Technical Datasheet

INEOS Composites

HETRON™ FR 992 FR / CR Epoxy Vinyl Ester Resin

HETRON FR992 resin is a low viscosity, unpromoted, flame retardant(1) patented epoxy vinyl ester with F-Cat technology. This patented technology results in a resin that exhibits no foaming, excellent exotherm control, and industry-leading storage stability. Laminates made with HETRON FR992 resin have achieved a flame spread of <25 (ASTM E-84) when 3% antimony trioxide is added and a flame spread of <75 without antimony trioxide. HETRON FR992 resin gives final products with:

- Excellent flame retardancy
- High strength characteristics
- Excellent impact strength and toughness
- Fast wet-out and low drainage
- Excellent corrosion resistance to acidic and alkaline environments

APPLICATIONS AND USE

HETRON FR992 resin can be used for corrosion resistant, reinforced thermosetting plastic equipment including filament wound, hand lay-up and spray-up tanks, pipes, ducts, stacks, scrubbers, linings or other equipment handling corrosive gases, vapors or liquids where a high degree of flame retardancy is required.

HETRON 922 resin is a non-flame retardant epoxy vinyl ester. HETRON FR992Sb resin can be used to achieve <25 flame spread without adding additional antimony. HETRON FR998/35 resin can be used to fabricate laminates with improved corrosion resistance. Conditions for these resins are outlined in INEOS Composites's Resin Selection Guide at www.hetron.com. For recommendations on specific services and environments, please contact us at hetron@ineos.com.

TYPICAL LIQUID RESIN PROPERTIES

Property(2) at 25°C (77°F)	Value	Unit
Viscosity, Brookfield # 2 spindle @ 30 rpm	425	mPas (cps)
Percent Solids	57.5	%
Color	<5	Gardner
Specific Gravity	1.16	gm/cc

(1) HETRON vinyl ester resin will burn if provided with a sufficient amount of heat and oxygen. The degree of flame retardancy of the cured vinyl ester resin is characterized by the ASTM E-84 tunnel

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test. This test is performed under strictly controlled conditions where a flame spread rating is assigned according to comparisons with test set-point materials. The behavior of the cured composite under these controlled conditions can vary from an actual fire situation.
(2) Properties are typical values based on material tested in our laboratories. Typical values should not be construed as a guaranteed analysis of any specific lot or as specification items.

TYPICAL CURING CHARACTERISTICS

SPI Gel Time at 82°C (180°F) Bath	Value	Unit
Gel Time, 2% Luperco(2) ATC Paste	17	minutes
Total Time	23	minutes
Peak Exotherm	193 (380)	°C(°F)

MEKP Cure System

Typical geltimes at different temperatures using different pre-acceleration systems and curing with Delta(3) X-9, Lupersol(3) DDM-9 and Hi-Point(4) 90 catalysts(5).

CAUTION: Thoroughly mix promoters with resin before adding catalyst.

Temperature / MEKP Catalyst (phr)	DMA (phr)	Co-nap6% (phr)	Delta X-9 (minutes)	DDM-9 (minutes)	HiPoint 90 (minutes)	HiPoint 90/CHP 50/50 (minutes)
18°C (65°F) / 1.25	0.1	0.2	15	27	25	60
	0.075	0.2	20	30	30	70
	0.05	0.2	25	40	33	75
25°C (77°F) / 1.25	0.04	0.3	10	12	13	27
	0.04	0.2	15	20	20	40
	0.04	0.1	30	40	36	74

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29°C (85°F) / 1.25	0.05	0.3	8	8	8	18
	0.05	0.2	10	12	12	24
	0.05	0.1	20	25	24	50

BPO / DMA Cure System

Temperature / BPO Paste 50% (phr)	DMA (phr)	Gel Time (minutes)
18°C (65°F) / 2.0	0.3	26
	0.2	36
	0.1	70
24°C (75°F) / 2.0	0.3	16
	0.2	24
	0.1	50
29°C (85°F) / 2.0	0.3	11
	0.2	16
	0.1	27

(3) Registered trademark of Atofina Chemicals Inc.
(4) Registered trademark of Witco Chemical Corporation.
(5) All levels are based on parts per hundred resin (phr)

Effect of Copper Naphthenate

Copper Naphthenate(6) (Cu-nap8%) will influence gel time, gel-to-peak and peak exotherm at different temperatures and pre-accelerations. Catalyst used is Delta X-9 at 1.25 phr.

