Technical Datasheet

INEOS Composites

DERAKANE™ SIGNIA 411 Epoxy Vinyl Ester Resin

DERAKANE SIGNIA 411 epoxy vinyl ester resin is based on bisphenol-A epoxy resin. It provides resistance to a wide range of acids, alkalis, bleaches, and organic compounds used in chemical processing industry applications.

For **Composite Manufacturers**, DERAKANE SIGNIA resins incorporate the best of INEOS Composites's corrosion resistant resin technologies, offering improved shop efficiencies, reduced styrene emissions and improved storage stability.

- Designed to enhance secondary bonding properties and reduce or even eliminate the need for surface preparation between laminate layers during initial production, reducing labor costs and producing a cleaner, employee friendly work place.
- Formulated for better wet out, reduced gassing and faster composite consolidation.
- Prepared with an innovative styrene suppression system, providing a lower odor environment with up to 35% reduction in emissions (based on data generated using the VSE test per 40 CFR Subpart WWWW Appendix A (the US Composites MACT Standard)).

For **Asset Owners**, DERAKANE SIGNIA resins offer the same proven INEOS Composites resin technology and peformance as with legacy DERAKANE series resins, now with the added benefit of a unique, proprietary identification system. This unique, identifiable technology confirms tanks, pipes, etc. are built as specified.

- Extends the service life of equipment designed for corrosive environments, postponing the need* for equipment replacement.
- Facilitates design and operation under heavy loads.
- Provides improved toughness and reduced cracking from cyclic temperature and pressure fluctuations or mechanical shocks during shipping, installation and operation.
- When properly formulated and cured, complies with FDA regulation 21 CFR 177.2420 covering materials intended for repeated use in contact with food.

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

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APPLICATIONS AND USE

This resin is suitable for fabricating FRP storage tanks, vessels, piping, ducts, and on-site maintenance projects, particularly in chemical processing and pulp and paper operations. DERAKANE SIGNIA 411 resin is designed for ease of fabrication using hand lay-up, spray-up and filament winding molding techniques. Properly made laminates, including laminate build up in multiple steps, have shown good interlaminar adhesion. Necessary practices to achieve good secondary bonding include minimal to no resin excess between laminate layers. Manufacturers should determine if their practices yield similar characteristics. Hazy resin is indicative of storage below suggested temperatures. Gently warm and mix the resin to normal usage temperatures (typically 20°C) to eliminate haze before use. For additional information on mixing resins, please consult INEOS Composites' "A Guide to Fabricating FRP Composites" and the supplemental document "Mix Room Practices." Recommendations for specific services and environments can be provided by contacting us at derakane@ineos.com.

TYPICAL LIQUID RESIN PROPERTIES

Property(1) at 25°C (77°F)	Value	Unit
Dynamic Viscosity	370	mPa·s (cps)
Kinematic Viscosity	350	cSt
Styrene Content	44	%
Density	1.046	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.

Emissions Comparison

The following table compares emissions from DERAKANE SIGNIA 411 resin calculated per rules established by the U.S. EPA per Table 1 to Subpart WWWW of Part 63 of the RPC MACT and shows the styrene content of a non-suppressed resin necessary to achieve the same emissions profile.

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	Manual Resin Application	Non-Atomized Mechanical Resin Application	Filament Winding Application
DERAKANE SIGNIA 411 Resin Emissions (lbs/ton)	106	79	118
Equivalent Non LSE Styrene Content (%)	37%	35.7%	32.4%

VAPOR SUPPRESSION EFFECTIVENESS (VSE) per 40 CFR Subpart WWWW Appendix A

Table 1 Subpart WWWW of Part 63 Emission Calculation Factor	
VSE Factor	0.55

TYPICAL CURING CHARACTERISTICS

Typical gel times(2) using Norox(3) (ME)KP-925H(4) catalyst (MEKP) and Cobalt Naphthenate or Octoate-6%(5) (Cobalt6%), Dimethylaniline(7) (DMA) and 4-tert-Butylcatechol (TBC) 10% concentration expressed in phr(6).

Warning: Using less than 0.05 phr cobalt 6% may cause undercure under certain conditions. Please contact INEOS Composites Technical Service for further details or if such low levels are envisaged.

Gel time at 16°C (60°F)	MEKP (phr)	Cobalt6% (phr)	DMA(7) (phr)	TBC 10% (phr)
15 +/- 5 minutes	2.0	0.40	0.10	-
30 +/- 10 minutes	2.0	0.25	0.05	-
60 +/- 15 minutes	2.0	0.20	0.05	0.20

Gel time at 22°C (72°F)	MEKP (phr)	Cobalt6% (phr)	DMA (phr)	TBC 10% (phr)
15 +/- 5 minutes	1.5	0.40	0.05	-
30 +/- 10 minutes	1.5	0.30	0.05 (+)	0.15 (+)
60 +/- 15 minutes	1.5	0.20	-	0.15

(+) If faster Barcol hardness development in thin layers is desired, please consider adding an accelerator like DMA, Diethylaniline (DEA) or DiEthyl-AcetoAcetamide (DEAA). For thicker layers and 30 minute gel time at 22°C (72°F), DMA and TBC 10% may not be needed.

