

ANCAMIDE® 2353 Curing Agent**DESCRIPTION**

Ancamide 2353 curing agent is a high-performance modified polyamide intended for use with epoxy resins in two part ambient cure coatings. Special features of this product include fast dry, good cure at low temperatures and good resistance to solvents.

ADVANTAGES

- Fast dry time
- Good cure at 5°C
- High solvent resistance
- Good corrosion resistance
- High gloss finish
- Excellent development of hardness
- Non-corrosive according to EC
- Directives and not regulated or transport
- Zero induction time
- Good adhesion to damp concrete
- Moderate viscosity

APPLICATIONS

- High solids marine and
- Maintenance coatings
- Concrete primers

SHELF LIFE

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

PACKAGING AND HANDLING

Refer to the Safety Data Sheet for Ancamide 2353 curing agent.

TYPICAL PROPERTIES

Appearance	Amber liquid
Colour¹ (Gardner)	max 12
Viscosity² @ 25°C, [mPa.s]	3,000
Amine Value³ (mg KOH/g)	330
Specific Gravity @ 21°C	1.01
Equivalent Wt/{H}	114
Recommended use Level⁴ [PHR]	60

TYPICAL HANDLING PROPERTIES

Mixed Viscosity² at 25°C, [mPa.s]	5,800
Gel Time⁵ (150g mix at 25°C), [mins]	65
Peak Exotherm (150g mix at 25°C), [°C]	149
Thin Film Set Time⁶ 25°C, [h]	4.5
Typical cure schedule	2- 7 days

TYPICAL PERFORMANCE PROPERTIES

Compressive Strength⁷, [MPa]	78
Tensile Strength⁸, [MPa]	59
Flexural Strength⁹, [MPa]	112
Heat Distortion Temperature¹⁰, [°C]	55

Footnotes:

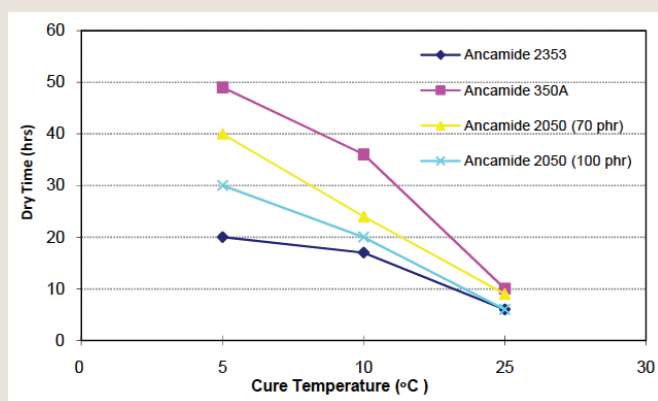
- (1) ASTM D 1544-80
- (2) Brookfield RVT, Spindle 4
- (3) Perchloric Acid Titration
- (4) With Bisphenol A diglycidyl ether (EEW=190)
- (5) Techne GT-3 Gelation Timer
- (6) BK Drying Recorder Phase III
- (7) ISO 604
- (8) ISO 527
- (9) ISO 178
- (10) ASTM D648

SUPPLEMENTARY INFORMATION

FAST DRY TIME

As shown in Figure 1, the thin film dry time of Ancamide 2353 curing agent with liquid epoxy resin is significantly faster than Ancamide 2050 and Ancamide 350A curing agents. At room temperature, the thin film set time (tack-free) is reduced to 4.5 h from 7 h and 11 h, respectively. At 5°C, the thin film set time is reduced from 46 h for Ancamide 350A curing agent and 30-40 h for Ancamide 2050 curing agent, depending on use level, to 20 h for Ancamide 2353 curing agent. Ancamide 2353 curing agent-based coatings can be recoated after overnight cure at 5°C.

FIGURE 1: COMPARATIVE DRY TIMES



* Set to Touch times measured by BK dry time recorder

Tables 9, 10, 11 and 12 contain preliminary formulations based on Ancamide 2353 curing agent for an anti-corrosive primer, an aluminium mastic and two white gloss enamels (one low VOC formulation with liquid resin and one fast dry formulation with solid resin). The tack-free times for these formulations are all under 4.5 h, with the primer formulation being only 1 h.

