

Ancamine® 2432 Curing Agent

DESCRIPTION

Ancamine 2432 curing agent is a modified aliphatic amine intended for use with liquid epoxy resins. It imparts very rapid development of physical properties at ambient and low temperatures, while maintaining longer working life than conventional „fast cure“ hardeners. It yields formulations with outstanding chemical resistance. These properties make Ancamine 2432 curing agent ideal for formulating chemically resistant coatings, flooring and secondary containment linings. It is also an effective accelerator for aliphatic and cycloaliphatic curing agents in civil engineering and coating formulations.

ADVANTAGES

- Very rapid cure and property development at ambient and low temperatures
- Outstanding chemical resistance to solvents, acids and alcohols
- Good working life/cure speed balance

APPLICATIONS

- Chemically resistant coatings and mortars
- Accelerator for high solids coatings and flooring
- Secondary containment linings

STORAGE 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.

HANDLING PRECAUTIONS

Refer to the Safety Data Sheet for Ancamine 2432 curing agent.

TYPICAL CURE SCHEDULE

2-7 days at ambient temperature.

TABLE 1: TYPICAL PROPERTIES

Appearance:	Yellow Liquid
Color⁽¹⁾ (Gardner):	3
Viscosity⁽²⁾ @ 77°F (cPs)	300
Amine Value⁽³⁾ (mg KOH/g)	368
Specific Gravity⁽⁴⁾ @ 77°F	1.10
Flash Point⁽⁵⁾ (°F)	>235
Equivalent Wt/{H}	88
Recommended Use Level (phr, EEW=190)	46

TABLE 2: TYPICAL HANDLING PROPERTIES

	A*	B*
Use Level (phr)	46	45
Mixed Viscosity⁽²⁾ @ 77°F (cPs)	2,100	1,000
Gel Time⁽⁶⁾ (150g mix @ 77°F) (min)	27	29
Thin Film Set Time⁽⁷⁾ @ 77°F (h)	2.0	2.6
Thin Film Set Time⁽⁷⁾ @ 40°F (h)	8.0	9.5

TABLE 3: TYPICAL PERFORMANCE

	A*	B*
After 7 day cure @ 77°F		
Glass Transition Temperature⁽⁸⁾ (°F)	100	80
Compressive Strength⁽⁹⁾ @ yield (psi)	11,700	9,400
Compressive Modulus⁽⁹⁾ (thousand psi)	356	286
Tensile Strength⁽⁹⁾ (psi)	9,500	7,500
Tensile Modulus⁽¹⁰⁾ (thousand psi)	474	382
Tensile Elongation⁽¹⁰⁾ @ break (%)	4.8	7.6
Flexural Strength⁽¹¹⁾ (psi)	15,700	11,800
Flexural Modulus⁽¹¹⁾ (thousand psi)	525	395
Hardness12 (Shore D)	81	80
60° Specular Gloss13		
cured @ 77°F	109	109
cured @ 40°F	60	—

A* Ancamine 2432 curing agent formulated with standard liquid Bisphenol-A based (DGEBA, EEW=190) epoxy resin.

B* Ancamine 2432 curing agent with 90% Bisphenol-A based resin (EEW=190) and 10% Epodil* 748 diluent (C12-C14 alkyl glycidyl ether) blend.

NOTE: Please see last page for footnotes

SUPPLEMENTARY DATA

CHEMICAL RESISTANCE: Immersion studies following ASTM D543 were performed using standard liquid bisphenol-A based (DGEBA, EEW=190) epoxy resin cured with Ancamine 2432 curing agent for 7 days at 77°F. Three samples were tested for each reagent. Table 1 shows the average percentage weight change after immersion at 77°F for 3 days, 7 days and 28 days in various chemicals.

