Technical Bulletin

HUNTSMAN

ACCELERATOR 399

Epoxy Curing Promoter for use with
JEFFAMINE® Curing Agents
[CAS 102-71-6, 110-85-0, 140-31-8]

DESCRIPTION

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

Appearance	Clear, pale yellow, slightly viscous liquid
Color, Pt-Co	200 max.
Water, wt. %	0.40 max.

TYPICAL PHYSICAL PROPERTIES

Color, Pt-Co	100
Density, g/cc, 77°F	1.089
Flash point, PMCC, °F	194
Pour point, °F	5
Viscosity, cp, 25°C	874
Amine equivalent weight	126
Hydrogen equivalent weight	145

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 used at levels of 2 to 20 parts per 100 parts of epoxy resin, depending upon which of the 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 to 95% 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, 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 data were obtained using a liquid bisphenol A-based epoxy resin or equivalent weight 185 to 192.

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.

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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/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	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)	280[1]	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 film				
Drying time, hr				
Set-to-touch	8.9	8.1	7.6	5.0
Surface-dry	12.6	11.0	9.9	8.5
Thru-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

Table II

JEFFAMINE D-230/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	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 cylinders, 1/2-inch diameter

Table III

JEFFAMINE D-400/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	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 film				
Drying time, hr				
Set-to-touch	15.0	12.0	11.0	9.2
Surface-dry	18.7	14.8	12.5	10.5
Thru-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

Table IV

JEFFAMINE D-400/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	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 cylinders, 1/2-inch diameter

Table V

JEFFAMINE T-403/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 T-403	42	42	42	42
Accelerator 399	—	2	5	10
Exothermic data				
Brookfield viscosity (approx.), cp, 25°C	1,600	1,500	1,600	1,500
Gel time, minutes (200-g mass)	280[1]	160[1]	81	27
Peak exothermic temperature, °C	38	49	163	193
Time to peak temperature, minutes	450	274	90	34
Coating properties, 6-mil film				
Drying time, hr				
Set-to-touch	8.6	7.0	5.5	4.9
Surface-dry	13.0	9.9	7.1	6.8
Thru-dry	16.3	13.2	11.7	10.0
Pencil hardness				
Cure: 24 hr ~25°C	2B	HB	F	F
24 hr ~25°C, 1 hr 110°C	H	H	H	H
48 hr ~25°C	H	H	F	F
7 days ~25°C	H	H	H	H
Reverse impact, in-lb to fail				
Cure: 24 hr ~25°C	<4	6	6	6
24hr ~25°C, 1 hr 110°C	>160	>160	140	>160
48 hr ~25°C	<4	<4	6	6
7 days ~25°C	6	6	10	10
Direct impact, in-lb to fail				
Cure: 24 hr ~25°C	20	34	34	34
24 hr ~25°C, 1 hr 110°C	130	140	120	140
48 hr ~25°C	26	26	40	54
7 days ~25°C	30	50	120	>130
Gloss, 60°, 7 days ~25°C	110	109	109	109
Crosshatch adhesion, %, 7 days ~25°C	100	100	100	100

[1]No definite gel; time to reach l0,000 cp

Table VI

JEFFAMINE T-403/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	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 cylinders, 1/2-inch diameter

Table VII

JEFFAMINE D-400 • JEFFAMINE D-2000 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	50	50	50	50
JEFFAMINE D-2000	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 film				
Drying time, hr				
Set-to-touch	22.4	17.7	16.8	13.7
Surface-dry	26.1	20.6	18.2	15.1
Thru-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

Table VIII

JEFFAMINE D-400 • JEFFAMINE D-2000 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	50	50	50	50
JEFFAMINE D-2000	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 cylinders, 1/2-inch diameter

NOTES

FOR MORE LITERATURE OR INFORMATION
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