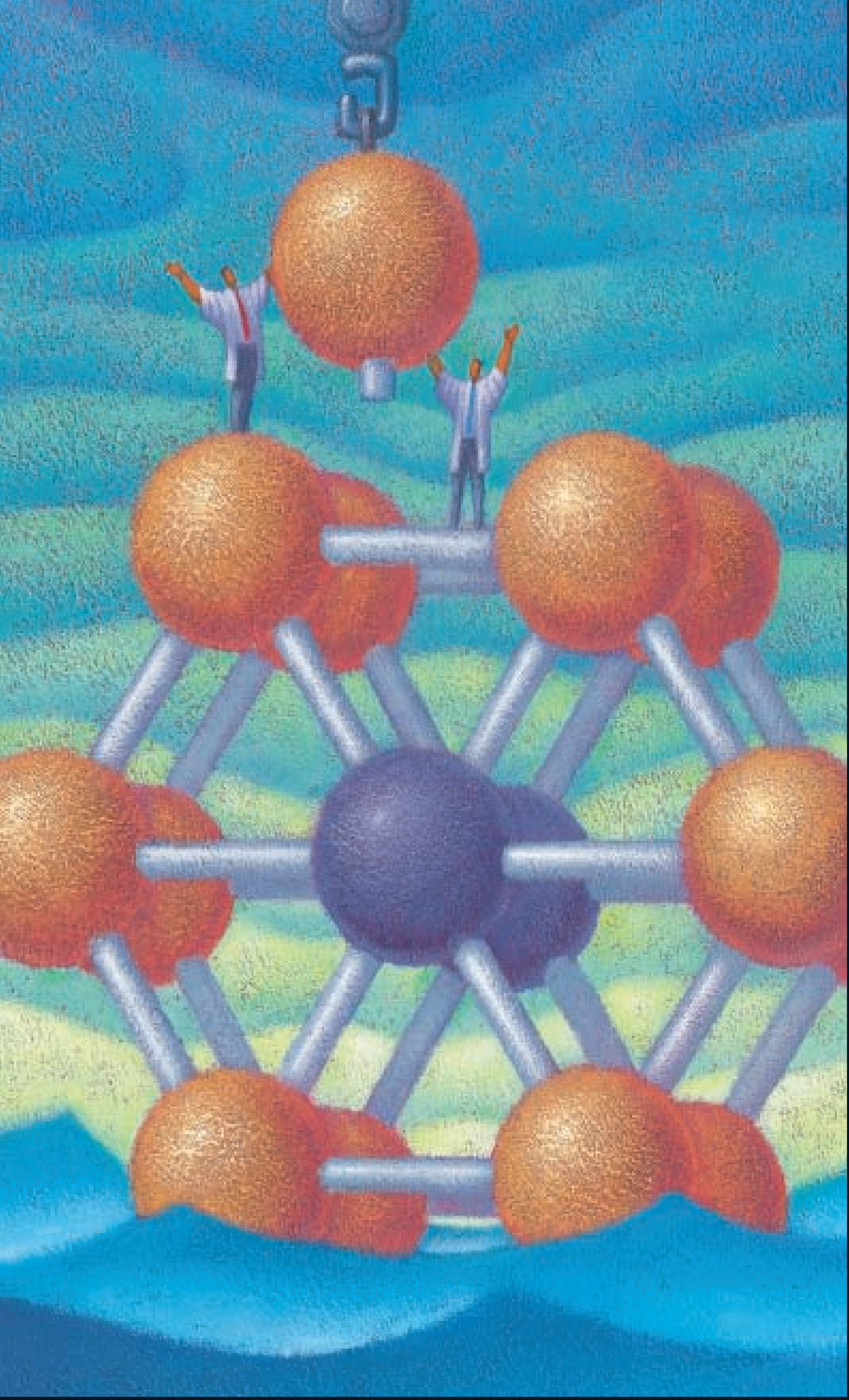

CoREZYN® Vinyl Ester Resins

Epoxy-based, thermoset resins developed by Interplastic Corporation for FRP manufacturing.

INTERPLASTIC CORPORATION
Thermoset Resins Division

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Appendix

CoREZYN vinyl esters eliminate blistering common in pools and spas.

Introduction

Interplastic Corporation is the high-performance corrosion resistant resin specialist you can count on. For years, we've assisted reinforced plastics composites manufacturers and the industries that use reinforced plastics build better, stronger, tougher, and longer-lasting products.

In 1959, we introduced a line of isophthalic and orthophthalic polyester resins with outstanding laminating, casting and molding capabilities.

At about the same time, we developed a line of top-performing gel coats for a wide variety of applications. Today, Interplastic gel coats give you extremely durable finishes for a brilliant surface in whatever color you choose.

In 1976, we announced our line of epoxy-based vinyl ester resins that have set the standard for the industry. In extremely challenging environments that require superior physical performance and corrosion resistance, Interplastic's CoREZYN vinyl esters consistently outperform the competition.

CoREZYN vinyl ester resins (designated "VE") are a family of liquid thermosetting resins developed for the production of fiber-reinforced plastics. They are an ideal choice for severe applications, particularly in highly corrosive environments. The vinyl ester products exhibit similar strength characteristics to epoxy, but they are less expensive and much easier to handle. There is a wide variety of resins available within our vinyl ester family to meet a broad range of design and engineering needs, and all of them possess corrosion resistance and exceptional physical properties. This toughness and durability, compared to traditional polyester resins, is clearly demonstrated by the flexural cycle testing shown in Table 1 (page 2).

The high strength-to-weight ratio and superior fatigue resistance of vinyl ester-based composites make these resins an excellent choice for automotive, military, aerospace and other applications where these characteristics are critical.

Fiberglass pipe, tanks, scrubbers, and structural shapes using CoREZYN vinyl esters have delivered years of trouble-free service in the chemical processing, mining, oil and gas, pulp and paper, and pollution control industries.

Resistance to water permeation and abrasion, combined with light weight and good flexural strength, make these products outstanding for marine applications such as boat hulls, swimming pools and spa composites. Whether gel-coated or acrylic-faced, vinyl esters vastly improve the blister resistance of spas and pools.

For applications where the maximum corrosion resistance of a vinyl ester resin may not be essential, a group of Interplastic products called *modified vinyl esters* (designated "MVR") offers a lower-cost alternative. These resins are chemical modifications of the corresponding straight vinyl esters, developed to achieve specific, though slightly more limited properties, with improved economy.

Our industry is complex and dynamic and our chemists are committed to a continuing program of applications research and product development. Consequently, some new products and custom formulations may not be covered in the brochure.

For additional information or technical assistance regarding your specific resin needs, contact your qualified CoREZYN representative or contact us at:

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Thermoset Resins Division
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St. Paul, MN 55110-5145

Telephone: (651) 481-6860
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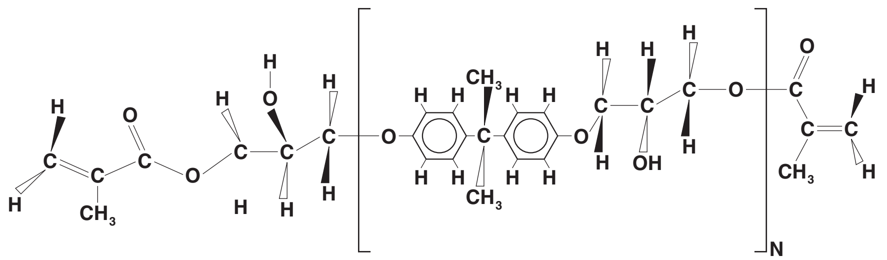


The CoREZYN VE8300 bisphenol-A epichlorohydrin-based vinyl ester molecule.

Technical Data

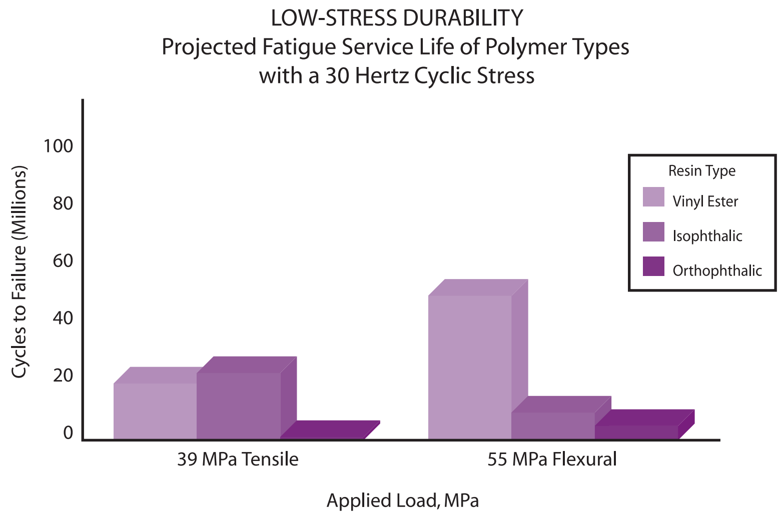
CoREZYN vinyl ester resins are epoxy-based, thermosetting resins that are cured by free radical initiation of polymerization, similar to the curing mechanism of conventional polyester resins. There are numerous types of reactants that comprise the vinyl esters so that each resin has its own unique properties. However, the chemistry can be typified by the most versatile of these resins, the CoREZYN VE8300. This vinyl ester is the reaction product of a bisphenol-A epoxy and methacrylic acid, as depicted in the molecule on page 1.

The terminal carbon-carbon double bonds are the reactive groups that enter into the free radical initiated polymerization or cure. In effect, this structure allows an epoxy to react like a polyester. This by itself is very important since epoxy reactions in general are very sluggish compared to the polyester free radical reactions. Another important feature of this structure is that it is styrene soluble, the styrene also enters into the free radical reactions. Since styrene solutions of vinyl ester resins are low in viscosity, this makes the resultant resin solution easily worked in the reinforced plastic (composite manufacturing) process. Epoxy resins, on the other hand, are high viscosity materials and require more difficult and expensive processing methods.

Compared to epoxies, the vinyl esters are fast and easy to handle, quick curing, and versatile. At the same time, they have been designed to retain most of the desirable properties of epoxy resins. Tensile strength, elongation, and fatigue resistance of VE8300, for example, are very close to the premium aromatic amine cured epoxies, and significantly greater than a typical polyester resin, as shown in Graphs 1 and 2 and Table 1. Their construction is shown in Table 1.

Even the adhesive characteristics of VE8300 are of the same order as the excellent adhesive properties well known for epoxies. This is demonstrated by the compatibility and bond strength of VE8300 to glass, graphite fibers, and to newer high strength organic fibers, such as KEVLAR®.

Graph 1



Graph 2

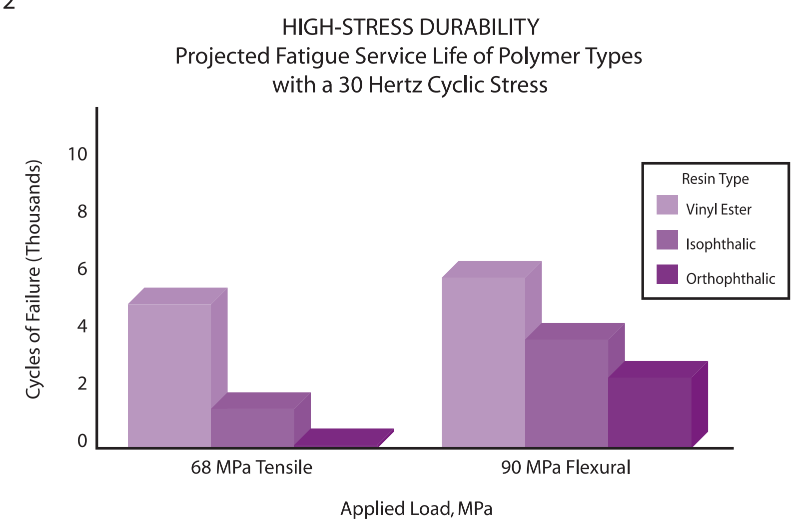


Table 1: Laminate Cycle Testing for Comparison by ASTM D671

Resin	Strength, psi/MPa for 1 cycle	Cycles at 8,500/58.6 psi/MPa	Cycles at 10,000/69.0 psi/MPa	Cycles at 11,500/79.3 psi/MPa	Cycles at 13,000/89.7 psi/MPa
VE8300	21,218/146	5,448,341	874,487	140,360	22,528
Orthophthalic laminating resin	14,436/100	2,517,450	60,738	1,465	35
Isophthalic laminating resin	16,117/111	1,744,815	102,939	6,083	358

1. Laminates were constructed of 3 plies of 24-ounce woven roving, with 4 plies of alternating 3/4 ounce fiberglass mat for a total of 25% glass. The laminates were hand laid at room temperature using 1% methyl ethyl ketone peroxide (MEKP) and post-cured.

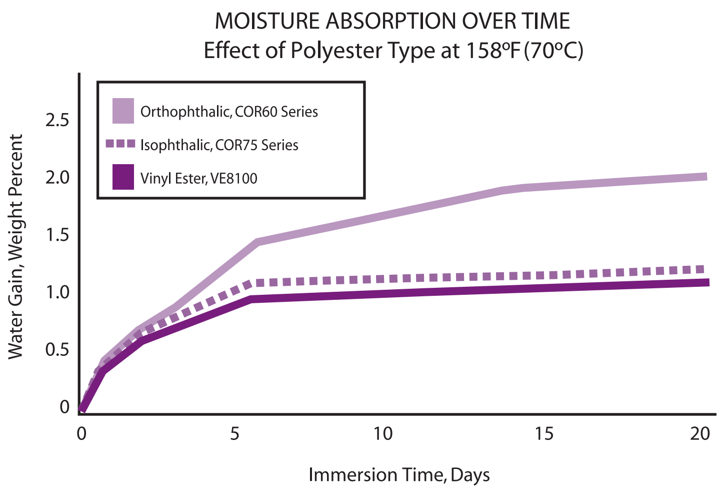
2. ASTM D671 "Flexural Fatigue of Plastics by Constant Amplitude of Force."

The chemical resistance of VE8300 represents the best of two worlds: the excellent alkali resistance of the epoxy and the acid and oxidizing chemical resistance of the polyester. The alkali resistance is retained since there are relatively few ester linkages, only terminal groups. These terminal ester groups are made hydrolytically stable by the hindrance afforded by the methyl group of the methacrylic acid. Graphs 3 and 4—showing the results of water immersion tests on a variety of resins, including vinyl ester—dramatically demonstrate this characteristic.

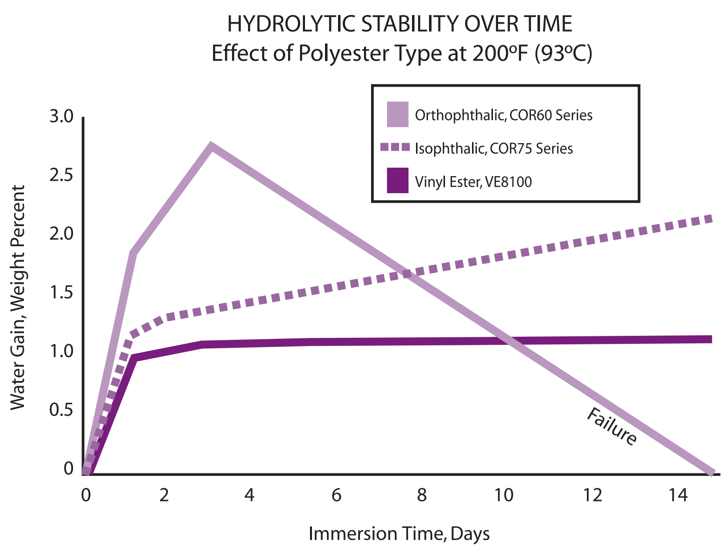
In addition, the copolymerized styrene offers steric hindrance protection to acid and oxidizing chemical attack on the ester groups. Further enhancing the overall chemical resistance of the vinyl ester, the reactive double bond sites are present only as terminal groups that react during cure. This leaves minimal residual reactive sites that would be subject to attack by corrosive chemicals in service. By contrast, conventional polyester resins have reactive double bond sites and ester linkages throughout the molecular structure. The resulting widespread structural vulnerability greatly reduces corrosion resistance compared to the premium-performing vinyl ester products.

The VE8730 Novolac epoxy-based vinyl esters comprise our premier offerings. They are specified for corrosion resistant equipment requiring exposure to mixtures of chemicals, temperature and load cycling, solvent exposure, and oxidation resistance. VE8730 resins are more capable than bisphenol-A epichlorohydrin vinyl esters in chlor-alkalai exposure, or in paper processing. Therefore they are widely used in tanks, washer covers, pipes, valves, ducting, etc., in the paper processing industry.

Graph 3



Graph 4



Vinyl Ester Products

Interplastic Corporation manufactures more than 100 separate CoREZYN vinyl ester resins that fall into several different functional groups. The number coding system for these products is simple—products ending in "0" are non-promoted resins; those ending in "1" are pre-promoted.

