CYCOM® PR 520 RTM Resin System

Description

CYCOM® PR 520 RTM is a one-part, 180°C (355°F) curing epoxy resin system offering superior damage tolerance and good strain to failure required for composite primary structure applications.

The value of resin infusion is the ability to design complex geometric parts while leveraging a unitized structure which ultimately leads to a reduction in weight, lower part counts and the elimination of many post-manufacturing processes.

CYCOM PR 520 RTM is an off-white thick paste at room temperature reducing to a low viscosity when heated for injection. The resin has a low enough viscosity to allow injection at 90 – 100°C (194 – 212°F). Following injection, the resin viscosity decreases with increasing tool temperature to below 50 cP, thus helping to ensure full fiber wetting.

CYCOM PR 520 RTM resin is fully cured following a 2-hour dwell at 180°C (355°F) after which it has a continuous hot/wet service temperature of 104°C (220°F).

For reinforcement preforming operations, a fully compatible binder system, CYCOM® 7720 RTM, and a low areal weight film, PR 520-1, have been developed for use with CYCOM PR 520 RTM. The binder and low areal weight film are available pre-coated onto fabrics of the customer’s choice. A separate datasheet for CYCOM 7720 RTM is available upon request.

Features & Benefits

- One-part epoxy resin system
- 30 day out-life at room temperature
- Two year shelf-life at -18°C (0°F)
- Low exotherm, i.e., thick part production capable
- ~500 cP initial injection viscosity
- <30 cP minimum viscosity
- Full cure after 2 hours at 180°C (355°F)
- Continuous hot/wet service performance >104°C (220°F)
- Low moisture absorption, ~0.6%
- High resin toughness
- Fully compatible binder available

Suggested Applications

Primary structure applications requiring superior toughness

- Engine Blades
- Engine Blade Spacers/Platforms
- Containment Cases

- Outer Guide Vanes
- Hinge/Brackets/Fittings
CHARACTERISTICS

PR 520 RTM Rheometric Data
Figure 1 shows the dynamic viscosity of CYCOM PR 520 RTM heated from 50°C (122°F) to 220°C (428°F) at 2°C (3.5°F) per minute. Note that suitable injection viscosities of <500 cP are reached at temperatures over 100°C (212°F).

Figure 1 | CYCOM PR 520 RTM Dynamic Viscosity at 2°C (3.5°F) per minute

Figure 2 shows the isothermal viscosity of CYCOM PR 520 RTM at 106°C (223°F). Note that at this temperature the viscosity remains in the region of 500 cP for approximately 5 hours.

Figure 2 | CYCOM PR 520 RTM Isothermal Viscosity at 106°C (223°F)
Figure 3 shows the isothermal viscosities of CYCOM PR 520 RTM at four different temperatures. Note that at 160°C (320°F) the viscosity remains below 500 cP for approximately 40 minutes.

Table 1 | Neat Resin Characteristics

<table>
<thead>
<tr>
<th>Property 1</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cured resin density, g/cm³</td>
<td>1.25</td>
</tr>
<tr>
<td>T₆ by DSC, °C (°F)*</td>
<td>161 (322)</td>
</tr>
<tr>
<td>Tensile Strength, MPa (ksi)</td>
<td>82.1 (11.9)</td>
</tr>
<tr>
<td>Tensile Modulus, GPa (Msi)</td>
<td>4.0 (0.58)</td>
</tr>
<tr>
<td>Tensile Strain at Break, %</td>
<td>3.0</td>
</tr>
<tr>
<td>Poisson's Ratio</td>
<td>0.398</td>
</tr>
<tr>
<td>Compressive Strength, MPa (ksi)</td>
<td>128 (18.5)</td>
</tr>
<tr>
<td>Compressive Modulus, GPa (Msi)</td>
<td>3.7 (0.53)</td>
</tr>
<tr>
<td>Shear Strength, MPa (ksi)</td>
<td>61.4 (8.9)</td>
</tr>
<tr>
<td>Shear Modulus, GPa (Msi) ²</td>
<td>0.8 (0.12)</td>
</tr>
<tr>
<td>Flexural Strength, MPa (ksi)</td>
<td>153.1 (22.2)</td>
</tr>
<tr>
<td>Flexural Modulus, GPa (Msi)</td>
<td>3.5 (0.50)</td>
</tr>
<tr>
<td>SENB KIC, MPa-m¹/² (ksi-in¹/²)</td>
<td>2.2 (2.0)</td>
</tr>
<tr>
<td>SENB GIC, J/m² (in-lb/in²)</td>
<td>1410 (8.1)</td>
</tr>
<tr>
<td>CTE by TMA, m/m°C</td>
<td>52.9 x 10⁻⁶</td>
</tr>
</tbody>
</table>

¹ All data tested at room temperature, dry conditions
² Minimum modulus below T₆

*NOTE:* Tg data is not applicable for U.S. export control classification or licensing. For export-related information please contact us.
PROPERTIES

Table 2 | CYCOM PR 520 RTM Typical Laminate Properties (3K-T650-35 8HS)

