

ANCAMIDE[®] 2445**Curing Agent****DESCRIPTION**

Ancamide 2445 curing agent is a modified polyamide designed to be used with liquid epoxy resin. It has moderate viscosity, exhibiting fast cure at low temperatures. Ancamide 2445 curing agent has a low residual amine content which gives rise to coatings where amine blush is eliminated. The curing agent can be used to formulate low VOC, anti-corrosive coatings for marine and industrial maintenance applications.

TYPICAL PROPERTIES

| Property | Value | Unit | Method |
|-------------------------|--------------|----------|---|
| Appearance | Amber liquid | | |
| Colour | 7 | Gardner | ASTM D 1544-80 |
| Viscosity @ 25°C | 4,500-6,500 | mPa.s | Brookfield RVTD, spindle 4 |
| Amine Value | 180-220 | mg KOH/g | Perchloric Acid Titration |
| Specific Gravity @ 21°C | 1.03 | | |
| Equivalent | 133 | Wt/{H} | |
| Recommended use Level | 70-100 | PHR | With Bisphenol A diglycidyl ether (EEW=190) |

ADVANTAGES

- Fast-cure at low temperatures (5°C)
- Moderate viscosity
- Non-critical loading
- Good film appearance and no amine blush
- Good humidity and corrosion resistance

APPLICATIONS

High solids, corrosion resistant coatings for marine and industrial maintenance applications

SHELF LIFE

At least 24 months from the date of manufacture in the original sealed container at ambient temperature. Store away from excessive heat and humidity in tightly closed containers.

PACKAGING AND HANDLING

Refer to the Safety Data Sheet for Ancamide 2445 curing Agent.

TYPICAL HANDLING PROPERTIES*

| Property | Value | Unit | Method |
|-----------------------------|-------|------|------------------------------|
| Gel Time (150g mix at 25°C) | ± 90 | min | Techne GT-3 Gelation Timer |
| Thin Film Set Time 25°C | 5 | h | BK Drying Recorder Phase III |
| Typical cure schedule | 2 - 7 | days | |

TYPICAL PERFORMANCE PROPERTIES*

| Property | Value | Unit | Method |
|-----------------------------|-------|------|--|
| Heat Distortion Temperature | 45 | °C | ASTM D 648 |
| Carbamation Test | 3 | | ISO 2812 (Wet Patch Method), scale 1-5 (5 is best) |

* With Bisphenol A diglycidyl ether (EEW=190)

SUPPLEMENTARY DATA

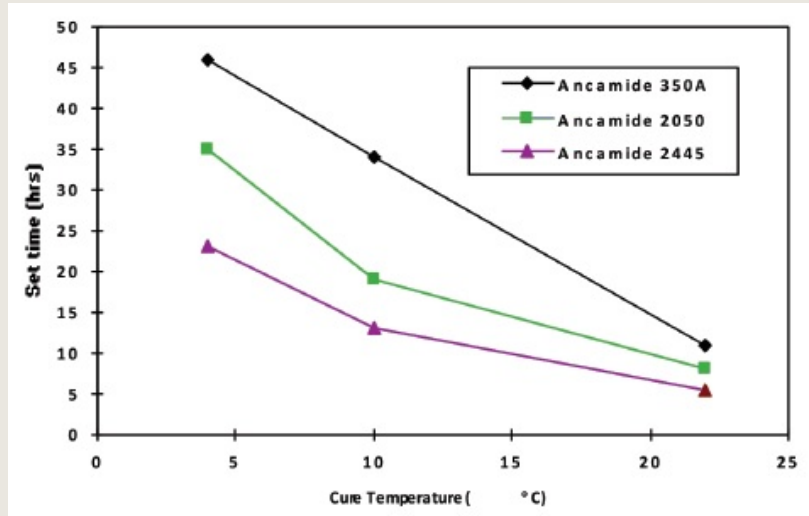
Ancamide 2445 curing agent is a moderate viscosity, modified polyamide. When used with liquid epoxy resins, Ancamide 2445 curing agent offers fast dry time, improved Coating flexibility and excellent long term humidity and corrosion resistance. Ancamide 2445 curing agent also has a low Level of free, unreacted amine, which reduces curing Agent corrosivity and improves surface appearance by reducing the tendency of the coating to blush.

High volume solids, low VOC coatings can be formulated using this product which can be used for a wide variety in industrial maintenance and marine applications.

Ancamide 2445 curing agent has non-critical loading and can be used at levels ranging from 70 to 100 phr when used with a liquid epoxy resin.