VE8300

Premium, High Performance

This is the most versatile and widely used vinyl ester resin. It shows excellent resistance to acids, alkalies, and oxidizing chemicals, and has outstanding toughness and fatigue properties. VE8300 also demonstrates excellent adhesive properties, which make for reliable secondary bonding operations.

It is well-suited for use in fabricating tanks, pipe and process equipment, filament winding, hand lay-up and spray lay-up, BMC match-metal-die molding, pultrusion, tank linings and coatings where premium corrosion resistance is required.

When cured properly, VE8300 can be fabricated into thick sections without cracking, crazing, or excess warping.

This resin has a viscosity of 500 cps and contains 45% styrene. If a different viscosity is desired, other formulations are available at different styrene levels, all of which have essentially similar properties.

FDA/USDA-Approvable

This non-promoted resin is manufactured from materials listed in Title 21 of *The Code of Federal Regulations* and is suitable for use as described therein.

Related Products:

VE8300-35

35% styrene with 2500 cps viscosity.

VE8300-40

40% styrene with 1200 cps viscosity.

VE8300-50

50% styrene with 275 cps viscosity.

VE8301

A pre-promoted version of VE8300 for field applications where it is undesirable to add promoters. Gel time of 15-20 minutes.

VE8301S

Gel time of 25-30 minutes.

VE8100

Lower Viscosity

This resin is a lower molecular weight version of VE8300. It has lower intrinsic viscosity, making it ideal for centrifugal casting and resin transfer molding. It contains 50% styrene and has a nominal viscosity of 100 cps. When cured, VE8100 exhibits physical properties similar to VE8300.

FDA/USDA-Approvable Laminates

This non-promoted resin is manufactured from materials listed in *The Code of Federal Regulations*, Title 21, and is suitable for use as described therein.

Related Products:

VE8101

The pre-promoted version of VE8100. Gel time of 15-20 minutes.

VE8100-45

A version of VE8100 modified specifically for Resin Transfer Molding (RTM). This resin is characterized by low foaming after catalyst addition, fast gel and cure and high physical strength. It contains 45% styrene with 250 cps viscosity.

VE8101-45

The pre-promoted version of VE8100-45. Gel time of 15-20 minutes.

VE8100-35

35% styrene with 1500 cps viscosity.

VE8360

Low Styrene Vinyl Esters

A low styrene-content analog of VE8300. A bisphenol-A epichlorohydrin vinyl ester with 500 cps at 34% or less monomer. The corrosion resistance and physical properties of this VE8360-34 are similar to the VE8300.

Related Products:

VE8361

A pre-promoted version of VE 8360. Gel time of 15-20 minutes.

VE8180

Pultrusion Vinyl Ester

1,000-1,500 cps viscosity for faster line speeds.

Related Products:

VE8182

a lower viscosity verion of VE8180 at 400-600cps.

In the world's most intense applications, CoREZYN vinyl esters are top performers.

VE8110
Thixotropic

This extremely tough thixotropic vinyl ester is specially formulated for spray-up and hand lay-up requirements. It is easily worked and will minimize drain-off, making it ideal for large vertical applications like boat hulls, windmill blades and swimming pool walls. A non-promoted resin with 625 cps viscosity.

Related Products:

VE8112
Non-promoted, lower viscosity, shorter gel time version of VE8110.

VE8115
The pre-promoted version of VE8110 with 475 cps viscosity and a gel time of 12-15 minutes.

VE8117
Similar properties and viscosity to VE8115 with a 15-20 minute gel time.

VE8119
Similar properties and viscosity to VE8115. Gel time of 20-25 minutes.

VE8121
Similar to VE8115 with gel time of 25-30 minutes. Viscosity 600 cps.

VE8123
Similar to VE8115; gel time of 32-37 minutes. Viscosity 600 cps.

VE8150
Thixotropic, High Heat Distortion

The VE8150 laminating series is intended for mold and tool making applications, as well as for composites where a higher heat distortion point (270° F/132° C) and high modulus are required.

Related Products:

VE8151
The pre-promoted version of VE8150. Similar physical properties to above with a viscosity of 650 cps and gel time of 15-20 minutes.

VE8153
Similar to VE8151 and gel time of 20-25 minutes.

VE8156
Similar to VE8151 and gel time of 27-32 minutes.

VE8121LH
Thixotropic, Low HAP

A promoted, thixotropic resin with excellent physical properties along with fast hardness development for the spray-up and hand lay-up applications of the boat and pool manufacturing industries. The VE8121LH series contain a maximum of 35% styrene (HAP) by weight, which meets the EPA 40 CFR Part 63 requirements of the National Emission Standards for Hazardous Air Pollutants (HAP) for boat manufacturing. They also meet the current VOC requirements of California SCAQMD Rule 1162 for "High Strength Resin."

Related Products:

VE8121LH-15
Viscosity of 475-675 cps and gel time of 15-20 minutes.

VE8121LH-20
Similar properties to VE8121LH-15 with a gel time of 20-30 minutes.

VE8121LH-30
Similar properties to VE8121LH-20 with a gel time of 30-40 minutes.

VE8121LH-40
Similar properties to VE8121LH-30 with a gel time of 40-50 minutes.

VE8440
Fire Resistant

These are fire resistant, brominated counterparts of VE8300. When mixed with 1.5% antimony trioxide,* the flame spread rating of the VE8440 is less than 25 (ASTM E84 Tunnel Test). At the same time, VE8440 retains excellent physical properties and corrosion resistance.

** Please review the information in the appendix concerning gel time and cure effects of using Antimony Trioxide (page 36).*

Related Products:

VE8441
The pre-promoted version of VE8440. Gel time of 15-20 minutes.

VE8441M-AT
Promoted, fire resistant resin with antimony trioxide for low flame spread. It has a flame spread of <25 (Class 1) without additives according to the ASTM E84 Tunnel Test.

VE8430
Fire Resistant

This fire resistant vinyl ester resin is designed to be used in combination with alumina trihydrate. In the flaming mode, a smoke density of 82 was achieved in 90 seconds with a mixture 45% ATH and 55% resin in a laminate with 30% fiberglass reinforcement when tested according to ASTM E-662.

Table 2: Thixotrope

Vinyl ester resins can be made thixotropic with the addition of several chemicals. Listed below are some of the chemicals and typical levels.

Chemical	Manufacturer	Typical Levels
R-202	Degussa	0.25 – 3.0
TS-720	Cabot	0.25 – 3.0
BYK R-605[1]	BYK-Chemie	0.10 – 1.5

1. To be used in combination with hydrophilic fumed silicas like Degussa's R-200, Cabot's PTG, and Wacker's HDK at levels of 0.25 to 3.0. Corrosion and water resistance are poorer.

Thixotropic additives can degrade the corrosion resistance of the cured resin in many media. Consult with Interplastic Corporation's laboratory for corrosion recommendations before using thixotropic resins. A useful reference is the Thermoset Resins Division's "Evaluation of Thixotropic Vinyl Ester Resins According to ASTM C-581 for Use in Corrosive Environments."

VE8515
Resilient

This is an extremely tough and flexible resin having 15% elongation. A non-rubber modified resin, developed to minimize cracking or crazing caused by thermal or mechanical shock or physical abuse in liner applications. VE8515 retains good chemical resistance and is 100% compatible with other CoREZYN vinyl esters. It is also well-suited for use in coatings, tank linings, primers and adhesives.

Related Products:

VE8517
The pre-promoted version of VE8515. Gel time of 15-20 minutes.

VE8510
A version of VE8515 having 10% elongation.

VE8511
The pre-promoted version of VE8510. Gel time of 15-20 minutes.

VE8550
Resilient

Rubber-modified vinyl ester for high impact and flexibility. Tensile elongation at 7.5%.

Related Product:

VE8551
Pre-promoted version of VE 8550 with a gel time of 15-20 minutes.

VE8710
Superior Acid-Base Resistant, High Heat Capability

This resin features a higher crosslink density than VE8300, which produces a higher heat distortion point, along with exceptional chemical resistance—particularly caustic and solvent resistance—and hydrolytic stability.

Related Product:

VE8711
The promoted version of VE8710. Gel time of 15-20 minutes.

VE8730
Novolac Vinyl Ester

Novolac epoxy-based vinyl esters afford excellent corrosion resistance, high structural properties, and excellent laminate capabilities at ambient and high temperatures. These resins comprise our premier offerings in infrastructure building and repair, as well as corrosion resistance.

CoREZYN Novolac vinyl esters are specified for corrosion resistant equipment requiring exposure and oxidation resistance. The CoREZYN VE8730 Novolac resins are very capable vinyl esters in chlor-alkalai exposure or in paper processing chlorination processes, resulting in wide use in tanks, washer covers, pipes, valves, ducting, etc., for the paper processing industry. They offer good resistance to alcohols and other solvents for chemical storage and handling equipment. This wide range of capabilities makes this resin a versatile product in corrosion resistant applications.

Related Products:

VE8730-34
A Novolac epoxy-based vinyl ester. Heat distortion of 270°F/132°C with high solvent resistance. Less than 35% styrene monomer and a viscosity of 500 cps.

VE8730-36
A non-promoted Novolac vinyl ester with 36% styrene monomer and a viscosity of 250 cps.

VE8730-45
Lower viscosity version of VE8730-34 with 45% styrene and a viscosity of 125 cps.

VE8731-34
Promoted version of VE8730-34. Gel time of 15-20 minutes using one of the approved MEKP's.

VE8731-36
Promoted version of VE8730-36. Gel time of 15-20 minutes using one of the approved MEKP's.

VE8770
Superior Solvent Resistance, High Heat Capability

Our highest heat distortion point (300°F/149°C) vinyl ester with outstanding retention of physicals in high heat exposure.

CoREZYN VE8770 is an excellent choice in solvent exposure and in construction of high heat exposure corrosion resistant laminates. Used for UL 1316 "All Fuels" applications.

The liquid resin, clear casting, and laminate properties of CoREZYN vinyl ester resins are detailed in Tables 3, 4 and 5.

Related Product:

VE8771
The pre-promoted version of VE8770. Gel time of 15-20 minutes.

Vinyl Ester Products, continued

Table 3: Typical VE Liquid Properties

Property	VE 8100	VE 8300	VE 8360	VE 8440	VE 8450	VE 8510	VE 8515	VE 8550	VE 8710	VE 8730	VE 8770
% Non-Volatile	50	55	63	60	60	60	66	60	55	63	60
Brookfield Viscosity cps at 77°F/25°C #3 spindle at 60 rpm	100	500	500	500	325	500	400	500	500	350	500
Density in gm/ml	1.02	1.03	1.06	1.17	1.13	1.03	1.04	1.05	1.03	1.03	1.03
Flash Point Setaflash °F/°C	86/30	86/30	86/30	86/30	86/30	86/30	86/30	86/30	100/38	86/30	100/38
Reactivity: Gel Time at 77°F/25°C (min.)*	18	18	18	18	18	18	18	18	18	18***	18
Reactivity: SPI Gel Time at 180°F/82°C (min.)**	13	13	11	10	8	11	10	10	13	13	13

* *Test Method Only: 1.2 phr (50%) MEKP / 0.20% (12%) Cobalt / 0.50% Dimethylaniline unless otherwise noted.*
** *Test Method Only: 1.0 phr BPO.*
*** *Test Method Only: 1.2 phr (50%) MEKP / 0.15% (12%) Cobalt.*

Table 4: Typical Clear Casting Properties

Property	VE 8100	VE 8300	VE 8360	VE 8440	VE 8450	VE 8510	VE 8515	VE 8550	VE 8710	VE 8730	VE 8770
Tensile Strength, psi/MPa	11,800/81.4	11,600/80	12,600/86.9	12,750/87.9	11,700/80.7	9,500/65.5	8,000/55.2	11,100/75.9	11,000/75.9	11,000/75.9	7,100/49.0
Tensile Modulus, psi/GPa	530,000/3.66	470,000/3.24	500,000/3.45	470,000/3.24	480,000/3.31	440,000/3.03	380,000/2.62	470,000/3.24	500,000/3.45	500,000/3.45	480,000/3.31
Tensile Elongation, %	4.5	5.0	4.1	2.5	4.0	10.0	15.0	7.0	2.0	2.5	1.5
Flexural Strength, psi/MPa	21,200/146	19,400/134	20,500/141	19,500/134	20,600/142	15,000/103	14,000/96.6	17,800/123	18,100/125	18,000/124	11,900/82.1
Flexural Modulus, psi/GPa	520,000/3.59	450,000/3.10	500,000/3.45	470,000/3.24	510,000/3.52	390,000/2.69	380,000/2.62	447,000/3.08	480,000/3.31	480,000/3.31	470,000/3.24
Heat Distortion Temp., °F/°C	220/104	210/99	240/115	225/106	230/109	175/80	140/60	189/87	220/104	270/132	300/149
Barcol Hardness, 934-1	30–38	30–38	32-38	32–38	36-42	24–30	15–23	30–40	32–38	32–38	40–48
Specific Gravity	1.12	1.12	1.14	1.26	1.21	1.12	1.13	1.11	1.26	1.15	1.13
% Volumetric Shrinkage	7.9	7.8	7.0	7.0	7.0	7.7	7.6	6.5	8.6	9.2	9.4

Table 5: Typical Properties of Laminates*

Property (ASTM C-581 laminate)	VE 8100	VE 8300	VE 8360	VE 8440	VE 8450	VE 8510	VE 8515	VE 8550	VE 8710	VE 8730	VE 8770
Flexural Strength, psi/MPa	19,500/134	19,500/134	20,900/144	19,500/134	17,700/122	19,500/134	19,700/136	21,700/150	19,000/131	19,500/134	14,500/100
Flexural Modulus, psi/GPa	840,000/5.79	870,000/6.00	940,000/6.48	870,000/6.00	790,000/5.45	680,000/4.69	560,000/3.86	764,000/5.27	910,000/6.28	930,000/6.41	10,500,000/72.41
Tensile Strength, psi/MPa	13,700/94.5	13,800/95.2	14,820/102	13,800/95.2	14,500/100	14,200/97.9	14,200/97.9	15,000/103	16,200/112	11,800/81.4	11,200/77.2
Tensile Modulus, psi/GPa	1,000,000/6.90	980,000/6.76	1,340,000/9.24	980,000/6.76	1,190,000/8.21	890,000/6.14	820,000/5.66	1,020,000/7.03	1,020,000/7.03	1,070,000/7.38	1,090,000/7.52
Tensile Elongation, %	1.8	1.9	1.5	1.9	1.5	2.2	2.5	2.1	1.5	1.6	1.2

