Anti Flashover Solution for Transmission line and Substation Equipment

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Flashover of power equipment

Flashover is one of the main problems that threaten the safe operation of the power equipment.

Due to the changes in the global climate and environment, the heavy fog, rain and snow and other bad weather are increasing, and the outdoor insulation flashover frequently occurs, causing great losses to the national economy. How to take effective measures to prevent the occurrence of flashover is an urgent problem for the power company.
In order to solve the flashover problems, it is necessary to understand all kinds of flashover mechanism of insulators.
Flashover mechanism of outdoor insulation --- Rain flashover

**Porcelain**: a hydrophilic medium (a contact angle less than 90°)
The surface is easy to form continuous water films, which might result in pollution flashover.

A water-drop contact angle on the clean surface of a porcelain insulator is far less than 90°, and a continuous water film could simply form on the surface.
Foggy weather, drizzle, and condensation. Cause the surface of porcelain insulators to be moist.

The decrease of surface resistance leads to the increase of leakage current, which leads to the formation of dry zone and wet zone.

The dry zone bears most of the voltage and thus appears partial discharge.

Ultimately causing pollution flashover.
During the rain, most of the water film on the surface of the insulator is uneven and discontinuous, and most of the applied voltage is borne by the undampened surface.

When the rainfall is larger, the rainwater bridged adjacent two sheds, the high conductivity of rain water is very easy to cause breakdown.
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Traditional anti flashover solution

Manual cleaning

- Passive treatment
- High risk
- Power cut operation
- Cannot prevent rain flashover & icing flashover

RTV/PRTV Coating

- PRTV is prone to aging and loss of hydrophobicity
- Repeated spraying, high cost
- Cannot effectively prevent Rain flashover & Icing flashover
- Serious environmental pollution
SHEMAR anti flashover solution: Silicone Jacket

- Porcelain Insulators
- Silicone Jacket
- Adhesive

Under 625g counterweight
Shemar anti flashover solution

**Technical advantage :**
- Increase the creepage distance of insulators
- Improve the partial hydrophobicity
- Obstruct the formation of rain bridge

**Performance advantage :**
- It is made of HTV material and has excellent aging resistance.
- Full clad structure with high strength and not easy to deform
- High construction efficiency
Both HTV and PRTV have good hydrophobicity, but the hydrophobicity of PRTV will decrease obviously with time. Therefore, Shemar has conducted a comparison test between HTV and PRTV about their materials hydrophobic transport.
Performance advantage --- Excellent material hydrophobicity

The first pollution painting:

**HTV Sample**
- drying for 30min: 77.3 °
- drying for 60min: 117.4 °

**PRTV Sample**
- drying for 3 hour: 30.1 °
Performance advantage ---Excellent material hydrophobicity

The fourth pollution painting, after repeated cleaning:

<table>
<thead>
<tr>
<th>HTV Sample</th>
<th>PRTV Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>drying for 30min; 111.8°</td>
<td>drying for 24hours; 44.3°</td>
</tr>
<tr>
<td>drying for 24hours; 119.9°</td>
<td>drying for 24hours, placed static for 5 min.; 104.0°</td>
</tr>
</tbody>
</table>

Conclusion: the PRTV coating is thin, which contained less small molecules with hydrophobicity migration. Silicon jacket is thicker, and its interior contains more molecules with hydrophobicity migration, which can show the characteristics of long time hydrophobicity and hydrophobicity migration.
Performance advantage --- Excellent anti pollution flashover performance

Test sample :

A: Porcelain transformer bushing  
B: Porcelain transformer bushing with RTV  
C: Porcelain transformer bushing with 3 SJs  
D: Porcelain transformer bushing with 4 SJs  
E: Porcelain transformer bushing with 6 SJs

Test conditions :

1. Pollution grade: severe pollution, equivalent SDD 0.2mg/cm², equivalent NSDD 1.0mg/cm²
2. Standing for 4 days after spraying pollution, and carry out the artificial pollution test.
3. Reference standard : IEC60507

The surface bedaub  
Fogging environment
<table>
<thead>
<tr>
<th>No.</th>
<th>Sample</th>
<th>Flashover voltage ( kV )</th>
<th>Average flashover voltage ( kV )</th>
<th>Flashover voltage increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>A</td>
<td>Porcelain bushing</td>
<td>93.5</td>
<td>89.2</td>
<td>92</td>
</tr>
<tr>
<td>B</td>
<td>Bushing with RTV</td>
<td>160.6</td>
<td>155.9</td>
<td>154.8</td>
</tr>
<tr>
<td>C</td>
<td>Bushing with 3 SJs</td>
<td>145.8</td>
<td>130.6</td>
<td>142.2</td>
</tr>
<tr>
<td>D</td>
<td>Bushing with 4 SJs</td>
<td>160.3</td>
<td>171.3</td>
<td>157.1</td>
</tr>
<tr>
<td>E</td>
<td>Bushing with 6 SJs</td>
<td>239.9</td>
<td>231.8</td>
<td>238.5</td>
</tr>
</tbody>
</table>
Performance advantage --- Excellent anti icing flashover performance

The post insulator without silicon jackets was totally covered by ice, and the sheds were all bridged by ice. But at the same condition, the post insulator with silicon jackets blocked the ice cover effectively.
Performance advantage --- Excellent anti icing flashover performance

The arc develops along the ice bridge until the flashover occurs.

