Starting Formulation

SF 8017

Epoxy Resin System for Pultrusion or Filament Winding
EPON™ Resin 826 or EPON™ Resin 862 / LS-81K Anhydride Curing Agent (MTHPA)

Introduction
EPON Resin 826 or EPON Resin 862/LS-81K Curing Agent system is based on an epoxy resin cured with an anhydride. LS-81K Curing Agent is a formulated methyltetrahydrophthalic anhydride (MTHPA) containing an internal mold release additive and a cure accelerator, LS-81K is manufactured by Lindau Chemicals Inc.

This resin system’s combination of low viscosity, good pot life and fast gelation characteristics during cure make it favorable for wet processing fabrication of composite parts.

• In Pultrusion processes, it processes at high line speeds with low pull loads, and it yields good surface quality. No internal release agents are needed because they are already incorporated in the curing agent.

• In Filament Winding processes, good fiber wet-out is achieved because of the resin system’s low viscosity. It also has a relatively long pot life.

Neat resin casting data indicate this resin system has a unique balance of Tg, tensile and flexural strength, while providing high toughness properties.

Suggested Uses
• Composite structures
• Civil engineering
• Sporting goods
• Transportation
• Electrical
• Marine

Features
• Non-MDA
• Non-styrene
• Low viscosity
• Long pot life
• Good surface quality
• Retention of properties up to 105 °C (221 °F)
• Good elongation
• High toughness
• Good electrical properties

Chemical Description
• EPON Resin 826 is a bisphenol A epoxy resin
• EPIKOTE Resin 862 is a bisphenol F epoxy resin
• LS-81K is a specially formulated methyltetrahydrophthalic anhydride with an internal mold release agent

Typical Properties

<table>
<thead>
<tr>
<th>Method</th>
<th>Units</th>
<th>EPON Resin 826</th>
<th>EPON Resin 862</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxide equivalent weight</td>
<td>eq/g</td>
<td>178-186</td>
<td>166-177</td>
</tr>
<tr>
<td>Viscosity @ 25 °C (77 °F)</td>
<td>cP</td>
<td>6,500-9,500</td>
<td>2,500-4,500</td>
</tr>
<tr>
<td>Color</td>
<td>Gardner</td>
<td>1 max.</td>
<td>2 max.</td>
</tr>
<tr>
<td>Density @ 25 °C</td>
<td>lbs/gal</td>
<td>9.7</td>
<td>9.9</td>
</tr>
<tr>
<td>Specific gravity @ 25 °C, (g/cc)</td>
<td>g/cc</td>
<td>1.16</td>
<td>1.18</td>
</tr>
</tbody>
</table>

Anhydride equivalent weight | eq/g | 185-195

DISCLAIMER

The information provided herein was believed by Hexion Inc. (“Hexion”) to be accurate at the time of preparation or prepared from sources believed to be reliable, but it is the responsibility of the user to investigate and understand other pertinent sources of information, to comply with all laws and procedures applicable to the safe handling and use of the product and to determine the suitability of the product for its intended use. All products supplied by Hexion are subject to Hexion’s terms and conditions of sale. HEXION MAKES NO WARRANTY, EXPRESS OR IMPLIED, CONCERNING THE PRODUCT OR THE MERCHANTABILITY OR FITNESS THEREOF FOR ANY PURPOSE OR CONCERNING THE ACCURACY OF ANY INFORMATION PROVIDED BY HEXION, except that the product shall conform to Hexion’s specifications. Nothing contained herein constitutes an offer for the sale of any product.
Table 2 / Typical neat resin properties of EPON Resin 826 or EPON 862/LS-81K Anhydride Curing Agent

<table>
<thead>
<tr>
<th>Properties</th>
<th>Units</th>
<th>826/LS-81K</th>
<th>862/LS-81K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity @ 25 °C</td>
<td>cP</td>
<td>1230</td>
<td>897</td>
</tr>
<tr>
<td>Density @ 25 °C</td>
<td>lbs/gal</td>
<td>9.8</td>
<td>9.9</td>
</tr>
<tr>
<td>Specific gravity @ 25 °C</td>
<td>g/cc</td>
<td>1.18</td>
<td>1.17</td>
</tr>
</tbody>
</table>

