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Technical Bulletin

ACCELERATOR 399

Epoxy Curing Promoter for use with JEFFAMINE® Curing Agents

Accelerator 399 is a superior epoxy curing promoter designed for use with amine hardeners. The product was developed specifically for use with JEFFAMINE® curing agents, but it is compatible with most amines and may be used in most amine-cured epoxy systems.

SALES SPECIFICATIONS

Property	Specifications	Test Method*
Appearance	Clear, pale yellow, slightly viscous liquid free of suspended matter	ST-30.1
Color, Pt-Co	200 max.	ST-30.12
Water, wt%	0.40 max.	ST-31.53, 6

*Methods of Test are available from Huntsman Corporation upon request.

ADDITIONAL INFORMATION

Regulatory Information

DOT Classification	Not regulated for drums Regulated in containers in excess of 119 gal. (Bulk): Combustible liquid, n.o.s. (Piperazine)
TDG Classification	Not regulated
HMIS Code	3-2-0
WHMIS Classification	D2B: Irritant B3: Combustible liquid
CAS Number	102-71-6, 110-85-0, 140-31-8

Chemical Control Laws

Australia, AICS	Listed
Canada, DSL	Listed
Europe, EINECS/ELINCS	Listed
Japan, METI	Listed
United States, TSCA	Listed

Typical Physical Properties

AHEW (Amine hydrogen equivalent wt.)	145
Amine equivalent weight	126
Density, g/cc, 77°C	1.089
Flash point, PMCC, °C (°F)	90 (194)
pH	12.3
Pour Point, °F	5
Viscosity, cSt, 25°C (77°F)	810

AVAILABILITY

Accelerator 399 is available in 55-gallon drums of 500 pounds net weight and in 5-gallon pails. Samples are available through any Huntsman Corporation sales office.

USE IN EPOXY FORMULATIONS

Accelerator 399 is typically used at levels of 2 to 20 parts per 100 parts of epoxy resin, depending upon which amine curing agents is used and the degree of cure acceleration desired.

The accelerator is blended with the curing agent before use. Mixtures with JEFFAMINE hardeners are stable indefinitely, even at temperatures as low as 0°C. It should be emphasized that formulations in which high amounts of Accelerator 399 (10 to 20 phr) are used may blush and form a surface haze on curing under conditions of high humidity (>75% R. H.). Under conditions of normal humidity (~50% R.H.), surface blushing should not appear.

EFFECT ON CURE RATES AND PROPERTIES OF CURED PRODUCTS

Tables I through VIII show properties obtained by curing an epoxy resin with JEFFAMINE D-230, JEFFAMINE D-400, JEFFAMINE T-403, or blends of JEFFAMINE D-400 • JEFFAMINE D-2000 amines, either alone or in combination with Accelerator 399. Tables I, III, V, and VII indicate exothermic and coating properties of a number of formulations containing variable amounts of Accelerator 399. Tables II, IV, VI, and VIII show the effect of ambient- and elevated-temperature curing on the physical properties of unfilled castings based on these same formulations. It is suggested

that the given data be used as a guide to establish general limitations of various reactive epoxy-JEFFAMINE product combinations.

All formulations used a liquid bisphenol A-based epoxy resin of equivalent weight 185 to 192. Compensation for the AHEW of the accelerator was not done for these formulations. As with amines, Accelerator 399 is best maintained under dry nitrogen.

SAFETY AND TOXICITY

Accelerator 399 should be handled with caution as it has the potential to cause severe eye irritation. Chemical-type goggles must be worn when handling this product. Should accidental contact with the eyes occur, flush thoroughly with water for at least 15 minutes and get immediate medical attention.

Accelerator 399 is moderately irritating to the skin and protective clothing, including impervious gloves, is recommended when working with the product. This product is rated slightly toxic by swallowing, based on a single oral dose LD_{50} value in the rat of 3.3 g/kg. The Draize score for skin irritation in the rabbit is 3.25/8.0 and the Draize score for eye irritation in the rabbit is 41.5/110.0.

Accelerator 399 did not cause skin sensitization when tested in the guinea pig. However, certain individuals may be sensitive to some of the components of this product and users should be alert to this possibility.

In normal operations, the vapor pressure of this material is sufficiently low that no significant concentrations would be present in the workplace atmosphere. However, supplied air respiratory protection is recommended for cleaning up large spills or for entry into confined spaces. For further information, request the Material Safety Data Sheet.

