Study Group: Check the necessity to add a Special test to C57.19.00

Group Members

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Problem:

Partial discharge was detected in OIP bushings during the Low Frequency Test when current flew through the bushing, whereas the same bushings did not show partial discharge in cold condition.

1. We found this effect in 2 bushings during the reactor test
2. Another case of a transformer-bushing where no PD could be measured in cold condition although bushing had “high combustible gases” in service and “significant difference in Dissipation Factor before and after AC withstand test” was found in the literature [1].

[1] Mike Lau, 500KV BUSHINGS FAILURES AND BUSHING OIL SAMPLING PROGRAM, Internet, www.vieiraevarela.com.br/arquivos/MLauPaper.pdf

IEEE C57.19.00 offers only a Special Test called “Thermal Stability Test”, where 1.2 times the line to ground voltage is applied when the rated current of the bushing flows and where the Power Factor is evaluated.

Currently there is no test available which proves that the bushings are PD-free at the Overvoltage Test level of around 1.5 times the line to ground voltage when the rated current flows.

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Possible reasons for PD in warm bushings:

- Migration of water from the wet paper into the oil as a consequence of heating can result in a reduced PD inception voltage in oil

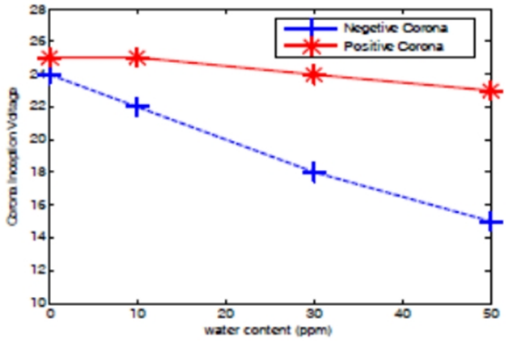

Fig. 15. Positive and negative corona inception voltage as a function of humidity

[2] M. Ghaffarian Niasar, H. Edin, "Corona in oil as a Function of Geometry, Temperature and Humidity", 2010 Annual Report Conference on Electrical Insulation and Dielectric Phenomena

The influence of the moisture on the PD inception voltage for a needle-plane geometry in oil is analyzed in [2]. The above graph from [2], Figure 15 shows that the negative corona inception voltage is lower for higher moisture in the oil.

The oil of the bushing in which we detected PD was analyzed at a later date. The moisture measured in the oil was 5ppm at around 20°C. As per the Oommen Curves this would correspond to 35ppm moisture in the oil at 55°C in steady state.
For 35ppm moisture in the oil, the negative corona inception voltage would have reduced by around 30% based on the curve given above.

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Possible reasons for PD in warm bushings:

- Surface discharge may be facilitated at higher temperature

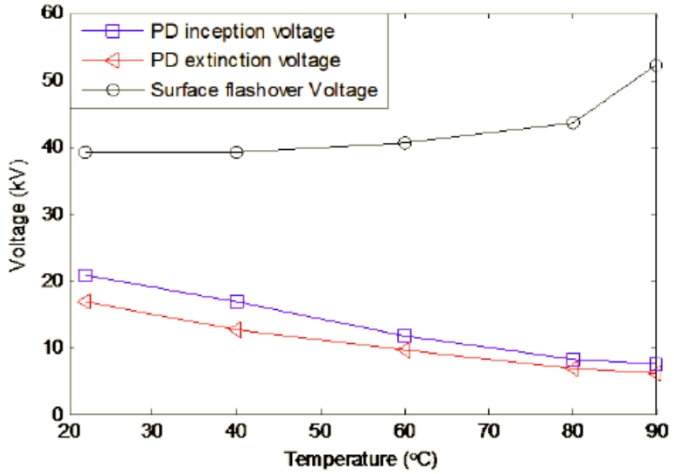

Fig. 3. PD inception, extinction and surface flashover voltage as a function of temperature

[3] M. Ghaffarian Niasar, R. Clemence, X. Wang, R. Nikjoo, H. Edin , "Effect of temperature on Surface discharge in Oil", KTH Royal Institute of Technology, 2012 Annual Report Conference on Electrical insulation and dielectric Phenomena

The effect of surface discharge on an "oil pressboard interface" is analyzed in [3]. The above graph from [3], Figure 3 shows that the PD inception and extinction voltage for surface discharge is reduced by approximately 50% if the temperature of the oil increases from 20°C to70°C.

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Possible reasons for PD in warm bushings:

- Potential contacts are lost due to thermal movements when the bushing is heated. Or parts become free floating and give rise to PD of some other reason during the test.

- Thermal movements of the oil could get "dirt" in the bushing to come into stressed volumes.

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Summary:

- The probability for this kind of failure seems to be low.
- The real root cause for the measured PD in the analyzed bushings was not found.
- Theoretical explanations for possible root causes were found in the literature and collected by the group members.
- The temperature of the bushing during the mentioned reactor-test where PD appeared, was still much lower than the temperature in service. The collected information from literature indicates that at the higher service temperature the risk for PD could be higher.

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Conclusions:

Is the proposed Special Test necessary?

4 Votes were received from the group members:

Steven Brzoznowski: I think the test is good and it does not sound like it would place an undue burden on suppliers to perform the test in the manner described.

Egon Kirchenmayer: With the proposed special test we could make sure that the risk for PD in a warm bushing is detected already at the suppliers site. Finally this could also help to reduce the risk for PD inception in service.

Loren Wagenaar: You, as the customer, can specify a special test in your specifications any time you wish. I still think that another routine test is premature.

Bengt-Olof Stenestam: I am not in favor of any extra test. If this kind of PD "more frequently" happens on different bushings and transformers/reactors then consideration must although be made. If this is the case, first it must be established the reason for the PD, so suitable tests/measures can be taken to prevent them from happening.

$\Rightarrow$ We did not come to an agreement about the necessity of this Special test.