Product information

# ANCAMINE® 2264 AND 2167

## Curing Agent

## DESCRIPTION

Ancamine® 2264 and Ancamine 2167 curing agents are cycloaliphatic amines designed for use with liquid epoxy resins in the fabrication of industrial composites. Ancamine 2264 and Ancamine 2167 curing agents contain polycycloaliphatic polyamines (high functionality cycloaliphatic amines). Incorporation of polycycloaliphatic polyamines in these curing agents improves stiffness and elevated temperature performance in cured systems as compared with cycloaliphatic diamine cured systems.

## TYPICAL PROPERTIES

| Property | Ancamine 2264 | Ancamine 2167 | Unit | Method |
|---|---|---|---|---|
| **Appearance** | Amber Liquid | Yellow Liquid | | |
| **Colour** | 9 | 3 | (Gardner) | ASTM D 1544-80 |
| **Viscosity @ 25°C** | 1800 | 210 | mPa.s | Brookfield RVTD, Spindle 4 |
| **Amine Value** | 502 | 520 | mg KOH/g | Perchloric Acid Titration |
| **Specific Gravity @ 21°C** | 1.00 | 0.975 | g/ml | |
| **Equivalent** | 54 | 53 | Wt/{H} | |
| **Recommended use Level** | 29 | 28 | PHR | With Bisphenol A diglycidyl ether (EEW=182) |

## ADVANTAGES

- Low temperature reactivity
- Rapid development of cure
- Excellent thermal and mechanical performance
- Superior solvent and acid resistance

## APPLICATIONS

- Filament winding
- Resin transfer molding
- Compression molding
- Tooling
- Safer alternative to Aromatic Amines

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## SHELF LIFE

At least 24 months from the date of manufacture in the original sealed container at ambient temperature.

## STORAGE AND HANDLING

Refer to the Safety Data Sheet for Ancamine 2264 and Ancamine 2167 curing agent.

## TYPICAL HANDLING PROPERTIES[1]

| Property | Ancamine 2264 | Ancamine 2167 | Unit | Method |
|---|---|---|---|---|
| **Mixed Viscosity @ 25°C** | 5,800 | 2,340 | mPa.s | Brookfield RVTD, Spindle 4 |
| **Gel Time (150g mix @ 25°C )** | 195 | 210 | mins | Techne GT-3 Gelation Timer |
| **Stroke Gel Time (150°C)** | 105 | 100 | sec | |
| **Stroke Gel Time (175°C)** | 50 | 42 | sec | |

## TYPICAL PERFORMANCE PROPERTIES[1,2]

| Property | Ancamine 2264 | Ancamine 2167 | Unit | Method |
|---|---|---|---|---|
| **Glass Transition Temperature** | 162 | 161 | °C | DSC Method |
| **Tensile Strength** | 72 | 76 | MPa | ISO 527 |
| **Tensile Modulus** | 2,670 | 2,560 | MPa | ISO 527 |
| **Flexural Strength** | 134 | 131 | MPa | ISO 178 |
| **Flexural Modulus** | 3,450 | 3,050 | MPa | ISO 178 |
| **Plain Strain Fracture Toughness** | 0.75 | 0.78 | MPa√m | |
| **Stain Energy Release rate** | 177 | 205 | Pa.m | |

[1] With Bisphenol A diglycidyl ether (EEW=182)
[2] Cure Schedule: 30 min at 80°C plus 3 hrs at 150°C

## SUPPLEMENTARY DATA

### LOW-TEMPERATURE REACTIVITY AND RAPID DEVELOPMENT OF CURE

Ancamine 2264 and Ancamine 2167 curing agents react readily with epoxy resin at temperatures less than 100°C. This low-temperature reactivity contributes to rapid viscosity build before and during the initial stages of cure. Although rapid viscosity build before cure can shorten pot life, it can also reduce resin loss during composite part fabrication. Ancamine 2264 and Ancamine 2167-based formulations, with a lowviscosity diglycidyl ether of bisphenol-F (DGEBF) epoxy resin, offer a 30 to 40% viscosity reduction compared with standard diglycidyl ether of bisphenol-A (DGEBA) epoxy resin formulations. Such formulations also maintain a 2-to-3 hour pot life.