Table I
JEFFAMINE® D-230 AMINE/ACCELERATOR 399 CURING DATA I
EXOTHERMIC AND CLEAR COATING PROPERTIES

Formulation, pbw	**A**	**B**	**C**	**D**
Epoxy resin (EEW 188)	100	100	100	100
JEFFAMINE® D-230 amine	32	32	32	32
Accelerator 399	—	2	5	10
Exothermic data				
Brookfield viscosity (approx.), cP, 25°C	600	700	700	700
Gel time, minutes (200-g mass)	2801	193[1]	65	25
Peak exothermic temperature, °C	64	92	191	213
Time to peak temperatures, minutes	396	244	72	30
Coating properties, 6-mil draw down				
Drying time, hr				
Set-to-touch	8.9	8.1	7.6	5.0
Surface-dry	12.6	11.0	9.9	8.5
Through-dry	16.2	14.9	13.6	12.5
Pencil hardness				
Cure: 24 hr ~25°C	B	HB	HB	HB
24 hr ~25°C + 1 hr 110°C	H	H	H	H
48 hr ~25°C	H	H	H	H
7 days ~25°C	H	H	H	H
Reverse impact, in-lb to fail				
Cure: 24 hr ~25°C	<4	<4	<4	16
24 hr ~25°C + 1 hr 110°C	>160	>160	>160	>160
48 hr ~25°C	<4	<4	<4	<4
7 days ~25°C	<4	<4	<4	6
Direct impact, in-lb to fail				
Cure: 24 hr ~25°C	14	28	22	30
24 hr ~25°C + 1 hr 110°C	>160	>160	>160	>160
48 hr ~25°C	16	20	20	28
7 days ~25°C	24	40	36	30
Gloss, 60°, 7 days ~25°C	108	110	107	106
Crosshatch adhesion, %, 7 days ~25°C	100	100	100	100

[1]No definite gel; time to reach 10,000 cP

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Table II

JEFFAMINE D-230 AMINE/ACCELERATOR 399 CURING DATA II
PHYSICAL PROPERTIES OF UNFILLED CASTINGS
AMBIENT AND ELEVATED TEMPERATURE CURES

Formulation, pbw	**A**	**B**	**C**	**D**
Epoxy resin (EEW 188)	100	100	100	100
JEFFAMINE® D-230 amine	32	32	32	32
Accelerator 399	—	2	5	10
Properties of cured 1/8-inch castings, cure: 7 days ~25°C				
Shore D hardness, 0-10 sec	89-87	84-82	84-81	83-79
Elongation at break, %	2	2	2	2
HDT, °C, 264 psi	46	46	45	47
Izod impact strength, ft-lb/in	0.23	0.28	0.33	0.32
Tensile strength, psi	8,750	9,500	9,900	10,200
Flexural strength, psi	l0,800	13,900	13,300	15,500
Flexural modulus, psi	477,000	560,000	530,000	534,000
% wt. gain, 24-hr water boil	2.4	2.5	3.3	2.7
3-hr acetone boil	30.8	32.0	26.4	16.4
Compressive strength[1], psi, at yield	12,500	13,400	13,300	13,100
at failure	34,000	27,000	27,000	25,900
Properties of cured 1/8-inch castings, cure: 2 hr 80°C + 3 hr 125°C				
Shore D hardness, 0-10 sec	78-75	76-73	76-73	76-73
Elongation at break, %	8	9	7	8
HDT, °C, 264 psi	80	76	69	58
Izod impact strength, ft-lb/in	1.1	1.4	1.4	2.3
Tensile strength, psi	9,400	9,900	10,200	9,600
Flexural strength, psi	14,900	16,000	17,200	16,500
Flexural modulus, psi	429,000	467,000	491,000	488,000
% wt. gain, 24-hr water boil	2.4	2.6	3.2	3.2
3-hr acetone boil	6.9	6.2	6.7	10.8
Compressive strength[1], psi, at yield	—	—	—	12,200
at failure	46,700	47,400	42,000	40,000

[1]1-inch tall cylinders, 1/2-inch diameter

Table III
JEFFAMINE® D-400 AMINE/ACCELERATOR 399 CURING DATA I
EXOTHERMIC AND CLEAR COATING PROPERTIES

Formulation, pbw	**A**	**B**	**C**	**D**
Epoxy resin (EEW 188)	100	100	100	100
JEFFAMINE® D-400 amine	55	55	55	55
Accelerator 399	—	2	5	10
Exothermic data				
Brookfield viscosity (approx.), cP, 25°C	600	600	500	600
Gel time, minutes (200-g mass)	480[1]	287[1]	136[1]	54
Peak exothermic temperature, °C	35	36	67	140
Time to peak temperature, minutes	~700	~430	182	68
Coating properties, 6-mil draw down				
Drying time, hr				
Set-to-touch	15.0	12.0	11.0	9.2
Surface-dry	18.7	14.8	12.5	10.5
Through-dry	24.8	21.0	16.4	14.5
Pencil hardness				
Cure: 24 hr ~25°C	[2]	<3B	<3B	<3B
24 hr ~25°C + 1 hr 110°C	F	F	F	F
48 hr ~25°C	2B	B	B-HB	B-HB
7 days ~25°C	F	F	F	F
Reverse impact, in-lb to fail				
Cure: 24 hr ~25°C	[2]	>160	>160	>160
24 hr ~25°C + 1 hr 110°C	>160	>160	>160	>160
48 hr ~25°C	>160	>160	>160	>160
7 days ~25°C	20	140	150	>160
Direct impact, in-lb to fail				
Cure: 24 hr ~25°C	[2]	>160	>160	>160
24 hr ~25°C + 1 hr 110°C	>160	>160	>160	>160
48 hr ~25°C	>160	>160	>160	>160
7 days ~25°C	>160	>160	>160	>160
Gloss, 60°, 7 days ~25°C	104	104	105	109
Crosshatch adhesion, %, 7 days ~25°C	100	100	100	100

