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What methods exist for assessing the condition of composite insulators in service?

A question from a reviewer is what test methods are applicable for the condition assessment of composite insulators in service? Traditional methods are well-known and include visual inspections, IR-inspections and UV-inspections (sometimes electrical field measurements are also applied). Their pros and cons are summarized e.g., in [1].

Unfortunately, our recent practical experience in comparison of visual/IR/UV detection of core/housing issues in service followed by after-service investigations shows that the in-service detection is *too late* to reveal the defects in early stage (examples adopted from [2] are in Fig.1):

1. Visual inspection reveals punctures, which mean already developed conductive path in the interface
2. IR detection reveals hot spots, which again indicate already developed conductive path in the interface, also, there is no international consensus on criteria for critical temperature or critical length
3. UV detection reveals punctures, which again leads to item 1

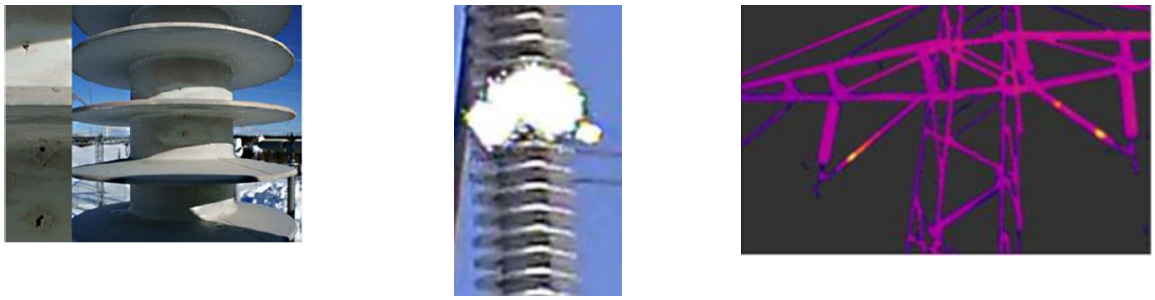

Fig. 1 Examples of in-service observations indicating issues in interface core/housing by using visual (left); IR (middle) and UV (left) inspection techniques.

Traditional in-service detection methods are also rather expensive, requiring advanced detection techniques. Often in-service inspections are outsourced for service providers, having low knowledge about design and technology of composite insulators.

Therefore, instead of in-service inspections, it is proposed the optimized maintenance of composite insulators based on the so-called “inspection-based maintenance”. The intention is to acquire limited number of insulators along with electrical and environmental data. Our paper 10828 describes test methods and criteria for validation of functional properties of composite insulators from storage specifically related to materials and interface core/housing. Similar test matrix was already tested on the insulators removed from service.

This was done by a group of eight European power companies (both TSOs and DSOs) together with the Independent Insulation Group (I^2G, Sweden). These results were combined with the results from Transgrid (Australia), and ESKOM (South Africa) and the comprehensive paper is expected at the end of 2022 [3].

The test array consisted of eighty-four (84) insulators removed from the overhead lines (OHL) for the investigations. The collected test array covers many different parameters:

- Insulators made by ten different manufacturers
- Different insulator designs such as standard, alternating and under-rib shed profiles, different designs of fittings and sealings, etc.
- Suspension and tension insulators.
- Different time in service (1-40 years).
- Different years of manufacturing (1981-2020).
- Different housing materials
- Different voltage and mechanical classes

Analysis of the results from three different programs for the after-service tests allowed to make a proposal for optimal matrix for such tests. The preliminary optimized minimum test program for insulators removed from service is as follows:

- Visual inspection

- Measurement of standard pollution parameters (ESDD/NSDD)
- Assessment of hydrophobicity class according to IEC TS 62073
- Measurement of hardness of housing according to IEC 62217,
- Measurement of dynamic hydrophobicity according to [2],
- Adhesion test of fiberglass rod/housing including water diffusion and pull-off tests according to [2]
- Dye penetration test on core according to IEC 62217,
- Inspection of cross-section of sealings
- Corrosion and saltwater boiling test of fitting/sealing proposed in [4].

The test matrix above makes possible to evaluate the following parameters of composite insulators:

- Ageing parameters
- Pollution parameters
- Choice of material considering dynamics of hydrophobicity
- Quality of adhesion core/housing
- Manufacturer's knowledge regarding control of the electric field in sensitive areas
- Manufacturer's knowledge regarding the sensitive sealing area.

References

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