Fast Dry Times: When used with liquid epoxy resin, Ancamide 2445 curing agent exhibits fast cure speed. As shown in Figure 1, the thin film set times obtained with Ancamide 2445 curing agent offer a significant improvement over conventional polyamide curing agents including Ancamide 2050 and Ancamide 350A. At room temperature, the thin film set time is reduced to 5 h from 8 h and 11 h, respectively. At lower application temperatures (5#C), thin film set times of less than 24 h are achievable for Ancamide 2445, compared to 36 h for Ancamide 2050 and 46 h for Ancamide 350A curing agents respectively.

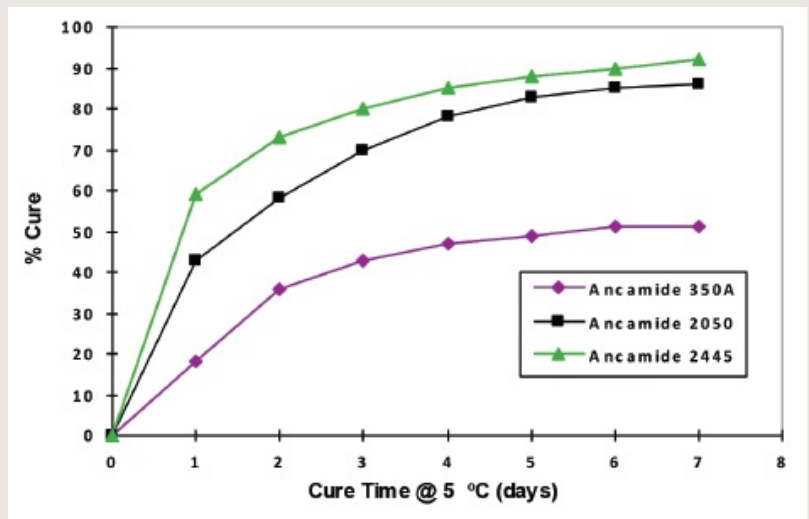
FIGURE 1: THIN FILM SET TIMES



The results above are based on loadings of 70 phr for Ancamide 2445 and Ancamide 2050 and 80 phr for Ancamide 350A. All results were measured using a B-K recorder, 150 micron wet film applied to glass plates.

Further evidence supporting the excellent low temperature cure characteristics of Ancamide 2445 curing agent is also shown in Figure 2. This plot compares the cure development of Ancamide 2445, Ancamide 2050 and Ancamide 350A curing agents by measurement of the residual exotherm during low temperature cure. The test method utilized, is to measure residual exotherm using differential scanning calorimetry (DSC).

FIGURE 2: LOW TEMPERATURE (5 ° C) CURE PROFILES



Systems based on Ancamide 2445 curing agent reach approximately 60% of full cure within the first 24 h, significantly higher than both Ancamide 2050 (43%) and Ancamide 350A (16%) systems. After 7 days cure at 5°C, Ancamide 2445 reaches 90% cure, which is slightly above the 85% for Ancamide 2050, but significantly higher than 48% cure for Ancamide 350A.

Film Properties: In a clear coat formulation, Ancamide 2445 curing agent also exhibits a high degree of flexibility. As shown in Table 1, the direct impact resistance of Ancamide 2445 is comparable to Ancamide 2050 and superior to Ancamide 350A. Ancamide 2445 also exhibits greater reverse impact resistance compared to conventional polyamides.

TABLE 1: PERFORMANCE PROPERTIES

| Property | Ancamide 2445 | Ancamide 2050 | Ancamide 350A |
|-----------------------|---------------|---------------|---------------|
| Direct Impact, cm.kg | 200 | 200 | 40 |
| Reverse Impact, cm.kg | 200 | 200 | 10 |
| Specular Gloss 60° | 142 | 140 | 95 |
| Pendulum Hardness | 142 | 140 | 95 |
| Mandrel Bend | 142 | 140 | 95 |

Starting Point Formulations: Attached at the back of this technical bulletin are preliminary starting point formulations based on Ancamide 2445 curing agent for an anti-corrosive primer and a general purpose white gloss top-coat respectively. When pigmented, dry to touch time of coatings is generally less than 4 h, with hard dry achievable within approximately 12 h for systems applied and cured at 24°C. Pot lives in the order of 5 to 6 h can be obtained with proper formulation, while maintaining VOCs of less than 330 gm/l.

Formulation 2445P1 is a high volume solids (74%), low VOC (290 gm/l) red iron oxide primer. The primer formulation has a low mix viscosity ~ 1000 mPa.s, with a pot life of 6 h. The coating formulation can be spray applied with conventional spray equipment or brush applied to a steel substrate without the addition of extra solvents. Dry to touch is reached after 4 h and the coating system is hard dry in less than 15 h.