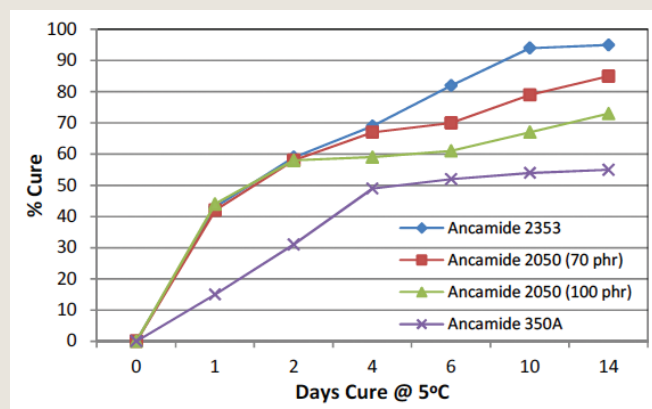
LOW TEMPERATURE PERFORMANCE

Ancamide 2353 curing agent is designed to cure at temperatures as low as 5°C when used with liquid epoxy resins. It produces hard, high gloss coatings which are highly resistant to amine blush even when cured at low temperature and high humidity.

Figure 2 compares the cure development of Ancamide 2353, Ancamide 2050 and Ancamide 350A curing agents at 5°C. Both Ancamide 2353 and Ancamide 2050 curing agents have a faster and more complete cure than the conventional polyamide, even when the conventional polyamide is accelerated with Ancamine K-54 curative. The superior cure is most evident in the first 3 days of cure at 5°C when rapid property development is needed most. Ancamide 2353 and Ancamide 2050

curing agents both show very good cure rate and degree of cure at 5°C. Both curing agents also possess a good balance of degree of cure and glass transition temperature, which is necessary for good coating performance.

FIGURE 2: LOW TEMPERATURE THROUGH CURE



CORROSION RESISTANCE

Formulations developed for an aluminium epoxy mastic and an inhibitive metal primer based on Ancamide 2353 are detailed in Tables 9 and 10. These formulations have been evaluated for salt spray resistance after 1000 h of exposure and the results are shown in Table 1. Both formulations show very good performance.

TABLE 1: SALT SPRAY RESISTANCE—ANCAMIDE 2353

	General Corrosion	Scribe Corrosion	Field Blistering	Blister Size
Aluminium Mastic	10	6-7	8	8
Red Primer	10	8-9	8-9	7-8

5% salt spray, cabinet temperature 35°C—ASTM B-1 17, film thickness 65 microns. Rating: 10 = Best, 0 = Worst

TABLE 2: HUMIDITY EXPOSURE—ANCAMIDE 2353

	General Corrosion	Blistering Degree	Blister Size
Aluminium Mastic	10	10	10
Red Primer	10	10	10

Continuous 100% Humidity Exposure - ASTM D-2247, cabinet temperature 50°C, film thickness 65 microns. Rating: 10 = Best, 0 = Worst

ADHESION

STEEL SUBSTRATE

The Ancamide 2353-based primer and aluminium mastic formulations have been evaluated per ASTM D-4541, Pull-Off Adhesion Test, for adhesion to heavy, hot rolled steel. Panels were prepared by shotblasting. Greater than 3.1 MPa was required for each formulation to cause failure and all failures occurred in the adhesive. No cohesive failure in the coatings, nor adhesive failure at any interface, was observed. Both formulations show good results.

CONCRETE

Ancamide 2353 curing agent provides excellent adhesion to damp concrete even when used in conjunction with a diluted epoxy resin at 5°C. By comparison, Ancamide 350A curing agent exhibits poor adhesion to concrete when cured at low temperature or when used with diluted epoxy resin. Ancamine K54 curing agent is ineffective at improving the adhesion of Ancamide 350A to damp concrete.