FIGURE 1: RESIN BATH BEHAVIORS FOR ANCAMINE 2264 AND ANCAMINE 2167 WITH DGEBA EPOXY RESIN

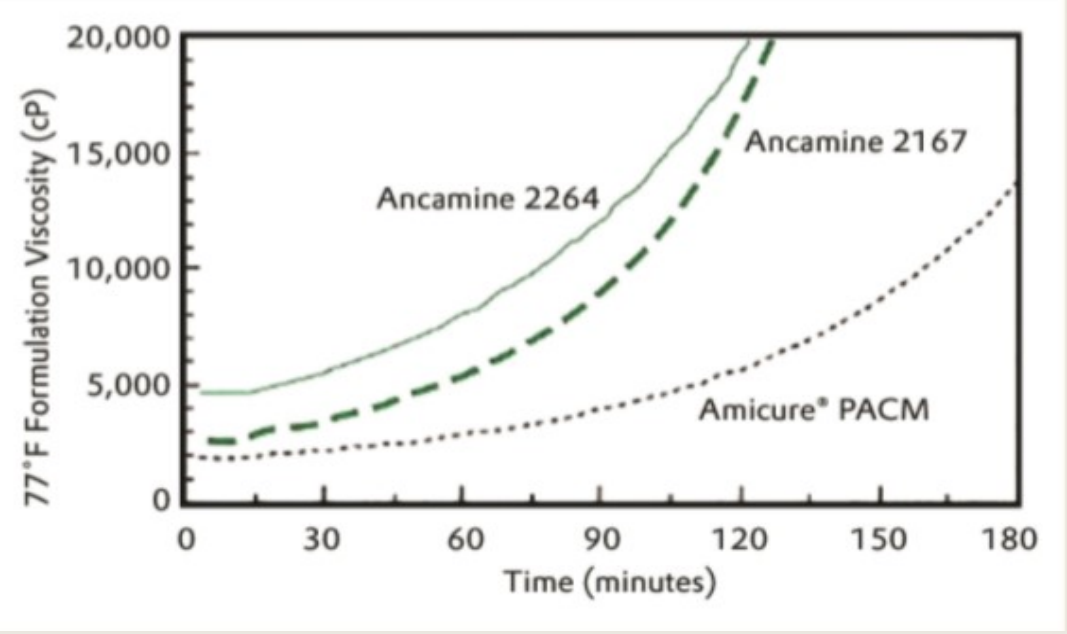


FIGURE 2: USING DGEBA EPOXY RESIN WITH ANCAMINE 2264 AND ANCAMINE 2167 CAN REDUCE FORMULATION VISCOSITY

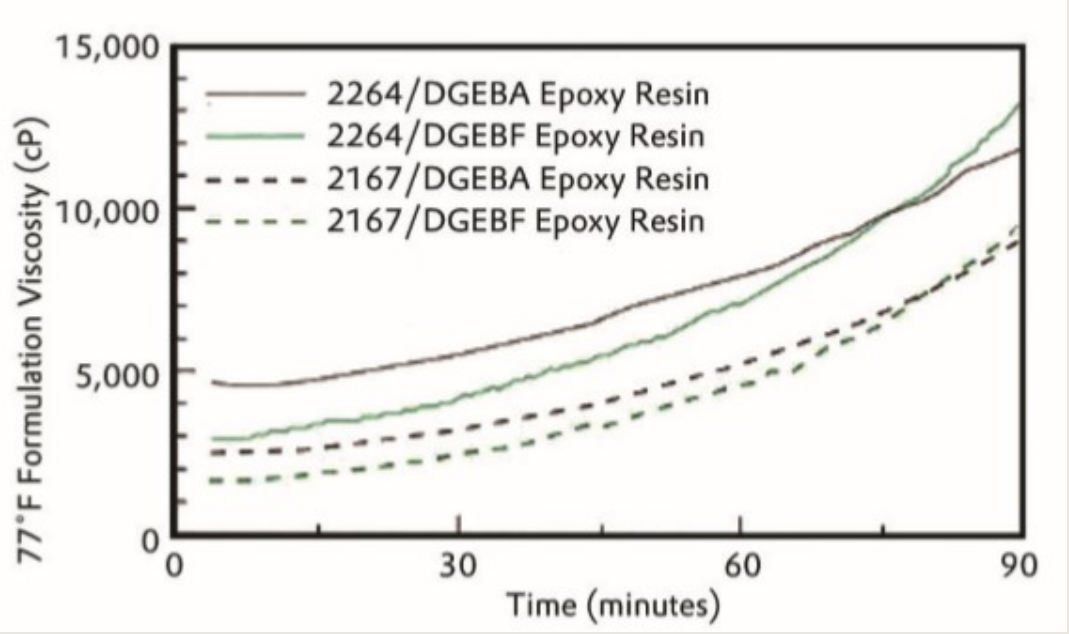
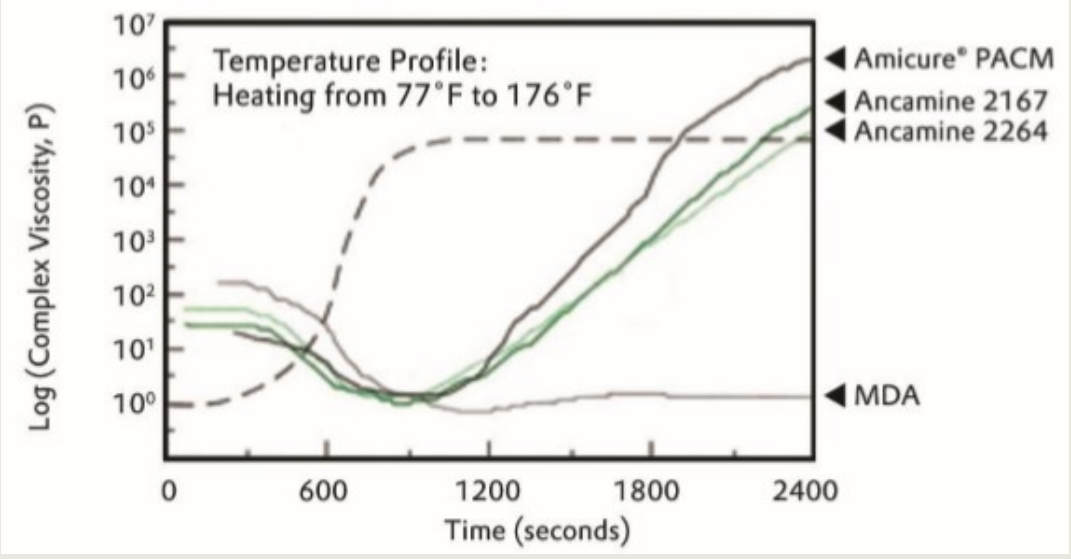



FIGURE 3: ANCAMINE 2264 AND ANCAMINE 2167 CAN REDUCE RESIN LOSS DURING INITIAL STAGE OF SURE



During the initial stage of cure, the viscosity of the epoxy matrix decreases and then rapidly builds to gelation as the composite part is heated. The magnitude and duration of this initial viscosity drop can influence the loss of matrix resin and/or part integrity. Ancamine 2264 and Ancamine 2167 curing agents exhibit minimal viscosity reduction, with minimum viscosities as much as four times that of an aromatic diamine (methylenedianoline)-cured formulation. Furthermore, as shown in figure 3, the poly-cycloaliphatic polyamine curing agent formulations begin to increase viscosity rapidly after less than 10 minutes.

