LAPOX®

atul

ELECTRICAL AND ELECTRONICS

EPOXY RESINS, CURING AGENTS AND REACTIVE DILUENTS

Energising possibilities...
Stimulating growth...

LAPOX®

First manufacturing site, Atul, India

LEGACY

Founded in 1947 by a legendary Indian, Kasturbhai Lalbhai, Atul Ltd (Atul), is amongst the first companies of independent India. It has the distinction of being the first private sector company of India inaugurated by its first Prime Minister, Pandit Jawaharlal Nehru. Atul is part of Lalbhai Group, one of the oldest diversified business houses of the country engaged in manufacturing since 1896. Ever since its inception, Atul has been committed to serving society, particularly in the areas of education, empowerment, health, relief, infrastructure and conservation.

PROFILE

The first site of Atul, spread over 1,250 acres of land, houses one of the greenest and largest chemical complexes of its kind in the world. Starting with just a few textile dyes, the Company now manufactures 900 products and 450 formulations, managing complex chemical processes in a responsible way. It has also established fruitful and time-tested collaborations with leading multinational companies of the world.

Atul serves customers belonging to diverse industries including Adhesives, Agriculture, Animal Feed, Automobile, Composites, Construction, Cosmetic, Defence, Dyestuff, Electrical and Electronics, Flavour, Food, Footwear, Fragrance, Glass, Home Care, Horticulture, Hospitality, Paint and Coatings, Paper, Personal Care, Pharmaceutical, Plastic, Polymer, Rubber, Soap and Detergent, Sports and Leisure, Textile, Tyre and Wind Energy. In order to enhance customer focus, the Company has divided its product portfolio into seven businesses - Aromatics, Bulk Chemicals and Intermediates, Colors, Crop Protection, Floras, Pharmaceuticals and Intermediates and Polymers, and has established subsidiary companies in the USA, the UK, China, Brazil and the UAE.

PURPOSE

We are committed to significantly enhancing value for our Stakeholders by:

- fostering a spirit of continuous learning and innovation
- adopting developments in science and technology
- providing high quality products and services, thus becoming the most preferred partner
- having people who practice Values and exemplify a high standard of behaviour
- seeking sustained, dynamic growth and securing long-term success
- taking responsible care of the surrounding environment
- improving the quality of life of the communities we operate in

POLYMERS BUSINESS

Epoxy resins, reactive diluents and curing agents are manufactured and marketed under the trade name 'Lapox®' by the Polymers Business of Atul. The manufacture of epoxy systems began in 1960 in Cibatul Ltd, a joint venture between the erstwhile Ciba-Geigy (Switzerland) and Atul. Following the disintegration of Ciba-Geigy, Cibatul was merged into Atul in 1999.

The state-of-the-art manufacturing facilities for these products are located in Atul complex, 200 km north of Mumbai. In addition to its leadership position within India, Polymers also sells to discerning customers outside the country. The Business has been awarded ISO 9001:2008 and ISO 14001.

Product range

Resins

Bisphenol-A and Bisphenol-F based resins

Cycloaliphatic resins

Epoxy phenol novolac resins

Modified and formulated resins

Multifunctional resins

Reactive diluents

Aliphatic and Aromatic (mono, di and trifunctional)

Curing agents

Aliphatic amines and their adducts

Aromatic amines and their adducts

Cycloaliphatic amines and their adducts

Phenalkamines

Polyamides and Polyamidoamines

Accelerators and catalysts

Lapox® range of products for electrical and electronics

Atul's epoxy systems are designed to achieve high performance in the electrical and electronics industry for various process techniques including:

Automatic Pressure Gelation (APG)

