

ANCAMINE[®] 2489**Curing Agent****DESCRIPTION**

Ancamine 2489 curing agent is a low-color cycloaliphatic amine adduct intended for use with liquid epoxy resins. It has a very low viscosity which imparts low mixed viscosity in epoxy systems and reduced need for diluents. Ancamine 2489 curing agent gives very rapid development of physical properties at ambient and low temperatures for a fast return to service, while maintaining longer working life than conventional fast cure hardeners. It yields formulations with good waterspot resistance, resistance to amine blush and chemical resistance. Ancamine 2489 curing agent utilizes state-of-the-art adduct technology to provide a favorable combination of properties for formulating a variety of civil engineering and coating materials.

TYPICAL PROPERTIES

Property	Value	Unit	Method
Appearance	Clear liquid		
Colour	1-2	Gardner	ASTM D 1544-80
Viscosity @ 77°F	80	cP	ASTM D 445-83, Brookfield, RVTD, Spindle 4
Amine Value	360	mg KOH/g	Perchloric Acid Titration
Specific Gravity @ 77°F	1.04		ASTM D 1475-85
Flash Point (closed cup)	230	°F	Seta Flash Closed Cup
Equivalent Wt{H}	83		
Recommended use Level	44	p/hr	EEW=190

ADVANTAGES

- Very low viscosity and mixed viscosity in epoxy systems
- Rapid cure and property development at ambient and low temperatures
- Good working life/ cure speed balance
- Good resistance to blush and waterspotting
- Good chemical resistance

APPLICATIONS

- Decorative and industrial flooring
- Chemically resistant high-solids coatings
- Mortars and grouts
- Sealers and primers

SHELF LIFE

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

STORAGE AND HANDLING

Refer to the Safety Data Sheet for Ancamine 2489 curing agent.

TYPICAL CURE SCHEDULE

2–7 days at ambient temperature

TYPICAL HANDLING PROPERTIES

Property	A*	B*	Unit	Method
Use Level	44	41	phr	
Mixed Viscosity @ 77°F	860	580	cP	ASTM D 445-83, Brookfield, RVTD, Spindle 4
Gel Time 150 g mix @ 77°F	32	41	min	Techne GT-4 Gelation Timer
150 g mix @ 50°F	106	360	min	Techne GT-4 Gelation Timer
Thin Film Set Time @ 77°F	3.0	4.0	h	BK Drying Recorder
@ 50°F	8.0	13.5	h	BK Drying Recorder
@ 40°F	10	16	h	BK Drying Recorder
Peak Exotherm (150 g mix @ 77°F)	250	-	°F	ASTM D 2471-71

TYPICAL PERFORMANCE

Property	A*	B*	Unit	Method
7 day cure @ 77°F				
Glass Transition Temperature	118	111	°F	ASTM D 3418-82
Compressive Strength @ yield	11,700	10,100	psi	ASTM D 695-85
Compressive Modulus	303	280	thousand psi	ASTM D 695-85
Tensile Strength	10,500	9,400	psi	ASTM D 638-86
Tensile Modulus	620	-	thousand psi	ASTM D 638-86
Tensile Elongation @ break	2.3	5.6	%	ASTM D 638-86
Flexural Strength	19,600	17,900	psi	ASTM D 790-86
Flexural Modulus	787	582	thousand psi	ASTM D 790-86
Hardness	85	84	Shore D	ASTM D 2240-86
60° Specular Gloss @ 77°F	126	123		ASTM D 523-85
60° Specular Gloss @ 40°F	92	88		ASTM D 523-85

A* Ancamine 2489 formulated with standard bisphenol-A (DGEBA, EEW=190) resin

B* Ancamine 2489 with 90% bis-A resin (EEW=190) and 10% Epodil® 748 diluent (C₁₂-C₁₄ alkyl glycidyl ether)

SUPPLEMENTARY INFORMATION

LOW MIXED VISCOSITY: Ancamine 2489 curing agent has a viscosity of 80 cP, which is lower than typical modified cycloaliphatic curing agents. Because of its low viscosity and excellent compatibility with epoxy resins, Ancamine 2489 curing agent gives a mixed viscosity of 860 cP with standard bis-A resin. Low mixed viscosity is a benefit in many applications, such as flooring and mortars, because it promotes easier handling of the final product. The mixed viscosity provided by Ancamine 2489 is the lowest for the modified cycloaliphatic curing agents Air Products now offers. As shown in Table 4, the mixed viscosity of Ancamine 2489 curing agent with straight resin is lower than that of many other modified cycloaliphatics, such as Ancamine 1618 or Ancamine 2423 curing agents, with 10% diluted resin.