**TABLE 1:
CHEMICAL RESISTANCE FOR ANCAMINE 2432 FORMULATION
WITH BISPHENOL-A BASED (EEW=190) RESIN
% WEIGHT CHANGE AS A FUNCTION OF TIME — CONTINUOUS IMMERSION**

Reagent	After 3 days % wt. change	After 7 days % wt. change	After 28 days % wt. change
Deionized Water	0.33	0.51	1.11
Methanol	6.38	8.94	9.55
Ethanol	1.55	2.40	4.68
Toluene	0.17	0.43	0.99
Xylene	0.25	0.42	0.69
Butyl Cellosolve	0.31	0.48	1.18
MEK	9.35	13.48	11.19
10% Lactic Acid	1.10	1.64	3.24
10% Acetic Acid	1.23	1.94	3.85
70% Sulfuric Acid	0.10	0.10	0.13
50% Sodium Hydroxide	0.04	0.05	0.09
Bleach	0.27	0.45	0.93
1,1,1 Trichloroethane	0.18	0.26	0.43
10% Nitric Acid	0.55	0.92	2.05
30% Nitric Acid	2.04	2.74	4.17

NOTE: Samples cured for 7 days at 77 °F before testing. Tested in accordance with ASTM D543-84.

These studies show that Ancamine 2432 curing agent imparts outstanding chemical resistance to all types of reagents (acids, solvents and alcohols).

Chemical resistance of Ancamine 2432-cured formulations can be optimized for specific chemicals using different resin blends. Table 2 shows immersion study data for Ancamine 2432 curing agent with standard bisphenol-F resin and with a bisphenol-F / multifunctional novolac resin blend. Ancamine 2432 curing agent imparts outstanding chemical resistance to all of the reagents with these resins. Resistance to methyl ethyl ketone (MEK) and 98% sulfuric acid is exceptional with these resins, as most conventional epoxy formulations are destroyed by these reagents.

STARTING POINT FORMULATION HYBRIDUR® 570 GLOSS WHITE COATING

One-Component Polyurethane-Acrylic Hybrid Coating Prepared with a Resin-Free Grind
Formulation – HYS70MWT01

TABLE 2:
CHEMICAL RESISTANCE FOR ANCAMINE 2432 FORMULATIONS
WITH BISPHENOL-F BASED RESIN AND BISPHENOL-F / NOVOLAC RESIN BLEND
% WEIGHT CHANGE AS A FUNCTION OF TIME — CONTINUOUS IMMERSION

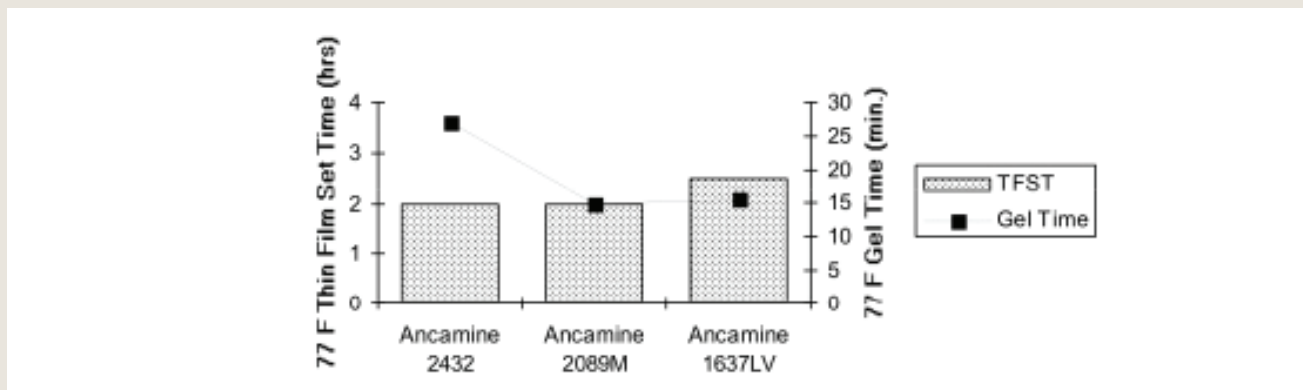
Reagent	BISPHENOL-F BASED RESIN			BISPHENOL-F / NOVOLAC RESIN BLEND		
	3 days	7 days	28 days	3 days	7 days	28 days
Deionized Water	0.43	0.63	1.30	0.48	0.70	1.43
Methanol	6.79	9.71	4.15	6.82	9.70	7.07
Ethanol	1.26	1.76	3.47	1.24	1.74	3.45
Toluene	0.12	0.15	0.37	0.15	0.15	0.36
MEK	7.29	10.75	7.87	6.40	9.35	6.74
10% Acetic Acid	1.36	1.96	3.71	1.57	2.23	4.19
98% Sulfuric Acid	0.62	0.77	-0.01	0.72	1.23	0.45