** Construction: V/M/M/V*
V = Synthetic Veil
M = 1.5 oz. Mat

Vinyl Ester Products, continued

Table 6: Physical Properties Retention at Various Temperatures

Property	°C	°F	VE 8100	VE 8300	VE 8360	VE 8440	VE 8450	VE 8510	VE 8515	VE 8550	VE 8710	VE 8730	VE 8770
Flexural Strength, psi/MPa	-29	-20	37,000/255	36,700/253	45,700/315	38,500/266	34,800/240	37,000/255	42,300/292	37,100/256	39,100/270	39,000/269	30,300/209
	25	77	32,000/221	33,700/232	46,800/323	36,100/249	31,900/220	32,100/221	31,700/219	35,600/246	35,700/246	29,800/206	29,000/200
	66	150	31,500/217	32,500/224	30,600/211	28,500/197	28,800/199	17,000/117	12,500/86.2	29,500/203	28,900/199	25,400/175	27,000/186
	93	200	29,000/200	28,300/195	28,700/198	27,900/192	25,700/177	5,500/37.9	3,200/22.1	17,200/119	27,200/188	25,100/173	25,600/177
	121	250	3,500/24.1	3,300/22.8	11,600/80.0	11,900/82.1	8,000/55.2	—	—	2,700/18.6	11,500/79.3	21,000/145	22,100/152
	149	300	—	—	—	4,600/31.7		—	—	—	5,000/34.5	14,900/103	17,000/117
	177	350	—	—	—	—		—	—	—	—	5,600/38.6	9,900/68.3
	204	400	—	—	—	—		—	—	—	—	4,700/32.4	6,800/46.9
Flexural Modulus, psi	-29	-20	1,220,000	1,210,000	1,320,000	1,260,000	1,110,000	1,3130,000	1,280,000	1,140,000	1,240,000	1,690,000	1,240,000
	25	77	1,170,000	1,110,000	1,370,000	1,190,000	1,270,000	1,260,000	1,110,000	1,120,000	1,180,000	1,130,000	1,180,000
	66	150	1,150,000	1,010,000	990,000	1,050,000	220,000	760,000	540,000	910,000	2,080,000	1,100,000	1,140,000
	93	200	960,000	930,000	900,000	1,010,000	920,000	—	—	600,000	990,000	1,060,000	1,010,000
	121	250	190,000	150,000	550,000	510,000	500,000	—	—	180,000	470,000	970,000	860,000
	149	300	—	—	—	270,000		—	—	—	290,000	610,000	710,000
	177	350	—	—	—	—		—	—	—	—	—	510,000
	204	400	—	—	—	—		—	—	—	—	—	460,000
Flexural Modulus GPa	-29	-20	8.41	8.34	9.10	8.69	7.66	9.03	8.83	7.86	8.55	11.6	8.55
	25	77	8.07	7.66	9.45	8.21	8.76	8.69	7.66	7.72	8.14	7.79	8.14
	66	150	7.93	6.97	6.83	7.24	1.52	5.24	3.72	6.28	14.34	7.59	7.86
	93	200	6.62	6.41	6.21	6.97	6.34	—	—	4.14	6.83	7.31	6.97
	121	250	1.31	1.03	3.79	3.52	3.45	—	—	1.24	3.24	6.69	5.93
	149	300	—	—	—	1.86	—	—	—	—	2.00	4.21	4.90
	177	350	—	—	—	—	—	—	—	—	—	—	3.52
	204	400	—	—	—	—	—	—	—	—	—	—	3.17
Tensile Strength, psi/MPa	-29	-20	26,800/185	27,700/191	26,100/180	22,000/152	27,800/192	25,000/172	22,400/154	24,600/170	21,900/151	22,800/157	23,700/163
	25	77	26,100/180	25,600/177	25,000/172	21,100/146	24,700/170	19,400/134	20,500/141	26,700/184	20,400/141	18,000/124	19,500/134
	66	150	23,500/162	23,900/165	21,200/146	19,900/137	24,000/166	19,000/131	19,200/132	27,400/189	20,100/139	17,300/119	19,300/133
	93	200	22,600/156	22,500/155	23,500/162	19,500/134	22,000/152	—	18,300/126	22,000/152	19,700/136	16,600/114	18,800/130
	121	250	13,000/89.7	12,700/87.6	20,300/140	18,500/128	18,300/126	—	—	15,300/106	16,800/116	15,800/109	17,900/123
	149	300	—	—	—	16,900/117		—	—	—	17,100/118	15,000/103	17,600/121
	177	350	—	—	—	—		—	—	—	—	14,100/97.2	17,100/118
	204	400	—	—	—	—		—	—	—	—	9,900/68.3	12,300/84.8
Tensile Modulus, psi	-29	-20	2,010,000	1,960,000	2,020,000	1,820,000	1,840,000	1,950,000	1,860,000	1,090,000	1,730,000	2,210,000	1,960,000
	25	77	1,750,000	1,510,000	1,790,000	1,590,000	1,620,000	1,560,000	1,490,000	1,050,000	1,480,000	1,750,000	1,840,000
	66	150	1,520,000	1,610,000	1,600,000	1,240,000	1,430,000	1,090,000	980,000	1,120,000	1,280,000	1,490,000	1,410,000
	93	200	1,330,000	1,530,000	1,410,000	1,160,000	1,220,000	—	—	880,000	1,190,000	1,310,000	1,360,000
	121	250	620,000	1,360,000	690,000	1,090,000	1,080,000	—	—	610,000	110,000	1,240,000	1,310,000
	149	300	—	590,000	—	990,000		—	—	—	950,000	990,000	1,180,000
	177	350	—	—	—	—		—	—	—	—	980,000	1,120,000
	204	400	—	—	—	—		—	—	—	—	820,000	1,090,000
Tensile Modulus, GPa	-29	-20	13.9	13.5	13.9	12.6	12.7	13.4	12.8	7.52	11.9	15.2	13.5
	25	77	12.1	10.4	12.3	11.0	11.2	10.8	10.3	7.24	10.2	12.1	12.7
	66	150	10.5	11.1	11.0	8.55	9.86	7.52	6.76	7.72	8.83	10.3	9.72
	93	200	9.17	10.6	9.72	8.00	8.41	—	—	6.07	8.21	9.03	9.38
	121	250	4.28	9.38	4.76	7.52	7.45	—	—	4.21	0.76	8.55	9.03
	149	300	—	4.07	—	6.83	—	—	—	—	6.55	6.83	8.14
	177	350	—	—	—	—	—	—	—	—	—	6.76	7.72
	204	400	—	—	—	—	—	—	—	—	—	5.66	7.52

Construction: V/M/M/WR/M/WR/M; 40% glass to 60% resin.

V = Synthetic Veil

M = 1.5 oz. Mat

WR = 24 oz. Woven Roving

Conversions: psi/145 = MPa; 1 GPa = 1000 MPa

VE8930 SMC/BMC

Vinyl Ester Resins

Highest Tg, temperature is used where outstanding retention of properties at elevated temperatures is required. It is chemically thickenable so it can be formulated into SMC and BMC with conventional thickeners.

Related Products:

VE8935-1

One-pack, low-profile, heat-resistant version of VE8930. This resin can be formulated to provide SMC or BMC with excellent dimensional control. It can be used in applications where retention of properties at elevated temperatures is required.

VE8920

A thickenable vinyl ester that can be formulated for BMC and SMC applications where heat resistance, resistance to hot oil and dimensional stability are needed.

VE8920-45

A thickenable vinyl ester that can be formulated into BMC and SMC applications where retention of properties after hot oil exposure and dimensional stability are needed.

VE8932

A high-strength, high heat-resitant vinyl ester with physical properties useful for structural applications. It has excellent retention of properties after heat aging.

VE8980

A high-strength, heat-resistant, Novolac vinyl ester with physical properties useful for exceptional corrosion resistant and high-temperature applications. It has excellent retention of properties after heat aging.

VE8990-30

A vinyl toluene thinned, heat-resistant vinyl ester that has exceptional retention of properties and very low weight loss after aging at elevated temperatures.

VE8100 RTM

RTM Vinyl Ester Resins

A low viscosity vinyl ester resin with excellent toughness and chemical resistance.

Related Products:

VE8101 RTM

A pre-promoted version of VE8100 RTM. Gel time of 15-20 minutes.

VE8300-50

A premium, high-performance vinyl ester resin with excellent toughness and fatigue properties.

VE8301-50

A pre-promoted version of VE 8300-50. Gel time of 15-20 minutes.

Table 7: Vinyl Ester SMC/BMC Resins

Property	VE 8930	VE 8935-1	VE 8920	VE 8920-45	VE 8932	VE 8980	VE 8990-30
Brookfield Viscosity cps at 77°F/25°C	200–400	900–1000	1900–2100	350–550	550–750	1600–1800	3100–3500
Non-Volatile	47–50	47–50	61–64	52–55	54–57	62–66	68–72
SPI Gel Time (min.)*	18–24	13–19	13–19	24–30	15–20	9–13	5–9
Gel-to-Peak (min.)	2–5	1–4	1–4	1–4	1–4	1–4	1–4
Peak (°F)	420–470	400–450	375–430	390–430	400–450	380–420	380–420
Peak (°C)	216–243	204–232	190–221	199–221	204–232	193–216	193–221

Table 8: Vinyl Ester RTM Resins

Property	VE 8100 RTM	VE 8101 RTM	VE 8300-50	VE 8301-50
Brookfield Viscosity cps at 77°F/25°C	200–300	200–300	225–300	225–300
Non-Volatile	54–56	54–56	49–51	49–51
Gel Time (min.)	8–12*	15–20***	16–19**	15–20***
Gel-to-Peak (min.)	2–5	13–18	10–15	11–16
Peak (°F)	340–380	320–360	340–380	340–380
Peak (°C)	171–193	160–182	171–193	171–193

*Test Method Only: 1.0 phr BPO, SPI method.
**Test Method Only: 1.0 phr (50%) MEKP / 0.20% (12%) Cobalt, 0.05% DMA.
***Test Method Only: 1.2 phr (50%) MEKP.

1. Room Temperature Curing

By adjusting the promoter-catalyst levels, CoREZYN vinyl ester resins can be cured under a wide variety of room temperature cure conditions.

The cobalt-N, N-dimethylaniline (DMA)-methyl ethyl ketone peroxide (MEKP) system is generally the most satisfactory promoter catalyst system since:

- All components are liquid, making them easy to weigh, measure or meter, and mix.
- The promoters, Co-DMA, can be premixed in drums of resin or large resin batches since the stability of the mix is 90 days from the date of manufacture.
- There is more air inhibition with this system than the DMA-BPO room temperature cure system.

The benzoyl peroxide is typically stirred in first due to the difficulty of incorporation. The DMA is added just before use;* at the same time the catalyst would be added in an MEKP system.

Unless otherwise noted, all CoREZYN vinyl ester resin corrosion resistance published data is based on the Co-DMA-MEKP cure system.

***PRECAUTION: The cobalt, DMA, and then the MEKP must be separately and thoroughly mixed into the resin. Any contact of unmixed DMA or cobalt with MEKP may lead to fire or explosion. Likewise, the BPO must be thoroughly mixed into a resin before the addition of a promoter (DMA, DEA, etc.). Any contact of BPO and a promoter can result in fire or explosion.**

MEKP Selection

Catalyzing for room temperature curing of CoREZYN vinyl ester resins requires certain considerations that may not be applicable to other classes of polyester resins. There are four brands of methyl ethyl ketone peroxide (MEKP) that seem best suited for curing CoREZYN vinyl ester resins:

- L-50 (Akzo® Nobel)
- DHD-9 (Arkema)
- Hi-Point 90 (Chemture Corporation)
- MEKP-925 (Norac® Company)

All brands of MEKP do not react at the same rate with these vinyl ester resins, even though they may contain the same percentage of MEKP and active oxygen.

The densities of MEKP can vary. The amount of MEKP used may need to be altered. Consult your peroxide supplier for their most current information.

A gel time check should be made with the same MEKP that will be used in production. Usually only minor changes in promoter or catalyst levels will compensate for the differences in MEKP reactivities.

*Table 9: Typical 100 Gram Cup Gel Times BPO-DMA System**

CoREZYN VE8100, VE8300, VE8360, VE8440, VE8510, VE8515, VE8550, VE8710, VE8770

		Gel Time, Minutes		
Temperature	Chemical	10–20	21–30	31–40
60–69°F (15–20°C)	BPO DMA	2.00 0.25	2.00 0.15	2.00 0.10
70–79°F (21–26°C)	BPO DMA	1.50 0.30	1.50 0.20	1.50 0.10
80–89°F (27–32°C)	BPO DMA	1.00 0.30	1.00 0.20	1.00 0.10

Gel times are run in 100 gram mass.

** Minimum levels of BPO and DMA in a room temperature cure system are 1.0% of active BPO and 0.075% of DMA by weight.*

Table 10: Typical 100 Gram Cup Gel Times MEKP-Cobalt System

CoREZYN VE8100, VE8300, VE8360, VE8440, VE8510, VE8515, VE8550, VE8710, VE8770

		Gel Time, Minutes		
Temperature	Chemical	10–20	21–30	31–40
60–69°F (15–20°C)	MEKP 12% Cobalt DMA 2,4-PD*	2.00 0.20 0.17 —	2.00 0.20 0.10 —	1.50 0.20 0.05 —
70–79°F (21–26°C)	MEKP 12% Cobalt DMA 2,4-PD*	1.50 0.20 0.05 —	1.50 0.20 0.05 0.05	1.25 0.20 0.05 0.05
80–89°F (27–32°C)	MEKP 12% Cobalt DMA 2,4-PD*	1.25 0.20 0.05 —	1.25 0.20 — —	1.25 0.20 — 0.05

**2,4-Pentanedione (acetyl acetone).*

Gel times are run in 100 gram mass.

Longer gel times can be achieved with additional 2,4-Pentanedione.

Catalyst is (50%) MEKP by volume.

The densities of MEKP can vary. The amount of MEKP used may need to be altered. Consult your peroxide supplier for their most current information.

The maximum level of 12% cobalt that should be used with any of the CoREZYN vinyl ester resins is 0.25%. If 6% cobalt is used, the maximum level is 0.50%.

Cobalt levels above this limit will not only inhibit the cure, but will decrease the physical properties and corrosion resistance of the resin and laminates.

Under normal conditions of fabrication, a minimum level of 0.05% DMA is recommended to ensure complete cure. This is especially true when working with thin films or thin laminates. A minimum of 0.05% to 0.075% DMA should always be used in these applications. With higher temperature fabrication (over 90°F/32°C), DMA may be eliminated since the high ambient temperature will ensure complete cure. Inclusion of DMA under these conditions may shorten the pot life excessively.

In the fabrication of exceptionally thick sections, even at normal ambient temperatures, DMA may be eliminated, as the exothermic heat generated will ensure complete cure. Inclusion of DMA with such fabrications may cause excessive exothermic heat leading to delamination and possible warping.

Cure temperatures below 60°F/15°C should be avoided to ensure complete cure. When this is not possible, it may be necessary to post-cure to obtain the required Barcol hardness. The Barcol hardness should attain at least 90% of the value given in Table 4, "Typical Clear Casting Properties," (page 7) for the resin used.

Often the resin temperature will be appreciably different from the temperature of the mold being used in the fabrication. When this is the case, the pot life of the resin will be considerably different from the gel time of the laminate on the mold. Compensations for this will need to be made by adjusting the catalyst-promoter levels.

Tables 9 through 13 will be useful in determining catalyst-promoter levels.

ArmorGRIP® panels by Insituform are assembled to rehabilitate a large sewer line.

2. Elevated Temperature Curing

The same catalysts that are used with polyesters at elevated temperatures can be used with CoREZYN vinyl esters.

Benzoyl peroxide is commonly used for elevated temperature curing. Used at a level of 1–2% of active BPO, the pot life is several days, yet rapid cures are obtained at temperatures over 180°F/82°C. The half-life data published by the manufacturers of the many available catalysts can be used as a guide for comparative time-temperature reactivities. Combinations of catalysts are recommended to obtain optimum properties and to reduce cure time schedules.

3. Air Inhibition

CoREZYN vinyl esters are subject to air inhibition similar to conventional polyesters. To eliminate this, a recommended solution of wax-in-styrene can be added. Consult your Thermoset Resins Division representative for complete information.

PRECAUTION should be taken to eliminate the use of any wax in the laminate where subsequent laminating or overcoating will be used. The migration of the wax to the surface will prevent adhesion and delamination may occur. Where secondary bonding operations are to be performed, special care should be taken to ensure that all wax has been removed from the bonding surfaces.

4. Reinforcement Compatibility

CoREZYN vinyl ester resins are compatible with a wide variety of fiberglass finishes. For specific recommendations, check with suppliers of fiberglass reinforcement materials.

CoREZYN vinyl esters show exceptional compatibility and inter-laminar shear strength when used with carbon, graphite, boron, and high-strength organic fibers like KEVLAR.

Gel Time Adjustment

Gel times of vinyl esters can be adjusted with several chemicals. The addition of these chemicals can greatly decrease the shelf life of these products, so care should be taken to monitor the resin after the addition of any chemicals. If the additives are not thoroughly mixed into the resin, it can also cause the resin to have a dramatically shorter shelf life. These chemicals should be uniformly mixed into the resin before it is used.

A recommended procedure for making additions to drums or other large quantities is to incorporate the additives individually into a small portion of the resin, mix it thoroughly, then add the mixture to the rest of the resin, and mix it to a uniform consistency. The gel time should be checked on the mixture before using to ensure the desired results.

A 100 gram gel time can be checked on the mixture to ensure it has the desired gel and a laminate tested for cure properties. The chemicals noted in Table 11 can be used to adjust the gel time of the vinyl ester resins.

Post-Cure

When post-curing fiber-reinforced plastics, dwell time at specific temperatures is critical to ensure you are sufficiently curing the composite. The times/temperatures listed are the minimum times recommended for curing the composite after the whole mass has reached the specific temperature.

125°F (52°C)	48 hours
140°F (60°C)	24 hours
150°F (66°C)	16 hours
200°F (93°C)	4 hours
250°F (121°C)	2 hours

Post-curing should be done with hot air or radiant heat. Hot water can attack the composite to degrade the physical properties and corrosion resistance.

Table 11: Promoters and Inhibitors Used for Gel Time Adjustments

Chemical	Typical Levels Weight Percent	Effects	Problems
12% Cobalt[1,2] (12% Co)	0.025–0.25	Shortens gel time.	Resin can gel but not cure properly if too much is added.
N, N-Dimethylaniline[1] (DMA)	0.01–0.25	Shortens gel time, improves cure development.	Increases exotherm and decreases shelf life.
N, N-Diethylaniline[1] (DEA)	0.01–0.25	Shortens gel time, improves cure development.	Increases exotherm and decreases shelf life.
2,4-Pentanedione[1] (2,4-PD)	0.01–0.25	Lengthens gel time without increasing the gel-to-cure interval.	Increases exotherm and decreases shelf life.
10% solution of T-Butyl Catechol[1]	0.01–0.30	Lengthens gel time.	Gel time may lengthen over time.

1. Resins may already have these present, so care must be taken not to exceed the maximum in the resin.
2. N, N-DMA is preferred to shorten the gel time.