The low-temperature reactivity of Ancamine 2264 and Ancamine 2167 curing agents allows for reduced cure times or lower cure temperatures compared with higher activation temperature aromatic diamines. This can translate into higher throughput capability. The recommended cure schedule of 0.5 hours at 176°F followed by 1 to 2 hours at 338 °F is designed to maximize development of cure and productivity. This cure schedule may require adjustment to accommodate part thickness, part geometry or heat transfer.

## EXCELLENT MECHANICAL AND THERMAL PERFORMANCE

Formulations of Ancamine 2264 and Ancamine 2167 curing agents can exhibit the high strength and modulus characteristic of aromatic diamine-cured systems, combined with the ductility and toughness characteristic of cycloaliphatic diamine-cured systems. The strength, modulus and ductility of Ancamine 2264- and Ancamine 2167-cured systems are further enhanced when DGEBF epoxy resin is used.

TABLE 1: ANCAMINE 2264 AND ANCAMINE 2167 IMPART EXCELLENT THERMAL AND MECHANICAL PERFORMANCE

| Formulations | Cure Schedule | Tensile Modulus [MPa] | Tensile Strength [MPa] | Elongation at Failure [%] | $K_{Ic}$, psi in | $T_g$, [°C] |
|---|---|---|---|---|---|---|
| **Amicure® PACM/ DGEBA Epoxy Resin** | 2 hr @ 80°C + 3 hr @ 150°C | 2,310 | 79 | 7.4 | 710 | 158 |
| **Ancamine 2167 DGEBA Epoxy Resin** | 2 hr @ 80°C + 3 hr @ 150°C | 2,560 | 76 | 6.9 | 710 | 163 |
| **Ancamine 2264/ DGEBA Epoxy Resin** | 2 hr @ 80°C + 3 hr @ 150°C | 2,670 | 72 | 4.9 | 680 | 162 |
| **MDA/ DGEBA Epoxy Resin** | 2 hr @ 80°C + 3 hr @ 150°C | 2,620 | 73 | 4.4 | 660 | 160 |
| **Amicure® PACM/ DGEBA Epoxy Resin** | 0.5 hr @ 80°C + 2 hr @ 170°C | 2,400 | 79 | 6.6 | - | 162 |
| **Ancamine 2167/ DGEBA Epoxy Resin** | 0.5 hr @ 80°C + 2 hr @ 170°C | 2,620 | 76 | 6.2 | - | 155 |
| **Ancamine 2264/ DGEBA Epoxy Resin** | 0.5 hr @ 80°C + 2 hr @ 170°C | 2,740 | 74 | 4.8 | - | 156 |

TABLE 2: CURED DGEBF EPOXY RESIN CAN EXHIBIT IMPROVED MECHANICAL PERFORMANCE OCMPARED WITH DGEBA EPOXY RESIN

| Formulations | Cure Schedule | Tensile Modulus [MPa] | Tensile Strength [MPa] | Elongation at Failure [%] | $T_g$, [°C] |
|---|---|---|---|---|---|
| **Ancamine 2167/ DGEBF Epoxy Resin** | 2 hr @ 80°C + 3 hr @ 150°C | 2,740 | 86 | 8.5 | 130 |
| **Ancamine 2167 DGEBA Epoxy Resin** | 2 hr @ 80°C + 3 hr @ 150°C | 2,560 | 76 | 6.9 | 163 |
| **Ancamine 2264/ DGEBF Epoxy Resin** | 2 hr @ 80°C + 3 hr @ 150°C | 3,020 | 92 | 6.9 | 130 |
| **Ancamine 2264/ DGEBA Epoxy Resin** | 2 hr @ 80°C + 3 hr @ 150°C | 2,675 | 72 | 4.9 | 162 |

## SUPERIOR SOLVENT AND ACID RESISTANCE

DGEBA epoxy resin cured with Ancamine 2264 and Ancamine 2167 exhibits chemical resistance superior to common cycloaliphatic diamine-cured resins. In the case of Ancamine 2264-cured DGEBA epoxy resin, the chemical resistance approaches that exhibited by aromatic amine-cured epoxy resin. The chemical resistance of an Ancamine 2264-cured system can be further enhanced using novolac epoxy resins.