Encapsulation

Filament winding

Hand lay-up

Impregnation

Prepregging

Pultrusion

Vacuum casting

Systems	Type of system Unf | Prf[1]	Nature Hot cure | Cold cure Outdoor | Indoor	Mixing ratio R/CA/Acc/Flx/Flr/Sol[2] pbw	CVC	APG	Vacuum potting	Filament winding	Pultrusion	Hand lay-up	Impregnation | VPI	Encapsulation	Prepregging	Bonding	Mix viscosity mPa s/°C	Pot life hr/°C	Gel time min/°C	Density of components Resin Curing agent g/cm³
ARC-15 AH-122	Prf	Hot cure Indoor	R: 100 CA: 100	•	•									40,000/25 10,500/40 2,000/60	-	60/100 20/120	1.70 - 1.90 1.70 - 1.90
ARC-16 AH-118 ADP-11 Silica	Unf	Hot cure Indoor	R: 100 CA: 80 Flx: 0 - 8 Flr: 320 - 350	•	•									5,500/40 3,000/60 1,500/80	24 - 48/25	228/80 12/120	1.13 - 1.18 1.15 - 1.20
ARCH-11 K-3 K-13 Silica	Unf	Hot cure Outdoor	R: 100 CA: 90 Acc: 0.5 - 2.0 Flr: 300	•										10,000 - 15,000/40 3,000 - 5,000/60 1,000 - 1,500/80	3/60 1/80	4/140 3/150 2/160	1.20 - 1.25 1.36 - 1.40
ARCH-11 AH-214 K-13 Silica	Unf	Hot cure Outdoor	R: 100 CA: 90 Acc: 0.5 - 2.0 Flr: 270 - 300	•	•									1,000/80	1/80	12 - 13/100	1.20 - 1.25 1.15 - 1.20
ARCH-11 AH-215 Silica	Unf	Hot cure Outdoor	R: 100 CA: 90 Flr: 270	•	•									1,000/80	1/80	12 - 13/100	1.20 - 1.25 1.15 - 1.20
ARCH-12 AH-214 K-13 Silica	Unf	Hot cure Outdoor	R: 100 CA: 80 Acc: 0.5 - 2.0 Flr: 270	•	•									6400/25 3000/40 700/60	8/40 4/60	122/80 11/120 5/140	1.14 - 1.20 1.15 - 1.20
ARCH-12 AH-215 Silica	Unf	Hot cure Outdoor	R: 100 CA: 80 Flr: 270	•	•									6,400/25 3,000/40 700/60	8/40 4/60	122/80 11/120 5/140	1.14 - 1.20 1.15 - 1.20
ARCH-13 AH-215 Silica	Unf	Hot cure Outdoor	R: 100 CA: 70 Flr: 270	•	•									1,600 - 2,200/80	8/40	90 - 100/100	1.14 - 1.20 1.15 - 1.20
C-17 K-12 K-13 K-14 Silica	Unf	Hot cure Indoor	R: 100 CA: 100 Acc: 0.5 - 1.5 Flx: 0 - 20 Flr: 400	•	•									41,500/40 1,500/80	14/40 1.5/80	90/80 35/100 12/120	1.15 - 1.20 1.15 - 1.22
C-50 K-61 Silica	Unf	Hot cure Indoor	R: 100 CA: 80 Flr: 270	•	•									26,000/40 6,800/60 1,000/80	15/40 2/80	285/80 14/120 5/140	1.10 - 1.20 1.15 - 1.25
C-50 K-225 Silica	Unf	Hot cure Indoor	R: 100 CA: 80 Flr: 270	•	•									50,000/40 11,800/60 2,300/80	48/25	265/80 14/120 4/140	1.10 - 1.20 1.15 - 1.25
C-51 K-6 Silica	Unf	Cold cure Indoor	R: 100 CA: 10 Flr: 120			•					•			8,500/25	0.5/25	-	1.13 - 1.16 0.97 - 0.99
ARC-18 AH-123	Prf	Hot cure Indoor	R: 100 CA: 25	•		•								2,500 - 3,500/25	-	30 - 40/100	1.74 - 1.84 1.18 - 1.22
ARC-30 AH-714	Prf	Cold cure Indoor	R: 100 CA: 25	•		•								1,800/27	2.5/27	90/130 50/140	1.42 - 1.62 0.95 - 0.98
C-2 K-1 Silica	Unf	Hot cure Indoor	R: 100 CA: 30 Flr: 200	•										4,000/120 2,500/140	1/120 0.5/140	100/130 60/140	1.20 - 1.25 1.50 - 1.55
C-59 K-1 Silica	Unf	Hot cure Indoor	R: 100 CA: 30 Flr: 200	•										1,900/120 790/130 500/140	6/120	330/130 150/150	1.20 - 1.25 1.50 - 1.55