NOTE: The bisphenol-F resin tested was DGEBF (EEW=172) and the bisphenol-F / novolac resin blend tested was 60 Wt% DGEBF (EEW=172) and 40 Wt% epoxy novolac (EEW=176). Samples were cured for 7 days at 77 °F before testing. They were tested in accordance with ASTM D543-84.

The outstanding chemical resistance imparted by Ancamine 2432 curing agent makes it particularly useful in formulating chemically resistant coatings, mortars and secondary containment linings. For information on the chemical resistance of many other Air Products curing agents, please refer to publication number 125-9326 (Rev 1996): "Chemical Resistance for Ambient Cure Epoxy Formulations."

CURE SPEED AND POT LIFE: The thin film set time of Ancamine 2432 curing agent with standard bisphenol-A resin (DGEBA, EEW=190) in a 6 mil film was 2.0 hours at 77°F, and 8.0 hours at 40°F. Using a 90% bisphenol-A resin / 10% Epodil 748 diluent blend, the thin film set time was 2.6 hours at 77°F and 9.5 hours at 40°F. Ancamine 2432 provided 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 2432 with Ancamine 2089M and Ancamine 1637LV curing agents when formulated with standard bisphenol-A resin.

FIGURE 2:
THIN FILM SET AND GEL TIME COMPARISON



NOTE: Formulated with standard bisphenol-A (DGEBA, EEW=190) resin.

Thin film set time (TFST), which is an indicator of the time for an applied coating to set, was about the same for the three curing agents in Figure 2. However, gel time, which is an indicator of pot life in a mixing container, was almost twice as long with Ancamine 2432 curing agent. This allows a faster return to service while giving the applicator more time to apply the formulated product after mixing.

HARDNESS DEVELOPMENT: Gel time and thin film set time define the development of cure, however they often do not predict the development of hardness accurately. König pendulum hardness was measured as a function of cure time at 77°F for 10 mil coatings formulated with Ancamine 2432 curing agent and bisphenol-A resin. Shore D hardness development was measured at 77°F and 40°F cure temperatures with a casting 1/4" thick and 3" in diameter. Results are presented below:

ANCAMINE 2432 FORMULATION HARDNESS DEVELOPMENT

With bisphenol-A based (EEW=190) resin:

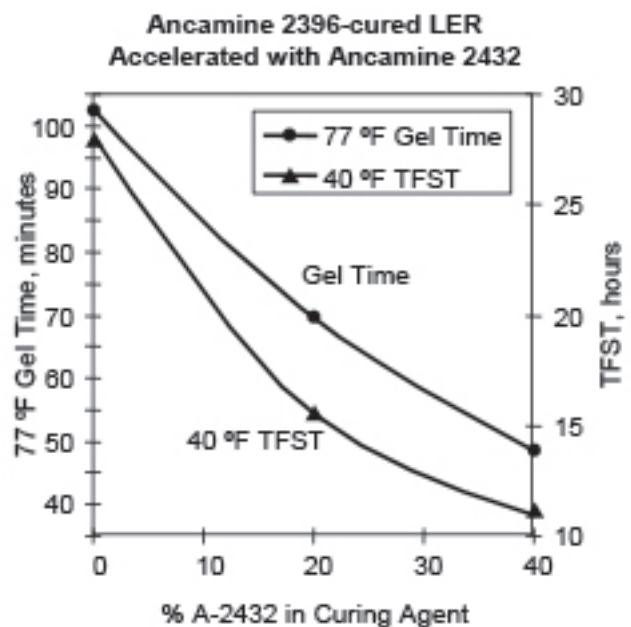
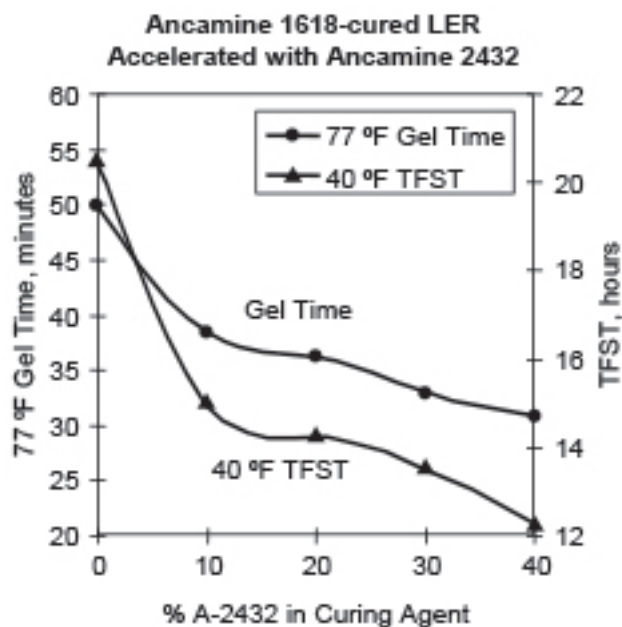
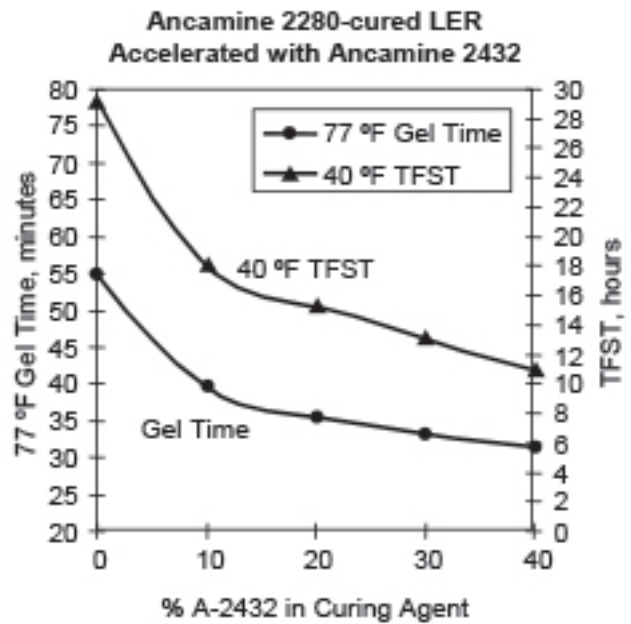
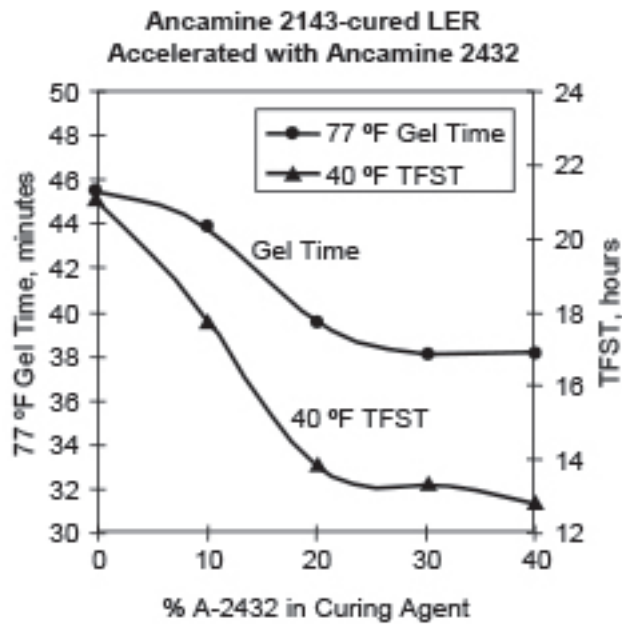
Number of Days Cure	1 day	3 days	7 days
77°F Cure König Pendulum Hardness	127	132	134
77°F Cure Shore D Hardness ⁽¹²⁾	81	81	81
40°F Cure Shore D Hardness ⁽¹²⁾	60	72	78