Table 12: MEKP/Promoter—Thin Laminate Construction

CoREZYN VE8100, VE8300, VE8440, VE8510, VE8710, VE8770

		Gel Time Minutes		
Temperature	Chemical	10-20	21-30	31-40
60–69°F (15–20°C)	MEKP	2.00	2.00	2.00
	12% Cobalt	0.20	0.20	0.15
	DMA	0.17	0.10	0.075
	2,4-PD	—	—	—
70–79°F (21–26°C)	MEKP	2.00	2.00	1.75
	12% Cobalt	0.12	0.15	0.15
	DMA	0.075	0.05	0.05
	2,4-PD	—	0.05	0.05
80–89°F (27–32°C)	MEKP	1.75	1.75	1.75
	12% Cobalt	0.15	0.15	0.15
	DMA	0.05	0.05	0.05
	2,4-PD	0.02	0.05	0.075

Gel times are run in 100 gram mass.
Longer gel times can be achieved with additional 2,4-Pentanedione.
Catalyst is (50%) MEKP by volume.

The densities of MEKP can vary. The amount of MEKP used may need to be altered. Consult your peroxide supplier for their most currect information.

RECOMMENDATIONS FOR A POST-CURE SCHEDULE

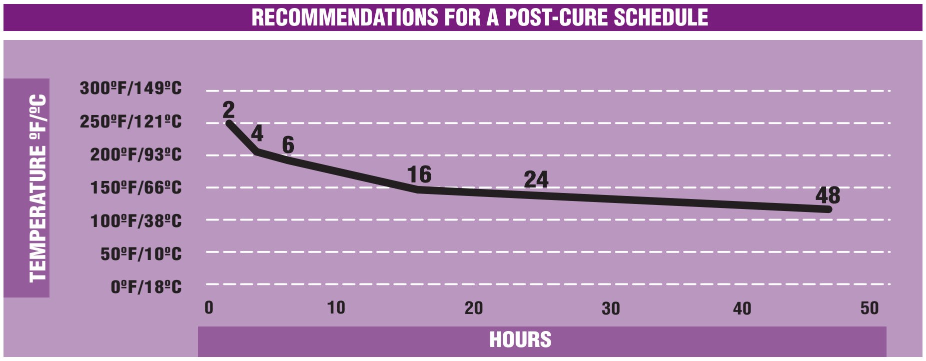


Table 13: Typical 100 Gram Cup Gel Times for VE8730-36 Resin

Cumene Hydroperoxide WT%	12% Co WT%	DMA WT%	2,4-PD WT%	Typical Gel Time[1] (Minutes)	Typical Cure Time (Minutes)
1.50	0.20	0.10	0.00	29	40
1.50	0.20	0.10	0.05	43	59
1.50	0.20	0.10	0.10	63	90
1.50	0.20	0.10	0.15	100	131
2.00	0.20	0.10	0.00	30	44
2.00	0.20	0.10	0.10	56	102
1.50	0.20	0.20	0.00	32	42
1.50	0.20	0.20	0.10	56	76
1.50	0.30	0.10	0.00	24	34
1.50	0.30	0.10	0.10	48	67

1. Typical gel times at 77°F (25°C).

5. Corrosion Resistance

Corrosion resistance of CoREZYN vinyl esters is determined by several criteria. ASTM C 581 is the primary tool used for these determinations, with exposure times of one year minimum. Recommendations are frequently tempered by specific industry or chemical characteristics, particularly where instability and variability are prevalent. In many media, laboratory determinations are not feasible, in which cases determinations are made by exposure in the process fluids, either as test panels or as test process equipment.

The temperature or concentration limits as shown in the corrosion chart, beginning on page 17, do not necessarily constitute limits to which the laminate can safely be used; they may only represent the limits to which testing has been performed. For exposure over the recommendations, it is advised that the Interplastic technical service department be consulted or exposure testing be performed.

In the corrosion resistance chart, recommendations in fluids above the heat distortion temperature of the resin are excluded. There are many chemical media that will produce no deleterious effect on the laminates above the heat distortion point. However, special engineering design considerations are required and should be handled as special cases.

Corrosion testing at the Interplastic laboratory is run on a continuing basis. Testing of laminates or finished products in special fluids is invited. ASTM C 581 coupons of the CoREZYN vinyl esters are immediately available for immersion testing and in-process exposures. Special laminate constructions are available on request.

C-glass veil is normally used in the corrosion barrier liner (refer to RTP Type 1 Composition, on page 32).

Whenever fluorine or fluorine compounds are encountered, an organic veil must be used. Organic veils made from polyester fibers have been found to be satisfactory for these services. Where the corrosion medium is hot alkaline above 150°F/66°C, an organic veil is recommended.

Consult with Interplastic technical services for veil recommendations in alkaline and halogenated media.

6. FDA/USDA Regulation Suitability

The CoREZYN vinyl esters used for FDA/USDA-approvable FRP composites are VE8300, VE8301, VE8100, and VE8101. These products are manufactured from products listed in Title 21 of *The Code of Federal Regulations* (CFR).

The levels of the residual components in the final FRP composite are critical to determine if the composite will pass the extraction tests outlined in the CFR for plastics that have contact with food products. The residuals are dependent on all of the ingredients as well as processing. Processing entails the curing, post-curing, and cleaning of the parts.

The finished fiberglass parts should be post-cured for a minimum of 16 hours at 150°F (66°C) or five hours at 200°F (93°C). After it is post-cured, it should be washed with soap and water. The final step is to rinse the FRP composite with clean water to remove any remaining residual contaminates.

This scrubber assembly was manufactured with VE8300 resins.

7. Quality Control

Interplastic Corporation maintains precise specifications on its product resins. Upon request, desired batch constants will be forwarded with the resin shipment. The inhibitors in CoREZYN vinyl esters may be reactivated by introducing dissolved oxygen by the incorporation of *clean dry* air. Use an air-powered mixer in a well-ventilated work area, away from any ignition source, to thoroughly incorporate the clean dry air. (Ensure that your compressor is delivering dry, oil-free air.)

To ensure the maximum efficiency of the inhibitors and to maximize the shelf life of the vinyl ester, bubble *clean, dry air* into the vinyl ester drum weekly for 30 minutes at 1 cfm.

8. Storage

CoREZYN vinyl esters are stable for a minimum of three months when stored at 77°F/25°C or below.

9. Safety and Health Considerations

The base vinyl ester resins are low in toxicity and may be handled openly by observing normal good housekeeping practices.

The same precautions should be used for handling the styrene solutions of the vinyl ester resins as are used in handling other styrene diluted polyesters and styrene monomer. It is recommended that good ventilation be provided in the working area to keep the styrene level in the air below safe working limits for health and freedom from fire and explosion.

The flashpoint for most CoREZYN vinyl ester resins is 86°F/30°C by Setaflash.

Fires involving CoREZYN vinyl ester resins can be safely extinguished with foam, dry powder or carbon dioxide. Foam should be used with caution where electricity is open, presenting the dangers of electrical shock.

CoREZYN vinyl esters allow We•no•nah Canoe to use very thin laminates in their canoes.

Users should take special precautions in the storage and handling of the initiators, promoters, and catalysts used with resins. These materials by themselves can present health, fire, and explosion hazards. These materials should never be stored in proximity to each other and should never be allowed to come together in handling or use. Refer to the Gel Time Adjustment procedures on page 12 for proper mixing instructions.

The user should consult the manufacturers of these materials for safe handling procedures.

APPLICATIONS
Ducting, underground and aboveground tanks, pipes, pulp and paper, flooring, grating, structural platforms, hoods, vents, scrubbers.

MANUFACTURING TECHNIQUES
Filament winding, centrifugal casting, hand lay-up

CoREZYN VE8300 FAMILY
Most often used where premium corrosion and physical strength are prime considerations. This family has superior physical properties, corrosion resistance and adhesion to substrates.

Only materials listed in Title 21 of the Code of Federal Regulations are used to manufacture VE8300. It remains the end users' responsibility to ensure FDA regulation compliance of the finished articles by extraction analysis.

CoREZYN VE8360 is the low HAP/low VOC version of the VE8300. Also FDA-approvable.

APPLICATIONS
Pipes, tanks, high-strength parts, boat hulls and decks.

MANUFACTURING TECHNIQUES
RTM, vacuum bagging, SCRIMP®, pultrusion, centrifugal casting.

CoREZYN VE8100 FAMILY
A lower viscosity resin with superior physical properties, corrosion resistance and adhesion to substrates.

Only materials listed in Title 21 of the Code of Federal Regulations are used to manufacture VE8100. It remains the end users' responsibility to ensure FDA regulation compliance of the finished articles by extraction analysis.

APPLICATIONS
Boats, spas and pools.

MANUFACTURING TECHNIQUES
Spray-up and hand lay-up.

CoREZYN VE8110 FAMILY
A proprietary line of thixotropic resins used where resistance to sag and drain-out is important. They are specifically designed for water-contact surfaces where water permeation and blistering are problems. Used as a barrier coat behind the gel coat or in the entire laminate for a lower specific gravity, higher-strength composite. Pre-promoted and non-promoted versions provide versatility.

Do not use these resins where premium corrosion resistance is required unless testing is done to prove the suitability of the thixotropic resin.

APPLICATIONS
Mold making, tooling and general laminating.

MANUFACTURING TECHNIQUES
Hand lay-up, spray-up.

CoREZYN VE8150 FAMILY
A laminating series used where a higher heat distortion point (270°F/132°C) and high modulus values are required.

Filament wound parts.

APPLICATIONS
Fire and corrosion resistance, pipes, ducting, tanks, grating, and doors.

MANUFACTURING TECHNIQUES
Filament wound, centrifugal casting, pultrusion, hand lay-up, spray-up.

CoREZYN VE8440 FAMILY
A fire-resistant, brominated counterpart of VE8300. Use where fire and corrosion resistance are both required. Provide high strength and superior adhesion to substrates.

Formulas with and without antimony are available. Ask your Thermoset Resins Division representative.

Fountain Powerboats uses only CoREZYN vinyl esters.

APPLICATIONS

Tank and pipe liners; lightweight, bullet-proof parts; coatings, contact-molded or match-metal-die molded parts; furniture; athletic equipment and other protective equipment.

MANUFACTURING TECHNIQUES

Spray-up, hand lay-up, filament winding, centrifugal casting.

CoREZYN VE8515 FAMILY

Flex resins that achieve their flexibility and high tensile elongation without rubber modifiers. Use them wherever resiliency is required or to modify rigid formulations to prevent cracking and crazing. They are compatible with Kevlar® and Twaron®.

APPLICATIONS

Military vessels, helmets, flooring, and pipe and tank linings.

MANUFACTURING TECHNIQUES

Spray-up, hand lay-up.

CoREZYN VE8550 FAMILY

A rubber-modified vinyl ester designed for toughness and crack resistance.

APPLICATIONS

Tank construction and relining; ducting, pipes, grating, structural platforms, paper processing, washer covers, valves, hoods, vents and other highly corrosive applications.

MANUFACTURING TECHNIQUES

Spray-up, hand lay-up, filament winding, centrifugal casting, pultrusion.

CoREZYN VE8710, VE8703 and VE8770

These resins have higher heat distortion temperatures of 240°F/116°C, 270°F/132°C and 300°F/149°C respectively. These Novolac vinyl ester resins are more capable than the bisphenol-A epichlorohydrin vinyl esters in chlor-alkalai exposure or in paper processing chlorination processes.

VE8710 has excellent resistance to caustic and oxidizing agents.

VE8730 offers excellent corrosion resistance, high structural properties and excellent laminate capabilities at ambient and high temperatures.

VE8770 has excellent solvent resistance.

APPLICATIONS

Boats, pools, spas, general laminate construction where surfaces contact water, and applications where optimum properties in physicals, hydrolytic stability and surface characteristic retention are desired.

MANUFACTURING TECHNIQUES

Infusion, pre-preg, RTM, spray-up, hand lay-up.

MVR 8000 FAMILY

Tough, versatile, corrosion resistant and easy to work with. They do not offer the performance extremes of the straight vinyl esters, but where that is not required, these modified vinyl esters offer an excellent cost-saving alternative.

Pre-promoted and thixotropic versions are available.

MVR8031LH Family

Low HAP/low VOC formulations. Promoted, thixotropic resins designed specifically for marine laminate construction.

APPLICATIONS

Cured-in-Place Pipe (CIPP).

MANUFACTURING TECHNIQUES

Inversion and pull-through.

VE8190

Tough, versatile, bisphenol-A resin.

VE8738

Novolac epoxy-based vinyl ester.

VE8790

High crosslink vinyl ester.

Intermarine used the Vacuum Infusion Process to manufacture their 123-foot hull.

VE Chemical Resistance

The guidelines that follow are intended to cover only parts and equipment manufactured according to industry standards such as The Society for the Plastic Industry's *Quality Assurance Report, RTP Corrosion-Resistant Equipment*.

Table 14: Chemical Resistance of CoREZYN Vinyl Ester Resins

Maximum Recommended Temperature °F/°C

Chemical	Concentration Percentage by Weight	VE8100 VE8300 VE8360	VE8440 VE8450	VE8710	VE8730	VE8770	VE8515	VE8550
A								
Acetaldehyde		NR	NR	NR	–	–	NR	NR
Acetic Acid	1–10	210 / 99	210 / 99	210 / 99	210 / 99	150 / 66	140 / 60	140 / 60
	11–25	210 / 99	210 / 99	210 / 99	210 / 99	150 / 66	140 / 60	–
	26–50	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	75 / 24	–
	51–75	150 / 66	150 / 66	180 / 82	150 / 66	125 / 52	75 / 24	–
Acetic Anhydride		NR	NR	100 / 38	100 / 38	NR	NR	NR
Acetone	100	NR	NR	NR	NR	NR	NR	NR
Acrylic Acid (4)	25	100 / 38	100 / 38	100 / 38	100 / 38	80 / 27	NR	80
Acrylonitrile	All	NR	NR	NR	NR	NR	NR	NR
Alcohol, Butyl	All	100 / 38	100 / 38	120 / 49	120 / 49	120 / 49	NR	NR
Alcohol, Ethyl	10	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	120 / 49	120 / 49
	95	80 / 27	80 / 27	100 / 38	100 / 38	100 / 38	NR	NR
Alcohol, Isopropyl	10	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	140 / 60	140 / 60
	100	100 / 38	100 / 38	120 / 49	120 / 49	120 / 49	NR	NR
Alcohol, Methyl	5	120 / 49	120 / 49	120 / 49	120 / 49	120 / 49	NR	100 / 38
	20	100 / 38	100 / 38	100 / 38	100 / 38	100 / 38	NR	NR
	100	NR	NR	NR	90 / 32	90 / 32	NR	NR
Alcohol, Secondary Butyl	All	100 / 38	100 / 38	120 / 49	120 / 49	120 / 49	NR	NR
Allyl Chloride	All	NR	NR	NR	80 / 27	80 / 27	NR	NR
Alum	All	210 / 99	210 / 99	220 / 104	250 / 121	210 / 99	140 / 60	140 / 60
Aluminum Chloride	All	210 / 99	210 / 99	220 / 104	250 / 121	210 / 99	140 / 60	NR
Aluminum Fluoride (2)	All	80 / 27	80 / 27	80 / 27	80 / 27	80 / 27	NR	140 / 60
Aluminum Hydroxide (2)	All	180 / 82	180 / 82	200 / 93	200 / 93	150 / 66	140 / 60	140 / 60
Aluminum Nitrate	All	160 / 71	160 / 71	180 / 82	180 / 82	180 / 82	100 / 38	160 / 71
Aluminum Potassium Sulfate	All	210 / 99	210 / 99	220 / 104	250 / 121	220 / 104	140 / 60	160 / 71
Ammonia, Aqueous	20	150 / 66	150 / 66	150 / 66	150 / 66	120 / 49	120 / 49	150 / 66
Ammonia, Gas (Dry)	100	100 / 38	100 / 38	180 / 82	100 / 38	100 / 38	100 / 38	100 / 38
Ammonia, Liquified Gas		NR	NR	NR	NR	NR	NR	NR
Ammonium Acetate	65	80 / 27	80 / 27	80 / 27	80 / 27	80 / 27	NR	NR
Ammonium Bicarbonate	1–50	160 / 71	160 / 71	160 / 71	160 / 71	140 / 60	140 / 60	140 / 60
Ammonium Bisulfite (Black Liquor)		180 / 82	180 / 82	180 / 82	180 / 82	120 / 49	NR	–
Ammonium Carbonate	All	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	120 / 49	120 / 49
Ammonium Chloride (2)	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Ammonium Citrate	All	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	120 / 49	120 / 49
Ammonium Fluoride (2)	All	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	120 / 49	120 / 49
Ammonium Hydroxide (2)	5	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	140 / 60	–
	10	150 / 66	150 / 66	150 / 66	150 / 66	120 / 49	120 / 49	–
	20	150 / 66	150 / 66	150 / 66	150 / 66	120 / 49	120 / 49	–
	29	100 / 38	100 / 38	150 / 66	180 / 82	100 / 38	NR	NR
Ammonium Nitrate	All	210 / 99	210 / 99	220 / 104	250 / 121	210 / 99	140 / 60	160 / 71
Ammonium Persulfate	All	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	140 / 60	160 / 71

