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REGISTRATION NUMBER :	7293	QUESTION N° :	2.07

D1_PS2_Q2.07_T. Kondo

Question 2.07: In D1-10828 shows evaluates test methods and acceptance criteria for validating essential functional properties of composite line insulators. Experts are asked "What gaps still exist in standards which need to be addressed to improve ultimately in-service performance?"

Contribution for Q2.07:

Introduction for nitric acid immersion test and small-scale weathershed aging test on polymer insulators

Currently, the following three tests are required for polymer insulators in IEC in order to detect potential weakness in material and design, which compromise the insulator performance in-service.
Acid resistance test has been applied to FRP core, but not to housing material.

Properties	Test item	Reference
Tracking and erosion resistance	Test methods for evaluating resistance to tracking and erosion (Inclined plane test for housing material)	IEC 60587
Tracking and erosion resistance	1,000h salt fog test	IEC 62217
Resistance to chemical attack	Acid resistance test for FRP core	IEC TR 62039

*Acid water immersion test for housing material is described in Annex A of IEC TR 62039.

Under very heavy SPS condition, partial discharge can occur on insulator trunk at not only the line/ground ends but also at the center portion of the insulator, even if arcing and field control devices are applied at the ends. Fig. 1 shows the example of partial discharge activity in-service under the wet-polluted condition. Fig. 2 shows typical crack appearance observed on the removed polymer insulator. According to FT-IR analysis on the cracked area, evidence of nitric acid was confirmed as shown in Fig. 3.

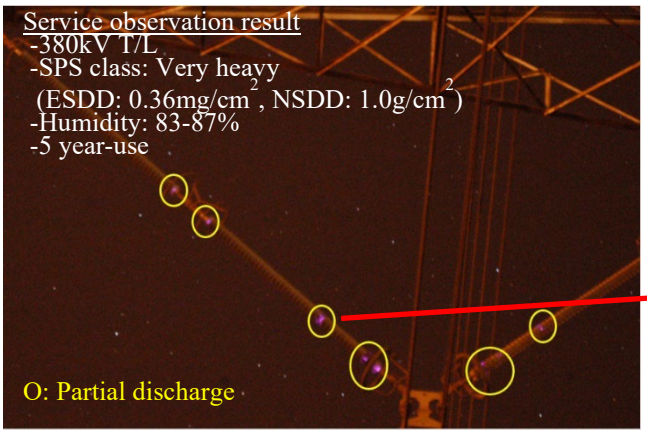

Fig.1 Partial discharge activity in service

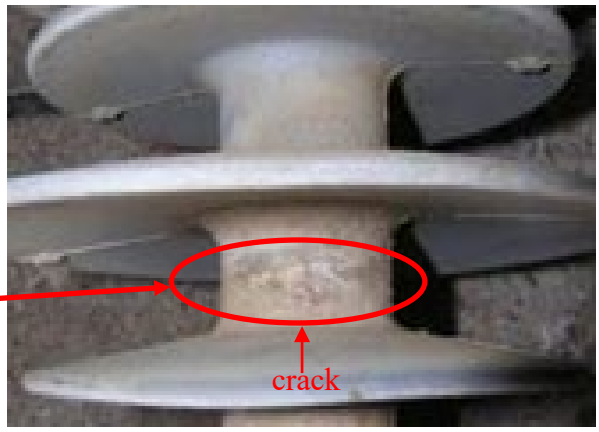

Fig. 2 Typical crack appearance on insulator trunk

(Note) SPS: Site Pollution Severity, ESDD: Equivalent Salt Deposit Density, NSDD: Non Soluble Deposit Density

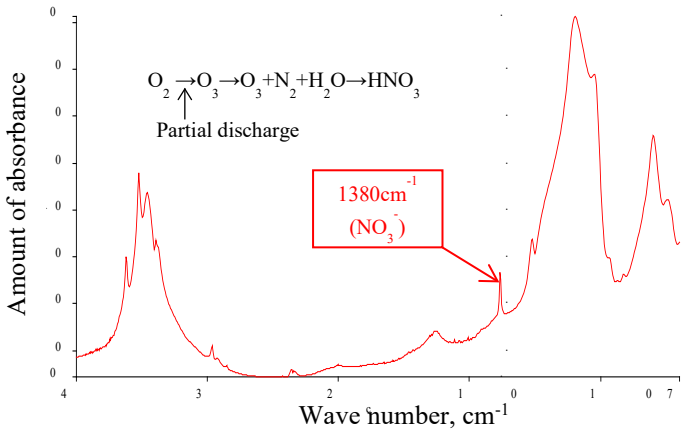

Fig. 3 FT-IR analysis on cracked area

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In order to evaluate housing material performance against nitric acid, newly evaluation method is proposed.
1. Nitric acid immersion test [1], [2] which is under consideration by CIGRE WG D1.62 as shown in Fig. 4.
2. Small-scale weathershed corona aging test [3], [4] developed by EPRI as shown in Fig. 5.