[1]Unf - Unfilled; Prf - Pre-filled
[2]Mixing ratio stated in order of Resin/Curing agent/Accelerator/Flexibiliser/Filler/Solvent
Applications: SG - Switchgears; Ins - Insulators; Bush - Bushings; IT - Instrument Transformers (CT and PT); DDT - Dry Type Distribution Transformers; RM - Rotating Machines; Ecomp - Electro composites; Adh - Adhesives; Eass - Electronic assembly
Processing techniques: CVC - Conventional Vacuum Casting; APG - Automatic Pressure Gelation; VPI - Vacuum Pressure Impregnation

Systems	Processing guideline: Cure schedule hr/°C	Tensile strength Elongation ISO 527-2 MPa | %	Flexural strength Surface strain ISO 178 MPa | %	Glass transition temperature (Tg) DIN 11357-2 °C	Thermal conductivity ISO 8894-1 W/mK	Thermal class IEC 60085 -	Coefficient of linear thermal expansion ISO 11359-2 (°C)⁻¹	Breakdown strength (BDV) IEC 60243-1 kV/mm	Dielectric constant / Relative permittivity DIN 53483 -	Dielectric dissipation factor (Tan D) IEC 60250 %	Applications SG/Ins/Bush/IT/DDT/RM/Ecomp/Adh/Paper coating/Eass
ARC-15 AH-122	10/80 + 1/140	75 - 85 0.8 - 1.2	120 - 130 -	110 - 120	0.65 - 0.75	H	27 - 30	18 - 22	4.2	< 2	SG/Ins/Bush
ARC-16 AH-118 ADP-11 Silica	10/140	75 - 85 1.1 - 1.3	135 - 155 1.5 - 1.8	105 - 115	0.85 - 0.95	F	31 - 36	18 - 22	4.1	2 - 3	SG/Ins/Bush/IT/DDT
ARCH-11 K-3 K-13 Silica	6/80 + 10/140	90 - 100 1.7 - 1.9	150 - 165 2.0 - 2.5	100 - 110	0.80 - 0.90	F	39 - 41	19 - 21	3.8 - 4.2	1.5 - 2.0	SG/Ins/Bush
ARCH-11 AH-214 K-13 Silica	10/140	90 - 100 1.7 - 1.9	150 - 165 2.0 - 2.5	100 - 110	0.80 - 0.90	F	-	19 - 21	3.8 - 4.2	2 - 3	SG/Ins/Bush/IT
ARCH-11 AH-215 Silica	10/140	90 - 100 1.7 - 1.9	150 - 165 2.0 - 2.5	100 - 110	0.80 - 0.90	F	-	19 - 21	3.8 - 4.2	2	SG/Ins/Bush/IT
ARCH-12 AH-214 K-13 Silica	6/80 + 10/140	70 - 90 1.0 - 1.5	150 - 170 1.7 - 2.0	75 - 85	-	F	-	18 - 22	-	2 - 3	SG/Ins/Bush
ARCH-12 AH-215 Silica	6/80 + 10/140	70 - 90 1.0 - 1.5	150 - 170 1.7 - 2.0	75 - 85	-	F	-	18 - 22	-	2 - 3	SG/Ins/Bush
ARCH-13 AH-215 Silica	6/80 + 10/140	60 - 70 0.75 - 1.25	-	100 - 110	-	F	-	19 - 21	-	2 - 3	SG/Ins/Bush
C-17 K-12 K-13 K-14 Silica	8/80 + 8/130	75 - 85 0.9 - 1.1	125 - 135 1.1 - 1.5	85 - 95	0.80 - 0.90	F	31 - 36	18 - 22	4	1.3	Ins/Bush/SG/IT/DDT
C-50 K-61 Silica	6/80 + 8/140	70 - 80 1.0 - 1.3	110 - 125 1.2 - 1.7	105 - 125	0.80 - 0.90	H	35 - 37	18 - 20	4.3	1.7	SG/Ins/Bush
C-50 K-225 Silica	6/80 + 10/130	70 - 80 1.0 - 1.5	110 - 120 1.2 - 1.7	90 - 105	0.80 - 0.90	H	36 - 40	18 - 20	3.8	1.7	SG/Ins/Bush
C-51 K-6 Silica	6/80	35 - 50 -	50 - 60 -	60 - 70	0.54	B	60 - 65	18 - 22	4.4	2 - 3	Adh/Eass
ARC-18 AH-123	4/80 + 2/130	60 - 70 -	110 - 120 1.5 - 2.5	122 - 132	0.60	F	34 - 36	25	3 - 4	1.3	SG/Ins/Bush
ARC-30 AH-714	4 - 6/80 - 100	15 - 25 1.5 - 2.5	60 - 90 1.5 - 2.5	60 - 70	-	B	-	18 - 20	-	2 - 3	IT/Eass
C-2 K-1 Silica	12/140	80 - 100 1.0 - 1.4	130 - 150 2.1 - 2.3	115 - 130	-	F	-	22 - 25	-	2 - 3	Ins/Bush/IT
C-59 K-1 Silica	24/140	85 - 95 1.0 - 1.4	135 - 145 2.1 - 2.3	115 - 130	0.75 - 0.90	F	35 - 38	-	4.1	1.5	Ins/Bush/SG/IT/DDT