VE Chemical Resistance, continued

Chemical	Concentration Percentage by Weight	VE8100 VE8300 VE8360	VE8440 VE8450	VE8710	VE8730	VE8770	VE8515	VE8550
		Maximum Recommended Temperature °F/°C						
Ammonium Phosphate	65	210 / 99	210 / 99	210 / 99	210 / 99	180 / 82	140 / 60	160 / 71
Ammonium Sulfate	All	210 / 99	210 / 99	220 / 104	250 / 121	210 / 99	140 / 60	160 / 71
Amyl Acetate	100	NR	NR	70 / 21	120 / 49	120 / 49	NR	NR
Aniline	All	NR	NR	NR	100 / 38	100 / 38	NR	NR
Aniline Hydrochloride	All	150 / 66	150 / 66	180 / 82	180 / 82	150 / 66	140 / 60	–
Aniline Sulfate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	–
Arsenic Acid	All	100 / 38	100 / 38	100 / 38	100 / 38	80 / 27	NR	NR
Arsenious Acid	All	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	–	120 / 49
B								
Barium Acetate	All	190 / 88	190 / 88	190 / 88	190 / 88	150 / 66	140 / 60	–
Barium Carbonate	All	210 / 99	210 / 99	220 / 104	250 / 121	250 / 121	140 / 60	160 / 71
Barium Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Barium Hydroxide (2)	1–10	150 / 66	150 / 66	180 / 82	150 / 66	120 / 49	100 / 38	120 / 49
Barium Sulfate	All	210 / 99	210 / 99	210 / 99	250 / 121	210 / 99	140 / 60	160 71
Barium Sulfide	All	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	140 / 60	–
Beer	100	120 / 49	–	–	–	–	–	–
Benzene (4)	100	NR	NR	NR	100 / 38	100 / 38	NR	NR
5% Benzene in Kerosene		180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	–
Benzene Sulfonic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Benzoic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
O-Benzoyl Benzoic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	–
Benzyl Alcohol	100	NR	NR	80 / 27	100 / 38	100 / 38	NR	NR
Benzyl Chloride	100	NR	NR	NR	80 / 27	NR	NR	NR
Black Liquor Recovery (furnace gasses)		325 / 163	325 / 163	350 / 177	400 / 204	350 / 177	–	–
Brass Plating Solution: 3% Copper Cyanide 6% Sodium Cyanide 1% Zinc Cyanide 3% Sodium Carbonate		180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	–	160 / 71
Brine	All	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	120 / 49	130/54
Bromic Acid	100	NR	NR	NR	NR	NR	NR	NR
Bromine, Liquid	100	NR	NR	NR	NR	NR	NR	NR
Bromine Water (2)	5	180 / 82	180 / 82	200 / 93	200 / 93	200 / 93	120 / 49	–
Bronze Plating Solution: 4% Copper Cyanide 5% Sodium Cyanide 3% Sodium Carbonate 4.5% Rochelle Salts		180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	–	–
Butanol (see Alcohol, Butyl)								
Butyl Acetate	All	NR	NR	NR	80 / 27	80 / 27	NR	NR
Butyl Benzyl Phthalate	100	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	–	–
Butyl Carbitol	100	–	–	100 / 38	100 / 38	100 / 38	–	–
Butyl Cellosolve	100	NR	NR	100 / 38	100 / 38	100 / 38	–	–
Butylene Glycol	100	160 / 71	160 / 71	180 / 82	180 / 82	180 / 82	–	NR
Butyric Acid	1–50 100	210 / 99 NR	210 / 99 NR	210 / 99 100 / 38	210 / 99 100 / 38	210 / 99 NR	– NR	– NR
C								
Cadmium Chloride	All	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	160 / 71

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VE Chemical Resistance, continued

Chemical	Concentration Percentage by Weight	VE8100 VE8300 VE8360	VE8440 VE8450	VE8710	VE8730	VE8770	VE8515	VE8550
		Maximum Recommended Temperature °F/°C						
Cadmium Cyanide Plating Solution 3% Cadmium Oxide 10% Sodium Cyanide 1% Caustic Soda		180 / 82	180 / 82	180 / 82	180 / 82	–	–	160 / 71
Calcium Bisulfite	All	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	160 / 71
Calcium Carbonate	All	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	160 / 71
Calcium Chlorate (2)	All	210 / 99	210 / 99	220 / 104	250 / 121	210 / 99	–	160 / 71
Calcium Chloride (2)	All	210 / 99	210 / 99	220 / 104	250 / 121	210 / 99	140 / 60	160 / 71
Calcium Hydroxide (2)	All	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	–	160 / 71
Calcium Hypochlorite (1) (2)	All	160 / 71	180 / 82	180 / 82	150 / 66	140 / 60	100 / 38	120 / 49
Calcium Nitrate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Calcium Sulfate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Calcium Sulfite	All	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	140 / 60	160 / 71
Cane Sugar Liquor	All	180 / 82	–	–	–	–	–	–
Caprylic Acid (Octanoic Acid)	100	180 / 82	180 / 82	210 / 99	210 / 99	180 / 82	–	160 / 71
Carbon Dioxide Gas		210 / 99	210 / 99	240 / 116	350 / 177	350 / 177	140 / 60	160 / 71
Carbon Disulfide	100	NR	NR	NR	NR	NR	NR	NR
Carbon Monoxide Gas		210 / 99	210 / 99	240 / 116	350 / 177	350 / 177	140 / 60	160 / 71
Carbon Tetrachloride	100	100 / 38	100 / 38	150 / 66	150 / 66	150 / 66	–	–
Carbonic Acid	All	100 / 38	100 / 38	150 / 66	150 / 66	–	–	–
Carbowax	100	100 / 38	100 / 38	100 / 38	100 / 38	100 / 38	–	–
Carboxy Ethyl Cellulose	10	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	–	120 / 49
Carboxy Methyl Cellulose	10	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	–	120 / 49
Castor Oil	100	75 / 24	75 / 24	100 / 38	120 / 49	120 / 49	–	120 / 49
Caustic (2) (See Sodium Hydroxide)								
Chlorinated Brine Liquors (2)(5) (caustic chlorine cell)				Consult Laboratory				
Chlorinated Wax	All	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	140 / 60	–
Chlorine Dioxide/Air	5/95	200 / 93	200 / 93	200 / 93	200 / 93	200 / 93	–	–
Chlorine Dioxide, Wet Gas	5	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	–
Chlorine, Dry Gas	100	210 / 99	210 / 99	210 / 99	200 / 93	200 / 93	140 / 60	160 / 71
Chlorine, Wet Gas	100	200 / 93	200 / 93	200 / 93	200 / 93	200 / 93	140 / 60	160 / 71
Chlorine Liquid	100	NR	NR	NR	NR	NR	NR	NR
Chlorine Water (2)	Sat.	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	NR
Chloroacetic Acid	25	120 / 49	120 / 49	120 / 49	120 / 49	–	NR	NR
	50	100 / 38	100 / 38	100 / 38	100 / 38	–	NR	NR
	Conc	NR	NR	NR	NR	NR	NR	NR
Chlorobenzene (4)	100	NR	NR	90 / 32	100 / 38	100 / 38	NR	NR
Chloroform	100	NR	NR	NR	NR	NR	NR	NR
Chlorosulfonic Acid	100	NR	NR	NR	NR	NR	NR	NR
Chrome Plating Bath 19% Chromic Acid Sodium Fluorosilicate Sulfate		–	–	140 / 60	–	–	–	–
Chromic Acid	10	150 / 66	150 / 66	150 / 66	150 / 66	NR	NR	–
	20	120 / 49	120 / 49	150 / 66	150 / 66	NR	NR	100 / 38
	30	NR	NR	120 / 49	NR	NR	NR	NR
Chromium Sulfate	All	150 / 66	150 / 66	180 / 82	180 / 82	150 / 66	–	–
Citric Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60

Conc – Concentrated
Sat'd – Saturated
NR – Not Recommended
– No Data on Environment
(1) BPO/DMA Cure Recommended
(2) Synthetic Veil Recommended
(3) C-Glass Recommended
(4) Post-Cure Recommended
(5) Consult Laboratory for Specific Recommendation

All services within 20°F/11°C maximum service temperature should be post-cured to ensure a long service life.

VE Chemical Resistance, continued

Chemical	Concentration Percentage by Weight	VE8100 VE8300 VE8360	VE8440 VE8450	VE8710	VE8730	VE8770	VE8515	VE8550
		Maximum Recommended Temperature °F/°C						
Coconut Oil	100	180 / 82	180 / 82	200 / 93	200 / 93	200 / 93	140 / 60	160 / 71
Copper Brite Plating (2) Caustic-Cyanide		160 / 71	160 / 71	190 / 88	160 / 71	–	–	–
Copper Chloride	All	210 / 99	210 / 99	250 / 121	250 / 121	250 / 121	140 / 60	160 / 71
Copper Cyanide	All	210 / 99	210 / 99	210 / 99	210 / 99	–	–	160 / 71
Copper Fluoride (2)	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	–
Copper Matte Dipping Bath: 30% Ferric Chloride 19% Hydrochloric Acid		180 / 82	180 / 82	180 / 82	180 / 82	–	–	–
Copper Nitrate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	–	
Copper Pickling Bath: 10% Ferric Sulfate 10% Sulfuric Acid		200 / 93	200 / 93	200 / 93	200 / 93	–	–	–
Copper Plating Solution: Copper Cyanide 10.5% Copper 14% Sodium Cyanide 6% Rochelle Salts		160 / 71	160 / 71	190 / 88	160 / 71	–	–	
Copper Plating Solution: 45% Copper Fluoroborate 160 / 71 19% Copper Sulfate 8% Sulfuric Acid			180 / 82	180 / 82	200 / 93	180 / 82	–	–
Copper Sulfate	All	210 / 99	210 / 99	210 / 99	250 / 121	–	–	160 / 71
Corn Oil	100	210 / 99	190 / 88	210 / 99	210 / 99	210 / 99	–	–
Corn Starch, Slurry	All	210 / 99	210 / 99	210 / 99	210 / 99	–	–	–
Corn Sugar	All	210 / 99	–	–	–	–	–	120 / 49
Cottonseed Oil	100	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	–	NR
Cresylic Acid	100	NR	NR	NR	NR	NR	NR	NR
Crude Oil, Sour	100	210 / 99	210 / 99	210 / 99	250 / 121	210 / 99	–	120 / 49
Crude Oil, Sweet	100	210 / 99	210 / 99	210 / 99	250 / 121	210 / 99	120 / 49	–
Cumene	100	80 / 27	80 / 27	100 / 38	120 / 49	120 / 49	NR	–
Cyclohexane	100	120 / 49	120 / 49	120 / 49	150 / 66	150 / 66	–	–
Cyclohexanone	100	100 / 38	100 / 38	100 / 38	120 / 49	120 / 49	NR	–
D								
Deionized Water	100	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	120 / 49	150 / 66
Demineralized Water	100	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	120 / 49	150 / 66
Detergents, Sulfonated	All	210 / 99	210 / 99	210 / 99	220 / 104	220 / 104	–	–
Diallyl Phthalate	100	180 / 82	180 / 82	210 / 99	210 / 99	210 / 99	–	120 / 49
Diammonium Phosphate	65	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	150 / 66
Dibromophenol (2)	100	NR	NR	NR	100 / 38	100 / 38	NR	NR
Dibutyl Ether	100	80 / 27	80 / 27	80 / 27	150 / 66	150 / 66	NR	–
Dichlorobenzene	100	NR	NR	120 / 49	120 / 49	120 / 49	NR	NR
Dichloroethylene	100	NR	NR	NR	NR	NR	NR	NR
Dichloromonomethane	100	NR	NR	NR	NR	NR	NR	NR
Dichloropropane	100	NR	NR	NR	100 / 38	–	NR	NR
Dichloropropene	100	NR	NR	NR	80 / 27	–	NR	NR
Diesel Fuel	100	180 / 82	180 / 82	200 / 93	200 / 93	200 / 93	NR	120 / 49
Diethanolamine	100	80 / 27	80 / 27	100 / 38	120 / 49	100 / 38	NR	NR
Diethylamine	100	NR	NR	NR	NR	NR	NR	NR

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Chemical	Concentration Percentage by Weight	VE8100 VE8300 VE8360	VE8440 VE8450	VE8710	VE8730	VE8770	VE8515	VE8550
		Maximum Recommended Temperature °F/°C						
Diethylbenzene	100	80 / 27	80 / 27	100 / 38	120 / 49	120 / 49	NR	NR
Diethyl Carbonate	100	NR	NR	NR	80 / 27	–	NR	NR
Diethylene Glycol	100	180 / 82	180 / 82	200 / 93	200 / 93	200 / 93	NR	150 / 66
Diethylhexyl Phosphoric Acid (in Kerosene)	20	120 / 49	120 / 49	150 / 66	150 / 66	120 / 49	100 / 38	–
Diethyl Sulfate	100	NR	NR	100 / 38	100 / 38	100 / 38	–	–
Diisobutylene	100	100 / 38	100 / 38	100 / 38	120 / 49	100 / 38	–	–
Diisobutyl Phthalate	100	150 / 66	150 / 66	180 / 82	200 / 93	200 / 93	100 / 38	–
Diisopropanolamine	100	100 / 38	100 / 38	150 / 66	150 / 66	150 / 66	NR	NR
Dimethyl Formamide	100	NR	NR	NR	NR	NR	NR	NR
Dimethyl Morpholine	100	NR	NR	NR	100 / 38	–	NR	NR
Dimethyl Phthalate	100	150 / 66	150 / 66	180 / 82	180 / 82	180 / 82	100 / 38	–
Dioctyl Phthalate	100	150 / 66	150 / 66	150 / 66	200 / 93	200 / 93	100 / 38	120 / 49
Dipropylene Glycol	100	180 / 82	180 / 82	200 / 93	210 / 99	210 / 99	100 / 38	120 / 49
Distilled Water (see Water, Distilled)								
DMA 4 Weed Killer, 2,4D	100	–	–	120 / 49	–	–	–	–
DMA 6 Weed Killer	100	–	–	120 / 49	–	–	–	–
Dodecyl Alcohol	100	150 / 66	150 / 66	180 / 82	180 / 82	180 / 82	–	–
E								
EDTA	All	100 / 38	100 / 38	100 / 38	100 / 38	100 / 38	NR	NR
Electrosol	5	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	–	–
Epichlorohydrin	100	NR	NR	NR	–	–	NR	NR
Epoxidized Soybean Oil	100	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	100 / 38	120 / 49
Esters, Fatty Acids	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	120 / 49
Ethanol, (see Alcohol, Ethyl)								
Ethyl Acetate	100	NR	NR	NR	–	–	NR	NR
Ethyl Acrylate	100	NR	NR	NR	NR	NR	NR	NR
Ethyl Benzene	100	NR	NR	NR	100 / 38	100 / 38	NR	NR
Ethyl Bromide	100	NR	NR	NR	NR	NR	NR	NR
Ethyl Chloride	100	NR	NR	NR	–	–	NR	NR
Ethyl Ether	100	NR	NR	NR	NR	NR	NR	NR
Ethylene Chlorohydrin	100	NR	NR	100 / 38	100 / 38	–	NR	NR
Ethylene Glycol	100	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Ethylene Glycol Monobutyl Ether	100	–	–	100 / 38	100 / 38	100 / 38	NR	NR
Ethyl Sulfate	All	80 / 27	80 / 27	100 / 38	100 / 38	100 / 38	NR	NR
F								
Fatty Acids	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Ferric Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Ferric Nitrate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Ferric Sulfate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Ferrous Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Ferrous Nitrate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Ferrous Sulfate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
8-8-8 Fertilizer		120 / 49	120 / 49	120 / 49	120 / 49	120 / 49	–	120 / 49
Fertilizer-Urea Ammonium Nitrate	All	120 / 49	120 / 49	120 / 49	120 / 49	120 / 49	–	–
Flue gas		325 / 163	325 / 163	340 / 171	340 / 171	340 / 171	–	–

Conc – Concentrated
Sat'd – Saturated
NR – Not Recommended
– No Data on Environment
(1) BPO/DMA Cure Recommended
(2) Synthetic Veil Recommended
(3) C-Glass Recommended
(4) Post-Cure Recommended
(5) Consult Laboratory for Specific Recommendation

All services within 20°F/11°C maximum service temperature should be post-cured to ensure a long service life.

