Technical Datasheet

INEOS Composites

DERAKANE™ 441-400 Epoxy Vinyl Ester Resin

DERAKANE™ 441-400 epoxy vinyl ester resin is a lower styrene-content resin that has an optimized epoxy backbone and resulting superior thermal properties and corrosion resistance performance which place it as a resin type between DERAKANE 411-350 and DERAKANE 470-300 resins. DERAKANE 441-400 resin offers superior stability compared to conventional vinyl ester resins which provide additional flexibility to fabricators in storage and handling.

The raw materials used in the manufacture of this resin are listed as acceptable in FDA regulation Title 21 CFR 177.2420 for repeated use in contact with food, subjerct to user's compliance with the prescribed limitations of that regulation.

Equipment fabricated with DERAKANE 441-400 resin exhibit excellent corrosion resistant protection to organic solvents such as methanol, chlorobenzene, and methyl ethyl ketone to provide long-lasting, reliable equipment for corrosive services. Strength properties are comparable to those for DERAKANE 411 and 470 epoxy vinyl ester resins, allowing flexibility in design and fabrication while still meeting safety requirements.

DERAKANE 441-400 resin contains only 33 weight percent styrene which allows fabricators to meet California's South Coast Air Quality Management District Rule 1162. Styrene emissions at ambient temperatures can be reduced up to 50% compared with DERAKANE 411-350 resin.

The heat distortion temperature (HDT)of DERAKANE 441-400 resin is 10-15°C (20-30°F) higher than the HDT of DERAKANE 411-350 resin. The percent elongation is two times that of DERAKANE 470-300 resin and similar to DERAKANE 411-350 resin. The higher elongation provides FRP equipment with increased toughness and a safety factor for impact damage during process upsets or during shipping and installation.

Equipment fabricated with DERAKANE 441-400 resin exhibits superior toughness, better impact resistance and is less prone to cracking due to cyclic temperature, pressure fluctuations and mechanical shocks providing a safety factor against damage during process upsets or during shipping installation. Composites fabricated with DERAKANE 441-400 resin provide resistance to a wide range of acids, alkalis, bleaches and solvents. This resin holds up well in corrosive environments, postponing the need for replacements. Equipment fabricated with DERAKANE 441-400 resin tolerates heavy design loads without causing failure due to resin damage. This facilitates working with large weight-bearing equipment with confidence.

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APPLICATIONS AND USE

DERAKANE™ 441-400 resin is designed for ease of fabrication using hand lay-up, spray-up, filament winding, compression molding and resin transfer molding techniques, pultrusion and molded grating applications. This resin is recommended for fabricationg FRP storage tanks, vessels, ducts, and on-site maintenance projects, particularly in chemical processing, pulp and paper operations, including chlorine dioxide bleaching towers.

Recommendations for specific services and environments can be provided by contacting us at derakane@ineos.com.

Note: Contact us before using thixotropic agents and fillers. Addition of thixotropic agents and fillers can compromise corrosion resistance.

TYPICAL LIQUID RESIN PROPERTIES

Property(1) at 25°C (77°F)	Value	Unit
Dynamic Viscosity	430	mPas (cps)
Kinematic Viscosity	400	cSt
Styrene Content	33	%
Density	1.07	g/ml

(1) Properties are typical values, based on material tested in our laboratories. Results may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specification items.

TYPICAL CURING CHARACTERISTICS

The following tables provide typical geltimes for MEKP. This and other information are available at www.derakane.com.

MEKP Cure System

Typical(1) geltimes(2) using NOROX(3) (ME)KP-925H catalyst (MEKP) and Cobalt Naphthenate-6%(4) (Co-nap6%), Dimethylaniline (DMA) and 2,4-Pentanedione (2,4-P).

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Geltime at 18°C (65°F)	MEKP (phr)(5)	Co-nap6% (phr)	DMA (phr)
15 +/- 5 minutes	2.50	0.30	0.15
30 +/- 10 minutes	2.50	0.20	0.15
50 +/- 10 minutes	2.00	0.20	0.05

Geltime at 24°C (75°F)	MEKP (phr)	Co-nap6% (phr)	DMA (phr)
15 +/- 5 minutes	1.75	0.20	0.05
30 +/- 10 minutes	1.25	0.20	0.05
50 +/- 10 minutes	1.00	0.20	0.05

Geltime at 30°C (85°F)	MEKP (phr)	Co-nap6% (phr)	DMA (phr)	2,4-P (phr)
15 +/- 5 minutes	1.25	0.30	-	-
30 +/- 10 minutes	1.25	0.20	0.05	0.05
50 +/- 10 minutes	1.25	0.20	0.05	0.08

Geltime at 35°C (95°F)	MEKP (phr)	Co-nap6% (phr)	DMA (phr)	2,4-P (phr)
15 +/- 5 minutes	1.50	0.20	-	0.035
30 +/- 10 minutes	1.00	0.20	-	0.08
50 +/- 10 minutes	1.50	0.20	-	0.12