LAPOX®

Systems	Type of system (Unf | Prf[1])	Nature (Hot cure | Cold cure | Outdoor | Indoor)	Mixing ratio (R/CA/Acc/Flx/Flr/Sol[2]) pbw	CVC	APG	Vacuum potting	Filament winding	Pultrusion	Hand lay-up	Impregnation | VPI	Encapsulation	Prepregging	Bonding	Mix viscosity mPa s/°C	Pot life hr/°C	Gel time min/°C	Density of components (Resin / Curing agent) g/cm^3
	Lapox®			Processing techniques										Physical / Chemical properties			
ARL-111 AH-358 ARS-101	Unf	Hot cure Indoor	R: 100 CA: 15	•								•		1,300/25	> 8/25	45/120 12/140	0.90 - 1.00 1.02 - 1.06
C-1 K-1 Silica	Unf	Hot cure Indoor	R: 100 CA: 30 Flr: 200	•										4,000/120 2,500/140	1/120	90/130 50/140	1.20 - 1.24 1.50 - 1.55
ARF-11 K-918 K-13	Unf	Hot cure	R: 100 CA: 85 Acc: 1 - 3				•	•						300 - 500/25	> 8/25	8 - 11/120	1.17 - 1.18 1.18 - 1.22
L-12 AH-113 K-13	Unf	Hot cure	R: 100 CA: 95 Acc: 0.1 - 2.0				•	•						1,900 - 2,100/25	50 - 55/25	-	1.10 - 1.20 1.36 - 1.40
L-12 K-918 K-13	Unf	Hot cure	R: 100 CA: 85 Acc: 0.1 - 2.0				•	•	•					600 - 900/25	80 - 95/25	10 - 12/120	1.10 - 1.20 1.18 - 1.22
L-247 K-918 K-13	Unf	Hot cure	R: 100 CA: 65 Acc: 1 - 3				•	•						-	> 8/25	8 - 10/120	- 1.18 - 1.22
ARC-31 AH-114 AC-13	Unf	Hot cure Indoor	R: 100 CA: 100 Acc: 0.0 - 0.2							•	•			700 - 750/23	1/80	17/120	1.15 - 1.20 1.15 - 1.22
ARC-35 AH-676	Prf	Hot cure Indoor	R: 100 CA: 26								•			10,000 - 13,000/25	> 8/25	30/120	1.72 - 1.76 1.00 - 1.05
ARPN-36 K-10 K-86 Solvent[3]	Unf	Hot cure	R: 100 CA: 40 Acc: 1 Sol: 125									•		-	> 8/25	7 - 12/120	1.20 - 1.22 1.30
ARPN-36 K-86 Solvent[3]	Unf	Hot cure	R: 100 CA: 3 - 6 Sol: 80									•		-	> 8/25	8 -12/120	1.20 - 1.22 1.42
L-12 G-11 K-10 K-86 Solvent[3]	Unf	Hot cure	R: 100 CA: 35 Acc: 1 - 3 Sol: 100 - 150									•		-	6 - 8 weeks/25	-	1.10 - 1.20 1.30
L-67 G-10 K-66 K-13 Solvent[3]	Unf	Hot cure	R: 100 CA: 23 Acc: 0.2 Sol: 10									•		-	3 - 4 weeks/20	8.5/150 3.5/172	- 1.06 - 1.09
L-68 FR-4 K-66 K-13 Solvent[3]	Unf	Hot cure	R: 100 CA: 32 Acc: 1 - 3									•		-	3 - 4 weeks/20	8.5/150 3 - 4/172	0.98 - 1.05 1.06 - 1.09
A-31 AH-717	Unf	Cold cure	R: 100 CA: 80										•	25,000 - 40,000	130 - 150/25	-	1.06 - 1.18 0.92 - 0.98
A-35 K-35	Unf	Hot cure	R: 100 CA: 30										•	400 - 600	3 - 4 weeks/25	-	-
A-38 K-99	Unf	Cold cure	R: 100 CA: 40										•	60,000 - 90,000	35 - 45/25	-	1.65 - 1.75 1.65 - 1.75
C-51 K-6	Unf	Cold cure	R: 100 CA: 10						•				•	-	-	-	1.13 - 1.16 0.97 - 0.99