TABLE 4: MIXED VISCOSITY OF SELECTED CYCLOALIPHATIC CURING AGENTS

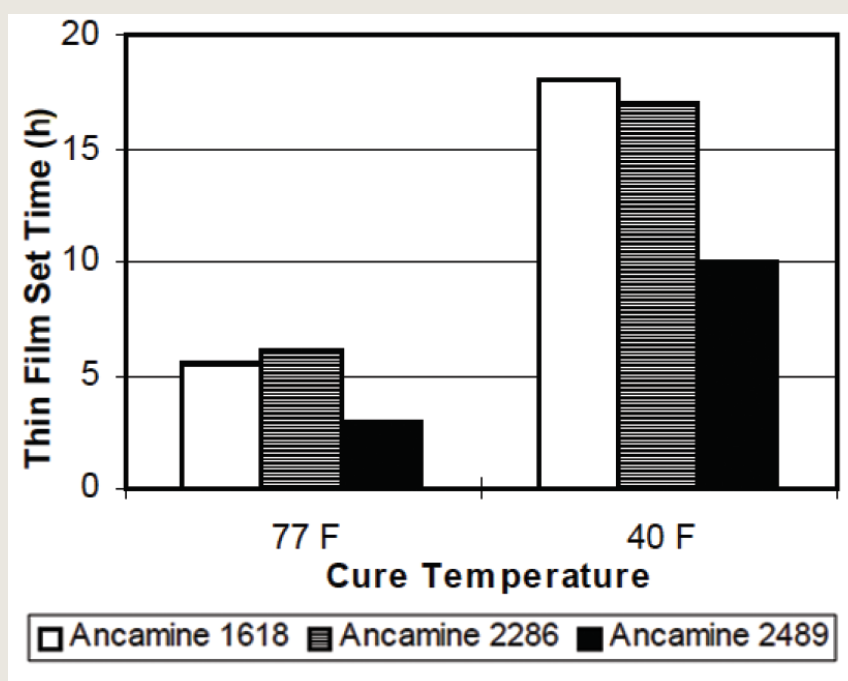
Property	With 100% Bis-A Resin	With 90% Bis-A Resin/ 10% Epodil 748 Diluent Blend	Unit
Ancamine 1618	2,400	1,370	cP
Ancamine 2423	4,280	2,020	cP
Ancamine 2489	1860	580	cP



Ancamine 2489 curing agent can provide cost effectiveness in epoxy formulations compared with standard modified cycloaliphatic curing agents. The low mixed viscosity of Ancamine 2489 can give a lower cost in use because it allows higher filler loading and/or reduced use of reactive diluents in the formulated system. Using less diluent in the formulation also results in less of an impact on some performance properties, such as cure speed and chemical resistance, that can be affected by reactive diluent addition.

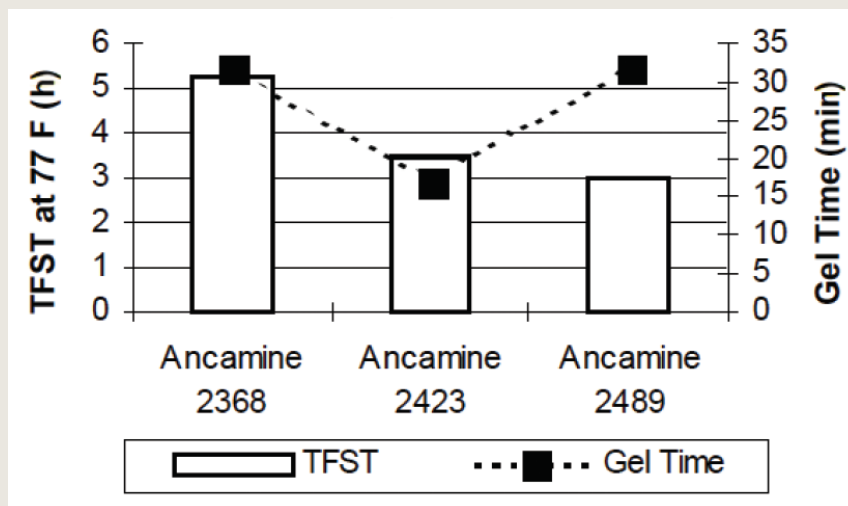
FAST CURE SPEED: Ancamine 2489 curing agent provides fast cure and property development at ambient and low temperatures without accelerators, allowing application under a range of temperatures, with a quick return to service. The thin film set time of Ancamine 2489 curing agent with bis-A based liquid resin in a 3-mil film is 3.0 hours at 77°F, and 8.0 hours at 50°F. Cure speed is faster than with most cycloaliphatic curing agents. Figure 1 shows the thin film set time of Ancamine 2489 versus cycloaliphatic curing agents, Ancamine 1618 and Ancamine 2286, with bis-A based liquid resin at 77°F and 40°F.

