nF 30kV capacitor

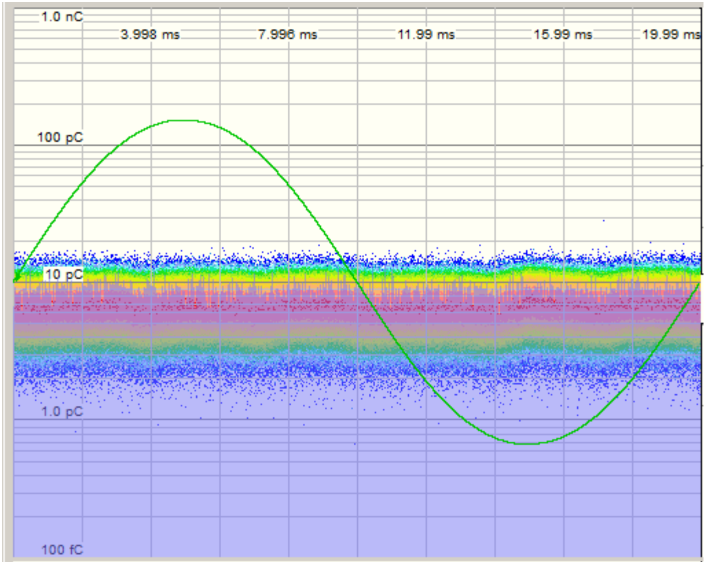

Fig. 5. Capacitor without partial discharges

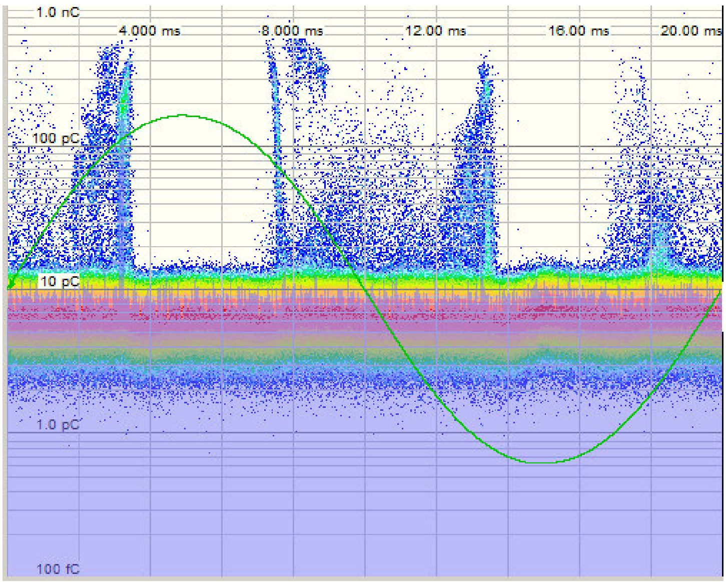

Fig. 6. Capacitor with partial discharges

In fig 6 is presented a measurement results where, the conection between measurement system and the tested capacitor is not the best. The result of measurement is falsch because the partial discharges are come from wrong conections and not from internal discharges. In fig 8 is presented a measurement result where the discharges are coming from a high power switching power supply devices.

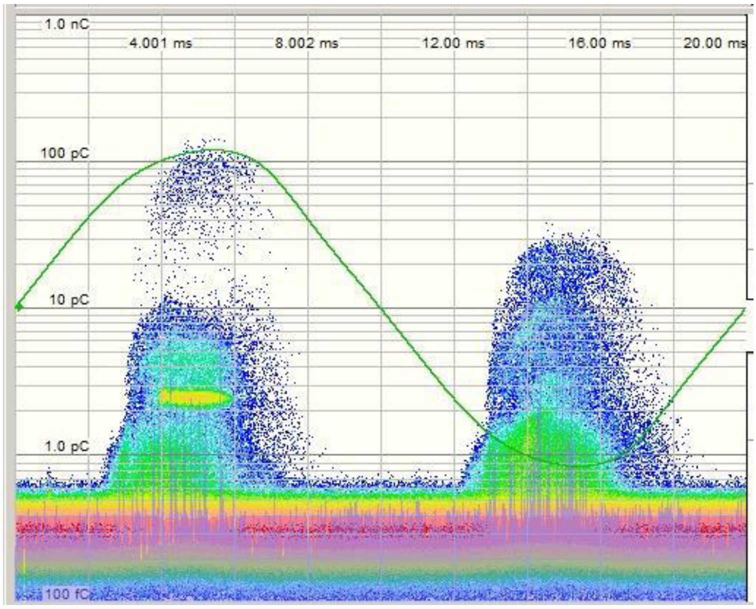

Fig. 7. Capacitor with wrong connection

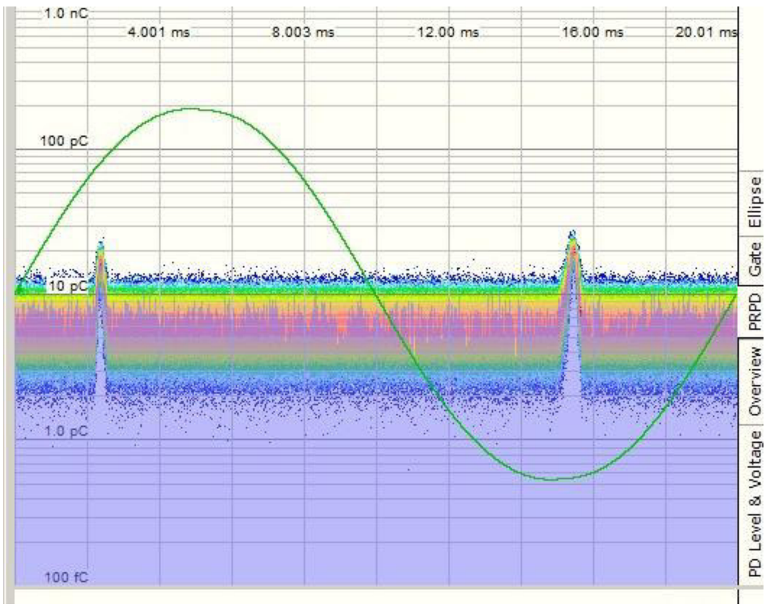

Fig. 8. Noises from power supply lines

Conclusions

During the partial measurement discharges is important to be sure that the measurement results is correct and it is not influenced by ambient noises or by measurement mistakes.

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