TABLE 3:

Curing Agent	Epoxy Resin	Tensile Pull Off (M Pa) 22°C Cure	Failure Mode	Tensile Pull Off (M Pa) 5°C Cure	Failure Mode
Ancamide 2353	DGEBA#*	2.07	Surface	1.72	Surface
	90% DGEBA* 10% Epodil® 748*	2.00	Mortar	2.34	Mortar
Ancamide 350A	DGEBA*	1.45	Cohesive	0.41	Cohesive
	90% DGEBA* 10% Epodil 748*	0.41	Cohesive	0.34	Cohesive
95% Ancamide 350A 5% Ancamine K54	DGEBA*	1.38	Cohesive	0.41	Cohesive
	90% DGEBA* 10% Epodil 748*	0.28	Cohesive	0.28	Cohesive

DGEBA: Diglycidyl Ether of Bisphenol A (EEW=190)

Epodil 748: C₁₂₋₁₄ Alkyl Glycidyl Ether

Surface Failure: Bond failure in the upper 10% of the mortar specimen

Mortar Failure: Bond failure in the lower 90% of the mortar specimen

Cohesive Failure: Bond failure in the epoxy bond line

HANDLING PROPERTIES

Table 4 compares the handling properties of Ancamide 2353, Ancamide 2050 and Ancamide 350A curing agents. Ancamide 2353 has the lowest viscosity and zero induction time, resulting in easier handling than a conventional polyamide such as Ancamide 350A. Equivalent loading compared with Ancamide 350A allows Ancamide 2353 curing agent to be substituted into existing formulations with minimal modifications.

TABLE 4:

Handling Properties	Ancamide 2353	Ancamide 350A	Ancamide 2050
Viscosity (poise)	30	110	40
Mixed Viscosity* (poise)	58	120	64
Pot Life (min)*	60	200	100
Tack Free (h @ 22°C)*	4.5	11	7
Tack Free (h @ 5°C)*	20	46	140

* Curing agents were mixed with liquid DGEBA epoxy (EEW= 1 90) @ 60 phr for Ancamide 2353 and Ancamide 350A and 70 phr for Ancamide 2050

FILM PROPERTIES

Table 5 shows that the direct and reverse impact resistance of Ancamide 2353 are comparable to Ancamide 350A curing agent. Gloss is superior, while VOC content in a formulated paint can be at least maintained at the same level, as shown in Table 5. Table 11 shows a new white gloss enamel preliminary formulation based on liquid epoxy resin and Ancamide 2353 where the VOC has been reduced to 190 gm/litre.

TABLE 5:

Film Properties	Ancamide 2353	Ancamide 350A
VOC (gm/litre)	275	275
Direct Impact (cm.kg)	220	230
Reverse Impact (cm.kg)	12	14
Gloss, 60°	100	90

Pigmented formulations based on solid epoxy resin (EEW 325) were mixed with each curing agent, applied to cold rolled steel panels and cured 7 days @ 22°C before testing.

Table 6 compares the hardness development of Ancamide 2353 and Ancamide 2050 curing agents with liquid DGEBA resin at ambient temperature. Also shown are film appearance results under various conditions for both curing agents. Ancamide 2353-based films harden much more rapidly than those based on Ancamide 2050 and the Ancamide 2353-based films develop greater ultimate hardness.

Film appearance also favours Ancamide 2353 in low temperature/high humidity conditions. Both curing agents give clear, tack free film appearance at ambient temperature and moderate humidity.

TABLE 6: FILM PROPERTIES*

Hardness Development (pendulum)	Ancamide 2353	Ancamide 2050
1 day	98	5
7 days	137	60
14 days	140	112
Film Appearance		
1 day, 25°C, 50% RH	clear, tack free	clear, tack free
1 day, 10°C, 90% RH	slight haze, tacky	haze, tacky
1 day, 5°C, 80% RH	clear, tacky	clear, very tacky
7 days, 10°C, 90% RH	slight haze, tacky	haze, tack free
7 days, 5°C, 80% RH	clear, tacky	clear, tacky

* Clear formulations with liquid epoxy resins (EEW = 190)

PHYSICAL PROPERTIES

Table 7 shows the superior physical properties of Ancamide 2353 curing agent compared to Ancamide 350A. The high tensile strength, flexural strength and Shore D hardness show that Ancamide 2353 curing agent produces harder, tougher, more resilient coatings than the conventional polyamide.

