Performance of Insulators under Impulse, AC and HVDC Voltage.

Olanrewaju Lasabi
University of KwaZulu-Natal, Durban

Paper Number 2.03
Session 2
15 November 2017
Outline of Presentation

- Introduction: Outdoor Insulators
- Research Objectives
- Experimental Procedures
- Experimental Setup
- Experimental Results and Discussion
- Electric Field Analysis
- Conclusions
Outdoor Insulators

• Function of an Insulator: Mechanical and Electrical.
• Types of Outdoor Insulator
  – Ceramic: Glass and Porcelain.
  – Non-ceramic: Composite or Polymer.
• Outdoor insulators experience climate and high electric stresses.
• Insulator surface encounter physical or chemical changes.
• Insulator discharge during the rainy season.
• Electric field distortion.
• flashover scenario exists in HVAC and HVDC transmissions.
Objectives of Paper

• Investigation of the flashover performance of a 22 kV insulator.

• Analyse the breakdown voltage when the insulator is energized by AC, standard lightning impulse and DC voltages under both dry and wet environmental conditions.

• Development of Finite element models to aid in the understanding of the differences in the electric field distribution.
Experimental Procedures

• Breakdown tests were carried out in compliance with SANS60060-1 standard requirements.

• The insulator was energized with AC, DC and impulse voltages and the respective breakdown voltages were taken.

• Breakdown test was done under dry and wet environmental conditions.
Experimental Setup
Experimental Results and Discussions

<table>
<thead>
<tr>
<th>TEST VOLTAGE</th>
<th>DRY (kV)</th>
<th>WET (kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>POSITIVE</td>
<td>NEGATIVE</td>
</tr>
<tr>
<td>DC</td>
<td>193</td>
<td>223</td>
</tr>
<tr>
<td>IMPULSE</td>
<td>321</td>
<td>309</td>
</tr>
<tr>
<td>AC (RMS)</td>
<td>135</td>
<td>114</td>
</tr>
</tbody>
</table>

![Breakdown Voltage Chart](chart.png)
Electric field Analysis

<table>
<thead>
<tr>
<th>Case</th>
<th>Conductivity (S/m)</th>
<th>Current (nA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>$10^{-13}$</td>
<td>0.45+j*16.60e3</td>
</tr>
<tr>
<td>DC1</td>
<td>$10^{-13}$</td>
<td>0.45</td>
</tr>
<tr>
<td>DC2</td>
<td>$10^{-12}$</td>
<td>0.46</td>
</tr>
<tr>
<td>DC3</td>
<td>$10^{-10}$</td>
<td>1</td>
</tr>
<tr>
<td>DC4</td>
<td>$10^{-8}$</td>
<td>36</td>
</tr>
</tbody>
</table>
Conclusions

• Based on this investigation, it was discovered that the breakdown voltages were decreased during the wet tests.
• The impulse having the highest breakdown and the AC having the lowest breakdown voltage.
• The electric field distribution for DC was proved to be purely resistive and distorted due to the effect of space charge.
Acknowledgement

The authors would like to thank Eskom for the funding provided for this research through the Centre for High Voltage Engineering DC and FACTS at the University of Kwa-Zulu Natal, Durban.
Thank you for Listening