CAUTION: Thoroughly mix promoters with resin before adding catalyst.

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Temperature / Cu-nap8% (phr)	Co-nap6% (phr)	DMA (phr)	Gel Time (minutes)	Gel-Peak (minutes)	Peak Exo
18°C (65°F) / 0	0.3	0.05	11	10	166°C (330°F)
18°C (65°F) / 0.04	0.3	0.05	11	15	116°C (240°F)
25°C (77°F) / 0	0.1	0.04	26	12	168°C (335°F)
25°C (77°F) / 0.04	0.1	0.04	22	17	129°C (265°F)
29°C (85°F) / 0	0.1	0.03	19	12	168°C (335°F)
29°C (85°F) / 0.04	0.1	0.03	20	20	127°C (260°F)
35°C (95°F) / 0	0.1	0.02	19	12	166°C (330°F)
35°C (95°F) / 0.04	0.1	0.02	20	26	121°C (250°F)

Exotherm control formulations - When laminates require a lower exotherm, copper(7) may be incorporated to achieve the desired reduction. High hydrogen peroxide catalysts, such as CADOX(8) M-50 or DELTA X-9, should be used to avoid dramatic moves in gel times.

(6) Can be acquired by Akcros Chemical, Inc., Huls America Inc., or O.M. Group Inc.
(7) More than 500 ppm of 8% copper naphthenate may be detrimental to cure
(8) Registered trademark of Akzo Nobel

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Effects of Copper Levels at 25°C (77°F)

Copper Naphthenate (Cu-nap8%) will influence Gel Time, Gel-to-Peak and Peak Exotherm at 25°C (77°F). Catalyst used is Delta X-9 at 1.25 phr.

CAUTION: Thoroughly mix promoters with resin before adding catalyst.

Cu-naphthenate 8% (phr)	DMA (phr)	Co-nap6% (phr)	Gel Time (minutes)	Gel-Peak (minutes)	Peak Exo
0	0.04	0.1	23	10	171°C (340°F)
0.01	0.04	0.1	20	10	160°C (320°F)
0.02	0.04	0.1	20	14	154°C (310°F)
0.03	0.04	0.1	21	16	143°C (290°F)
0.04	0.04	0.1	21	16	132°C (270°F)

For all surfaces that will be exposed to air during fabrication (top-coating, lining, patching, exterior surfaces, etc.) the addition of 0.4% paraffin wax to the final resin layer is recommended. A waxed surface may interfere with secondary bonding adhesion.

Flame retardant vinyl ester resins do not demonstrate ultraviolet stability equivalent to non-halogenated vinyl ester resins. Ultraviolet stability may be improved by adding 1.0% CYASORB[9] UV-9 ultraviolet screener to the exterior exposed surfaces where aesthetic appearance is desired.

TYPICAL MECHANICAL PROPERTIES

Property[2] of cured casting[10] at 25°C (77°F)	Value (SI)	Value (US)	Method
Barcol Hardness	35	35	ASTM D2583
Tensile Strength	90 MPa	13,000 psi	ASTM D638

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Tensile Modulus	3450 MPa	5.0 psi x 10^5	ASTM D638
Tensile Elongation at yield	4.6%	4.6%	ASTM D638
Tensile Elongation at break	5.0%	5.0%	ASTM D638
Flexural Strength	145 MPa	21,000 psi	ASTM D790
Flexural Modulus	3585 MPa	5.2 psi x 10^5	ASTM D790
Heat Distortion Temperature	108°C	227°F	ASTM D648

(9) Registered trademark of Cytec Industries
(10) Catalyzed with 1.0% BPO, cured two hours at 71°C (160°F), then one hour at 93°C (200°F), post-cured two hours at 138°C (280°F).