Mix ratio: pbw 100/100

Curing Agent:

- EPON Resin 826: pbw 100
- LS-81K Anhydride Curing Agent: pbw 100

Viscosity @ 25 °C:

- EPON Resin 826: 1230 cP
- LS-81K Anhydride Curing Agent: 897 cP

Time to double initial viscosity @ 25 °C:

- EPON Resin 826: 8 hrs
- LS-81K Anhydride Curing Agent: 5.5 hrs

Working life @ 25 °C:

- 1,000 cP: 1.0 hrs
- 2,000 cP: 7.0 hrs
- 3,000 cP: >9.0 hrs

Gel time:

- @ 150 °C (302 °F): 80 sec.
- @ 180 °C (356 °F): 32 sec.
- @ 200 °C (392 °F): 18 sec.

1 ASTM D2196 (Brookfield Viscometer – Small Sample Adapter, about 10 grams).
2 Hot plate gel time.

Graph 1 / EPON Resin 826 or 862/LS-81K Anhydride Curing Agent viscosity @ 25 °C (77 °F) – 10 gram sample

Graph 2 / EPO N Resin 826 or 862/LS-81K Anhydride Curing Agent cure sweep @ 5 °C per minute

Typical Cured State Table 2 / Typical cured neat resin system casting properties of EPON Resin 826 or 862/LS-81K Anhydride Curing Agent

<table>
<thead>
<tr>
<th>Properties</th>
<th>Units</th>
<th>826/LS-81K</th>
<th>862/LS-81K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cure Schedule</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

© and ™ Licensed trademarks of Hexion Inc.

DISCLAIMER

The information provided herein was believed by Hexion Inc. ("Hexion") to be accurate at the time of preparation or prepared from sources believed to be reliable, but it is the responsibility of the user to investigate and understand other pertinent sources of information, to comply with all laws and procedures applicable to the safe handling and use of the product and to determine the suitability of the product for its intended use. All products supplied by Hexion are subject to Hexion’s terms and conditions of sale. HEXION MAKES NO WARRANTY, EXPRESS OR IMPLIED, CONCERNING THE PRODUCT OR THE MERCHANTABILITY OR FITNESS THEREOF FOR ANY PURPOSE OR CONCERNING THE ACCURACY OF ANY INFORMATION PROVIDED BY HEXION, except that the product shall conform to Hexion’s specifications. Nothing contained herein constitutes an offer for the sale of any product.
<table>
<thead>
<tr>
<th>Step 1</th>
<th>hrs/°C (°F)</th>
<th>1.5/66 (151)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2</td>
<td>hrs/°C (°F)</td>
<td>1/85 (185)</td>
</tr>
<tr>
<td>Step 3</td>
<td>hrs/°C (°F)</td>
<td>3/150 (302)</td>
</tr>
<tr>
<td>Tg by rheometrics (max. tan delta)</td>
<td>°C (°F)</td>
<td>136 (277)</td>
</tr>
<tr>
<td>Tensile Strength, at Break</td>
<td>D-638</td>
<td>psi</td>
</tr>
<tr>
<td>Tensile Elongation, at Break</td>
<td>%</td>
<td>5</td>
</tr>
<tr>
<td>Tensile Modulus</td>
<td>ksi</td>
<td>396</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>D-790</td>
<td>psi</td>
</tr>
<tr>
<td>Flexural Modulus</td>
<td>ksi</td>
<td>439</td>
</tr>
<tr>
<td>Fracture toughness, Kq</td>
<td>E-399</td>
<td>psi-in ^.5</td>
</tr>
<tr>
<td>Moisture absorption</td>
<td>% wt.</td>
<td>3.01</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>D-792</td>
<td>g/cc</td>
</tr>
</tbody>
</table>

