Technical Datasheet

INEOS Composites

DERAKANE™ 411-45 Epoxy Vinyl Ester Resin

DERAKANE 411-45 epoxy vinyl ester resin is based on bisphenol-A epoxy resin and has become an "industry standard" due to its wide range of end-use applications and ability to be used in a wide range of fabrication techniques. 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, subject to user's compliance with the prescribed limitations of that regulation.

Equipment fabricated with DERAKANE 411-45 resin has superior elongation and toughness and better impact resistance and less cracking due to cyclic temperature, pressure fluctuations and mechanical shocks providing a safety factor against damage during process upsets or during shipping and installation.

Composites fabricated with DERAKANE 411-45 resin provide resistance to a wide range of acids, alkalis, bleaches and organic compounds for use in many chemical processing applications. DERAKANE 411-45 resin is the preferred choice for maximum resistance to caustic alkalis, hypochlorite bleaches and hot water. This resin holds up well in corrosive environments, postponing the need for replacements.

Equipment fabricated with DERAKANE 411-45 resin tolerates heavy design loads without causing failure due to resin damage. This facilitates working with large weight-bearing equipment with confidence.

APPLICATIONS AND USE

DERAKANE 411-45 resin is designed for use in fabricating FRP storage tanks, vessels, ducts and on-site maintenance projects, paticularly in chemical processing and pulp and paper operations. DERAKANE 411-45 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. DERAKANE 411-45 resin exhibits excellent mechanical properties over an entire service temperature range, very high damage resistance, down to -50°C (-58°F).

An alternate viscosity, optimized for some vacuum infusion processes, is available as DERAKANE MOMENTUM 411-200 resin. An alternate reactivity profile offering all the advantages of the DERAKANE MOMENTUM technology is available as DERAKANE MOMENTUM 411-350 resin.

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

Technical Datasheet

INEOS Composites

DERAKANE™ 411-45 Epoxy Vinyl Ester Resin

TYPICAL LIQUID RESIN PROPERTIES

Property(1) at 25°C (77°F)	Value	Unit
Dynamic Viscosity	495	mPa·s (cps)
Kinematic Viscosity	475	cSt
Styrene Content	45	%
Specific Gravity	1.04	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 methylethylketone peroxide (MEKP). This and other information are available at www.derakane.com.

MEKP Cure System

Typical geltimes(2) using BUTANOX(3) LPT(4) and 6% Cobalt Octoate(5) (CoOct6%), Dimethylaniline (DMA) and 2,4-Pentanedione (2,4-P).

Geltime at 15°C (59 °F)	MEKP (phr)(6)	CoOct6% (phr)	DMA (phr)	2,4-P (phr)
15 +/- 5 minutes	2.0	0.40	0.40	-
30 +/- 10 minutes	2.0	0.40	0.10	-
50 +/- 15 minutes	2.0	0.30	0.10	0.05

Geltime at 20°C (68°F)	MEKP (phr)	CoOct6% (phr)	DMA (phr)	2,4-P (phr)

Technical Datasheet

INEOS Composites

DERAKANE™ 411-45 Epoxy Vinyl Ester Resin

15 +/- 5 minutes	1.50	0.30	0.10	-
30 +/- 10 minutes	1.50	0.30	0.10	0.05
50 +/- 15 minutes	1.50	0.30	0.10	0.07

Geltime at 25°C (77°F)	MEKP (phr)	Co-nap6% (phr)	DMA (phr)	2,4-P (phr)
15 +/- 5 minutes	1.25	0.30	0.10	-
30 +/- 10 minutes	1.50	0.20	0.10	0.05
50 +/- 15 minutes	1.50	0.20	0.10	0.10

(2) Thoroughly test any other materials in your applications before full-scale use. Geltimes may vary due to the reactive nature of these materials. Always test a small quantity before formulating large quantities.
(3) Registered trademark of Akzo-Nobel
(4) Akzo-Nobel BUTANOX LPT or equivalent low hydrogen peroxide content MEKP. Use of other MEKP catalysts or additives may result in different geltimes.
(5) Use of cobalt naphthenate, especially in combination with 2,4-P can result in 20-30% shorter geltimes.
(6) phr = parts per hundred resin molding compound

TYPICAL MECHANICAL PROPERTIES

Casting Properties

Property(1) of clear casting(7) at 25°C (77°F)	Value (SI)	Method	Value (US)	Method
Tensile Strength	81 MPa	ISO 527	11,900 psi	ASTM D638
Tensile Modulus	3.3 GPa	ISO 527	4.8 x 10^5 psi	ASTM D638
Tensile Elongation at Yield	5-6%	ISO 527	5-6%	ASTM D638
Flexural Strength	124 MPa	ISO 178	18,000 psi	ASTM D790
Flexural Modulus	3.1 GPa	ISO 178	4.5 x 10^5 psi	ASTM D790
Heat Distortion Temperature(8)	102°C	ISO 75	216°F	ASTM D648

Technical Datasheet

INEOS Composites

DERAKANE™ 411-45 Epoxy Vinyl Ester Resin

Volume Shrinkage	8.3%		8.3%	
Barcol Hardness	35	EN 59	35	ASTM D2583
Density	1.12 g/cm^3	ISO 1183		ASTM D792

(7) Cure schedule: 24 hours at room temperature and 2 hours at 120°C (250°F).
(8) Maximum stress: 1.8 MPa (264 psi)

Laminate Properties

Property(1) of 6 mm (1/4 in.) laminate(9) at 25°C (77°F)	Value (SI)	Method	Value (US)	Method
Tensile Strength	143 MPa	ISO 527	20,700 psi	ASTM D3039
Tensile Modulus	12 GPa	ISO 527	17.4 x 10 ^{5} psi	ASTM D3039
Flexural Strength	204 MPa	ISO 178	29,600 psi	ASTM D790
Flexural Modulus	7.1 GPa	ISO 178	10.3 x 10 ^{5} psi	ASTM D790
Glass Content	40%	ISO 1172	40%	ASTM D2584

(9) Cure schedule: 24 hours at room temperature and 6 hours at 80°C (175°F). Laminate construction of 6 mm (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).

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.

STANDARD PACKAGE

Non-Returnable Drum with Net Weight of 205 Kgs (452 Lbs.)
DOT Label Requirement: Flammable Liquid

Technical Datasheet

INEOS Composites

DERAKANE™ 411-45 Epoxy Vinyl Ester Resin

COMMERCIAL WARRANTY	Six months from date of manufacture, when stored in accordance with the conditions stated below.
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.
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 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.