INDIVIDUAL TEMPERATURE CORRECTION (ITC) for INSULATION RESISTANCE MEASUREMENTS

May 2017

S. Zurek*, A. El-Rasheed*, M. Ohlen**

*Megger Instruments Ltd., Archcliffe Road, Dover, Kent, CT17 9EN, UK
**Megger Sweden, AB, Box 724, 182 17, Danderyd, Sweden
Contents

■ Introduction
■ Temperature Correction Factors
■ Individual Temperature Correction Concept
■ AC and DC excitation
■ Test Methods
■ Results from Motor trials
■ Results from Transformer trials
■ Conclusions & Future Work
Introduction

- Insulation Resistance is Temperature influenced
- Megger R&D
  - Patent US8428895, 2013
  - Patent SE537145, 2015
# Temperature Correction Factors

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Rotating Equipment</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class A</td>
<td>Class B</td>
</tr>
<tr>
<td>0</td>
<td>0.21</td>
<td>0.4</td>
</tr>
<tr>
<td>5</td>
<td>0.31</td>
<td>0.5</td>
</tr>
<tr>
<td>10</td>
<td>0.45</td>
<td>0.63</td>
</tr>
<tr>
<td>15.6</td>
<td>0.71</td>
<td>0.81</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>1.48</td>
<td>1.25</td>
</tr>
<tr>
<td>30</td>
<td>2.2</td>
<td>1.58</td>
</tr>
<tr>
<td>35</td>
<td>3.24</td>
<td>2</td>
</tr>
<tr>
<td>40</td>
<td>4.8</td>
<td>2.5</td>
</tr>
<tr>
<td>45</td>
<td>7.1</td>
<td>3.15</td>
</tr>
<tr>
<td>50</td>
<td>10.45</td>
<td>3.98</td>
</tr>
<tr>
<td>55</td>
<td>15.5</td>
<td>5</td>
</tr>
<tr>
<td>60</td>
<td>22.8</td>
<td>6.3</td>
</tr>
<tr>
<td>65</td>
<td>34</td>
<td>7.9</td>
</tr>
<tr>
<td>70</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>75</td>
<td>74</td>
<td>12.6</td>
</tr>
</tbody>
</table>

![Megger Logo]
Temperature Correction Coefficients

- Different publications provide different coefficients for the same material
- Coefficients are average values at spot temperatures
Individual Temperature Correction Concept

Based on activation energy of a material (in eV)

**ITC algorithm:**

- where: $E$ – material-specific activation energy (J),
  $k_B$ – Boltzmann constant $1.3806488 \times 10^{-23}$ (J/K),
  $T_1$ and $T_2$ temperatures (K) of interest

$$A(T_1, T_2) = e^{-\frac{E}{k_B} \left( \frac{1}{T_2} - \frac{1}{T_1} \right)}$$
Correction in Frequency & Time Domains

- In AC excitation: “temperature is frequency and frequency is temperature”
- In DC excitation: temperature affects both resistance and response time
Test Methods on Motor & Transformer

- Environment chamber used provides adjustable and consistent conditions
Motor Trial: Correction in Time Domain

- Algorithm used to correct measurements after 1min and after 10min
Motor Trial: Time affects Polarisation Index

- PI result is temperature dependant
- So, correction must be two dimensional: Resistance & Time
Dry Transformer Trial: Time Domain Correction

- Polarisation Index correction (1 min and 10 min)
- At 40°C the PI is 1.35 (“bad”), but corrected is 3.05 (“good”)
Conclusions & Future Work

- Current temperature correction coefficient method is based on average values at spot temperatures
- Patent granted for new ITC concept and algorithm
- ITC algorithm is based on material activation energy
- Temperature correction for both resistance & time
- PI measurements are affected by temperature and must be corrected

- Research on multi-material insulation is ongoing
- Commercialisation work is ongoing
QUESTIONS?