Formulation 2445P1 has been evaluated for salt spray, humidity and cohesion resistance. After 750 h, coatings exhibit excellent corrosion resistance. No signs of field blisters or scribe creep have been detected using the above accelerated weathering tests.

Formulation 2445E1 is a white gloss top-coat based on Ancamide 2445 in combination with the amidoamine, Ancamide 501. Evaluation of 2445E1 shows the paint formulation has an initial mix viscosity of 1300 mPa.s, with a pot life of 4.5 h. The paint reaches dry to touch after 4 h with a hard dry achievable in less than 15 h.

Performance Evaluation: All coatings were evaluated in 5% salt spray, and in constant humidity at 50°C. They were also evaluated using a prohesion weathering tester, following a 10 day ambient cure.

Coatings were applied to grit blasted, hot rolled steel (60-100 micron profile), using conventional spray equipment, in double coats to give 90-120 micron DFT. In salt spray, (ASTM B-117) panels were scribed and evaluated for field blisters using the US Federal Standard Test Method # 141a, Method 6461 and the scribe creepage was rated in accordance with ASTM D-1654. Similar evaluations were made for panels placed in the prohesion cabinet (ASTM G85-94). Panels exposed to humidity were not scribed and coatings were assessed for blistering only. These tests also included evaluations for changes in visual appearance.

Corrosion Resistance: Both of the attached formulations 2445 PI and 2445EI were evaluated for salt spray and constant humidity resistance. The results obtained are presented in Tables 2-4. Following 3000 hours salt fog exposure, formulations 2445P1 and 2445E1 both exhibit excellent resistance with only a faint trace of damage along the scribe for the primer formulation exposed in the prohesion cabinet. Both formulations gave excellent humidity resistance with no signs of field blistering being observed following 3000 h continuous testing.

TABLE 2: SALT SPRAY RESISTANCE — ANCAMIDE 2445

| Formulation | Scribe Creep | Field Blistering | Blister Size |
|-------------|--------------|------------------|--------------|
| 2445P1 | 9 | 10 | 10 |
| 2445E1 | 9 | 10 | 10 |

5% salt spray, cabinet temperature 35°C —
 ASTM B-117, film thickness 90-120 micron
 Rating: 10 = Best (no blisters), 0 = Worst

TABLE 3: PROHESION EXPOSURE — ANCAMIDE 2445

| Formulation | Scribe Creep | Field Blistering | Blister Size |
|-------------|--------------|------------------|--------------|
| 2445P1 | 7 | 10 | 10 |
| 2445E1 | 8 | 10 | 10 |

Prohesion ASTM G85-94 Film thickness 90-120 micron
 Rating: 10 = Best (no blisters), 0 = Worst, Prohesion data is after 2000 h exposure

TABLE 4: CLEVELAND HUMIDITY EXPOSURE — ANCAMIDE 2445

| Formulation | Field Blistering | Blister Size |
|-------------|------------------|--------------|
| 2445P1 | 10 | 10 |
| 2445E1 | 10 | 10 |

Continuous 100% humidity exposure — ASTM D-2247, cabinet temperature 50°C, Film thickness 90-120 micron
 Rating: 10 = Best (no blisters), 0 = Worst



COATINGS HIGH SOLIDS RED IRON OXIDE PRIMER — ANCAMIDE 2445 START FORMULATION

| Nb. | A-Component | | 2445P1 (kg) | 2445P1 (litres) |
|---------------------------------|--------------------|---------------------|---------------|-----------------|
| 1. | Liquid epoxy resin | DER 331 | 27.05 | 23.31 |
| 2. | MPA-1078 | Rheox | 0.47 | 0.53 |
| Mix well then add at high speed | | | | |
| 3. | Titanium Dioxide | DuPont | 2.90 | 0.72 |
| 4. | Wollastokup | NYCO | 42.83 | 14.76 |
| 5. | Xylenes | ICI | 9.94 | 11.42 |
| | | | 83.19 | 50.74 |
| Nb. | B-Component | | | |
| 6. | Ancamide® 2445 | Evonik | 22.73 | 21.03 |
| 7. | MPA 1078 | Rheox | 0.47 | 0.53 |
| 8. | Beetle 216-8 | Cytec Industries UK | 1.73 | 1.64 |
| Mix well then add at high speed | | | | |
| 9. | RIO J3100 | Mineral Pigments | 6.94 | 1.42 |
| 10. | Beaverwhite 325 | Cyprus | 11.20 | 4.07 |
| 11. | Phoplus J-0866 | Mineral Pigments | 16.36 | 4.87 |
| 12. | Aromatic 100 | Exxon, Total | 10.30 | 11.84 |
| 13. | Diacetone alcohol | Union Carbide | 3.62 | 3.85 |
| | | | 73.33 | 49.25 |
| Total | | | 156.52 | 99.99 |