FIGURE 1: THIN FILM SET TIME COMPARISON



Ancamine 2489 curing agent provides a fast cure with longer working life than other fast curing agents. Figure 2 compares the gel time and thin film set time (TFST) of Ancamine 2489 with Ancamine 2368 and Ancamine 2423 cycloaliphatic curing agents when formulated with standard bisphenol-A resin.

FIGURE 2: SET TIME / POT LIFE BALANCE



Thin film set time, which is an indicator of the time for an applied coating to set, is 2 hours faster with Ancamine 2489 than with Ancamine 2368 curing agent, while gel time, which is an indicator of pot life in a mixing container, is the same at 32 minutes. Compared with Ancamine 2423 curing agent, Ancamine 2489 gives almost twice the working time - 32 minutes vs. 17 minutes - with the same 3-hour set time. This allows a fast return to service while giving the applicator more time to apply the formulated product after mixing.

RAPID HARDNESS DEVELOPMENT: Gel time and thin film set time define the development of cure well, but often do not accurately predict development of hardness. Shore D hardness development was measured as a function of 77°F and 40°F cure for a 1/4-inch thick casting. The results are presented in Table 5.

TABLE 5: ANCAMINE 2489 HARDNESS DEVELOPMENT

Number of Days Cure	1	3	7	Method
77°F Cure Shore D Hardness	83	NT	85	ASTM D 2240-86
40°F Cure Shore D Hardness	55	70	80	ASTM D 2240-86

Note: Ancamine 2489 formulated with bis-A (EEW=190) resin.

The fast cure and rapid hardness development of formulations cured with Ancamine 2489 curing agent make it ideal for flooring, coatings and mortars applied at ambient or low temperatures. Even at a temperature as low as 40°F, Ancamine 2489 curing agent gives a Shore D hardness of 55 within 24 hours. This indicates that it is possible to formulate a system with this product that gives an overnight walk-on at normal temperatures and a oneday walk-on time at low temperatures.

If even faster thin film set and hardness development are needed, Ancamine 2489 curing agent can be accelerated with fast modified aliphatic amine curing agents such as Ancamine 2089M, Ancamine 2432, Ancamine 2205 or Ancamine 1856 curing agents.

BLUSH RESISTANCE: Ancamine 2489 curing agent gives high-gloss films with very low or no amine blush when cured at ambient and low temperatures. When combined with standard bis-A resin, the product gives a very high 60° gloss of 126 when cured at 77°F. High gloss at ambient cure is typical of most modified cycloaliphatic curing agents, but Ancamine 2489 curing agent maintains its high gloss and good film appearance characteristics even under low temperature conditions. When formulated with bis-A resin and cured at 40°F, the film is smooth and clear with a 60° gloss of 92. Most other fast curing hardeners show amine blush and film haziness under low temperature cure conditions.

WATERSPOT RESISTANCE: Waterspotting can be caused by water drops contacting a coating before it is cured. Ancamine 2489 curing agent was tested for waterspot resistance in formulations with both undiluted bis-A based resin and 90% bis-A based resin/10% Epodil® 748 reactive diluent blend. 10-mil films of each formulation were cured for eight hours at 77°F and 55% relative humidity. After eight hours, a cotton ball saturated with water was placed on the films. The films were then placed in the incubator for another 24 hours at 77°F and 55% relative humidity. After this period, the films were examined for white spots. The Ancamine 2489 formulations showed an absence of spots, indicating very good waterspot resistance at ambient Cure conditions.

Ancamine 2489 curing agent was also tested for waterspot resistance at low cure temperatures. A 10-mil film of Ancamine 2489 with bis-A based resin was cured for 24 hours at 45°F and 90% relative humidity. After 24 hours, a cotton ball saturated with water was placed on the film. The film was then placed in the incubator for 24 hours at 45°F and 90% relative humidity. The film showed minimal waterspotting. Most amine-based curing agents waterspot severely under these aggressive conditions, but Ancamine 2489 curing agent gives good waterspot resistance.

CHEMICAL RESISTANCE: Chemical immersion studies following ASTM D543 were performed on coupons using standard bis-A (DGEBA, EEW=190) liquid resin cured with Ancamine 2489 curing agent for 7 days at 77°F. Three samples were tested for each reagent. Table 6 shows the average percentage weight change after 3 days and 28 days immersion in various chemicals at 77°F.