[1] Unf - Unfilled; Prf - Pre-filled
[2] Mixing ratio stated in order of Resin/Curing agent/Accelerator/Flexibiliser/Filler/Solvent
[3] Acetone/methyl ethyl ketone/methyl isobutyl ketone/methyl cellosolve
Applications: SG - Switchgears; Ins - Insulators; Bush - Bushings; IT - Instrument Transformers (CT and PT); DDT - Dry Type Distribution Transformers; RM - Rotating Machines; Ecomp - Electro composites; Adh - Adhesives; Eass - Electronic assembly
Processing techniques: CVC - Conventional Vacuum Casting; APG - Automatic Pressure Gelation; VPI - Vacuum Pressure Impregnation

LAPOX®

Systems	Processing guideline: Cure schedule hr/°C	Tensile strength | Elongation (ISO 527-2) MPa | %	Flexural strength | Surface strain (ISO 178) MPa | %	Glass transition temperature (Tg) (DIN 11357-2) °C	Thermal conductivity (ISO 8894-1) W/mK	Thermal class (IEC 60085) -	Coefficient of linear thermal expansion (ISO 11359-2) $(^{\circ}C)^{-1}$	Breakdown strength (BDV) (IEC 60243-1) kV/mm	Dielectric constant / Relative permittivity (DIN 53483) -	Dielectric dissipation factor (Tan D) (IEC 60250) %	Applications: SG/Ins/Bush/IT/DDT/RM/Ecomp/Adh/Paper coating/Eass
	Processing guideline	Mechanical properties		Thermal properties				Electrical properties			Applications
ARL-111 AH-358 ARS-101	6/140	-	-	80 - 90	-	F	-	-	-	2.5 - 3.0	Paper coating
C-1 K-1 Silica	16/140	70 - 90 1.0 - 1.4	70 - 100 2.1 - 2.3	115 - 130	-	F	-	22 - 24	-	2 - 3	IT/SG/Bush
ARF-11 K-918 K-13	4/100 + 4/120	75 - 85 4.0 - 5.0	120 - 140 6.0 - 10.0	115 - 130	-	-	-	-	-	-	Ecomp
L-12 AH-113 K-13	2/100 + 2/120 + 8/180	45 - 60 1.5 - 3.0	100 - 140 4.0 - 7.0	165 - 185	-	-	-	18 - 20	3 - 4	2 - 3	Ecomp
L-12 K-918 K-13	2/100 + 2/140	75 -85 4.0 - 5.0	120 - 140 6.0 - 10.0	130 - 140	-	-	-	20 - 25	3.3	0.3	Ecomp
L-247 K-918 K-13	3/80 + 3/120 + 4/160	60 - 80 3.0 - 6.0	120 - 140 5.0 - 10.0	110 - 120	-	-	-	-	-	-	Ecomp
ARC-31 AH-114 AC-13	6/80 + 3/120	75 - 85 0.9 - 1.1	125 - 135 1.1 - 1.5	90 - 100	-	F	31 - 36	18 - 22	-	1.3	DDT/Eass/RM
ARC-35 AH-676	2/140	-	-	70 - 80	-	F	-	-	-	2 - 3	Eass
ARPN-36 K-10 K-86 Solvent[3]	1 - 2/80 or 15 min/130 (drying) 5/200 (in oven)	-	135 7.0	-	-	-	-	-	-	-	Ecomp
ARPN-36 K-86 Solvent[3]	1 - 2/80 or 15 min/130 (drying) 4/120 + 16/160 (in oven)	-	-	-	-	-	-	-	-	-	Ecomp
L-12 G-11 K-10 K-86 Solvent[3]	✚ 10 - 15 min/130 or 6 - 10 min/135 (drying) 5/200 (curing)	-	400 - 500 -	150 - 160	-	-	-	15 - 20	4.7 - 5.2	2.0 - 2.5	Ecomp
L-67 G-10 K-66 K-13 Solvent[3]	✚ 7 - 9 min/150 or 5 - 6 min/160 or 3 - 5 min/170	≥ 315 (LW)* ≥ 266 (CW)* 2.0 - 3.0	≥ 525 (LW)* ≥ 455 (CW)* 2.0 - 6.0	130 - 140	-	-	-	12 - 14	4.5 - 5.2	2.5 - 3.0	Ecomp
L-68 FR-4 K-66 K-13 Solvent[3]	✚ 7 - 9 min/150 or 5 - 6 min/160 or 3 - 5 min/170	≥ 315 (LW)* ≥ 266 (CW)* 2.0 - 3.0	≥ 525 (LW)* ≥ 455 (CW)* 2.0 - 6.0	130 - 140	-	-	-	12 - 14	4.5 - 5.2	2.5 - 3.0	Ecomp
A-31 AH-717	4 - 6/40 or 45 - 60 min/65 or 15 min/100	-	-	-	-	-	50 - 60	-	-	-	Adh
A-35 K-35	24/120 5/140 2/160 1/180	-	-	-	-	-	60	-	-	-	Adh
A-38 K-99	24 - 28/25 or 1/60	42 - 44 -	-	-	-	-	65	-	-	-	Adh
C-51 K-6	24/25 or 6/80	55 - 80 -	-	60 - 70	0.19 - 0.20	-	90 - 95	18 - 22	4	2 - 3	Adh