FIGURE 4: POLYCYCLOALIPHATIC POLYAMINE CURING AGENTS EXHIBIT SUPERIOR CHEMICAL RESISTANCE

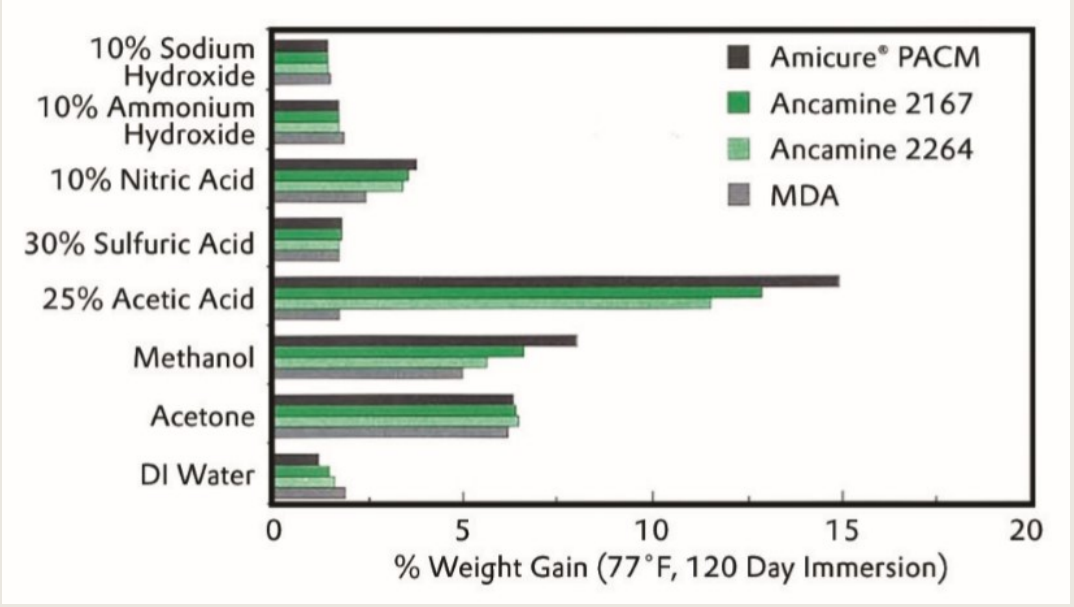


TABLE 3: FORMULATIONS CURED WITH ANCAMINE 2264 AND ANCAMINE 2167 CURING AGENTS EXHIBIT SUPERIOR SOLVENT, CAUSTIC, AND WATER RESISTANCE

| | Formulations with DGEBA Epoxy Resin: % Weight Change @ 120 Days, 73°F Immersion | | | |
|---|---|---|---|---|
| **Reagent** | **Amicure PACM** | **Ancamine 2167** | **Ancamine 2264** | **MDA** |
| **10% Sodium Hydroxide** | 1.5 | 1.4 | 1.5 | 1.5 |
| **10% Ammonium Hydroxide** | 1.8 | 1.7 | 1.8 | 1.9 |
| **10% Nitric Acid** | 3.8 | 3.7 | 3.4 | 2.5 |
| **30% Sulfuric Acid** | 1.9 | 1.8 | 1.8 | 1.8 |
| **25% Acetic Acid** | 15.0 | 13.0 | 11.5 | 1.8 |
| **Methanol** | 8.0 | 7.0 | 5.7 | 5.0 |
| **Acetone** | 6.4 | 6.9 | 6.5 | 6.2 |
| **Toluene** | 0.7 | 0.3 | 0.6 | - |
| **Ethanol** | 1.2 | 0.4 | 0.5 | - |
| **Deionized Water** | 1.2 | 1.6 | 1.7 | 1.9 |





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