Spillage resistance studies were conducted on Ancamine 2489 curing agent formulated with a 90% bis-A resin (EEW=190) and 10% Epodil 748 diluent (C₁₂-C₁₄ alkyl glycidyl ether) blend. Samples were cured for 7 days at 77°F before testing (tests were conducted in triplicate). The immersion/ recovery schedule for the testing is shown in Table 7. Percentage weight change and Shore D hardness were measured after each of the immersion periods. The samples were then allowed to recover before reimmersion for the next time period. Hardness retention is relevant in flooring applications where it indicates the ability of the floor to support traffic after exposure to chemical spills. The results of this study are presented in Table 8.

These studies show that Ancamine 2489 curing agent imparts good resistance to a variety of chemicals. The chemical resistance of Ancamine 2489-cured formulations can be optimized for specific chemicals using different resin blends, such as bisphenol-F and multifunctional novolac resins.

For information on the chemical resistance of many other Evonik curing agents, please refer to our brochure, Chemical Resistance for Ambient Cure Epoxy Formulations (125-9326). Table 2: Typical handling Properties



TABLE 6: CHEMICAL RESISTANCE FOR ANCAMINE 2489 FORMULATION % WEIGHT CHANGE AS A FUNCTION OF TIME (CONTINUOUS IMMERSION)

Reagent	Ancamine 2489 / Bis-A Resin	
	After 3 days % wt. change	After 28 days % wt. change
Deionized Water	0.42	1.43
Methanol	10.6	Destroyed
Ethanol	3.47	10.2
Toluene	3.10	10.4
Xylene	0.12	0.56
Butyl Cellosolve	2.91	7.15
MEK	11.6	Destroyed
10% Lactic Acid	2.10	5.82
10% Acetic Acid	3.35	9.20
70% Sulfuric Acid	0.24	-2.04
98% Sulfuric Acid	Destroyed	-
50% Sodium Hydroxide	0.95	0.86
Bleach	0.43	1.42
Trichloroethane	0.04	0.23

Note: Samples cured for 7 days at 77°F before testing. They were tested in accordance with ASTM D543-84.

TABLE 7: SPILLAGE RESISTANCE TEST METHOD SCHEDULE

Castings of 1/8" thickness are immersed for specified time period. Sample is then removed, weighed, and hardness tested immediately. Sample is then allowed to recover for specified time before re-immersion.

3 hr imm → test → 24 hr recovery
24 hr imm → test → 24 hr recovery
3 day imm → test → 3 day recovery
7 day imm → test → 7 day recovery
28 day imm → test → 7 day recovery
90 day imm → test



TABLE 8: SPILLAGE RESISTANCE FOR ANCAMINE 2489 WITH 90% BIS-A RESIN / 10% EPODIL 748
% WEIGHT CHANGE AND SHORE D HARDNESS AS A FUNCTION OF TIME

Reagent	Initial	Test After 3 hr		Test After 24 hr		Test After 3 days		Test After 7 days		Test After 28 days		Test After 90 days	
	Hard	% wt	Hard	% wt	Hard	% wt	Hard	% wt	Hard	% wt	Hard	% wt	Hard
10% Acetic Acid	84	0.33	81	1.10	75	2.30	74	3.50	73	5.54	69	7.15	65
10% Lactic Acid	84	0.14	83	0.57	81	1.30	81	2.09	79	3.10	74	3.98	70
Toluene	84	0.00	80	0.76	74	3.77	69	8.70	64	15.4	56	19.5	48
Xylene	84	0.00	80	0.01	77	0.30	75	1.28	71	4.52	67	6.89	62
Trichloroethane	84	0.27	78	0.60	76	2.50	73	6.02	68	12.2	64	18.6	61
Methanol	84	3.16	67	8.00	40	6.95	29	Destroyed					
Ethanol	84	1.04	76	2.61	73	4.96	70	8.00	62	7.54	57	5.96	54
Butyl Cellosolve	84	0.24	79	1.00	75	3.50	68	5.40	63	6.78	60	10.0	55
Methyl Ethyl Ketone	84	6.46	61	Destroyed									
Skydrol	84	0.04	78	0.09	78	0.28	77	0.71	77	0.94	75	1.02	70
70% Sulfuric Acid	84	0.08	82	0.05	81	0.05	82	0.06	80	0.11	80	0.12	79
98% Sulfuric Acid	84	-14.18	76	Destroyed									
Deionized Water	84	0.15	84	0.23	84	0.49	83	0.81	83	1.13	83	1.25	82
50% Sodium Hydroxide	84	0.07	82	-0.04	82	-0.07	81	-0.10	80	-0.09	78	-0.12	75
Bleach	84	0.24	81	0.50	82	0.80	81	0.11	82	0.24	80	0.38	78

Note: Samples were cured for 7 days at 77°F before testing.



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