The appearance of the crack observed on the insulators in service is similar to that of the crack observed in these tests. These tests would be effective methods in order to evaluate nitric acid resistance of housing material.

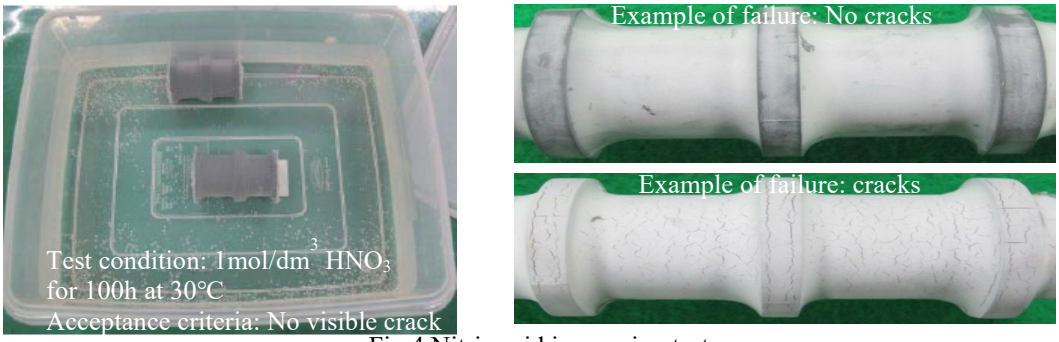
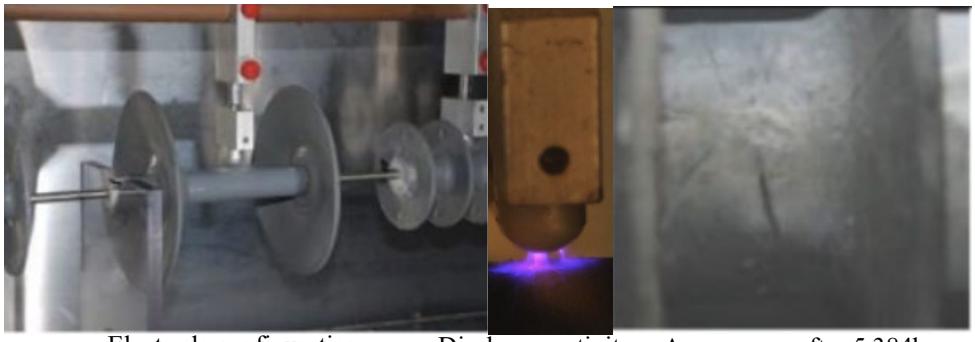


Fig.4 Nitric acid immersion test



Electrode configuration Discharge activity Appearance after 5,384h

Fig. 5 Small-scale weathershed corona aging test developed by EPRI

Test condition: 25 degree Celsius, 80% humidity for 6,000h
Apply voltage: AC 7.0kV, 60Hz corona source
Acceptance criteria : 1.Crack depth: Max. 80% of sheath thickness
2.Whitening depth: Max. 90% of sheath thickness

Our proposed contribution

1. The experience of cracks and deterioration of insulator trunk due to nitric acid generated by partial discharge under the wet-polluted conditions in-service has been reported.
2. Since nitric acid resistance test for housing material does not exist in the current standards, above two types of acid resistance tests are proposed to improve polymer insulator performance in-service.

References:

[1] IEC TR 62039 Ed.2.0 2021: Selection guidelines for polymeric materials for outdoor use under HV stress
[2] T. Nakachi, “Acid immersion test can mimic the naturally appearing environmental service conditions on silicone rubber for polymer insulators”, CIGRE contribution 2014
[3] A. Phillips, F. Bologna and T. Shaw of EPRI, “Small-Scale Test Chamber & Criteria for Evaluating Polymer Insulators”, INMR web site article on February 1st, 2020
[4] T. Kondo, R. Inoue and K. Edmonds, “New Accelerated Ageing test for Polymer Insulators”, ISEIM 2020