✚ Manufacturing of prepreg followed by compression moulding, 2 - 6 hr/160°C
*CW - Cross wise; LW - Length wise

COMMON ELECTRICAL PROPERTIES

Arc resistance
It is measure of time in seconds required to make an insulating surface conductive under a high voltage, low current arc.

Comparative Tracking Index (CTI)
Numerical value of voltage which specimen withstands during the test period for 50 drops of electrolyte without progressive formation of conducting paths.

Dielectric strength
It refers to electrical strength of Insulating materials. It is the measure of dielectric break down resistance of material. Expressed in kV/mm.

Dissipation factor/Tan δ
It is the angle by which the phase difference between current and voltage deviates from 90° out of phase.

Electrical conductivity
Electrical conductivity is a measure of how well a material accommodates the movement of an electric charge.

Electrical resistivity
Electrical resistivity is the reciprocal of conductivity.

Relative permitivity/Dielectric constant
It is the ratio of capacitance of a capacitor with insulating material to the capacitance of same configuration of electrodes in vacuum.

Surface resistivity
It is the electrical resistance offered to surface current when potential difference is applied between surface mounted electrodes. Measured in ohm per square.

Volume resistivity
It is the electrical resistance on an insulating material when electric potential is applied between opposite faces. Measured in ohm-cm.

CRITICAL PROPERTIES

Coefficient of thermal expansion
The coefficient of thermal expansion describes how the size of an object changes with a change in temperature. Specifically, it measures the fractional change in size per degree change in temperature at a constant pressure. Several types of coefficients have been developed: volumetric, area and linear.

Elongation at break
Elongation recorded at the moment of rupture of the specimen, often expressed as a percentage of the original length. It corresponds to the breaking or maximum load.

Flexural strength
Flexural strength, also known as modulus of rupture, bend strength, or fracture strength, a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load.

Heat Deflection Temperature (HDT)
The heat deflection temperature or heat distortion temperature (HDT, HDTUL, or DTUL) is the temperature at which a polymer or plastic sample deforms under a specified load.

Impact strength
The ability of a material to withstand shock loading or say the work done to fracture, under shock loading.