[1]No definite gel; time to reach 10,000 cP
[2]Coating too tacky to test

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Table IV
JEFFAMINE® D-400 AMINE/ACCELERATOR 399 CURING DATA II
PHYSICAL PROPERTIES OF UNFILLED CASTINGS
AMBIENT AND ELEVATED TEMPERATURE CURES

Formulation, pbw	**A**	**B**	**C**	**D**
Epoxy resin (EEW 188)	100	100	100	100
JEFFAMINE® D-400 amine	55	55	55	55
Accelerator 399	—	2	5	10
Properties of cured 1/8-inch castings, cure: 7 days 25°C				
Shore D hardness, 0-10 sec	75-71	76-72	79-75	79-74
Elongation at break, %	65	65	53	65
HDT, °C, 264 psi	28	32	34	36
Izod impact strength, ft-lb/in	0.90	0.88	1.0	2.1
Tensile strength, psi	5,200	5,800	6,400	6,150
Flexural strength, psi	8,750	9,500	8,600	8,700
Flexural modulus, psi	310,000	330,000	310,000	286,000
% wt. gain, 24-hr water boil	2.7	2.7	4.4	2.3
3-hr acetone boil	28.1	23.7	22.1	19.7
Compressive strength[1], psi, at yield	6,100	7,200	8,500	8,300
at failure	34,000	40,000	41,000	44,000
Properties of cured 1/8-inch castings, cure: 2 hr 80°C + 3 hr 125°C				
Shore D hardness, 0-10 sec	80-75	80-77	81-76	79-74
Elongation at break, %	6.5	7.0	6.0	10.0
HDT, °C, 264 psi	43	45	45	38
Izod impact strength, ft-lb/in	0.17	0.15	0.12	0.18
Tensile strength, psi	7,800	7,300	7,300	7,000
Flexural strength, psi	12,900	13,400	13,800	10,500
Flexural modulus, psi	460,000	500,000	460,000	350,000
% wt. gain, 24-hr water boil	2.8	2.7	3.4	0.6
3-hr acetone boil	24.2	24.0	17.4	21.8
Compressive strength[1], psi, at yield	8,200	8,400	8,800	8,000
at failure	42,000	41,000	47,000	41,000

[1]1-inch tall cylinders, 1/2-inch diameter

Table VI

JEFFAMINE® T-403 AMINE/ACCELERATOR 399 CURING DATA II
PHYSICAL PROPERTIES OF UNFILLED CASTINGS
AMBIENT AND ELEVATED TEMPERATURE CURES

Formulation, pbw	**A**	**B**	**C**	**D**
Epoxy resin (EEW 188)	100	100	100	100
JEFFAMINE® T-403 amine	42	42	42	42
Accelerator 399	—	2	5	10
Properties of cured 1/8-inch castings, cure: 7 days 25°C				
Shore D hardness, 0-10 sec	73-65	80-77	80-77	82-78
Elongation at break, %	3.0	3.0	4.5	4.5
HDT, °C, 264 psi	44	42	41	47
Izod impact strength, ft-lb/in	0.16	0.20	0.40	0.70
Tensile strength, psi	9,200	9,900	10,000	10,000
Flexural strength, psi	14,400	14,200	15,600	16,400
Flexural modulus, psi	500,000	533,000	536,000	520,000
% wt. gain, 24-hr water boil	2.0	1.9	2.4	2.9
3-hr acetone boil	26.3	28.4	23.4	16.4
Compressive strength[1], psi, at yield	11,500	13,600	13,400	13,500
at failure	24,000	16,800	17,000	23,000
Properties of cured 1/8-inch castings, cure: 2 hr 80°C + 3 hr 125°C				
Shore D hardness, 0-10 sec	78-75	85-82	84-81	81-78
Elongation at break, %	7.0	9.0	9.0	7.5
HDT, °C, 264 psi	83	80	72	62
Izod impact strength, ft-lb/in	0.90	0.80	0.90	0.20
Tensile strength, psi	9,500	9,700	9,700	9,700
Flexural strength, psi	15,500	15,700	15,300	16,400
Flexural modulus, psi	437,000	450,000	453,000	480,000
% wt. gain, 24-hr water boil	2.0	0.9	2.6	3.1
3-hr acetone boil	5.6	4.8	5.6	6.7
Compressive strength[1], psi, at yield	10,900	10,500	10,300	10,200
at failure	44,500	46,000	41,100	40,000

