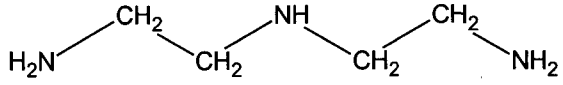
Diethylenetriamine (EPI-CURE® Curing Agent 3223) and Triethylenetetramine (EPI-CURE Curing Agent 3234)

Diethylenetriamine (DETA), available as EPI-CURE® Curing Agent 3223, and *triethylenetetramine (TETA)*, available as EPI-CURE Curing Agent 3234, are two liquid polyamine curing agents widely used with EPON® resins for fast cures or where room temperature cures are required. These materials are restricted, however, to small casting applications, since considerable exotherm develops and the pot life of the catalyzed resin is quite short. While these amines provide polymers having good properties at room temperature, better strengths at 180°F or higher may be obtained with aromatic-amine curing agents.



Application

The recommended concentration ranges of these amines for use with EPON Resins 830, 8280, 828, 826, 8201, 8132, 815C and 813 are as follows:

Amine	Concentration, phr
EPI-CURE Curing Agent 3223 (DETA)	12
EPI-CURE Curing Agent 3234 (TETA)	14

Initial Mix Viscosity with EPON Resin 828 @ 25°C, Pa-s (poise) 1.5-2.0 (15-20)
Pot life @ 23°C, min., 1 liter (quart) mass 20-35

Typical cure schedules for EPON Resin-EPI-CURE Curing Agent 3223 or 3234 systems are four days at room temperature (25°C) or one hour at 100°C. It should be recognized, however, that each EPON resin system could be cured using a variety of cure cycles depending upon fabrication and performance requirements. In all cases, the proper cure cycle must be selected on the basis of the application needs.

Specific Heat	
°C	Cal/g°C
10	0.31
25	0.39
100	0.48
150	0.62

Density of Casting (EPON Resin 828/EPI-CURE Curing Agent 3223 (DETA)) 1.19

Resin Properties

In general, these two curing agents are considered interchangeable in regard to chemical behavior and the properties of cured, EPON Resin 828 obtained. Somewhat poorer overall properties are obtained when EPON Resins 8201, 815C, 813 or 8132 are cured with these polyamines because of the reactive diluent

present. The lower vapor pressure often makes TETA more attractive for casting applications.

Table 24
Effect of DETA (EPI-CURE® Curing Agent 3223) Concentration on the Heat Deflection Temperature of EPON® Resin 828 Castings

(Cure Cycle: 3 hours at 25°C + 1 hour at 200°C)

DETA Concentration (phr)	Heat Deflection Temperature (°C)
8	95
9	105
10	114
11	119
12	124
13	117
14	112

Table 25
Effect of Post Cure on Heat Deflection Temperature of EPON® Resin 828-12 PHR DETA (EPI-CURE® Curing Agent 3223) Castings

(Specimens allowed to gel at room temperature prior to post cure)

Post Cure		Heat Deflection Temperature
Hours	°C	(°C)
2	100	115
4	100	118
12	100	122
24	100	122
4	150	121
8	150	124
24	150	123

Table 26
Effect of Concentration and Post Cure on the Heat Deflection Temperature on EPON® Resin 828-TETA (EPI-CURE® Curing Agent 3234) Castings

(Specimens allowed to gel at room temperature prior to post cure)

TETA Concentration	Post Cure		Heat Deflection Temperature
(phr)	Hours	°C	(°C)
10	1	200	98
11	1	200	103
12	1	200	109
13	1	200	115
14	1	200	123
15	1	200	123
16	1	200	119
14	4	100	119
14	8	100	120
14	12	100	122
14	24	100	124

Table 27
Typical Properties of Filled and Unfilled EPON® Resin 815C-TETA (EPI-CURE® Curing Agent 3234) Castings

(Cure Cycle: 20 hours at 25°C plus 24 hours at 65°C)[1]

EPON® RESIN 815C—WITH 10 PHR TETA (EPI-CURE® Curing Agent 3234)

- Filler[2]	Viscosity at 25°C		Compressive Properties		
Concentration phr	(Without Curing Agent) Pa • s (poise)	Heat Deflection Temperature (°C)	Strength 0.2% Offset MPa (psi)	Modulus MPa (psi)	Notched Izod Impact Strength J/m (ft-lb/in)
None	0.76 (7.6)	80	83 (12,000)	3500 (500,000)	26 (0.5)
100	1.7 (17)	82	90 (13,000)	4700 (680,000)	21 (0.4)
200	4.3 (43)	85	96 (14,000)	6200 (900,000)	21 (0.4)
400	75 (750)	87	110 (16,000)	8400 (1,220,000)	26 (0.5)

[1] This curing cycle was used to insure complete cure, and is not necessarily practical for commercial cast operations.