**Electrical Properties**

- **Dielectric constant**
  - D-150
  - @ 1 Meg Hz & 23 °C
  - 3.17
  - 3.24
- **Dissipation factor**
  - D-150
  - @ 1 Meg Hz & 23 °C
  - 0.018
  - 0.016
- **Dielectric strength**
  - D-149
  - Volts/mil
  - 432.3
  - 418.8

Composite Fabrication / Pultrusion

The properties of this low viscosity and quick cure system at elevated temperatures provide the pultruder with a processable epoxy resin system. The unique resin system characteristics translate into high line speeds, low pull forces and good surface quality. All features are advantages of fabricators who desire the higher performance properties of epoxy resins.

**Mixing**

- A high shear mixer is recommended to ensure complete dispersion of the filler.
- Mixing time should be kept to a minimum to avoid excessive heat build-up of the resin system, as this can reduce the working life of the system.

**Resin bath**

- The resin impregnation bath temperature should be as close to 25 °C (77 °F) as possible to maximize working life.

**Process**

- The EPON Resin 826 or EPIKOTE Resin 862 /LS-81K Curing Agent will cure at die temperatures ranging from 170-180 °C (338-356 °F). The optimum temperatures will depend on parameters such as part thickness, line speed, and preheat temperature. The epoxy part will react to a high degree of cure during the pultrusion process. A post cure, however, may enhance the properties.

Suggested Formulations

<table>
<thead>
<tr>
<th>Units</th>
<th>Pultrusion</th>
<th>Filament Winding</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPON Resin 826 or EPON Resin 862</td>
<td>pbw</td>
<td>100</td>
</tr>
<tr>
<td>LS-81K Anhydride Curing Agent</td>
<td>pbw</td>
<td>100</td>
</tr>
<tr>
<td>ASP-400P</td>
<td>pbw</td>
<td>10-20</td>
</tr>
</tbody>
</table>

1 ASP is a registered trademark of Engelhard Corporation.
Fabrication / Filament Winding

Winding

Mixing – A high shear mixer is recommended to insure complete mixing. Mixing time should be kept to a minimum to avoid excess heat build-up of the resin system, as this can reduce the working life of the system.

Resin bath – The resin impregnation bath temperature should be as close to 25 °C (77 °F) as possible to maximize working life. However, elevated temperatures may be required to obtain the appropriate viscosity for fiber wet-out.

Process – The 826 or 862/LS-81K system will cure at mandrel/oven temperatures of 80-150 °C within 1-3 hours. The optimum temperatures will depend on parameters such as part thickness.

Storage Recommendations regarding storage conditions can be obtained by visiting our web site at www.hexion.com

General Information

These are starting formulations and are not proven in the user’s particular application but are simply meant to demonstrate the efficacy of the products and to assist in the development of the user’s own formulation. It is the user’s responsibility to fully-test and qualify the formulation, along with the ingredients, methods, applications or equipment identified herein (“Information”), by the user’s knowledgeable formulator or scientist, and to determine the appropriate use conditions and legal restrictions, prior to use of any Information.

Safety, Storage & Handling

Please refer to the MSDS for the most current Safety and Handling information.

Exposure to these materials should be minimized and avoided, if feasible, through the observance of proper precautions, use of appropriate engineering controls and proper personal protective clothing and equipment, and adherence to proper handling procedures. None of these materials should be used, stored, or transported until the handling precautions and recommendations as stated in the Material Safety Data Sheet (MSDS) for these and all other products being used are understood by all persons who will work with them. Questions and requests for information on Hexion Inc. ("Hexion") products should be directed to your Hexion sales representative, or the nearest Hexion sales office. Information and MSDSs on non-Hexion products should be obtained from the respective manufacturer.

Contact Information

For product prices, availability, or order placement, please contact customer service:

www.hexion.com/Contacts/

For literature and technical assistance, visit our website at www.hexion.com