Tensile strength
The maximum load applied in breaking a tensile test piece divided by the original cross-sectional area of the test piece. Originally quoted as tons/sq.in. it is now measured as Newtons/sq.mm. Also termed Maximum Stress and Ultimate Tensile Stress.

Thermal cycling
Thermal cycling is the alternate heating and cooling of a material. Low frequency thermal cycle is the one in which the time taken for completion of the cycle is large enough to cool the component.

Thermal shock
Thermal shock is a sudden variation in temperature which causes stress in a material. It frequently causes breakage in the material, and is most common in brittle materials such as ceramics.

This is a process that takes place abruptly when there is a sudden variation of temperature, either from hot to cold or vice versa. It is most common in materials that are structurally weak as well as those which offer a poor heat conductivity.

Vapour pressure
The vapour pressure of a liquid is the equilibrium pressure of a vapour above its liquid (or solid); that is, the pressure of the vapour resulting from evaporation of a liquid (or solid) above a sample of the liquid (or solid) in a closed container. As the temperature of a liquid or solid increases its vapour pressure also increases. Conversely, vapour pressure decreases as the temperature decreases.

GENERAL PROPERTIES

Cross-linking
Reactive sites of the resin and curing agent make chemical bonds and form a three-dimensional network. Cross-linking starts as soon as the resin and curing agent come into physical contact. The speed of the reaction (i.e. of cross-linking) depends on the type of resin, curing agent and the temperature.

Cure time
Cure time is the amount of time required for a liquid resin-curing agent mix to convert into a completely cross-linked solid mass. It depends on various factors including the type of resin, curing agent and the temperature.

Epoxide Equivalent Weight (EEW)
EEW is the weight of the resin in grams that contains one gram-equivalent of epoxy. An interchangeable term, Epoxy Value (EV) may also be used. EV represents the fractional number of epoxy groups contained by 1,000 grams of resin. EEW can be obtained if 1,000 is divided by EV.

Gel time
Gel time is the amount of time required for a resin-curing agent mix to convert into a jelly-like mass. It depends on the type of resin and curing agent, the quantity of the mix and the temperature.

Post curing
When resin and curing agent react, cross-linking takes place and a solid, cured mass is obtained. In certain epoxy systems, even though the material appears cured and hard, optimum mechanical properties are not achieved. This happens due to the presence of free reactive sites of the resin and curing agent that can be completely cross-linked by heating (post curing) at appropriate temperatures.

Pot life
The amount of time taken to retain processable (i.e. usable) viscosity of a resin-curing agent mix. Mix viscosity increases with time. Pot life is dependent on the type of resin and curing agent, quantity of mix and the temperature.

Shrinkage
Shrinkage is defined as the change in dimension that occurs in a polymer(s) when cross-linking takes place. Volume shrinkage is expressed as a percentage while linear shrinkage is measured in millimeters or inches.

Viscosity
The internal resistance of a liquid to flow, viscosity can also be defined as 'fluid friction'.

Thermal classes	Y	A	E	B	F	H	C
Maximum permissible temperature, °C	90	105	120	130	155	180	> 180

STORAGE, HANDLING AND SAFETY

Storage

Epoxy resins and curing agents should be stored in a dry place in their original, sealed containers at temperatures between 60 - 100°F (16 - 38°C). Material temperatures should be above 65°F (18°C) when mixing. After use, tightly reseal containers.

Liquid epoxy resins stored for prolonged periods at normal room temperatures can crystallise; they should show little, if any, change in quality. However, at higher temperatures (> 35°C), some colour increase may occur. The rate of increase depends on the storage temperature and the particular epoxy resin being stored.

Some epoxy curing agents are susceptible to higher temperatures and a slight increase in colour or viscosity may occur. It is therefore advisable to store these curing agents in tightly sealed containers at < 25°C.

Safety

Epoxy resins and curing agents, by their nature, contain chemicals capable of causing damage to health. However, if these products are used with appropriate care and control, the risk should be minimised. Thus, the basic rule in the use of all chemicals is the avoidance of contact, or at least its limitation, to a level where the risk of damage to health is minimal. Contact can take the form of skin contact, inhalation or ingestion. Each component part, resin or curing agent, will have hazards associated with it. The resin can be harmful to health by inhalation, and in contact with the skin, it can cause irritant dermatitis as allergic reactions.