[1]1-inch tall cylinders, 1/2-inch diameter

Table VII

JEFFAMINE® D-400 AMINE • JEFFAMINE D-2000 AMINE BLENDS/ACCELERATOR 399
CURING DATA I
EXOTHERMIC AND CLEAR COATING PROPERTIES

Formulation, pbw	**A**	**B**	**C**	**D**
Epoxy resin (EEW 188)	100	100	100	100
JEFFAMINE D-400 amine	50	50	50	50
JEFFAMINE D-2000 amine	25	25	25	25
Accelerator 399	—	2	5	10
Exothermic data				
Brookfield viscosity (approx.), cP, 25°C	600	500	500	600
Gel time, minutes (200-g mass)	[1]	~444[2]	~262[2]	~100
Peak exothermic temperature, °C	33	34	36	58
Time to peak temperature, minutes	~960	780	316	108
Coating properties, 6-mil draw down				
Drying time, hr				
Set-to-touch	22.4	17.7	16.8	13.7
Surface-dry	26.1	20.6	18.2	15.1
Through-dry	37.0	27.1	23.9	22.6
Pencil hardness				
Cure: 24 hr ~25°C	[3]	[3]	[3]	[3]
24 hr ~25°C, + 1 hr 110°C	<3B	<3B	2B	B
48 hr ~25°C	[3]	[3]	<3B	<3B
7 days ~25°C	3B	3B	2B	2B
Reverse impact, in-lb to fail				
Cure: 24 hr ~25°C	[3]	[3]	[3]	[3]
24 hr ~25°C + 1 hr 110°C	>160	>160	>160	>160
48 hr ~25°C	[3]	[3]	>160	>160
7 days ~25°C	>160	>160	>160	>160
Direct impact, in-lb to fail				
Cure: 24 hr ~25°C	[3]	[3]	[3]	[3]
24 hr ~25°C + 1 hr 110°C	>160	>160	>160	>160
48 hr ~25°C	[3]	[3]	>160	>160
7 days ~25°C	>160	>160	>160	>160
Gloss, 60°, 7 days ~25°C	106	103	105	102
Crosshatch adhesion, %, 7 days ~25°C	100	100	100	100

[1]Reached 2,060 cP in ~480 minutes
[2]No definite gel; time to reach 10,000 cP
[3]Coating too tacky to test

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Table VIII

JEFFAMINE® D-400 AMINE• JEFFAMINE D-2000 AMINE BLENDS/ACCELERATOR 399 CURING DATA II
PHYSICAL PROPERTIES OF UNFILLED CASTINGS
AMBIENT AND ELEVATED TEMPERATURE CURES

Formulation, pbw	**A**	**B**	**C**	**D**
Epoxy resin (EEW 188)	100	100	100	100
JEFFAMINE D-400 amine	50	50	50	50
JEFFAMINE D-2000 amine	25	25	25	25
Accelerator 399	—	2	5	10
Properties of cured 1/8-inch castings, cure: 7 days 25°C[1]				
Shore D hardness, 0-10 sec	68-55	52-35	55-36	55-37
Elongation at break, %	109	70	79	73
Tensile strength, psi	1,200	1,400	1,900	1,700
Tear strength, pli	85	140	150	160
% wt. gain, 24-hr water boil	2.6	2.7	4.0	1.2
3-hr acetone boil	30.3	37.2	32.7	32.7
Compressive strength[2], psi, at yield	—	—	—	—
at failure	39,000	46,000	38,000	40,000
Properties of cured 1/8-inch castings, cure: 2 hr 80°C + 3 hr 125°C				
Shore D hardness, 0-10 sec	62-58	61-49	62-50	56-39
Elongation at break, %	86	86	80	75
HDT, °C, 264 psi	~25	26	23	24
Izod impact strength, ft-lb/in	2.81	0.73	1.13	7.31
Tensile strength, psi	1,700	2,300	2,100	1,200
Flexural strength, psi	970	1,300	1,200	200
Flexural modulus, psi	42,000	47,000	43,000	6,400
% wt. gain, 24-hr water boil	2.6	2.7	3.5	1.2
3-hr acetone boil	33.3	32.0	33.4	35.1
Compressive strength[2], psi, at yield	—	—	—	—
at failure	47,000	47,000	44,000	47,000

[1]Because of softness, samples were stamped out instead of cut
[2]1-inch tall cylinders, 1/2-inch diameter

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