[2] The filler used was iron oxide (grade MD – 101, Alcan Aluminum Corp)

Table 28
Effect of Post Cure on the Tensile Properties of EPON® Resin 828-12 PHR DETA (EPI-CURE® Curing Agent 3223) Castings

(Cure Cycle: Room temperature gel followed by 2 hours at 100°C)

	Strength			Elongation	
Test Temperature (°C)	Ultimate MPa (psi)	0.2% Offset MPa (psi)	Modulus MPa (psi)	0.2% Offset (%)	Ultimate (%)
100	32 (4,600)	22 (3,200)	1,800 (260,000)	1.4	9.0
50	60 (8,700)	32 (4,700)	2,500 (360,000)	1.5	6.0
25	75 (10,900)	37 (5,300)	2,800 (410,000)	1.5	6.3
0	76 (11,000)	40 (5,800)	3,200 (470,000)	1.4	4.0
-25	85 (12,300)	45 (6,500)	3,200 (470,000)	1.6	4.0

(Cure Cycle: Room Temperature gel followed by 1 hour at 200°C)

100	23 (3,400)	16 (2,300)	1,300 (190,000)	1.3	6.4
50	59 (8,600)	30 (4,300)	2,500 (360,000)	1.3	7.0
25	68 (9,800)	37 (5,300)	3,000 (430,000)	1.4	6.0
0	74 (10,700)	36 (5,200)	3,300 (480,000)	1.5	4.0
-25	68 (9,800)	43 (6,200)	3,700 (540,000)	1.3	2.6

Table 29
Effect of Room Temperature Cure Time on Tensile Properties of EPON® Resin 828-12 PHR DETA (EPI-CURE® Curing Agent 3223) Castings

		Strength			Elongation	
Cure	Test Temperature (°C)	Ultimate MPa (psi)	0.2% Offset MPa (psi)	Modulus MPa (psi)	0.2% Offset (%)	Ultimate (%)
3days	25	28 (4,100)	-	3,700 (540,000)	-	0.70
7 days	25	40 (5,800)	-	3,100 (450,000)	-	1.4
14days	24	65 (9,500)	51(7,400)	3,900 (560,000)	1.5	2.4
30 days	25	71 (10,300)	56 (8,200)	3,500 (510,000)	1.8	2.7
60 days	25	70 (10,200)	55 (8,000)	3,400 (490;000)	1.8	3.2
90 days	50	37 (5,400)	32(4,700)	2,500 (360,000)	1.5	7.0
90 days	-25	79(11,500)	67(9,700)	3,700 (530,000)	2.0	2.6

Table 30
Tensile Properties of EPON® Resin 828-DETA (EPI-CURE® Curing Agent 3223) Castings at Various Test Temperatures

(Cure Cycle: Room temperature gel followed by 4 hours at 100°C)

		Strength			Elongation	
Test Temperature (°C)	PHR DETA	Ultimate MPa (psi)	0.2% Offset MPa (psi)	Modulus MPa (psi)	0.2% Offset (%)	Ultimate (%)
100[1]	8					
50	8	68 (9,800)	42 (6,100)	2,800 (400,000)	1.7	6.5
25	8	78 (11,300)	57 (8,300)	3,400 (490,000)	1.8	3.7
0	8	63 (9,200)	-	3,800 (550,000)	-	1.8
-25	8	81(11,700)	79 (11,400)	3,800 (550,000)	2.4	2.4
100	10	19 (2,700)	08 (1,200)	1,200 (175,000)	0.80	24.0
50	10	59 (8,600)	45 (6,600)	3,000 (430,000)	1.7	3.6
25	10	79 (11,400)	49 (7,100)	3,000 (435,000)	1.8	5.7
0	10	78 (11,300)	48 (6,900)	3,700 (530,000)	1.5	3.2
-25	10	79 (11,400)	62 (9,000)	3,400 (490,000)	2.0	2.8
100	12	25 (3,700)	17 (2,400)	1,500 (220,000)	1.3	18.2
50	12	62 (9,000)	38 (5,500)	2,300 (340,000)	1.9	7.3
25	12	69 (10,000)	42 (6,100)	2,600 (380,000)	1.8	5.3
0	12	75 (10,900)	41 (6,000)	3,300 (480,000)	1.4	3.9
-25	12	95 (13,800)	58 (8,400)	2,900 (420,000)	2.2	4.9
100	14	23 (3,300)	11 (1,600)	1,000 150,000)	1.2	27.7
50	14	60 (8,700)	37 (5,400)	2,300 (330,000)	1.8	7.3
25	14	68 (9,900)	41 (5,900)	2,500 (370,000)	1.7	5.8
0	14	74 (10,700)	43 (6,200)	3,100 (450,000)	1.5	4.0
-25	14	96 (14,000)	56 (8,200)	3,000 (430,000)	2.1	5.4

[1] Too soft to test. Heat deflection temperature of cured polymer is below test temperature.