		Maximum Recommended Temperature °F/°C						
Chemical	**Concentration Percentage by Weight**	**VE8100 VE8300 VE8360**	**VE8440 VE8450**	**VE8710**	**VE8730**	**VE8770**	**VE8515**	**VE8550**
Fluoboric Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	–	–	120 / 49
Fluosilicic Acid	10	180 / 82	180 / 82	180 / 82	180 / 82	–	–	120 / 49
	20	100 / 38	100 / 38	100 / 38	100 / 38	–	–	NR
Formaldehyde	All	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	–	–
Formic Acid	10	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	120 / 49
	85	90 / 32	–	–	100 / 38	100 / 38	100 / 38	100 / 38
Freon 11	100	80 / 27	80 / 27	80 / 27	80 / 27	80 / 27	–	120 / 49
Fuel Oil	100	180 / 82	180 / 82	200 / 93	200 / 93	200 / 93	140 / 60	120 / 49
Furfural	5	120 / 49	120 / 49	150 / 66	150 / 66	150 / 66	–	NR
	100	NR	NR	NR	NR	NR	NR	NR
G								
Gallic Acid	Sat'd	–	–	–	100 / 38	–	–	–
Gas, Natural	100	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	–
Gasohol (5)				Consult Laboratory				
Gasoline, Auto (leaded and unleaded)	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	–
Gasoline, Aviation	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	120 / 49
Gasoline, Ethyl	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	–
Gasoline, Sour	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	–
Gluconic Acid	50	180 / 82	180 / 82	180 / 82	180 / 82	–	–	–
Glucose	All	210 / 99	210 / 99	210 / 99	250 / 121	250 / 121	140 / 60	–
Glutaraldehyde	50	120 / 49	120 / 49	120 / 49	120 / 49	120 / 49	–	100 / 38
Glutaric Acid	50	120 / 49	120 / 49	120 / 49	120 / 49	–	–	–
Glycerine	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Glycol, Ethylene	100	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Glycol, Propylene	100	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Glycolic Acid	10	180 / 82	180 / 82	200 / 93	200 / 93	–	–	–
(Hydroxyacetic Acid)	70	80 / 27	80 / 27	100 / 38	100 / 38	–	–	–
Glyoxal	40	80 / 27	80 / 27	80 / 27	80 / 27	80 / 27	–	–
Gold Plating Solution: 63% Potassium Ferrocyanide 0.2% Potassium Gold Cyanide 0.8% Sodium Cyanide		180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	140 / 60	140 / 60
H								
Heptane	100	200 / 93	200 / 93	200 / 93	200 / 93	200 / 93	140 / 60	150 / 66
Hexane	100	160 / 71	160 / 71	160 / 71	160 / 71	160 / 71	120 / 49	–
Hexylene Glycol	100	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	140 / 60	140 / 60
Hot Stack Gasses		340 / 171	340 / 171	340 / 171	340 / 171	340 / 171	–	–
Hydraulic Fluid								
Organic	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	120 / 49	120 / 49
Synthetic	100	–	–	–	120 / 49	–	–	–
Hydrazine	70	NR	NR	NR	NR	NR	NR	NR
Hydrobromic Acid (2)	25	180 / 82	180 / 82	180 / 82	180 / 82	140 / 60	–	160 / 71
	48	150 / 66	150 / 66	150 / 66	150 / 66	120 / 49	–	120 / 49
	60	100 / 38	100 / 38	100 / 38	100 / 38	80 / 27	–	NR
Hydrochloric Acid (2)	10	180 / 82	180 / 82	200 / 93	230 / 110	180 / 82	140 / 60	140 / 60
	20	180 / 82	180 / 82	180 / 82	180 / 82	120 / 49	140 / 60	140 / 60
	37	150 / 66	150 / 66	180 / 82	180 / 82	–	–	100 / 38
Hydrochloric Acid (saturated with Chlorine gas) (2)	30	180 / 82	180 / 82	180 / 82	220 / 104	180 / 82	–	–

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VE Chemical Resistance, continued

Chemical	Concentration Percentage by Weight	VE8100 VE8300 VE8360	VE8440 VE8450	VE8710	VE8730	VE8770	VE8515	VE8550
		Maximum Recommended Temperature °F/°C						
Hydrocyanic Acid	All	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	140 / 60	150 / 66
Hydrofluoric Acid	10 20	130 / 54 100 / 38	130 / 54 100 / 38	130 / 54 100 / 38	130 / 54 100 / 38	130 / 54 100 / 38	– –	120 / 49 NR
Hydrofluosilicic Acid (2)	10 35	150 / 66 100 / 38	150 / 66 100 / 38	150 / 66 100 / 38	150 / 66 100 / 38	150 / 66 100 / 38	– –	120 / 49 NR
Hydrogen Bromide (2), Wet Gas	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	120 / 49	–
Hydrogen Chloride (2) Dry Gas Wet Gas	 100 100	 210 / 99 210 / 99	 210 / 99 210 / 99	 210 / 99 210 / 99	 300 / 149 300 / 149	 210 / 99 210 / 99	 – –	 160 / 71 160 / 71
Hydrogen Fluoride (2), Vapor		180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	120 / 49	–
Hydrogen Peroxide	30	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	–	120 / 49
Hydrogen Sulfide, Aqueous	5	180 / 82	180 / 82	200 / 93	200 / 93	200 / 93	–	160 / 71
Hydrogen Sulfide, Dry Gas	100	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	–	160 / 71
Hydrosulfite Bleach	All	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	120 / 49	–
Hypochlorous Acid (1)(2)(4)	10 20	180 / 82 140 / 60	180 / 82 140 / 60	160 / 71 140 / 60	160 / 71 140 / 60	120 / 49 100 / 38	140 / 60 80 / 27	140 / 60 80 / 27
I								
Iron Plating Solution: (2) 45% $FeCl_3$: 15% $CaCl_2$ 20% $FeSO_4$: 11% $(NH_4)_2SO_4$		180 / 82	180 / 82	180 / 82	180 / 82	–	–	160 / 71
Iron and Steel Clean Bath: (2) 9% Hydrochloric Acid 23% Sulfuric Acid		–	–	100 / 38	–	–	–	–
Isopropyl Alcohol (see Alcohol, Isopropyl)								
Isopropyl Amine	All	100 / 38	100 / 38	120 / 49	120 / 49	120 / 49	–	–
Isopropyl Palmitate	100	210 / 99	210 / 99	210 / 99	230 / 110	230 / 110	140 / 60	140 / 60
J								
Jet Fuel (JP-4)	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	120 / 49	–
K								
Kerosene	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	120 / 49
L								
Lactic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Lasso* (50% Chlorobenzene) NR			NR	NR	120 / 49	120 / 49	120 / 49	NR
Latex	All	120 / 49	120 / 49	120 / 49	120 / 49	120 / 49	NR	120 / 49
Lauric Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Lauryl Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Lead Acetate	All	210 / 99	210 / 99	210 / 99	230 / 110	230 / 110	140 / 60	–
Lead Nitrate	All	210 / 99	210 / 99	210 / 99	230 / 110	230 / 110	140 / 60	–
Lead Plating Solution: 8% Lead 0.8% Fluorboric Acid 0.4% Boric Acid		180 / 82	180 / 82	180 / 82	180 / 82	–	–	–
Linseed Oil	100	210 / 99	210 / 99	210 / 99	230 / 110	230 / 110	140 / 60	140 / 60
Lithium Bromide (2)	Sat'd	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Lithium Chloride	30 50	210 / 99 210 / 99	210 / 99 210 / 99	210 / 99 210 / 99	210 / 99 210 / 99	210 / 99 210 / 99	140 / 60 140 / 60	160 / 71 160 / 71
Lithium Sulfate	Sat'd	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
M								
Magnesium Bisulfite	All	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	120 / 49	150 / 66

Conc – Concentrated
Sat'd – Saturated
NR – Not Recommended
– No Data on Environment
(1) BPO/DMA Cure Recommended
(2) Synthetic Veil Recommended
(3) C-Glass Recommended
(4) Post-Cure Recommended
(5) Consult Laboratory for Specific Recommendation

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** Lasso is made by Monsanto.*

Chemical	Concentration Percentage by Weight	VE8100 VE8300 VE8360	VE8440 VE8450	VE8710	VE8730	VE8770	VE8515	VE8550
		Maximum Recommended Temperature °F/°C						
Magnesium Carbonate	All	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	120 / 49	150 / 66
Magnesium Chloride (2)	All	210 / 99	210 / 99	210 / 99	240 / 116	240 / 116	120 / 49	150 / 66
Magnesium Hydroxide (2)	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Magnesium Sulfate	All	210 / 99	210 / 99	210 / 99	240 / 116	240 / 116	140 / 60	150 / 66
Maleic Acid	All	210 / 99	210 / 99	210 / 99	240 / 116	240 / 116	140 / 60	140 / 60
Mercuric Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Mercurous Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Methyl Alcohol	100	NR	NR	NR	100 / 38	100 / 38	NR	NR
Methanol (see Alcohol, Methyl)								
Methylene Chloride	100	NR	NR	NR	NR	NR	NR	NR
Methyl Ethyl Ketone	100	NR	NR	NR	NR	NR	NR	NR
Methyl Isobutyl Carbitol	100	NR	NR	NR	NR	NR	NR	NR
Methyl Isobutyl Ketone	100	NR	NR	NR	–	–	NR	NR
Methyl Styrene	100	NR	NR	NR	–	–	NR	NR
Mineral Oils	100	210 / 99	210 / 99	210 / 99	240 / 116	240 / 116	140 / 60	140 / 60
Molybdenum Disulfide	100	200 / 93	200 / 93	200 / 93	200 / 93	–	–	–
Monochloroacetic Acid	100	NR	NR	NR	NR	NR	NR	NR
Monoethanolamine	100	NR	NR	NR	80 / 27	–	NR	NR
Motor Oil	100	210 / 99	210 / 99	210 / 99	250 / 121	250 / 121	140 / 60	140 / 60
Muriatic Acid	37	150 / 66	150 / 66	180 / 82	180 / 82	–	–	100 / 38
Myristic Acid	100	210 / 99	210 / 99	210 / 99	210 / 99	180 / 82	140 / 60	120 / 49
N								
Naphtha	100	180 / 82	180 / 82	180 / 82	210 / 99	210 / 99	140 / 60	150 / 66
Naphthalene	100	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Nickel Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Nickel Nitrate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Nickel Plating: 11% Nickel Sulfate 2% Nickel Chloride 1% Boric Acid		180 / 82	180 / 82	180 / 82	180 / 82	–	100 / 38	150 / 66
Nickel Plating: 44% Nickel Sulfate 4% Ammonium Chloride 4% Boric Acid		180 / 82	180 / 82	180 / 82	180 / 82	–	100 / 38	150 / 66
Nickel Sulfate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Nitric Acid	5 20 52	150 / 66 120 / 49 NR	150 / 66 120 / 49 NR	150 / 66 140 / 60 80 / 27	150 / 66 140 / 60 80 / 27	– – NR	100 / 38 NR NR	140 / 60 120 / 49 NR
Nitric Acid Fumes	10-60	160 / 71	160 / 71	180 / 82	180 / 82	–	–	150 / 66
Nitrobenzene	All	NR	NR	NR	100 / 38	–	NR	NR
O								
Oakite Rust Stripper	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	140 / 60	–
Octanoic Acid	100	180 / 82	180 / 82	210 / 99	210 / 99	–	140 / 60	–
Oil, Sour Crude	100	210 / 99	210 / 99	250 / 121	250 / 121	210 / 99	140 / 60	140 / 60
Oil, Sweet Crude	100	210 / 99	210 / 99	210 / 99	250 / 121	210 / 99	140 / 60	150 / 66
Oleic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	160 / 71
Oleum (Fuming Sulfuric)		NR	NR	NR	NR	NR	NR	NR
Olive Oil	100	210 / 99	210 / 99	210 / 99	250 / 121	250 / 121	140 / 60	160 / 71
Oxalic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	–

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		Maximum Recommended Temperature °F/°C						
Chemical	**Concentration Percentage by Weight**	**VE8100 VE8300 VE8360**	**VE8440 VE8450**	**VE8710**	**VE8730**	**VE8770**	**VE8515**	**VE8550**
P								
Perchloric Acid (2)	10	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	–	–
	30	100 / 38	100 / 38	100 / 38	100 / 38	100 / 38	–	NR
Perchloroethylene		80 / 27	80 / 27	100 / 38	100 / 38	–	–	–
Peroxide Bleach (1) (2) 2% Sodium Peroxide, 96% 0.025% Epsom Salts, 5% Sodium Silicate, 42° BE 1.4% Sulfuric Acid, 66° BE		210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	140 / 60
Phenol	100	NR	NR	NR	–	–	NR	NR
Phenol Sulfonic Acid	100	NR	NR	NR	–	–	NR	NR
Phosphoric Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	150 / 66
(Super Phosphoric Acid 76% P_2O_5)	105	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	150 / 66
Phosphoric Acid Fumes	All	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	150 / 66
Phosphorous Pentoxide	1-54	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	140 / 60
Phosphorous Trichloride	100	NR	NR	NR	NR	NR	NR	NR
Phthalic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	–	–
Pickle Liquor (5)		Consult Laboratory						
Picric Acid, Alcoholic	10	100 / 38	–	100 / 38	100 / 38	–	–	NR
Polymer (Aqueous Acrylic Emulsion)	All	120 / 49	120 / 49	120 / 49	120 / 49	–	–	100 / 38
Polymer (Polyester Water Reducible)	All	120 / 49	120 / 49	120 / 49	120 / 49	–	–	100 / 38
Polyvinyl Acetate Latex	All	210 / 99	210 / 99	210 / 99	210 / 99	–	–	–
Polyvinyl Alcohol	100	100 / 38	100 / 38	120 / 49	120 / 49	120 / 49	–	–
Polyvinyl Chloride Latex with 35 parts DOP		120 / 49	120 / 49	120 / 49	120 / 49	120 / 49	–	–
Potassium Aluminum Sulfate	All	210 / 99	210 / 99	210 / 99	250 / 121	250 / 121	140 / 60	150 / 66
Potassium Bicarbonate	1-50	150 / 66	150 / 66	150 / 66	150 / 66	–	–	150 / 66
Potassium Bromide	All	160 / 71	160 / 71	160 / 71	160 / 71	–	–	150 / 66
Potassium Carbonate	All	150 / 66	150 / 66	150 / 66	150 / 66	–	–	150 / 66
Potassium Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Potassium Dichromate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Potassium Ferricyanide	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Potassium Ferrocyanide	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Potassium Hydroxide (2)(4)	1-10	150 / 66	150 / 66	150 / 66	150 / 66	150 / 66	–	–
	15	180 / 82	180 / 82	180 / 82	180 / 82	–	–	–
Potassium Nitrate (2) (4)	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Potassium Permanganate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	–	150 / 66
Potassium Persulfate	All	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	150 / 66
Potassium Sulfate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Propionic Acid	20	200 / 93	200 / 93	200 / 93	200 / 93	–	140 / 60	140 / 60
	50	180 / 82	180 / 82	180 / 82	180 / 82	–	–	NR
	100	NR	NR	NR	80 / 27	–	–	NR
Propylene Glycol	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Pulp Paper Mill Effluent (5)		Consult Laboratory						
Pyridine	100	NR	NR	NR	NR	NR	NR	NR
Q								
Quaternary Amine Salts Aqueous	All	120 / 49	120 / 49	150 / 66	150 / 66	–	–	–

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		Maximum Recommended Temperature °F/°C						
Chemical	**Concentration Percentage by Weight**	**VE8100 VE8300 VE8360**	**VE8440 VE8450**	**VE8710**	**VE8730**	**VE8770**	**VE8515**	**VE8550**
Quaternary Amine Salts Non-aqueous (5)		–	–	–	–	–	–	
S								
Salicylic Acid	All	160 / 71	160 / 71	160 / 71	160 / 71	–	–	–
Sebacic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	–
Salt Water (see Water, Salt)								
Sea Water (see Water, Sea)								
Selenius Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	–
Silver Nitrate	All	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	–
Silver Plating Solution: 4% Silver Cyanide 7% Potassium Cyanide 5% Sodium Cyanide 2% Potassium Carbonate		180 / 82	180 / 82	180 / 82	180 / 82	–	–	–
Soaps, Aqueous	All	200 / 93	200 / 93	200 / 93	200 / 93	200 / 93	140 / 60	–
Sodium Acetate	All	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	150 / 66
Sodium Akyl Aryl Sulfonates	All	150 / 66	150 / 66	150 / 66	180 / 82	150 / 66	100 / 38	120 / 49
Sodium Aluminate	All	160 / 71	160 / 71	160 / 71	160 / 71	–	–	100 / 38
Sodium Benzoate	100	180 / 82	180 / 82	180 / 82	180 / 82	–	–	150 / 66
Sodium Bicarbonate (2)	All	180 / 82	180 / 82	180 / 82	180 / 82	–	100 / 38	150 / 66
Sodium Bifluoride (2)	All	120 / 49	120 / 49	120 / 49	–	–	–	100 / 38
Sodium Bisulfate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Bisulfite	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Bromate (2)	10	140 / 60	140 / 60	140 / 60	140 / 60	–	140 / 60	150 / 66
Sodium Bromide	All	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	150 / 66
Sodium Carbonate	1-25 35	180 / 82 160 / 71	180 / 82 160 / 71	180 / 82 160 / 71	180 / 82 160 / 71	– –	– –	150 / 66 150 / 66
Sodium Chlorate (2)	All	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	150 / 66
Sodium Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Chlorite (1) (2) (4) pH 4-8	10 50	150 / 66 100 / 38	150 / 66 100 / 38	150 / 66 100 / 38	150 / 66 120 / 49	– –	100 / 38 –	100 / 38 –
Sodium Chromate	50	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Citrate	Sat	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Cyanide	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Sodium Dichromate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Di-Phosphate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Ferricyanide	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Ferrocyanide	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Fluoride (2)	All	180 / 82	180 / 82	180 / 82	180 / 82	–	–	150 / 66
Sodium Fluorosilicate (2)	All	150 / 66	150 / 66	150 / 66	120 / 49	–	–	100 / 38
Sodium Hexametaphosphates	All	120 / 49	120 / 49	120 / 49	120 / 49	–	–	100 / 38
Sodium Hydrosulfide	All	180 / 82	180 / 82	180 / 82	180 / 82	–	–	150 / 66
Sodium Hydroxide (2) (4)	1 5 10 25 50	180 / 82 180 / 82 150 / 66 180 / 82 200 / 93	180 / 82 180 / 82 150 / 66 180 / 82 200 / 93	200 / 93 200 / 93 200 / 93 200 / 93 200 / 93	150 / 66 150 / 66 120 / 49 150 / 66 180 / 82	– – – – –	120 / 49 – – – –	NR NR NR NR NR
Sodium Hypochlorite (1)(2)(4)	1–5 10–15	180 / 82 150 / 66	180 / 82 150 / 66	180 / 82 150 / 66	150 / 66 130 / 54	– –	– –	– –
Sodium Lauryl Sulfate	All	180 / 82	180 / 82	180 / 82	150 / 66	–	–	–