Prevention of exposure

By preventing contact and exposure to hazardous materials, it is possible to control and minimise the risks to health. This should be done in a structured manner through the use of engineering controls (such as enclosure of the process), ventilation, training and the use of Personal Protective Equipment (PPE).

Enclosure

In an ideal situation, all work using hazardous products would be carried out in an enclosed environment with the operator isolated from the chemical. Certain products, particularly curing agents, are more hazardous than others. It is recommended that processes be developed to protect personnel against the hazards to health and safety associated with any of the products. Ideally, materials should be used in an enclosed system. If this is not achievable, the following recommendations can be helpful in preventing health effects:

- Avoid skin and eye contact.
- Avoid ingestion.
- Avoid breathing dust, mist or vapours.
- Avoid working in dusty environments.
- It is possible that resins can penetrate clothing and shoes. If this occurs, do not wear or reuse contaminated articles until they have been cleaned completely.
- Ensure that operators maintain high standards of personal and workspace cleanliness. This is a vital requirement.
- Personnel should wash hands and exposed skin thoroughly before eating, drinking or using toilet facilities.
- Train all operators on the risks and hazards of epoxies.
- Ensure that only trained operators are allowed access to epoxy work areas and separate these from other work areas.

NOTES

KEY MARKETS

EUROPE
Belgium, Czech Republic
Finland, France, Germany
Hungary, Italy, Norway, UK

NORTH AMERICA
Canada
USA

MIDDLE EAST
Bahrain, Iran, Kuwait, Oman, Qatar
Saudi Arabia, Turkey, UAE

FAR EAST
China, Hong Kong
Japan, Korea, Taiwan

SOUTH AMERICA
Argentina
Brazil
Colombia
Peru

AFRICA
Algeria
Egypt
Kenya
Morocco
Nigeria
South Africa
Tunisia

SOUTH ASIA
Bangladesh
India
Pakistan

SOUTH EAST ASIA
Indonesia
Malaysia
Singapore
Thailand

INDIA

Head office

Atul 396 020, Gujarat
India
Telephone: (+91 2632) 230000
E-mail: contact@atul.co.in

Registered Office

Atul House
G I Patel Marg
Ahmedabad 380 014, Gujarat
India
Telephone: (+91 79) 26461294 | 3706

www.atul.co.in

Polymers Business - Mumbai (Goregaon)

Floor 15, C wing, Lotus Corporate Park
Western Express Highway, Goregaon (East)
Mumbai 400 063, Maharashtra
India
Telephone: (+91 22) 39877700
E-mail: polymers@atul.co.in

Polymers Business - Mumbai (Dadar)

310-B, Veer Savarkar Marg
Dadar (West)
Mumbai 400 028, Maharashtra
India
Telephone: (+91 22) 39876000

OUTSIDE INDIA

Atul Brasil Quimicos Ltda

Avenida Ipiranga, 318
Conjunto 1.001
Bloco A - Bairro República
São Paulo (SP), CEP 01046-010
Brazil
Telephone: (+55 19) 999442500

Atul China Ltd

Room number 806
Building 2E
686 Wuzhong Road
Shanghai 201103
China
Telephone: (+86 21) 64753255

Atul Europe Ltd

1|B Dean Row Court
Summerfields Village Centre
Dean Row Road
Wilmslow SK9 2TB, Cheshire
United Kingdom
Telephone: (+44 1625) 539209

Atul Middle East FZ-LLC

Office number 43, Floor 3
Nucleotide Complex
Dubai Science Park, Emirates Road
Al Barsha South
Dubai PO Box 500767
United Arab Emirates

Atul USA Inc

Building number 400
6917 Shannon Willow Road
Charlotte
NC 28226
United States of America
Telephone: (+1 704) 540 8460

Mar 2018

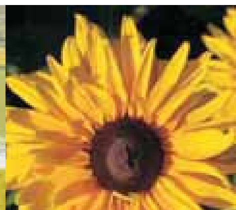

POLYMERS


AROMATICS


BULK CHEMICALS AND INTERMEDIATES


COLORS


CROP PROTECTION


FLORAS


PHARMACEUTICALS AND INTERMEDIATES

Lalbhai Group