VOLTSHIELD – ANTI-POLLUTANT TREATMENT FOR GLASS AND GLAZED PORCELAIN INSULATORS

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ABSTRACT

The paper describes the development-testing of an anti-pollution treatment for glass and glazed porcelain insulators that makes the surface "non-stick" and improves the performance and durability.

INTRODUCTION

A "non-stick" glass surface treatment (ClearShield) has been successfully applied for many years to glass in buildings, marine vessels and transportation vehicles to resist atmospheric pollution and make the surface much easier to clean and keep clean. Following the success with architectural glass, it was proposed to apply the treatment to glass and glazed electrical insulators (VoltShield).

The method for applying this liquid product to vitreous surfaces such as glass and glazed porcelain is simply to spray or pad it onto a chemically clean and dry surface. The product is a polymeric resin that chemically cross-links with the glass surface to form a ultra-thin but highly durable protective barrier. Atmospheric pollutants that normally bond firmly to the surface and cannot be removed by conventional cleaning methods do not attach. Especially in non-urban areas most, if not all, of the pollutants are washed away by rainfall.

Obviously, any new product must be tested to ensure that it is fit for purpose. This paper describes how we have planned and executed a test programme.

The tests have been made to complement each other.
1. High voltage laboratory tests
2. "Live" atmospheric pollution tests on high voltage systems.
3. Artificial-pollution tests on treated and untreated samples.

1. HIGH VOLTAGE LABORATORY TESTS

Initial "wet" tests (IEC 60060-1) at Allied Insulators' High Voltage laboratory showed that treated 33kV post-insulators had an improve corona inception level and a higher flashover level than untreated insulators (up to 18% improvement) [1].

Fig. 1 - VoltShield Treated Insulator

Fig. 2 - Untreated Insulator

Third rail railway insulators also showed similar improvements under wet-test conditions [2].

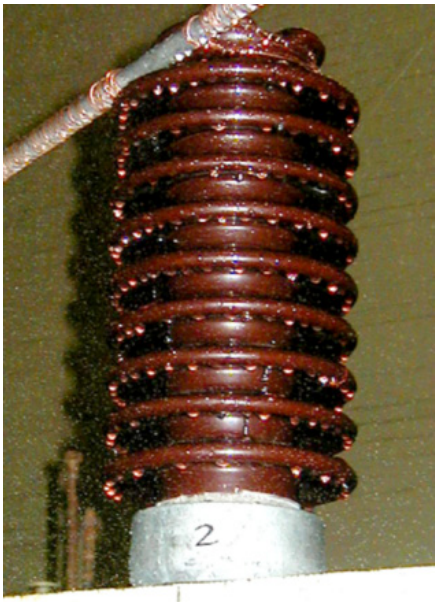

Fig. 3 - Test Assembly

Further tests (to National Grid Test Specification) have been made at the NaREC High Voltage laboratory on 400kV suspension insulator strings.

One string consisted of nineteen porcelain insulators on a simulated tower together with twin conductors. Another string comprised the same metalwork but with the porcelain insulators pre-treated with Ritec VoltShield.

Comprehensive Radio Interference Voltage (RIV) tests and Corona Extinction tests were made on individual and on complete strings. Dry lightning and Wet switching impulse tests were made up to 1500kV.

The performance of the treated insulators was as good as the untreated insulators showing that under these onerous high voltage tests the treatment did not affect the performance of porcelain insulators.

The earlier wet-tests at power frequency showed the improvement under steady state conditions [3].

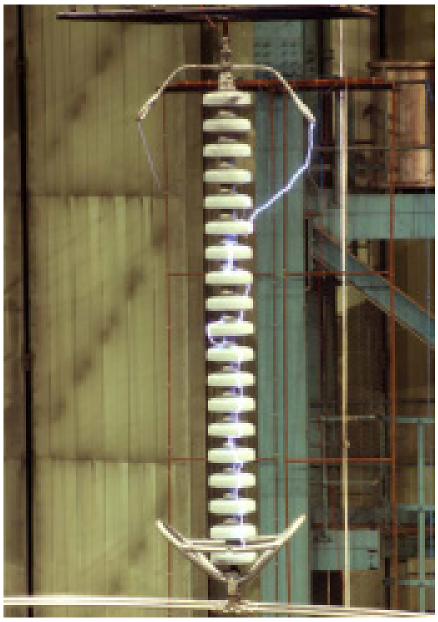

Fig. 4 - Typical Wet SI

2. "LIVE" ATMOSPHERIC-POLLUTION TESTS ON HIGH VOLTAGE SYSTEMS

Experience with the use of VoltShield treatment on insulators has been successful for a number of examples. CVTs on a distribution system were having noise problems because of condensation in the enclosure. The application of VoltShield to the insulation cured the problem. Some polluted Japanese 33kV transformer bushings were also giving problems; these too were able to be restored to an "as-new" condition by Ritec cleaning, drying and the application of VoltShield.

VoltShield insulators have been installed near a station on the London Underground system (alternating along the track with untreated insulators). So far results with the treated insulators have shown an improvement over the untreated insulators.

Tests have been made on a much-polluted site on the National Grid 400kV system. Insulators on eleven towers were treated with different types of anti-pollution coatings and some were treated with VoltShield. The tests have been ongoing for 18 months now and no flashovers have been reported.

3. ARTIFICIAL POLLUTION TESTS ON TREATED AND UNTREATED SAMPLES IN LABORATORIES

We have discussed the testing of actual insulators to show that VoltShield meets the requirements of international standards. There are also standards that have been prepared to enable different materials to be proven.