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VE Chemical Resistance, continued

Chemical	Concentration Percentage by Weight	VE8100 VE8300 VE8360	VE8440 VE8450	VE8710	VE8730	VE8770	VE8515	VE8550
		Maximum Recommended Temperature °F/°C						
Sodium Monophosphate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Nitrate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Nitrite	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sodium Persulfate	20	130 / 54	130 / 54	130 / 54	–	–	–	100 / 38
Sodium Silicate	All	210 / 99	210 / 99	210 / 99	–	–	–	150 / 66
Sodium Sulfate	All	210 / 99	210 / 99	210 / 99	210 / 99	–	–	150 / 66
Sodium Sulfide	All	210 / 99	210 / 99	210 / 99	210 / 99	–	–	150 / 66
Sodium Sulfite	All	210 / 99	210 / 99	210 / 99	210 / 99	–	–	150 / 66
Sodium Tetraborate	All	180 / 82	180 / 82	180 / 82	180 / 82	–	–	150 / 66
Sodium Thiocyanate	57	180 / 82	180 / 82	180 / 82	180 / 82	–	–	150 / 66
Sodium Thiosulfate	All	180 / 82	180 / 82	180 / 82	180 / 82	–	–	150 / 66
Sodium Tripolyphosphate	Sat	210 / 99	210 / 99	210 / 99	210 / 99	–	–	150 / 66
Sodium Xylene Sulfonate	All	210 / 99	210 / 99	210 / 99	–	–	–	–
Sorbitol Solutions	All	150 / 66	150 / 66	150 / 66	–	–	–	–
Sour Crude Oil (see Crude Oil, Sour)								
Soya Oil	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Stannic Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Stannous Chloride	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Stearic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Styrene (4)	100	NR	NR	NR	100 / 38	100 / 38	NR	NR
Succinonitrile	All	100 / 38	100 / 38	100 / 38	100 / 38	–	–	NR
Sugar, Beet and Cane Liquor	All	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	120 / 49	–
Sugar, Sucrose	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	–
Sulfamic Acid	1–10	200 / 93	200 / 93	200 / 93	200 / 93	200 / 93	–	150 / 66
Sulfanilic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	150 / 66
Sulfated Detergents	All	200 / 93	200 / 93	200 / 93	200 / 93	200 / 93	120 / 49	120 / 49
Sulfur Dioxide Gas, Dry or Wet	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Sulfur Trioxide Gas/Air	All	210 / 99	210 / 99	210 / 99	250 / 121	250 / 121	140 / 60	150 / 66
Sulfuric Acid	1–49 50–60 75 93	200 / 93 180 / 82 100 / 38 NR	200 / 93 180 / 82 100 / 38 NR	200 / 93 180 / 82 120 / 49 NR	200 / 93 180 / 82 120 / 49 NR	200 / 93 180 / 82 100 / 38 NR	140 / 60 120 / 49 NR NR	150 / 66 150 / 66 NR NR
Sulfurous Acid	All	100 / 38	100 / 38	100 / 38	100 / 38	–	–	100 / 38
Superphosphoric Acid, 76% P_2O_5		210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	150 / 66
T								
Tall Oil	100	150 / 66	150 / 66	150 / 66	200 / 93	–	–	–
Tannic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Tartaric Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Tetrachloroethylene	100	80 / 27	80 / 27	80 / 27	100 / 38	100 / 38	NR	NR
Tetrasodium Ethylene Diamine Tetraacetic Acid	All	120 / 49	120 / 49	120 / 49	150 / 66	–	–	150 / 66
Thioglycolic Acid	10	NR	NR	NR	100 / 38	–	–	NR
Thionyl Chloride	100	NR	NR	NR	NR	NR	NR	NR
Tin Plating: 18% Stannous Fluoroborate 7% Tin 9% Fluorboric Acid 2% Boric Acid		200 / 93	200 / 93	200 / 93	200 / 93	–	–	–

Conc – Concentrated
Sat'd – Saturated
NR – Not Recommended
– No Data on Environment
(1) BPO/DMA Cure Recommended
(2) Synthetic Veil Recommended
(3) C-Glass Recommended
(4) Post-Cure Recommended
(5) Consult Laboratory for Specific Recommendation

All services within 20°F/11°C maximum service temperature should be post-cured to ensure a long service life.

VE Chemical Resistance, continued

Chemical	Concentration Percentage by Weight	VE8100 VE8300 VE8360	VE8440 VE8450	VE8710	VE8730	VE8770	VE8515	VE8550
		Maximum Recommended Temperature °F/°C						
Toluene (4)	100	NR	NR	80 / 27	100 / 38	100 / 38	NR	NR
Toluene Sulfonic Acid	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Transformer Oils:								
Mineral Oil Types	100	210 / 99	210 / 99	210 / 99	300 / 149	300 / 149	140 / 60	140 / 60
Chloro-Phenyl Types	100	NR	NR	NR	–	–	NR	NR
Trichloroacetic Acid	50	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	140 / 60	140 / 60
Trichloroethane	100	–	–	100 / 38	120 / 49	120 / 49	–	NR
Trichloroethylene	100	NR	NR	NR	NR	NR	NR	NR
Trichloromonofluoromethane (2)	100	80 / 27	80 / 27	100 / 38	100 / 38	100 / 38	–	NR
Trichlorophenol	100	NR	NR	NR	NR	NR	NR	NR
Tricresyl Phosphate	100	100 / 38	100 / 38	120 / 49	120 / 49	–	–	–
Tridecylbenzene Sulfonate	All	210 / 99	210 / 99	210 / 99	210 / 99	210 / 99	–	–
Triethanolamine	100	120 / 49	120 / 49	120 / 49	120 / 49	120 / 49	–	NR
Trimethylene Chlorobromide	100	NR	NR	NR	NR	NR	NR	NR
Trisodium Phosphate	All	210 / 99	210 / 99	210 / 99	250 / 121	–	–	150 / 66
Turpentine	100	100 / 38	100 / 38	150 / 66	150 / 66	150 / 66	NR	NR
U								
Urea	1–50	150 / 66	150 / 66	150 / 66	150 / 66	–	–	120 / 49
Urea Formaldehyde Resin	100	100 / 38	100 / 38	100 / 38	120 / 49	120 / 49	–	NR
V								
Vegetable Oils	100	180 / 82	180 / 82	180 / 82	180 / 82	180 / 82	–	–
Vinegar	100	210 / 99	210 / 99	210 / 99	210 / 99	–	140 / 60	120 / 49
Vinyl Acetate	100	NR	NR	NR	–	–	NR	NR
Vinyl Toluene (4)	100	80 / 27	80 / 27	80 / 27	120 / 49	120 / 49	–	NR
W								
Water								
Deionized	100	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	120 / 49	150 / 66
Demineralized	100	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	120 / 49	150 / 66
Distilled	100	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	120 / 49	150 / 66
Fresh	100	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	120 / 49	150 / 66
Salt	100	200 / 93	200 / 93	200 / 93	200 / 93	150 / 66	120 / 49	150 / 66
Sea	100	180 / 82	180 / 82	180 / 82	180 / 82	150 / 66	120 / 49	150 / 66
White Liquor (Pulp Mill)	100	180 / 82	180 / 82	180 / 82	180 / 82	–	–	150 / 66
X								
Xylene (4)	100	NR	NR	80 / 27	100 / 38	100 / 38	NR	NR
Z								
Zinc Chlorate	All	210 / 99	210 / 99	210 / 99	250 / 121	250 / 121	140 / 60	150 / 66
Zinc Nitrate	All	210 / 99	210 / 99	210 / 99	250 / 121	250 / 121	140 / 60	150 / 66
Zinc Plating Solution: 9% Zinc Cyanide, 4% Sodium Cyanide, 9% Sodium Hydroxide		160 / 71	160 / 71	160 / 71	160 / 71	–	–	–
Zinc Plating Solution 49% Zinc Fluoborate, 5% Ammonium Chloride, 6% Ammonium Fluoroborate		200 / 93	200 / 93	200 / 93	200 / 93	–	–	–
Zinc Sulfate	All	210 / 99	210 / 99	210 / 99	250 / 121	–	–	150 / 66

Conc – Concentrated
Sat'd – Saturated
NR – Not Recommended
– No Data on Environment
(1) BPO/DMA Cure Recommended
(2) Synthetic Veil Recommended
(3) C-Glass Recommended
(4) Post-Cure Recommended
(5) Consult Laboratory for Specific Recommendation

All services within 20°F/11°C maximum service temperature should be post-cured to ensure a long service life.

Visit www.ResinWizard.com for general recommendations for CoREZYN vinyl ester, modified vinyl ester and isophthalic resins based on basic inputs from you. It is simple and fast to use.

Modified Vinyl Ester Products

Interplastic Corporation manufactures a series of CoREZYN modified vinyl ester resins (CoREZYN MVR). These products exhibit many of the same characteristics as their vinyl ester counterparts—they are tough, versatile, corrosion resistant and easy to work with. They do not offer the performance extremes of the straight vinyl esters, but where that maximum performance is not required, the modified vinyl esters offer an excellent cost-saving alternative. The number coding system for these products is simple—products ending in "0" are non-promoted resins; those ending in "1" are pre-promoted.

MVR8000

Versatile and Economical

This resin is the modified counterpart of VE8300. It has good corrosion resistance and physical properties, with all the functional versatility of the vinyl ester product. It is an economical choice where optimum vinyl ester corrosion resistance is not required.

Related Products:

MVR8001

A pre-promoted version of MVR8000.

MVR8021

A pre-promoted, thixotropic version of MVR8000. It is excellent for use where surfaces contact water, such as boats, pools, and spas.

Brookfield viscosity at 77°F (25°C); #3 spindle at 60 rpm is 500 cps and the gel time is 15-20 minutes.

MVR8031

A pre-promoted thixotropic modified vinyl ester resin. CoREZYN MVR8031 is designed for marine laminate construction where optimum properties in physicals, hydrolytic stability and surface characteristic retention are desired.

Brookfield viscosity at 77°F (25°C); #3 spindle at 60 rpm is 500 cps and the gel time is 15-20 minutes.

MVR8031LH Series

Low HAP

These promoted, thixotropic, modified vinyl ester resins are designed specifically for marine laminate construction. They contain a maximum of 35% styrene (HAP) by weight meeting the EPA requirements for the National Emission Standards for Hazardous Air pollutants for Boat Manufacturing as well as the high strength requirements in the National Emission Standards for Hazardous Air Pollutants for Reinforced Plastic Composites Production.

They also have good exotherms for good cosmetic surface and minimal glass print in thin layers. They also have fast Barcol development.

Related Products:

The MVR8031LH-15 has a gel time of 14-20 minutes.

The MVR8031LH-20 has a gel time of 19-25 minutes.

The MVR8031LH-25 has a gel time of 24-30 minutes.

The MVR8031LH-30 has a gel time of 30-38 minutes.

The MVR8031LH-40 has a gel time of 40-50 minutes.

Composite grating is functional and durable at Mandalay Bay.

The clear casting and laminate properties, as well as gel times of CoREZYN modified vinyl ester resins, are described in the following tables.

Table 15: Typical Clear Casting Properties

Property	MVR 8000	MVR 8021	MVR 8031	MVR 8031LH
Tensile Strength, psi/MPa	11,900 / 82.1	9,500 / 65.5	10,000 / 69.0	10,900 / 75.2
Tensile Modulus, psi/GPa	539,000 / 3.72	500,000 / 3.45	540,000 / 3.72	500,000 / 3.45
Tensile Elongation, %	4.5	4.5	3.5	2.7
Flexural Strength, psi/MPa	19,000 / 131	18,000 / 124	19,000 / 131	18,000 / 128
Flexural Modulus, psi/GPa	473,000 / 3.26	460,000 / 3.17	530,000 / 3.66	500,00 / 3.45
Heat Distortion Temp., °F/°C	210 / 99	210 / 99	250 / 121	228 / 108
Barcol Hardness, 934-1	30-36	30-38	35-45	30-38
Specific Gravity	1.16	1.16	1.15	1.15

Table 16: Typical Laminate Properties

Property	MVR 8000	MVR 8021	MVR 8031	MVR 8031LH
Tensile Strength, psi/MPa	22,900 / 158	22,500 / 155	23,200 / 160	23,000 / 159
Tensile Modulus, psi/GPa	1,520,000 / 10.5	15,500,000 / 10.7	15,300,000 / 10.6	15,400,000 / 10.6
Tensile Elongation, %	1.8	1.8	1.7	1.7
Flexural Strength, psi/MPa	30,100 / 208	30,500 / 210	30,700 / 212	29,900 / 206
Flexural Modulus, psi/GPa	10,400,000 / 7.17	10,300,000 / 7.10	10,600,000 / 7.31	10,300,000 / 7.10
Barcol Hardness, 934-1	40-46	40-46	42-48	42-50

Laminate Constrution: Veil/Mat/Mat/WR/Mat/WR/MAT
Veil = 10 MIL C-Glass
Mat = 1.5 oz. per sq. ft.
WR = 24 oz. per sq. ft.
(Glass Content 40%)

Room temperature curing of the MVR products can be accomplished using the following system: Catalyst range — (50%) MEKP: 0.75-2.50 phr
Promoter range — (12%) Cobalt: 0.10-0.25 phr
Activator range — DMA: 0-0.25 phr

Typical gel times when using this system are shown below.

Table 17: Typical 100 Gram Cup Gel Times (Minutes) at 77°F/25°C Using 1.2 phr of (50%) MEKP

DMA WT%	12% Cobalt WT%	MVR8000
0	0.10	75
	0.15	67
	0.20	55
0.05	0.10	29
	0.15	21
	0.20	18
0.10	0.10	15
	0.15	11
	0.20	9
0.15	0.10	11
	0.15	9
	0.20	6

Table 18: Catalyst-Promoter Measurements for CoREZYN Vinyl Ester Resins

12% Cobalt percent	cc/gal	cc/drum[1]	cc/lb	oz/gal[2]	oz/drum[1,2]	oz/lb[2]
0.05	2	100	0.22	0.07	3.6	0.008
0.10	4	200	0.44	0.14	7.2	0.016
0.15	6	300	0.66	0.21	10.8	0.024
0.20	8	400	0.88	0.28	14.4	0.032
0.25	10	500	1.10	0.35	18.0	0.040

DMA[3] percent	cc/gal	cc/drum[1]	cc/lb	oz/gal[2]	oz/drum[1,2]	oz/lb[2]
0.05	2	100	0.22	0.07	3.6	0.008
0.10	4	200	0.44	0.14	7.2	0.016
0.15	6	300	0.66	0.21	10.8	0.024
0.20	8	400	0.88	0.28	14.4	0.032
0.25	10	500	1.10	0.35	18.0	0.040

50% MEKP[4] percent	cc/gal	cc/lb	oz/gal[2]	oz/lb[2]
1.00	40	4.5	1.4	0.155
1.25	50	5.6	1.7	0.195
1.50	60	6.8	2.0	0.23
1.75	70	8.0	2.4	0.28
2.00	80	9.2	2.7	0.31

1. 450 pound drum

2. oz is fluid ounces

3. N, N-Dimethylaniline

4. • L-50a (Akzo Nobel®)
• DHD-9 (Arkema)
• Hi-Point 90 (Chemtura Corporation)
• MEKP-925 (Norac® Company)

The densities of MEKP can vary. The amount of MEKP used may need to be altered. Consult your peroxide supplier for their most current information.