TABLE 7:

Physical Properties	Ancamide 2353	Ancamide 350A
Tensile Strength (MPa)	58.6	39.3
Flexural Strength (MPa)	112.4	95.8
Compressive Strength (MPa)	77.9	90.3
Shore D Hardness	80	75

Curing agents were mixed with liquid epoxy (EEW=190) @ 60 phr and cured 7 days @ 22°C before testing.

CHEMICAL RESISTANCE

Comparative chemical resistance for Ancamide 2353 and Ancamide 350A curing agents is shown in Table 8. Ancamide 2353 curing agent imparts significantly higher chemical resistance than Ancamide 350A curing agent, particularly to toluene. The conventional polyamide is destroyed after 3 days immersion in toluene, while Ancamide 2353 curing agent is virtually unaffected after 28 days immersion in toluene.

Ancamide 2353-based systems have higher resistance to ethanol, 10% acetic acid, and 70% sulphuric acid, particularly as the immersion time increases. Resistance to 50% NAOH is comparable to the conventional polyamide.

TABLE 8: COMPARATIVE CHEMICAL RESISTANCE¹⁵

Reagent	Immersion Time (days)	Weight Gain (%)	
		Ancamide 2353	Ancamide 350A
Toluene	1	0.0	13.7
	3	0.1	26.3
	7	0.3	Destroyed
	28	1.8	Destroyed
Ethanol	1	1.7	3.3
	3	3.0	4.7
	7	4.4	6.1
10% HAc	28	8.5	10.4
	1	5.6	7.6
	3	9.7	13.9
70% H ₂ SO ₄	7	14.1	20.7
	28	25.1	36.8
	1	0.2	0.3
50% NaOH	3	0.4	0.7
	7	0.7	1.6
	28	2.4	10.3
50% NaOH	1	0	0
	3	0	0
	7	0	0
	28	0	0

Curing agents were mixed with liquid epoxy resin (EEW=190) at 60 phr and cured 7 days at 22oC before immersion.

ANTI-CORROSIVE PRIMER PRELIMINARY FORMULATION—ANCAMIDE 2353

A-Component		2353 Kg	2353 Litres
Liquid DGEBA Epoxy		106.0	91.20
MPA-1078	Rheox	1.8	2.05
Mix well, then add at high speed:			
TiPure R900	DuPont	11.3	2.84
10 Wollastekup AS	NYCO	167.8	57.88
Disperse to 5 Hegman and 50°C. Reduce speed and add:			
Xylene	Ashland	20.4	23.50
Total A component		307.3	177.47
B-Component			
Ancamide 2353	Evonik	56.9	57.58
MPA-1078	Rheox	1.8	2.05
Beetle 216-8	Cyanamid	6.8	6.53
Mix well at high speed, then add:			
Red Iron Oxide J-3100	Mineral Pigments	27.2	5.45
Beaverwhite 325	Cyprus	43.9	15.91
Phosplus J-0866	Mineral Pigments	64.1	19.17
Disperse to 5 Hegman and 50°C. Reduce speed and add:			
Diacetone Alcohol	Union Carbide	14.2	15.13
Super High Flash Naptha	Ashland	48.4	55.61
Total B component		263.3	177.43

TECHNICAL DATA

Volume Solids	71.8%	VOC	<250 gm/litre
PVC	39.7%	Mixing Ratio	1.1 by Volume
CPVC	54.6%	Pot Life, h	3
PVC/CPVC	.725	Thin film set time: - tack-free, h - hard-dry, h	1 6
weight/litre, Part A	1.73		
weight/litre, Part B	1.48		
weight/litre	1.61		

MPA-1078 is an anti-settling agent
 Ti-Pure R-900 is a surface treated grade of rutile titanium dioxide (non-yellowing)
 10 Wollastekup AS is amine-treated Wollastonite
 Beetle 216-8 is a flow control agent
 Beaverwhite 325 is 325-mesh talc

