배전반 설비의 온라인 모니터링 및 진단의 동향

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Trend in Off-Line PD Monitoring with HVAC Testing

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Abstract : The paper considers the relation between on-line monitoring and diagnostics on the one hand and high-voltage (HV) withstand and partial discharge (PD) on-site testing on the other. HV testing supplies the basic data (fingerprints) for diagnostics. In case of warnings by on-line diagnostic systems, off-line withstand and PD testing delivers the best possible information about defects and enables the classification of the risk. Because alternating voltage (AC) is the most important test voltage, the AC generation on site is considered. Frequency tuned resonant (ACRF) test systems are best adapted to on-site conditions. They can be simply combined with PD measuring equipment. The available ACRF test systems and their application to electric power equipment -from cable systems to power transformers - is described.

Key Words : Ccables, Gas-insulated switchgear, Monitoring, Partial discharges, Power transformers

1. Introduction

Monitoring and diagnostics of power apparatus and systems are applied for cost reduction by avoiding of defects during service (with consequences up to blackout), application of condition based maintenance, extension of lifetime, etc. This introduction shall demonstrate that diagnostics of electric insulation is not an isolated method, but only successful considering interactions with high-voltage (HV) testing and previous test results.

The electric breakdown is a weak point phenomenon caused by a defect in the insulation. The defect might be the result of a production failure (to be detected by the routine test in factory) or a too high stress during transportation or an assembling fault (to be detected by the on-site test). But also the normal aging process of the whole insulation causes degradation as a volume phenomenon and only finally a weak point leading to breakdown. The described physical breakdown process enables the following classification of HV tests and measurements:

Whether a certain defect is dangerous or not at a fixed test voltage level can only be decided by a HV withstand test which is therefore characterized as a "direct" test. This direct test needs no interpretation, the result interprets itself directly. Each measurement of a different quantity and the conclusion for critical defects and breakdown requires a more or less physically or technically based knowledge rule. Therefore measurements deliver always an "indirect" test result of higher uncertainty than a direct test. Last but not least partial discharge (PD) measurements which measure also a weak point phenomena deliver a less uncertain result related to critical defects than dielectric measurands (e. g. tanδ).

2. Experimentals

The static frequency converter (Fig. 1) (FC) of the ACRF system generates four switching pulses (of few 10 microseconds each) which may influence the PD measurement. In modern PD measuring devices (PD) they can be suppressed by triggered windowing (tw). But in many cases they can also remain on a PD pattern (Fig. 2, D) because they are simply identified as noise signals.

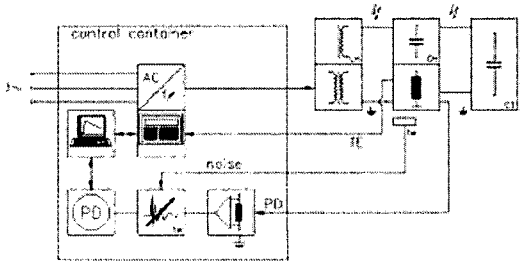

Fig. 1. ACRF test circuit for PD measurement.

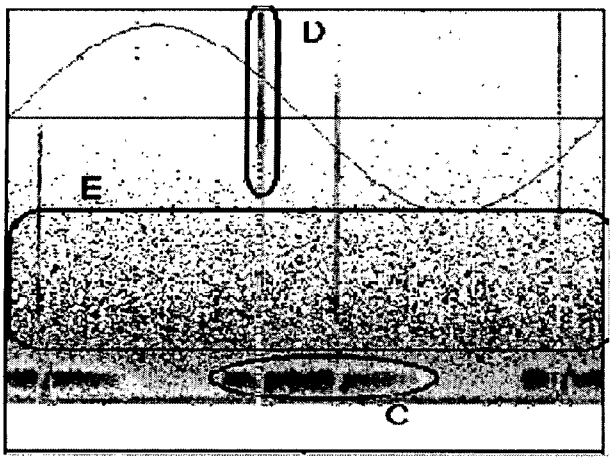

Fig. 2. Signal-to-noise relation for PD measurement at a frequency different from power frequency.

3. Results and Discussion

On-site testing of machines must be connected with PD and tanδ measurement. Whereas the PD behaviour is similar in a sufficiently wide frequency range [1], the dissipation factor depends on frequency by definition (power loss/capacitive apparent power). But more important than tanδ itself is its increase with voltage (Fig. 3) which is nearly independent of frequency. Therefore ACRF test systems completed with PD and tan δ measuring equipment are efficient tools for generator testing on site [1].

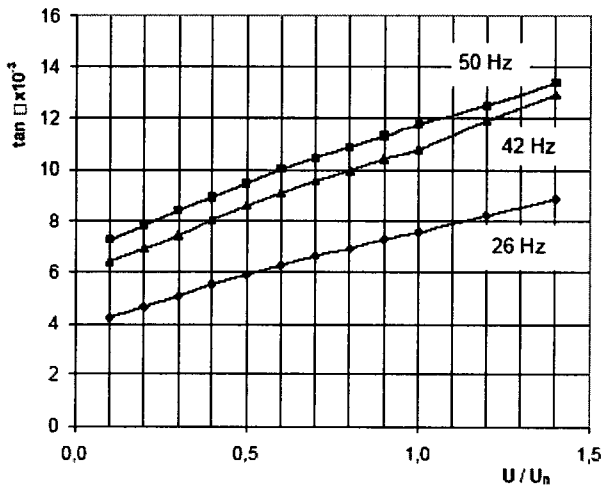

Fig. 3. Tanδ measurement at 50, 42, and 26Hz.

4. Conclusion

With respect to on-line monitoring and diagnostics, off-line testing and PD measurement is not unnecessary, but an important completion in case of a warning by the on-line diagnostic system. Off-line withstand testing in combination with PD measurement enables a classification of defects in connection with the life cycle record.

감사의 글

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참고 문헌

[1] IEC 60071:1993: Insulation coordination. Part 1: Definitions, principles and rules.