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Gel time at 28°C (82°F)	MEKP (phr)	Cobalt6% (phr)	DMA (phr)	TBC 10% (phr)
15 +/- 5 minutes	1.25	0.40	-	-
30 +/- 10 minutes	1.25	0.25	-	0.05
60 +/- 15 minutes	1.25	0.15	-	0.15

Geltime at 33°C (92°F)	MEKP (phr)	Cobalt6% (phr)	DMA (phr)	TBC 10% (phr)
15 +/- 5 minutes	1.0	0.20	-	-
30 +/- 10 minutes	1.0	0.15	-	0.10
60 +/- 15 minutes	1.0	0.15	-	0.20

Gel time at 40°C (104°F)	MEKP (phr)	Cobalt6% (phr)	DMA (phr)	TBC 10% (phr)
15 +/- 5 minutes	1.0	0.15	-	0.05
30 +/- 10 minutes	1.0	0.15	-	0.20
60 +/- 15 minutes	1.0	0.10	-	0.30

To avoid problems with water impacting resin cure, lamination work should only be carried out if the ambient temperature is at least 3°C above the dew point (relative humidity <80%). Hot humid summer conditions may require an adjustment of the above curing formulations (e.g. higher cobalt levels, additional inhibitor, alternate peroxide). Please contact INEOS Composites Technical Service for specific recommendations.

BPO Cure System

Typical geltimes(2) using 50% active Benzoyl Peroxide (BPO paste) and DEA(7). Note: Water based BPO pastes should not be used.

Gel time at 16°C (60°F)	BPO-50 (phr)	DEA (phr)
15 +/- 5 minutes	4.0	0.2
30 +/- 10 minutes	2.0	0.2
60 +/- 15 minutes	2.0	0.1

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Gel time at 24°C (75°F)	BPO-50 (phr)	DEA (phr)
15 +/- 5 minutes	3.0	0.16
30 +/- 10 minutes	2.0	0.12
60 +/- 15 minutes	2.0	0.05

Gel time at 32°C (90°F)	BPO-50 (phr)	DEA (phr)
15 +/- 5 minutes	2.0	0.10
30 +/- 10 minutes	2.0	0.07
60 +/- 15 minutes	2.0	0.035

(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 United Initiators.
(4) Norox (ME)KP-925H; (ME) used only in NA name, but not elsewhere. MEKP or equivalent low hydrogen peroxide content MEKP. Use of other MEKP catalysts or additives may result in different gel times.
(5) Use of cobalt octoate, especially in combination with 2,4-P can result in 20-30% slower gel times.
(6) phr = parts per hundred resin molding compound
(7) For pre-acceleration for prolonged storage (e.g. formulation of lining or flooring systems) consider DEAA in place of DMA or DEA. For further information, please contact INEOS Composites.

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TYPICAL MECHANICAL PROPERTIES

Typical properties(1) of a cured casting at 25°C (77°F).

Property of casting	Value (SI)	Method	Value (US)	Method
Tensile Strength	86 MPa	ISO 527	13,000 psi	ASTM D638
Tensile Modulus	3.1 GPa	ISO 527	450 ksi	ASTM D638
Tensile Elongation	5-6%	ISO 527	5-6%	ASTM D638
Flexural Strength	150 MPa	ISO 178	21,000 psi	ASTM D790
Flexural Modulus	3.4 GPa	ISO 178	500 ksi	ASTM D790
Density	1.13	ISO 1183	1.13	ASTM D792
Volume Shrinkage	8%			
Heat Distortion Temperature(8)	105°C	ISO 75	220°F	ASTM D648
Barcol Hardness	30	EN 59	30	ASTM D2583

(8) Maximum stress: 1.8 MPa (264 psi)

Typical properties(1) of a postcured 6 mm (1/4") laminate(9) at 25°C (77°F).

Property of laminate	Value (SI)	Method	Value (US)	Method
Tensile Strength	178 MPa	ISO 527	25,800 psi	ASTM D638
Tensile Modulus	10,700 MPa	ISO 527	1580 kpsi	ASTM D638
Flexural Strength	225 MPa	ISO 178	32,700 psi	ASTM D790
Flexural Modulus	8050 MPa	ISO 178	1170 kpsi	ASTM D790
Glass Content	38.6%	ISO 1172	38.6%	ASTM D2584

(9) 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).

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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 .
STANDARD PACKAGE	208 Liter (55 Gallon) Non-Returnable Drum Net Wt. 205 Kgs (452 Lbs.) DOT Label Required: Flammable Liquid
STORAGE	This resin contains ingredients which could be harmful if mishandled. Contact with skin and eyes should be avoided and necessary protective equipment and clothing should be worn. Drums - It is highly recommended that all material is stored at stable temperatures between 15° - 25°C (60° - 77°F). Avoid exposure to heat sources such as direct sunlight or steam pipes. To avoid contamination of product with water, do not store outdoors. Keep sealed to prevent moisture pick-up and monomer loss. 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 things being equal, higher storage temperature will reduce product stability.
COMMERCIAL WARRANTY	Eighteen 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.

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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.

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