Leading Independent Manufacturer
Coils & Bars for Steam- and Gas-Driven Generators, Hydrogenerators & High-Voltage Motors

NECCOBOND-E INSULATION SYSTEM

National Electric Coil
800 King Avenue • Columbus, Ohio 43212
Phone: (614) 488-1151 • FAX: (614) 488-8892
www.National-Electric-Coil.com

WORLD’S LARGEST OEM ALTERNATIVE
A Quality Foundation for Dependable Performance

Coils and bars made with our NECCOBOND-E insulation system benefit from its excellent and outstanding performance characteristics:

• dielectric strength
• mechanical strength
• thermal stability
• long-term resistance to the effects of aging
• resistance to tracking

The NECCOBOND-E Insulation System consists of two major components:

• a mica matte tape pre-loaded with a resin activator
• a modified anhydride-type epoxy resin used as the impregnating agent in the VPI

These components, when used with modern Vacuum Pressure Impregnation (VPI) and curing techniques, consistently produce high-quality coils and bars suitable in high temperature and/or high bar force applications.

To verify that the NECCOBOND-E Insulation System continues to satisfy the requirements of IEEE 1043-1996, IEEE 1310-1996 and IEEE 1553-2002, NEC regularly subjects sample and production bars to rigorous testing. The following graphs illustrate the results of the testing done by both NEC and the manufacturer of the tape and epoxy resin.

Dielectric Loss

The cured insulation system exhibits excellent dielectric loss properties. This makes it an ideal insulation system for high-voltage coils used high temperature applications. NEC checked the properties for sample bars made in its laboratory, as well as for production bars. The results are given in Figure 1 and Figure 2, which show tip-up losses at different temperatures.

Thermal Cycling Test

Production coils were subjected to thermal cycling per IEEE 1310-1996. The results were excellent. Coils passed a voltage endurance test after thermal cycling for 2000 hours at 30 kV and 100° C. Figure 5 shows the change in the dissipation factor plotted against the number of thermal cycles.

Breakdown Strength

The average breakdown on production coils was 550 V per mil.

Voltage Endurance Tests

Production coils were subjected to 39 kV for 400 hours at 100° C. None of the coils failed the tests, which were in accordance with IEEE 1043-1996.

Aging Tests

The manufacturer of the tapes and epoxy resins subjected laboratory insulation samples to an aging test. Samples were prepared with 40 mm by 8 mm by 700 mm straight section steel bars with an average insulation thickness of 2 mm (0.78”). The tested insulation system consisted of mica matte tape that was subjected to the vacuum pressure impregnation process using a solventless epoxy resin. The test bars were cured in heated steel dies at 338° F for eight hours. Three samples were subjected to a combined aging test by heating the samples to 155° C with 15 kV applied for 40 weeks (6720 hours).

Each week, the dissipation factor (tan) was measured at 10 kV, in accordance with the IEC-250 method. This method requires that the dissipation factor will not exceed 10% at 23° C and 10 kV. The results are shown in Figure 3, which confirms that the insulation dissipation factor at 10 kV and 23° C is at worst 2% and at 155° C, less than 7%.

Figure 4 shows properties changing on actual 13.8 kV coils that were exposed to aging at 30 kV and 100° C for 2000 hours.
Manufacturer's Laboratory Testing

In order to establish the properties of the cured insulation, manufacturer of NEC's mica tape and epoxy resin set the following parameters for its laboratory sample bars:

- Mica matte tape backed with glass fabric, preloaded with a small amount of epoxy resin and an organic catalyst
- Epoxy resin impregnant used in VPI
- Cured at 338° F for 8 hours

Values and resulting characteristics for the cured insulation product are shown in the table below.

<table>
<thead>
<tr>
<th>Property</th>
<th>Units</th>
<th>Value Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Strength</td>
<td>N/mm²</td>
<td>170 to 175°F</td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>W/(m x °K)</td>
<td>0.25 to 0.30°F</td>
</tr>
<tr>
<td>Thermal Coefficient of Expansion</td>
<td>¹/K</td>
<td>1.0 x 10⁻⁶ to 1.2 x 10⁻⁸</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>g/cm³</td>
<td>1.85 to 1.95°F</td>
</tr>
<tr>
<td>Dielectric Strength Samples</td>
<td>KV/mm (V/mil)</td>
<td>30 to 40 (750 to 1000)</td>
</tr>
<tr>
<td>Production barefoil</td>
<td>KV/mm (V/mil)</td>
<td>&gt;21 (&gt;550)</td>
</tr>
<tr>
<td>Dielectric Constant</td>
<td></td>
<td>4.10 to 4.40°F</td>
</tr>
<tr>
<td>Water Immersion 14 days at 73°C</td>
<td>Percentage of Change in Resistivity</td>
<td>No Change</td>
</tr>
<tr>
<td>Radiation Index</td>
<td>mGy/h</td>
<td>67 x 10⁻⁹</td>
</tr>
</tbody>
</table>

¹ Values resulting from manufacturer's laboratory data

For additional information about National Electric Coil, its manufacturing resources, or additional technical information about our NECCOBOND-E Insulation System, please contact Steve Jeney at (614) 488-1151 x105 by email at sjeney@national-electric-coil.com.

Or visit our website: www.National-Electric-Coil.com