With 90% bisphenol-A resin / 10% Epodil 748 diluent blend:

Number of Days Cure	1 day	3 days	7 days
77°F Cure König Pendulum Hardness	127	132	134
77°F Cure Shore D Hardness ⁽¹²⁾	81	81	81
40°F Cure Shore D Hardness ⁽¹²⁾	60	72	78

The fast cure and rapid hardness development of formulations cured with Ancamine 2432 curing agent make it ideal for flooring, linings, mortars and grouts applied at ambient or low temperatures. Even at a temperature as low as 40°F, Ancamine 2432 curing agent gave a Shore D hardness of 60 within 24 hours. This indicates that it is possible to formulate a coating with Ancamine 2432 curing agent that gives less than a one day walk on time at a cure temperature as low as 40°F.

ACCELERATING WITH ANCAMINE 2432: Ancamine 2432 curing agent can be used with other curing agents to accelerate cure at ambient and low temperatures. It is an especially effective accelerator when used with cycloaliphatic and amidoamine curing agents. The following charts show the effect of Ancamine 2432 curing agent level (as a percentage of the total curing agent component) on 40°F thin film set time and 77 °F gel time with standard bisphenol-A (DGEBA, EEW=190) resin. Charts are shown for cycloaliphatic curing agents Ancamine 2143, 2280 and 1618 as well as for modified amidoamine curing agent, Ancamide 2396. Ancamine 2432 is not recommended for acceleration of unmodified amidoamines or polyamides.



Adding Ancamine 2432 curing agent greatly improved set time, especially at low temperatures, while adequate working life (gel time) was maintained. Typically, adding 20% Ancamine 2432 curing agent will significantly reduce thin film set time. Table 3 shows handling characteristics of 20% Ancamine 2432 curing agent and 80% base curing agent formulated with standard bisphenol-A (DGEBA, EEW=190) resin.

**TABLE 3:
HANDLING PROPERTIES AND HARDNESS DEVELOPMENT OF
FORMULATIONS ACCELERATED WITH ANCAMINE 2432**

	20% 2432 /	After 7 days % wt. change	After 28 days % wt. change	After 28 days % wt. change
77°F TFST (hr) ⁷	4.5	4.5	4.6	6.4
40°F TFST (hr) ⁷	15.3	13.8	14.5	11.0
77°F Gel Time (min) ⁶	37	40	35	48
Mixed Viscosity (cps) ²	2,200	2,500	2,240	4,300
60° Gloss (7 days at 77°F) ¹³	110	110	109	105
Hardness Development				
77°F Shore D Hardness¹²				
after 1 day cure	72	71	78	79
after 2 days cure	75	71	78	81
after 3 days cure	78	73	80	81
40°F Hardness				
1 Day Cure (Shore A)	60	77	74	N.M.
2 Days Cure (Shore A)	83	87	87	84
7 Days Cure (Shore D) ¹²	70	73	76	71

NOTE: Curing agent blends were formulated with standard bisphenol-A (DGEBA, EEW=190) resin.

Formulations accelerated with Ancamine 2432 curing agent had reduced cure times. They also maintained good working life (gel time), low mixed viscosity and high gloss in the cured film. Systems accelerated with 20% Ancamine 2432 curing agent developed hardness quickly at both ambient and low temperatures. Rapid hardness development makes Ancamine 2432 curing agent an effective accelerator for flooring and lining formulations where fast return to service is important.

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 Techne GT-4 Gelation Timer
- 7 BK Drying Recorder
- 8 ASTM D 3418-82
- 9 ASTM D 695-85
- 10 ASTM D 638-86
- 11 ASTM D 790-86
- 12 ASTM D 2240-86
- 13 ASTM D 523-85

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