<table>
<thead>
<tr>
<th>Property</th>
<th>24°C (75°F) Dry</th>
<th>85°C (185°F) Wet</th>
<th>107°C (225°F) Wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warp Tensile Strength, MPa (ksi)³</td>
<td>945 (137)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Warp Tensile Modulus, GPa (Msi)³</td>
<td>75.8 (11.0)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Warp Compression Strength, MPa (ksi)³</td>
<td>814 (118)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Warp compression Modulus, GPa (Msi)³</td>
<td>63.4 (9.2)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>In-plane Shear Strength, MPa (ksi)</td>
<td>112 (16.3)</td>
<td>-</td>
<td>49 (7.12)</td>
</tr>
<tr>
<td>In-plane Shear Modulus, GPa (Msi)</td>
<td>5.7 (0.83)</td>
<td>-</td>
<td>3.6 (0.52)</td>
</tr>
<tr>
<td>OHT Strength, MPa (ksi)³</td>
<td>389 (56.4)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OHC Strength, MPa (ksi)³</td>
<td>319 (46.3)</td>
<td>238 (34.5)</td>
<td>203 (29.4)</td>
</tr>
<tr>
<td>Bearing Strength, MPa (ksi)³</td>
<td>910 (132)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CSAI, MPa (ksi)³</td>
<td>4.5 J/mm (1007 in-lb/in)</td>
<td>432 (62.7)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>7.0 J/mm (1576 in-lb/in)</td>
<td>396 (57.4)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>8.3 J/mm (1865 in-lb/in)</td>
<td>374 (54.2)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>11.8 J/mm (2647 in-lb/in)</td>
<td>329 (47.7)</td>
<td>-</td>
</tr>
</tbody>
</table>

¹ Dried in vacuum oven for 48 hours at 105°C (221°F) prior to testing
² 71°C (160°F) at 95% relative humidity to >90% equilibrium (where equilibrium ~0.47%)
³ Data normalized to 60% Vf

SUGGESTED PROCESSING PARAMETERS

The CYCOM PR 520 RTM resin infusion material system is characterized by a processing window that must be respected in order to successfully manufacture a composite component.

For these guidelines the process is divided into three steps, corresponding to infusion preparation, infusion and resin homogenization, and lock-off and cure.

Infusion Preparation

- To sufficiently degas this system it is recommended that a resin temperature of 105°C (221°F) is used. This gives a viscosity of approximately 500 cps and pot-life of 5 hours. Degassing should be administered for a minimum of 15 minutes at 65 mbar absolute (28” Hg).
- The resin holding reservoir and all transfer pipework should be kept at 105°C (221°F) for the duration of the injection in order to obtain an optimum viscosity/pot-life relationship (i.e., ~500 cps for ~5 hours).
- Apply full vacuum to the tool containing the preformed reinforcement, ensuring minimal vacuum loss (30 mbar in 5 minutes).
- Preheat the tool to a minimum of 165 + 5°C (330 + 8°F) before injection begins.
- If vent purging is required, heat exit lines to 105°C (221°F).
Infusion and Resin Homogenization

- For successful processing it is critical that the resin reaches a minimum of 165 ± 5°C (330 ± 8°F) prior to entering the preform. This ensures no preform filtration of one of the formulation ingredients during infusion. At this temperature the resin viscosity will remain below 500 cps for approximately 40 minutes and the formulation ingredient will be fully dissolved.
- Incorporation troughs or channels between inlet and preform (Refer to Figure where a suggested tool feature is illustrated to allow curative melt) or a heat exchanger prior to the inlet have been found to efficiently heat the resin for injection. It should be noted that relying solely on heated hosing is a very inefficient manner to heat the resin.
- With vacuum maintained within the mold, initiate injection using a steady flow rate to allow resin sufficient time to reach temperature.
- Continue injection with the assistance of positive pressure, where required, until resin is witnessed at the exit vents.

Lock-off and Cure

- Lock vents and continue injection to a positive pressure of 2.5 – 14.0 bar (37 – 204 psi). Once mold is full (as indicated by pressure being reached) purge each vent to remove entrapped air. Repeat until resin at vents is bubble free.
- Initiate cure cycle of 2°C (3.5°F) per minute to 180 ± 5°C (355 ± 9°F) and hold for 120 minutes while maintaining a positive pressure of 2.5 – 14.0 bar (37 – 204 psi) for at least 30 minutes of the cure dwell.

Tooling Recommendations

As previously mentioned and illustrated in Figure 4 the use of heat exchanging troughs and channels within the mold has been found to efficiently heat CYCOM PR 520 RTM for injection. The benefit of these features is that the resin has sufficient time to heat up prior to entering the preform. It is recommended that these Heat Exchange Areas run the entire injection length. Some example dimensions of this feature are a 0.5 mm (0.020 inch) gap and 50 mm (2 inch) width so that the resin is reduced to a thin liquid film into which heat is quickly transferred.

For larger or thicker parts, some parameters may require adjustment to avoid the risk of exotherm. Injection pressure for larger parts/alternative tooling may require adjustment to ensure filling of the tool cavity within an acceptable time and to ensure full consolidation of the component. Different injection equipment may require alternative conditions for degassing.
PRODUCT HANDLING AND SAFETY
Cytec Engineered Materials recommends wearing clean, impervious gloves when working with epoxy resin systems to reduce skin contact and to avoid contamination of the product. Materials Safety Data Sheets (MSDS) and product labels are available upon request and can be obtained from any Cytec Engineered Materials Office.

DISPOSAL OF SCRAP MATERIAL
Disposal of scrap material should be in accordance with local, state, and federal regulations.

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