ALUMINIUM MASTIC PRELIMINARY FORMULATION— ANCAMIDE 2353

A-Component		2353 Kg	2353 Litres
Liquid DGEBA Epoxy		139.3	120.0
MPA-1078	Rheox	3.6	3.8
10 Wollastekup AS	NYCO	113.4	39.0
Disperse to 6 Hegman and 55°C:			
Epodil L	Evonik	15.9	15.1
High Flash Naptha		54.4	62.5
Beetle 216-8	Cyanamid	11.3	10.6
Lansford L243	Silberline	56.7	38.6
Diacetone Alcohol	Union Carbide	10.9	11.4
Cabosil TS 720	Cabot	4.5	1.5
Total A component		410.0	302.5
B-Component			
Ancamide 2353	Evonik	76.7	75.7

LOW VOC WHITE GLOSS ENAMEL—ANCAMIDE 2353

A-Component		2353 Kg	2353 Litres
Grind Base			
Liquid DGEBA Epoxy		160.0	62.55
Nuosperse 657	Hüls America	1.8	0.43
Surfynol® 740	Evonik	0.8	0.43
Dowanol PM	Dow	22.1	10.85
TiPure R-960	DuPont	176.0	20.47
Let Down			
High Flash Naptha	Ashiand	30.7	15.83
Methyl Propyl Ketone	Eastman	6.4	3.59
Total A component		397.8	114.51
B-Component			
Ancamide 2353	Evonik	96.2	41.14
n-Butanol	Ashiand	28.6	16.04
Total B component		124.8	57.18

TECHNICAL DATA

Volume Solids	71.9%	VOC	<300 gm/litre
PVC	20.0%	Mixing Ratio	4.1 by Volume
CPVC	47.1%	Pot Life, h	5
PVC/CPVC	.426	Thin film set time: - tack-free, h - hard-dry, h	3 7
weight/litre, Part A	1.35		
weight/litre, Part B	1.01		
weight/litre	1.29		

Lansford L243 is aluminium powder
Cabosil TS 720 is a fumed silica thixatropo

TECHNICAL DATA

Part A Viscosity	73 KU	VOC	@ 70 KU 265 gm/litre
Part B Viscosity	64 KU	Mixing Ratio	2.1 by Volume
Mixed Viscosity	70 KU	Induction Time	0
PVC	17%	Pot Life, h	2
Volume Solids	70%	Thin film set times: - Tack-free, h - Dust Free, h - Hard Dry, h	5 7 Overnight
		60° Gloss	102

Nuosperse 657 is a pigment dispersant
Surfynol 740 is a silicon-based flow and levelling agent

FAST DRYING WHITE GLOSS ENAMEL—ANCAMIDE 2353

A-Component		2353 Kg	2353 Litres
Grind Base			
DER 66OX80	Dow	214.3	194.84
Nuosperse 657	Hüls America	1.6	1.59
Beetie 216-8	American Cyanamid	1.3	1.29
Dowanol PM	Dow	21.4	23.47
TiPure R-960	DuPont	139.3	35.73
Let Down			
High Flash Naptha	Ashiand	33.4	37.97
Methyl Propyl Ketone	Eastman	6.4	7.95
Total A component		418.0	302.84
B-Component			
Ancamide 2353	Evonik	59.6	56.25
n-Butanol	Ashiand	15.8	19.46
Total B component		75.4	75.71

TECHNICAL DATA

Part A Viscosity	86 KU	VOC	@ 80 KU 335 gm/litre
Part B Viscosity	64 KU	Mixing Ratio	4.1 by Volume
Mixed Viscosity	80 KU	Induction Time	0
PVC	15.2%	Pot Life, h	3
Volume Solids	62.2%	Thin film set times:	
		- Tack-free, min	50
		- Dust Free, min	75
		- Hard Dry, h	Overnight
		60° Gloss	104

Footnotes:

- (1) ASTM D 1544-80
- (2) ASTM D-445-83, Brookfield, RVTD, Spindle 4
- (3) Perchloric Acid Titration
- (4) ASTM D 1475-85
- (5) Seta Flash Closed Cup
- (6) Technea GT-4 Gelation Timer
- (7) BK Drying Recorder
- (8) ASTM D 2471-71
- (9) ASTM D 3418-82
- (10) ASTM 695-85
- (11) ASTM D 638-86
- (12) ASTM D 790-86
- (13) ASTM D 2240-86
- (14) ASTM D 4547
- (15) ASTM D 543-84

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