Air breakdown along the end of the ice edge

<table>
<thead>
<tr>
<th>No.</th>
<th>Test sample</th>
<th>Flashover voltage (kV)</th>
<th>Voltage increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>110kV porcelain post insulators</td>
<td>36.5</td>
<td>/</td>
</tr>
<tr>
<td>2</td>
<td>110kV porcelain post insulators with 3 SJs</td>
<td>75.9</td>
<td>108%</td>
</tr>
</tbody>
</table>
Performance advantage --- Excellent anti rain flashover performance

<table>
<thead>
<tr>
<th>Voltage level</th>
<th>Test sample</th>
<th>Rain flashover voltage (kV)</th>
<th>Increase rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>110kV</td>
<td>porcelain post insulators</td>
<td>277.3</td>
<td>/</td>
</tr>
<tr>
<td></td>
<td>With 3 SJs</td>
<td>350.7</td>
<td>26.5%</td>
</tr>
<tr>
<td>220kV</td>
<td>porcelain post insulators</td>
<td>470.9</td>
<td>/</td>
</tr>
<tr>
<td></td>
<td>With 4 SJs</td>
<td>535.7</td>
<td>13.8%</td>
</tr>
<tr>
<td></td>
<td>With 8 SJs</td>
<td>587.1</td>
<td>24.7%</td>
</tr>
</tbody>
</table>

the arc path formed along the rain bridge

Air gap breakdown between silicon jackets

Performance advantage --- Excellent anti rain flashover performance
Full life cycle cost advantage ---Comparison of silicone jacket and RTV coating

For one 400kV BPI, the cost comparison is shown as below.

<table>
<thead>
<tr>
<th>Total area(Sq.M)</th>
<th>Area painted per Kg</th>
<th>Total Qty Required in Kg</th>
<th>Total Material price in Rs.</th>
<th>Total application Cost in Rs.</th>
<th>Grand Total (Rs.)</th>
<th>Life (yrs)</th>
<th>Cost for each year(Rs.)</th>
<th>Total cost for whole life cycle(Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rs.4000/Kg</td>
<td>Rs. 400/Kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(A)</td>
<td>(B)</td>
<td>(A+B)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.88</td>
<td>2.35</td>
<td>27.92</td>
<td>111,672</td>
<td>11,167</td>
<td>122,839</td>
<td>6</td>
<td>20,473</td>
<td>614,196</td>
</tr>
</tbody>
</table>

Specifications of silicone jacket

<table>
<thead>
<tr>
<th>Specifications of silicone jacket</th>
<th>No. of jacket for each equip.</th>
<th>Unit price for jacket in Rs.</th>
<th>Total price for jacket(EX W in Rs.)</th>
<th>Life (yrs)</th>
<th>Cost for each year(Rs.)</th>
<th>Total cost for whole life cycle(Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ/QJ65THZ/φ465 × φ245 × 2.5</td>
<td>9.00</td>
<td>4,510</td>
<td>162,360</td>
<td>30</td>
<td>5,412</td>
<td>162,360</td>
</tr>
</tbody>
</table>
Service for anti flashover solutions
- Easy site installation compared to traditional solution

RTV Coating
- Can only be performed during scheduled shutdown plan
- Installation complicated & costly
- Not environmentally friendly

Silicone jacket
- Can be performed during scheduled or unscheduled shutdown
- Easy Installation
- Environmentally friendly
Service for anti flashover solutions - site installation

Shemar promised: we are fully responsible for the installation of each of the silicon jacket to ensure safe operation in the service life.
The service of the anti flashover solution

- **Fast design:** after the response, the design is completed within 24h.
- **Rapid installation:**
  The repair order: 4 days after the response to the site,
  the regular order: according to the customer blackout plan to complete the construction and installation;
- **Regular visits:** regular return visits, collection of users' opinions, so as to improve the quality of service for the anti flashover silicon jacket.
- **Maintenance free:** Shemar promises silicone jacket to be maintenance-free in the service life.
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Application of anti flashover solution

Covering 150 power stations in China, nearly 30 provinces.

Voltage grade:
- AC: 35kV-750kV
- DC: ±400-800kV
Application in India

In April 26, 2017, the anti flashover solutions to complete the construction and installation in 400 kV HVDC substation of Andhra Pradesh in India, officially put into operation.
Anti-flashover Solution pilot project for 765/400kV Jhatikara substation, Delhi, India.

Utility: PGCIL, NR 1

COD: March, 2019
Thanks!