(2) Thoroughly test any other materials in your applications before full-scale use. Gel times may vary due to the reactive nature of these materials. Always test a small quantity before formulating large quantities.
(3) Registered trademark of United Initiators. NOROX (ME)KP-925H, (ME) used in NA name, but not elsewhere. NOROX (ME)KP-925H or equivalent low hydrogen peroxide content MEKP. Use of other MEKP catalysts or additives may result in different geltimes.
(4) Use of cobalt octoate, especially in combination with 2,4-P can result in 20-30% slower geltimes.
(5) phr = parts per hundred resin molding compound

TYPICAL MECHANICAL PROPERTIES

Casting Properties

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Property[1] of clear casting[6] at 25°C (77°F)	Value (SI)	Method	Value (US)	Method
Tensile Strength	90 MPa	ISO 527	13,000 psi	ASTM D638
Tensile Modulus	3.4 GPa	ISO 527	490 kpsi	ASTM D638
Tensile Elongation at Yield	5-6 %	ISO 527	5-6 %	ASTM D638
Flexural Strength	160 MPa	ISO 178	21,000 psi	ASTM D790
Flexural Modulus	3.8 GPa	ISO 178	550 kpsi	ASTM D790
Heat Distortion Temperature[7]	120 °C	ISO 75	248 °F	ASTM D648
Glass Transition Temperature, Tg_2	125 °C	ISO 11357	257 °F	ASTM D3418
Volume Shrinkage	7.5 %		7.5 %	
Barcol Hardness	35	EN 59	35	ASTM D2583
Density	1.16 g/cm^3	ISO 1183	1.16 g/ml	ASTM D792

(6) Cure schedule: 24 hours at room temperature and 2 hours at 120°C (250°F).
(7) Maximum stress: 1.8 MPa (264 psi), catalyzed with 1.0% BPO + 0.15% TBPB, cured one hour at 70°C (150°F), then one hour at 95°C (200°F), post-cured two hours at 150°C (300°F).

Laminate Properties

Property[1] of 6 mm (1/4 in.) laminate[8] at 25°C (77°F)	Value (SI)	Method	Value (US)	Method
Tensile Strength	140 MPa	ISO 527	20,000 psi	ASTM D3039
Tensile Modulus	11,000 MPa	ISO 527	1600 kpsi	ASTM D3039
Flexural Strength	180 MPa	ISO 178	26,000 psi	ASTM D790
Flexural Modulus	7900 MPa	ISO 178	1100 kpsi	ASTM D790
Glass Content	40%	ISO 1172	40%	ASTM D2584

(8) Cure schedule: 24 hours at room temperature and 6 hours at 80°C (175°F); laminate construction of 6mm (1/4")is V/M/M/Wr/M/Wr/M where V=Continuous veil glass, M=Chopped strand mat 450 g/m^2 (1.5 oz/ft^2) and Wr=Woven roving 800 g/m^2 (24 oz/yd^2).

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CERTIFICATES AND APPROVALS	The manufacturing, quality control and distribution of products, by INEOS Composites, comply with one or more of the following programs or standards: ISO 9001, ISO 14001 and OHSAS 18001 by .
STANDARD PACKAGE	Non-Returnable Drum with Net Weight of 205 Kgs (452 Lbs.) DOT Label Required: Flammable Liquid
STORAGE	Drums - Store at temperatures below 25°C (77 °F). Storage life decreases with increasing storage temperature. Avoid exposure to heat sources such as direct sunlight or steam pipes. To avoid contamination of product with water, do not store outdoors. Keep containers sealed to prevent moisture pick-up and monomer loss. Mild mixing is recommended after prolonged storage. Rotate stock. Bulk - See INEOS Composites's Bulk Storage and Handling Manual for Polyesters and Vinyl Esters. A copy of this may be obtained from INEOS Composites at +1.614.790.3333 or 800.523.6963. All other conditions being equal, higher storage temperatures will reduce product stability and lower storage temperature will extend product stability.
COMMERCIAL WARRANTY	Nine (9) months from date of manufacture, when stored in accordance with the conditions stated above.
Notice	All information presented herein is believed to be accurate and reliable, and is solely for the user's consideration, investigation and verification. The information is not to be taken as an express or implied representation or warranty for which INEOS Composites assumes legal responsibility. Any warranties, including warranties of merchantability, fitness for use or non-infringement of intellectual property rights of third parties, are herewith expressly excluded. Since the user's product formulations, specific use applications and conditions of use are beyond

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the control of INEOS Composites, INEOS Composites makes no warranty or representation regarding the results which may be obtained by the user. It shall be the sole responsibility of the user to determine the suitability of any of the products mentioned for the user's specific application.

INEOS Composites requests that the user reads, understands and complies with the information contained herein and the current Material Safety Data Sheet.

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