Physical properties of laminates at various thicknesses and temperatures. Curing formulation = 100 phr HETRON FR992, 0.30 phr 6% cobalt naphthenate, 0.05 phr DMA, 1.50 phr HI POINT 90, post cured 2 hours at 121°C (250°F). V=10 mil glass surfacing veil, M=450 g/m^2 (1.5 oz/ft^2) chopped strand mat, WR=800 g/m^2 (24 oz/yd^2) woven roving

Laminate thickness (mm)	Temperature (°C)	Tensile Strength (MPa)	Tensile Modulus (MPa)	Flex Strength (MPa)	Flex Modulus (MPa)
3.18 (V, 2M; 25% glass)	25	140	5590	88	7720
	93	140	4960	91	6960
	121	106	2760	52	3450
6.35 (V, 2M, 2(WR); 39% glass)	25	240	8340	137	12,760
	93	223	7170	165	9790
	121	86	4140	130	9030
12.7 (V, 4M, 4(WR); 43% glass)	25	181	7450	160	13,240

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	93	218	8340	150	15,580
	121	159	6760	131	6760

Laminate Thickness (in.)	Temperature (°F)	Tensile Strength (psi)	Tensile Modulus (psi x 10^5)	Flex Strength (psi)	Flex Modulus (psi x 10^5)
0.125 (V, 2M; 25% glass)	77	19.800	8.1	12,800	11.2
	200	20,200	7.2	13,200	10.1
	250	15,400	4.0	7500	5.0
0.25 (V, 2M, 2(WR); 39% glass)	77	35,000	12.1	19,900	18.5
	200	32,400	10.4	23,900	14.2
	250	12,500	6.0	18,900	13.1
0.50 (V, 4M, 4(WR); 43% glass)	77	26,200	10.8	23,200	19.2
	200	31,600	12.1	21,400	22.6
	250	23,100	9.8	19,000	9.8

TYPICAL FLAME RETARDANCY OF LAMINATES

Tested Material	Class	ASTM E-84 Flame Spread
HETRON FR992 resin laminate(11) with 3% antimony trioxide	I	<25
HETRON FR992 resin laminate(11) without antimony trioxide	II	<75
Cement Asbestos Board (control)	I	0
Red Oak (control)	III	100

(11) Properties are typical values based on material tested in our laboratories. Typical values should not be construed as a guaranteed analysis of any specific lot or as specification items. Laminate

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thickness = 3.18 mm (0.125 in.) with approximately 27% glass content

Master Batch Guide

Cobalt Naphthenate 6% Quantity for:	55-Gal (230 kg, 507 lbs)	5-Gal (21 kg, 46 lbs)
0.2%	15.1 fl.oz/449 cc	1.3 fl.oz/39 cc
0.3%	22.8 fl.oz/673 cc	2.0 fl.oz/59 cc
0.4%	31.3 fl.oz/926 cc	2.7 fl.oz/78 cc

DMA Quantity for:	55-Gal (230 kg, 507 lbs)	5-Gal (21 kg, 46 lbs)
0.05%	4.0 fl.oz/119 cc	0.36 fl.oz/10 cc
0.10%	8.1 fl.oz/239 cc	0.73 fl.oz/21 cc
0.15%	12.1 fl.oz/358 cc	1.10 fl.oz/32 cc

Copper Naphthenate 8% Quantity for:	55-Gal (230 kg, 507 lbs)	5-Gal (21 kg, 46 lbs)
0.02%	1.1 fl.oz/34 cc	0.10 fl.oz/3 cc
0.03%	2.2 fl.oz/66 cc	0.19 fl.oz/6 cc
0.04%	3.4 fl.oz/100 cc	0.27 fl.oz/8 cc

9% MEKP Quantity for:	0.95 liter (1 quart)	2 kg (5 lbs)
1.25%	0.39 fl.oz/11.5 cc	0.90 fl.oz/26.6 cc

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 230 Kgs (507 Lbs)
DOT Label Requirement: Flammable Liquid

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COMMERCIAL WARRANTY	Six months from date of shipment, 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 temperatures 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.