Weather-resistant grating keeps its beauty and lasts longer with CoREZYN vinyl esters.

Table 19: Reinforced Thermoset Plastic (RTP) Corrosion Resistant Equipment Standard Laminate Composition Type 1

Nominal Thickness, in./mm [Notes (1), (2)]	Sequence of Plies 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Drafting Symbols
0.18/4.57	V	M	M	M	M	—	—	—	—	—	—	—	—	—	—	—	—	—	V,4M
0.23/5.84	V	M	M	M	M	M	—	—	—	—	—	—	—	—	—	—	—	—	V,5M
0.27/6.86	V	M	M	M	M	M	M	—	—	—	—	—	—	—	—	—	—	—	V,6M
0.31/7.87	V	M	M	M	M	M	M	M	—	—	—	—	—	—	—	—	—	—	V,7M
0.35/8.89	V	M	M	M	M	M	M	M	M	—	—	—	—	—	—	—	—	—	V,8M
0.40/10.2	V	M	M	M	M	M	M	M	M	M	—	—	—	—	—	—	—	—	V,9M
0.44/11.2	V	M	M	M	M	M	M	M	M	M	M	—	—	—	—	—	—	—	V,10M
0.48/12.2	V	M	M	M	M	M	M	M	M	M	M	M	—	—	—	—	—	—	V,11M
0.53/13.5	V	M	M	M	M	M	M	M	M	M	M	M	M	—	—	—	—	—	V,12M
0.57/14.5	V	M	M	M	M	M	M	M	M	M	M	M	M	M	—	—	—	—	V,13M
0.61/15.5	V	M	M	M	M	M	M	M	M	M	M	M	M	M	M	—	—	—	V,14M
0.66/16.8	V	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	—	—	V,15M
0.70/17.8	V	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	—	V,16M
0.74/18.8	V	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	V,17M

GENERAL NOTES:

(a) Thicknesses above 0.74 in. nominal can be used by adding additional plies of mat.
(b) Actual thickness and glass content of each sequence of plies shall be established by each fabricator based on design basis laminate.
(c) Corrosion barrier (plies 1, 2, 3) shall gel and exotherm before structural plies are added.
(d) Structural lay-up may be interrupted at intervals long enough to exotherm in accordance with fabricator's procedure.
(e) A weight equivalent layer of layers of chopped strand glass or mat may be used in place of layers of 1.5 oz. mat.

NOTES:

(1) Nominal thickness is calculated as follows:
V = 10 Mil Surface Mat (Veil) – 0.010 in. ply
M = 1 oz/sq. ft. Mat – 0.043 in. ply

(2) This information is based on historical data and may not reflect all laminates made today. Laminates made today are often thinner and have a higher glass content than noted in the table. The table should be used for establishing minimum glass plies per nominal laminate thickness. Ply thickness should be based on design basis laminates.

Typical NBS 15-69 Construction

Liner: 110 to 120 mils
(A)— 10 to 20 mils
90% Resin
10% Veil Material: C-Glass, Polyester, Mod Acrylic, or Others
(B)— 100 mils
72% Resin
28% Chopped Glass or Glass Mat (2 layers of 1-1/2 oz Mat)

Structural: (C)— Thickness as Required for Service
(1) Filament Wound: 30% Resin
70% Continuous Strand Glass
(2) Hand Lay-up: 50 to 70% Resin
Glass Mat, Woven Roving, or Combinations
(3) Combination of Filament Wound and Chopped Glass

ASTM Reinforced Plastic Related Standards

ANSI/ASTM E 84	Surface Burning Characteristics of Building Materials
ASTM D 229	Testing Rigid Sheet and Plate Materials used in Electrical Insulation
ASTM D 256	Impact Resistance of Plastic and Electrical Insulating Materials
ASTM F 412	Standard Definition of Terms Relating to Plastic Piping Systems
ANSI/ASTM D 445	Kinematic Viscosity of Transparent and Opaque Liquids
ASTM D 543	Resistance of Plastics to Chemical Reagents
ANSI/ASTM D 570	Water Absorption of Plastics
ASTM D 579	Woven Glass Fabrics
ASTM C 581	Chemical Resistance of Thermosetting Resins Used in Glass Fiber-Reinforced Structures
ASTM D 618	Conditioning Plastics and Electrical Insulating Materials for Testing
ASTM D 621	Deformation of Plastics Under Load
ANSI/ASTM D 635	Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ANSI/ASTM D 638	Tensile Properties of Plastics
ASTM D 648	Deflection Temperature of Plastics Under Flexural Load
ASTM D 671	Flexural Fatigue of Plastics by Constant-Amplitude-of-Force
ASTM D 674	Long-Time Creep or Stress-Relation Test of Plastics Under Tension or Compression Loads at Different Temperatures
ANSI/ASTM D 695	Compressive Properties of Rigid Plastics
ASTM D 696	Coefficient of Linear Thermal Expansion of Plastics
ASTM D 747	Stiffness of Plastics by Means of Cantilever Beam
ASTM D 759	Determining the Physical Properties of Plastics at Subnormal and Supernormal Temperatures
ASTM D 785	Rockwell Hardness of Plastics and Electrical Insulating Materials
ASTM D 790	Flexural Properties of Plastics
ASTM D 792	Specific Gravity and Density of Plastics by Displacement
ASTM D 883	Definition of Terms Relating to Plastics
ASTM D 1045	Sampling and Testing Plasticizers Used in Plastics
ASTM D 1180	Bursting Strength of Round Rigid Plastic Tubing
ANSI/ASTM D 1200	Viscosity of Paints, Varnishes, and Lacquers by the Ford Viscosity Cup
ANSI/ASTM D 1598	Time-To-Failure of Plastic Pipe Under Constant Internal Pressure
ASTM D 1599	Short-Time Rupture Strength of Plastic Pipe, Tubing, and Fittings
ASTM D 1600	Abbreviation of Terms Related to Plastics
ASTM D 1694	Threads of Reinforced Thermoset Resin Pipe
ASTM D 2105	Longitudinal Tensile Properties of Reinforced Thermosetting Plastic Pipe and Tube
ANSI/ASTM D 2122	Determining Dimensions of Thermoplastic Pipe and Fittings
ASTM D 2143	Cyclic Pressure Strength of Reinforced Thermosetting Plastic Pipe
ASTM D 2150	Specification for Woven Roving Glass Fiber for Polyester Glass Laminates
ASTM D 2153	Calculating Stress in Plastic Pipe Under Internal Pressure
ASTM D 2290	Apparent Tensile Strength of Ring or Tubular Plastics by Split Disk Method
ASTM D 2310	Classification for Machine-Made Reinforced Thermosetting Resin Pipe Standard
ANSI/ASTM D 2321	Underground Installation of Flexible Thermoplastic Sewer Pipe
ASTM D 2343	Tensile Properties of Glass Fiber Strands, Yarns, and Roving Used in Reinforced Plastics
ASTM D 2344	Apparent Horizontal Shear Strength of Reinforced Plastics by Short Beam Method
ASTM D 2412	External Loading Properties of Plastic Pipe by Parallel-Plate Loading
ANSI/ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2517	Reinforced Thermosetting Plastic Gas Pressure Pipe and Fittings
ANSI/ASTM D 2563	Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
ASTM D 2583	Indentation Hardness of Plastics by Means of a Barcol Impressor
ASTM D 2584	Ignition Loss of Cured Reinforced Resins
ASTM D 2585	Preparation and Tension Testing of Filament-Wound Pressure Vessels
ASTM D 2586	Hydrostatic Compressive Strength of Glass Reinforced Plastics Cylinders
ASTM D 2733	Interlaminar Shear Strength of Structural Reinforced Plastics at Elevated Temperatures
ASTM D 2774	Underground Installation of Thermoplastic Pressure Piping
ASTM D 2924	Test for External Pressure Resistance of Plastic Pipe
ASTM D 2925	Beam Deflection of Reinforced Thermoset Plastic Pipe Under Full Bore Flow
ASTM D 2990	Tensile and Compressive Creep-Rupture of Plastics
ASTM D 2991	Stress Relaxation of Plastics
ASTM D 2992	Obtaining Hydrostatic Design Basis for Reinforced Thermosetting Resin Pipe
ASTM D 2996	Specification for Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D 2997	Specification for Centrifugally Cast Reinforced Thermosetting Resin Pipe
ANSI/ASTM D 3262	Reinforced Plastic Mortar Sewer Pipe
ASTM D 3282	Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D 3299	Filament-Wound Glass Fiber-Reinforced Polyester Chemical-Resistant Tanks
ASTM D 3517	Specification for Reinforced Plastic Mortar Pressure Pipe
ASTM D 3567	Determining Dimensions of Reinforced Thermosetting Resin Pipe and Fittings
ASTM D 3615	Test for Chemical Resistance of Thermoset Molded Compounds Used in Manufacture
ASTM D 3681	Chemical Resistance of Reinforced Thermosetting Resin Pipe in the Deflected Condition
ASTM D 3753	Glass-Fiber-Reinforced Polyester Manholes
ASTM D 3754	Specification for Reinforced Plastic Mortar Sewer and Industrial Pressure Pipe
ASTM D 3839	Recommended Practice for Underground Installation of Flexible RTRP and RPMP
ASTM D 3840	Specification for RP Mortar Pipe Fittings for Nonpressure Applications
ASTM D 4097	Specification for Contact Molded Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks

ASTM = The American Society for Testing and Materials

ANSI = The American National Standards Institute

Table 20: Temperature Equivalents—Celsius/Fahrenheit

Celsius		Fahrenheit
-128.9	-200	-328.0
-73.3	-100	-148.0
-67.8	-90	-130.0
-62.2	-80	-112.0
-56.7	-70	-94.0
-51.1	-60	-76.0
-45.6	-50	-58.0
-40.0	-40	-40.0
-34.4	-30	-22.0
-28.9	-20	-4.0
-23.3	-10	14.0
-17.8	0	32.0
-17.2	1	33.8
-16.7	2	35.6
-16.1	3	37.4
-15.6	4	39.2
-15.0	5	41.0
-14.4	6	42.8
-13.9	7	44.6
-13.3	8	46.4
-12.8	9	48.2
-12.2	10	50.0
-11.7	11	51.8
-11.1	12	53.6
-10.6	13	55.4
-10.0	14	57.2
-9.4	15	59.0
-8.9	16	60.8
-8.3	17	62.6
-7.8	18	64.4
-7.2	19	66.2
-6.7	20	68.0
-6.1	21	69.8
-5.6	22	71.6
-5.0	23	73.4
-4.4	24	75.2
-3.9	25	77.0
-3.3	26	78.8
-2.8	27	80.6
-2.2	28	82.4
-1.7	29	84.2
-1.1	30	86.0
-0.6	31	87.8
0.0	32	89.6
0.6	33	91.4
1.1	34	93.2

Celsius		Fahrenheit
1.7	35	95.0
2.2	36	96.8
2.8	37	98.6
3.3	38	100.4
3.9	39	102.2
4.4	40	104.0
5.0	41	105.8
5.6	42	107.6
6.1	43	109.4
6.7	44	111.2
7.2	45	113.0
7.8	46	114.8
8.3	47	116.6
8.9	48	118.4
9.4	49	120.2
10.0	50	122.0
10.6	51	123.8
11.1	52	125.6
11.7	53	127.4
12.2	54	129.2
12.8	55	131.0
13.3	56	132.8
13.9	57	134.6
14.4	58	136.4
15.0	59	138.2
15.6	60	140.0
16.1	61	141.8
16.7	62	143.6
17.2	63	145.4
17.8	64	147.2
18.3	65	149.0
18.9	66	150.8
19.4	67	152.6
20.0	68	154.4
20.6	69	156.2
21.1	70	158.0
21.7	71	159.8
22.2	72	161.6
22.8	73	163.4
23.3	74	165.2
23.9	75	167.0
24.4	76	168.8
25.0	77	170.6
25.6	78	172.4
26.1	79	174.2
26.7	80	176.0

Celsius		Fahrenheit
27.2	81	177.8
27.8	82	179.6
28.3	83	181.4
28.9	84	183.2
29.4	85	185.0
30.0	86	186.8
30.6	87	188.6
31.1	88	190.4
31.7	89	192.2
32.2	90	194.0
32.8	91	195.8
33.3	92	197.6
33.9	93	199.4
34.4	94	201.2
35.0	95	203.0
35.6	96	204.8
36.1	97	206.6
36.7	98	208.4
37.2	99	210.2
37.8	100	212.0
43	110	230
49	120	248
54	130	266
60	140	284
66	150	302
71	160	320
77	170	338
82	180	356
88	190	374
93	200	392
99	210	410
100	212	414
104	220	428
110	230	446
116	240	464
121	250	482
127	260	500
132	270	518
138	280	536
143	290	554
149	300	572
154	310	590
160	320	608
166	330	626
171	340	644
177	350	662

$°C = \frac{°F - 32}{1.818}$ $\quad$ $°F = [°C \times 1.818] + 32$

Table 21: Metric/U.S. Conversion Equivalents

	Metric Units	U.S. Equivalents	U.S. System Units	Metric Equivalents
Lengths	1 millimeter	0.03937 inches	1 inch	25.4 millimeters or 2.54 centimeters
	1 centimeter	0.3937 inches	1 foot	0.3048 meters
	1 meter	39.37 inches or 1.0936 yards	1 yard	0.9144 meters
	1 kilometer	1093.61 yards or 0.6214 miles	1 mile	1.6093 kilometers
Areas	1 square millimeter	0.00155 square inches	1 square inch	645.16 square millimeters or 6.452 square centimeters
	1 square centimeter	0.155 square inches	1 square foot	0.0929 square meters
	1 square meter	10.764 square feet or 1.196 square yards	1 square yard	0.8361 square meters
	1 square kilometer	0.3861 square miles	1 square mile	2.59 square kilometers
Volumes	1 cubic millimeter	0.000061 cubic inches	1 cubic inch	16,387.2 cubic millimeters or 16.3872 cubic centimeters
	1 cubic centimeter	0.061 cubic inches	1 cubic foot	0.02832 cubic meters
	1 cubic liter	61.025 cubic inches	1 cubic yard	0.7646 cubic meters
	1 cubic meter	35.314 cubic feet or 1.3079 cubic yards		
Capacities	1 milliliter (0.001 liter)	0.0338 U.S. fluid ounces	1 U.S. fluid ounce	29.573 milliliters
	1 liter	2.1134 U.S. liquid pints	1 U.S. liquid pint	0.47317 liters
	1 liter	1.0567 U.S. liquid quarts	1 U.S. liquid quart	0.94633 liters
	1 liter	0.2642 U.S. gallon	1 U.S. gallon	3.78533 liters
Weights	1 gram	0.03527 avoir. ounces or 15.4324 grains	1 grain	0.0648 grams
			1 avoir. ounce	28.35 grams
	1 kilogram (1,000 grams)	2.2046 avoir. pounds	1 avoir. pound	0.4536 kilograms
			1 Troy ounce	31.1035 grams

FDA-Approvability

The basic vinyl ester resins used for FDA-approvable FRP composites are VE8300, VE8301, VE8100, VE8101, VE8360 and VE8361. These products are manufactured from products listed in Title 21 of *The Code of Federal Regulations* (CFR).

The levels of the residual components in the final FRP composite are critical to determine if the composite will pass the extraction tests outlined in the CFR for plastics that have contact with food products.* Processing entails the curing, post-curing, and cleaning of the parts. The finished fiberglass part should be post-cured. Refer to the Post-Cure Schedule on page 12. After it is post-cured, it should be washed with a mixture of soap and water. The final step is to rinse the FRP composite with clean water to remove any remaining residual contaminates.

**The residuals are dependent on all of the ingredients, as well as processing.*

Storage of Resin

To ensure the maximum efficiency of the inhibitors and shelf life of resin, bubble dry, clean air into the vinyl ester resin drum weekly for 30 minutes at 1 cfm.

Warranty

These products should be stored below 77°F (25°C). CoREZYN vinyl ester resins are guaranteed for 90 days from the date of manufacture.

The Use of Antimony Trioxide in Fire Resistant Resins

Antimony trioxide should be added immediately before using the resin and only to enough resin for an eight-hour period. If the antimony is added and the resin is not used in eight hours, the gel time can increase and cause gel and cure problems. When using resin that has had antimony trioxide added over eight hours before, the gel time and cure profile should be checked to ensure it will gel and cure, as well as perform properly, in the specific application. An additional 0.05 weight per percent of 12% cobalt can be added to reduce the gel time. If a further decrease in gel time is required, a maximum addition of 0.05% DMA may be incorporated.

Cured-in-place pipe installation.

All specifications and properties specified are approximate. Specifications and properties of material delivered may vary slightly from those given within. Interplastic Corporation makes no representations of fact regarding the material except those specified within. No person has any authority to bind Interplastic Corporation to any representation except those specified within. Final determination of the suitability of the material for the use contemplated is the sole responsibility of the Buyer. Sales representatives will assist in developing procedures to fit individual requirements.

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