In order to study VoltShield as a treatment, we need to work to a standard for materials and study how VoltShield works under laboratory conditions and to be able to examine the modified surface. The samples were tested to BS EN 60587 standard to evaluate resistance to tracking erosion. The study presented the changes occurring on the surface of VoltShield-treated toughened glass samples. The surface was observed with SEM imaging. The results showed that the VoltShield-treated samples not only passed the standard requirements but there was an average of 15% increase in the wet flashover performance [4].

The SEM images did reveal some micro-cracks on the surface due to stress failure. Any failure in the surface treatment will reveal the original insulating glass surface.

Experimental setup

Fig. 5 - Complete Apparatus Assembly

The glass samples were 50 x 80mm. Because the samples were of toughened glass the samples were not drilled but clamped on a jig. Fig. 5 shows the test assembly. The contaminant (0.1%NH_4Cl) was fed through a tube system and an 8-layer filter paper pad. Method 2 - a stepwise increase in applied voltage was used.

Surface Analysis

After completion of the tests, the samples were taken to the University of Newcastle upon Tyne 'Advanced Chemical and Material Analysis' facilities. The samples were prepared using a sputter coater to produce a thin gold coating. The surface of the samples was imaged with a Scanning Electron Microscope.

Results

The first sample tested was untreated. The end point criterion 'A' (current exceeds 60mA) was 1.5kV. The end point for the following five treated samples ranged from 1.750 to 2.5kV.

Corona discharges were less active on the VoltShield samples. The droplets of the liquid-contaminant were seen to be reduced in size.

Those treated samples that did fail did so at a higher voltage and sustained corona for longer. The SEM images showed that there could be some surface cracks due to the heat from the corona although another showed an unaffected surface. (see figs 6 and 7).

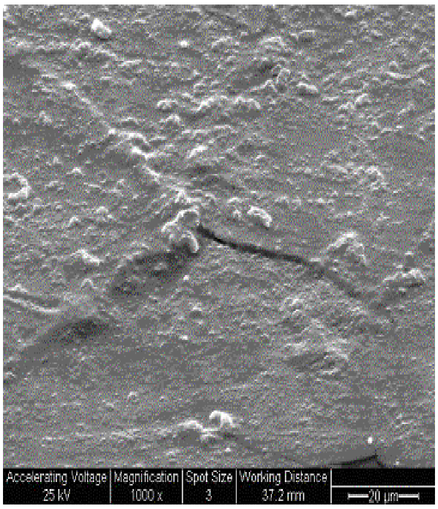

Fig. 6 - SEM surface image of VoltShield treated glass sample 2. x1000 20µm

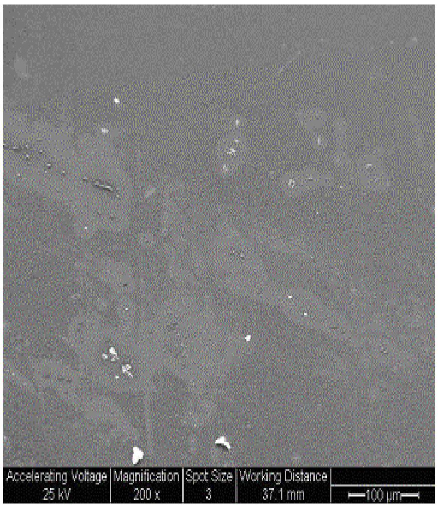

Fig. 7 - SEM surface image of VoltShield treated glass sample 3. x200 100µm

Future Work

Further testing is recommended. Samples of smaller size, although not conforming to the actual standard BS EN 60587 would be more suitable for SEM imaging.

In conjunction with National Grid Ritec are to test some full size 400kV insulators in a salt-fog chamber. These tests will be made on insulators used in sub-stations. Further artificial pollution tests are also planned in a smaller University laboratory.

CONCLUSION

VoltShield treatment improves the alternating-voltage corona-inception and flashover voltages of glass and glazed-porcelain insulators under wet-test conditions.

Tests have been made on railway insulators (750V system) 33kV post insulators and 400kV overhead-line insulators. Because the electrical stress per insulator is similar the tests will be applicable to Distribution voltage systems.

More tests (salt-fog) will be made on sub-station insulators such as post insulators, bushings and VTs.

VoltShield is more than a coating to be applied as a palliative for high voltage insulators. Just as glazing improves the insulation surface of ceramic insulators, VoltShield enhances the insulation properties of the glaze. Further tests have demonstrated that VoltShield-treated insulators meet international standards.

We shall continue monitoring laboratory test results as well as actual field experience to ensure that the use of VoltShield will continue to improve the performance of high voltage insulators under attack by atmospheric pollution.

REFERENCES

[1] HVL TEST Report No HV 383
Comparative wet power frequency electrical performance test between standard 33kV post insulators and the same insulators after VoltShield treatment

[2] HVL Test Report Ref HV381
Evaluation of VoltShield Insulator Treatment on Third Rail Insulators

[3] NaREC TEST REPORT No TR/L/08/33
To compare the performance of a 400kV suspension insulator string with porcelain insulators treated with Ritec VoltShield surface treatment to and identical string with untreated insulators
Test made to
IEC 60060-1; 1989 (corrigendum 1992)
IEC 600383-2: 1998 (+ amendment No.1)
IEC 60437 1997-09 2nd edition
IEC61284 1997 – 09 2nd edition
TS 3.4.17 – Issue 2 (Sept 2006 National Grid document)

[4] N. Evagelos, 2008, *"Tests on nano-coating of glass samples".*
MSc Report in Renewable Energy Flexible Training (REFLEX)
University of Newcastle upon Tyne

BS EN 60587:2007
"Electrical insulating materials used under severe ambient conditions – Test methods for evaluating resistance to tracking and erosion"

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