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SEMI-SOLID ANHYDRIDE CURING AGENTS

TECHNICAL DATA SHEET

The LS Series semi-solid curing agents are formulated anhydride curing agents designed for resin infusion and tooling applications. When formulated with a solid epoxy resin, the resulting resin system is solid at ambient temperature, but has a viscous fluid consistency above 100°F (37°C) and a liquid consistency at 175°F (80°C).

Specifically, these resin systems may be applied in the form of a viscous fluid at temperatures ranging from 100°F (37°C) to 125°F (52°C) by either manual or robotic dispensing methods to a dry reinforcement. After application, cooling affords a B-staged resin system, which can subsequently be cured by various molding techniques at temperatures ranging from 230°F (110°C) to 300° (150°C). Impregnation of the reinforcement is accomplished due to viscosity reduction as the temperature passes through the 160°F (70°C) – 175°F (80°C) range on heating to the final curing temperature.

LS-663K, the initial member of this group of curing agents, is based on MTHPA (Methyltetrahydrophthalic anhydride) and will cure bisphenol A type epoxy resins at moderate temperatures. This resin system has excellent adhesion to several reinforcements including glass and carbon fiber making this system an excellent choice for resin infusion applications.

LS-563K, is a semi solid curing agent based on MHHPA (Methylhexahydrophthalic Anhydride). It is designed to cure cycloaliphatic epoxy resins to afford cured resins which have a low degree of colour and which will maintain the low colour and physical properties on outdoor exposure.

LS-256, is a semi-solid curing agent designed to cure novolac and multifunctional resins to afford resin systems with higher glass transition temperatures for tooling and molding applications.

ADVANTAGES FOR RESIN INFUSION

- > Low volatile emissions
- > No shelf-life issues
- > Low resin viscosity at impregnation
- > Low void content
- Low shrinkage
- Low moisture absorption

TYPICAL PROPERTIES

	<u>LS-663K</u>	<u>LS-563K</u>	<u>LS-256</u>
Appearance	Clear, amber semi-solid	Clear, yellow semi-solid	Clear, brown semi-solid
Brookfield Viscosity (cps @ 50°C)	10,000-15,000	10,000 -15,000	12,000
Equivalent Weight (g/eq.)	230 – 240	235-245	222
Weight / Gallon (lbs.)	9.7 – 10.0	9.7-10.0	10.3
Flash Point (°F)	290°F min	290°F min	275°F

FORMULATION

<u>Component</u>	<u>phR⁽¹⁾</u>
Bisphenol A Resin (EEW: 250 g/eq) ⁽²⁾ LS-663K	100 100
-or-	
LINDOXY 590 ⁽³⁾ (EEW:220 g/eq) LS-563K	100 104
-or-	
LINDOXY 290 ⁽⁴⁾ LS-256	100 120

Notes:

- 1) parts per hundred parts of Resin
- 2) Dow's DER 337 or Hexion Specialty Chemicals' Epon 834 Resin
- 3) Lindau Chemicals' Cycloaliphatic Resin
- 4) Lindau Chemicals' Novalac Resin

TYPICAL PROCESSING CONDITIONS

Mixing: Both the resin and the LS Series curing agent should be heated separately to a temperature range of 100°F (37°C) to 125°F (52°C); then mixed at a ratio of 1: 1, by volume, through a static mixer of at least 30 inches in length, and applied directly to the perform.

Process: After application of the resin, the part may be cured by a vacuum bag technique as well as by other molding methods. In either case, the temperature should be ramped from ambient to a final cure temperature of 230°F (110°C) to 300° (150°C) and held there for one to four hours.

Consult Lindau Customer Service for assistance in the design of a time, temperature cure profile.

TYPICAL MIXED RESIN PROPERTIES

(Formulation: DER 337 / LS-663K : 100 / 100)

Cure:

1. Ramp from ambient temperature to 230°F (110°C) + 4 hours at 230°F (110°C)

Property	Method	Result
Gel Time, minutes @ 212°F (100°C)	Lindau # 10C	15
Reactivity @ 250°F (121°C)	ASTM # D2471	
a) Peak Exotherm Time (min.)		8.0
b) Peak Exotherm Temperature, °F (°C)		338.2°F (170.1°C)
c) Gel Time (min.)		6.5
d) Gel Temperature, °F (°C)		320.4°F (160.2°C)
Pot Life @ 122°F (50°C)	ASTM # D2196	
a) Minimum Brookfield Viscosity (cps)		14,000
b) Time (min.) to 100,000 cps		60
Ramped Pot Life (50°C -> 80°C)	ASTM # D2196	
a) Initial Brookfield Viscosity (cps)		15,500
b) Minimum Brookfield Viscosity (cps)		8,000
c) Temperature (°C) at Minimum Viscosity		80
d) Time (min.) to 100,000 cps		58
Heat Distortion Temperature (°C)	ASTM # D648	110°C
Glass Transition Temperature (°C)	ASTM # D3418	
1. DER 337 ⁽¹⁾ -100 / LS-663K-100 (Cure: 6 hr @ 105°C)		103°C
2. LINDOXY 290 ⁽²⁾ -100 / LS-256-121 (Cure: 1.5hr @ 90°C + 1hr @ 150°C 160°C + 2hr @ 200°C + 2hr @ 230°C)		155°C
3. MY-720 ⁽³⁾ -100 / LS-256-169 (Cure: 1hr @ 80°C + 1hr @ 120°C + 0.5hr @ 160°C + 0.5hr @ 200°C)		175°C

1. Product of the Dow Chemical Co
2. Lindau Chemicals' Novalac Resin
3. Product of Huntsman

1. Product of The Dow Chemical Co.
2. Lindau Chemicals, Inc. Novalac resin
3. Product of Vantico

Revision date: 5/8/02
Replace date: 3/14/02

We believe all information given is accurate. It is offered in good faith, but without guarantee. Since conditions of use are beyond our control. All risks of use are assumed by the user. Nothing herein shall be construed as a recommendation for uses which infringe valid patents or as extending a license under valid patents.

TYPICAL MIXED RESIN PROPERTIES

B. FORMULATION: LINDOXY 590 (EEW: 220g/eq) / LS-563K : 100/104

Cure:

1. Gel at 90°C + ramp 90°C to 150°C at 2°C/minute; hold at 150°C for 15 minutes.

Properties	Method	Result
Time to 95% cured 150°C (minutes): (Based on DSC Kinetic scan)	Lindau # 33	9.3 minutes
Pot Life at 50°C:	ASTM # D 2196	
a) Minimum Brookfield Viscosity (cps)		3480
b) Time (hours) to 100,000 cps		7.8
Ramped Pot Life (50°C ->80°C)	ASTM # D 2196	
a) Initial Brookfield Viscosity (cps)		6000
b) Minimum Brookfield Viscosity (cps)		1200
c) Temperature (°C) at Minimum Viscosity		72°C
d) Time (Minutes) to 100,000 cps		84 minutes
Glass Transition Temperature (°C)	ASTM # D 3418	97°C
a) Cure: Gel at 90°C + ramp 90°C to 150°C at 2°C/minute. Hold 150°C for 15 minutes.		

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