TECHNICAL DATA

| | | | |
|-----------------|--------------|-----------|-------|
| Mixing ratio | Comp. A to B | by volume | 1:1 |
| Density | Comp. A | g/ml | 1.64 |
| | Comp. B | g/ml | 1.49 |
| | Comp. A+B | g/ml | 1.57 |
| Potlife | | h | 6 |
| Non Volatile | Comp. A+B | by weight | 77.2% |
| Non Volatile | Comp. A+B | by volume | 73.8% |
| VOC | | g/l | 288 |
| PVC | | | 35.0% |
| Dry to touch | | h | 4 |
| Dry hard | | h | 12 |
| Pencil hardness | | | H |

COATINGS HIGH SOLIDS GENERAL PURPOSE WHITE TOP COAT — ANCAMIDE 2445 START FORMULATION

| Nb. | A-Component | | 2445E1 (kg) | 2445E1 (litres) |
|---------------------------------|--------------------|-----------------|---------------|-----------------|
| 1. | Liquid epoxy resin | DER 331 | 32.94 | 28.39 |
| 2. | Disparlon 650 | King Industries | 0.90 | 0.90 |
| Mix well then add at high speed | | | | |
| 3. | Mistron 400 Talc | Cyprus | 24.93 | 8.75 |
| 4. | Aromatic 150 | Exxon, Total | 1.03 | 11.93 |
| | | | 69.39 | 49.99 |
| Nb. | B-Component | | | |
| 6. | Ancamide 2445 | Evonik | 19.78 | 18.31 |
| 7. | Ancamide® 501 | Evonik | 2.33 | 2.34 |
| 8. | Disparlon NS-30 | King Industries | 0.64 | 0.74 |
| 9. | Titanium Dioxide | DuPont | 33.59 | 8.61 |
| 10. | Butanol | | 15.67 | 17.03 |
| 11. | Aromatic 150 | Exxon, Total | 2.69 | 3.00 |
| | | | 74.68 | 50.03 |
| Total | | | 144.07 | 100.02 |

TECHNICAL DATA

| | | | |
|-----------------|--------------|-----------|-------|
| Mixing ratio | Comp. A to B | by volume | 1:1 |
| Density | Comp. A | g/ml | 1.39 |
| | Comp. B | g/ml | 1.49 |
| | Comp. A+B | g/ml | 1.44 |
| Potlife | | h | 4.5 |
| Non Volatile | Comp. A+B | by weight | 78.9% |
| Non Volatile | Comp. A+B | by volume | 70.0% |
| VOC | | g/l | 290 |
| PVC | | | 24.8% |
| Dry to touch | | h | 4 |
| Dry hard | | h | 12 |
| Pencil hardness | | | HB |

Ancamide® is a registered trademark of Evonik Industries AG or one of its subsidiaries.

Disclaimer

This information and all further technical advice are based on our present knowledge and experience. However, it implies no liability or other legal responsibility on our part, including with regard to existing third party intellectual property rights, especially patent rights. In particular, no warranty, whether express or implied, or guarantee of product properties in the legal sense is intended or implied. We reserve the right to make any changes according to technological progress or further developments. The customer is not released from the obligation to conduct careful inspection and testing of incoming goods. Performance of the product described herein should be verified by testing, which should be carried out only by qualified experts in the sole responsibility of a customer. Reference to trade names used by other companies is neither a recommendation, nor does it imply that similar products could not be used.

EVONIK OPERATIONS GMBH

Business Line Crosslinkers
Paul-Baumann-Str. 1
45764 Marl
Germany

www.evonik.com/crosslinkers

Product Information: APCSE@evonik.com

Sample Request: APCSE@evonik.com

EVONIK CORPORATION

Business Line Crosslinkers
7201 Hamilton Blvd.
Allentown, PA 18195
USA

CrosslinkersProinfo@evonik.com

Crosslinkers-Samples@evonik.com

EVONIK SPECIALTY CHEMICALS (SHANGHAI) CO., LTD.

Business Line Crosslinkers
55, Chungong Road
Xinzhuang Industry Park
Shanghai, 201108
China

CL-Asiainfo@evonik.com

CL-Asiainfo@evonik.com

