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 1 / 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>

<table>
<thead>
<tr>
<th>Method</th>
<th>Units</th>
<th>LS-81K Anhydride Curing Agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhydride equivalent weight</td>
<td>eq/g</td>
<td>185-195</td>
</tr>
</tbody>
</table>

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Viscosity @ 25 °C (77 °F)  D-2196  cP  200-300
Density @ 25 °C  lbs/gal  9.8-10.0
Specific gravity @ 25 °C  g/cc  1.18-1.20

<table>
<thead>
<tr>
<th>Units</th>
<th>826/LS-81K</th>
<th>862/LS-81K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix ratio pbw</td>
<td>100/100</td>
<td>100/100</td>
</tr>
<tr>
<td>Viscosity @ 25 °C (77 °F) cP</td>
<td>1230</td>
<td>897</td>
</tr>
<tr>
<td>Density @ 25 °C lbs/gal</td>
<td>9.8</td>
<td>9.9</td>
</tr>
<tr>
<td>Specific gravity @ 25 °C g/cc</td>
<td>1.18</td>
<td>1.17</td>
</tr>
</tbody>
</table>

Typical Handling Table 2 / Typical neat resin properties of EPON Resin 826 or EPON 862/LS-81K Anhydride Curing Agent

<table>
<thead>
<tr>
<th>Units</th>
<th>826/LS-81K</th>
<th>862/LS-81K</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPON Resin 826 pbw</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td>EPON Resin 862 pbw</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>LS-81K Anhydride Curing Agent pbw</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Viscosity @ 25 °C 1</td>
<td>cP</td>
<td>1230</td>
</tr>
<tr>
<td>Time to double initial viscosity @ 25 °C 1 hrs</td>
<td>8</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Working life @ 25 °C, time to reach:
- 1,000 cP hrs N/A 1.0
- 2,000 cP hrs 4.6 7.0
- 3,000 cP hrs >8.0 >9.0

Gel time 2
- @ 150 °C (302 °F) sec. 80 82
- @ 180 °C (356 °F) sec. 32 28
- @ 200 °C (392 °F) sec. 18 18

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

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### Step 1
- hrs/°C (°F): 1.5/66 (151)

### Step 2
- hrs/°C (°F): 1/85 (185)

### Step 3
- hrs/°C (°F): 3/150 (302)

### Tg by rheometrics (max. tan delta)
- D-4065 °C (°F): 136 (277) 126 (259)

### Tensile Strength, at Break
- D-638 psi: 10,700 10,700

### Tensile Elongation, at Break
- %: 5 5

### Tensile Modulus
- ksi: 396 413

### Flexural Strength
- D-790 psi: 17,800 17,800

### Flexural Modulus
- ksi: 439 457

### Fracture toughness, Kq
- E-399 psi-in ^0.5: 1187 1234

### Moisture absorption
- % wt.: 3.01 2.97

### Specific gravity
- D-792 g/cc: 1.20 1.23

### Electrical Properties

#### Dielectric constant
- @ 1 Meg Hz & 23 °C: 3.17 3.24

#### Dissipation factor
- @ 1 Meg Hz & 23 °C: 0.018 0.016

#### Dielectric strength
- D-149 Volts/mil: 432.3 418.8

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**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 insure complete dispersion of the filler. 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.

**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.

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**Composite Fabrication / Filament Winding**

The low viscosity and long working life of the resin system make it desirable for Filament Winding thin wall parts.

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**Suggested Formulations**

<table>
<thead>
<tr>
<th></th>
<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>
<td>100</td>
</tr>
<tr>
<td>LS-81K Anhydride Curing Agent</td>
<td>pbw</td>
<td>100</td>
<td>N/A</td>
</tr>
<tr>
<td>ASP-400P ¹</td>
<td>pbw</td>
<td>10-20</td>
<td>N/A</td>
</tr>
</tbody>
</table>

¹ ASP is a registered trademark of Engelhard Corporation.

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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.

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