

# Starting Formulation

## SF 9000

### Epoxy Dispersion Formulations Cured with Dicyandiamide EPI-REZ™ Resins 3522-W-60, 5520-W-60, 5003-W-53 and WD-510

**Introduction** EPI-REZ™ Resin 3522-W-60, EPI-REZ Resin 5520-W-60 and EPI-REZ Resin 5003-W-55 are nonionic, completely aqueous dispersions of epoxy resins. EPI-REZ Resin WD-510 is a liquid, Bisphenol A epoxy resin specifically designed for water dilution. Typical properties of these products are shown in Table 1. Dicyandiamide can be used as a curing agent with these epoxy resins to provide extended pot life formulations which cure at elevated temperatures (for example, 300-350°F) to give highly crosslinked systems suitable for service at high temperature.

- Suggested Uses**
- Saturants for filtration media
  - Prepregs and composites
  - Nonwoven binders
  - Adhesives
  - Electrical insulating materials
  - Electrical dip coatings
  - Alternatives to Melamine, Phenolic, and Urea based binders

- Features**
- Completely water reducible
  - Zero to ultra low formaldehyde content
  - Extended pot life
  - B-stage capability
  - High crosslink density
  - High temperature performance
  - Good chemical resistance
  - Low color

Typical Properties Table 1 / Typical Properties of Epoxy Products

Product	Resin Description	Percent Nonvolatile	Volatile Component	WPE, on Solids, g/eq	Viscosity 25°C, cP <sup>1</sup>
EPI-REZ™ Resin 3522-W-60	Bisphenol A epoxy	60	Water	615-715	12,000
EPI-REZ Resin 5520-W-60	Urethane modified epoxy	59	Water	480-560	8000
EPI-REZ Resin 5003-W-55	Multifunctional BPA novolac epoxy	58	Water	195-215	7000
EPI-REZ Resin WD-510	Bisphenol A epoxy	100	None	190-205	10,000

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Example Formulations Table 2 / Example Formulations for Waterborne Epoxy Resins Cured with Dicyandiamide

<u>Material</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>
Parts by weight, as supplied					
EPI-REZ™ Resin 3522-W-60	100	–	–	–	–
EPI-REZ Resin 5520-W-60	–	100	–	–	–
EPI-REZ Resin 5003-W-55	–	–	100	–	–
EPI-REZ Resin WD-510	–	–	–	50	–
EPON™ Resin 1002F	–	–	–	–	65
HELOXY™ Modifier 8	–	–	–	5	–
Dicyandiamide (SKW Corp.)	1.2	1.4	3.5	3.4	1.2
2-Methyl imidazole (BASF Corp.)	0.15	0.15	0.10	0.10	0.08
Deionized water	21	21	13	50	–
Propylene glycol monomethyl ether	–	–	–	–	23
Methyl Ethyl Ketone	–	–	–	–	35

**Formulating Guidance** Dicyandiamide (dicy) is a high functionality (4-7) curing agent which promotes dense epoxy crosslinking at less than stoichiometric levels. The amount of dicy and amine catalyst in a formulation is critical in balancing cure response, pot life and performance properties. The recommended use range of dicy to achieve full cure varies by product due to the resin equivalent weight. For EPI-REZ Resin 3522-W-60, 1.5-2.4 parts dicy per hundred parts (pph) solid resin is recommended. For EPI-REZ Resin 5520-W-60, a suggested dicy level is 1.9-3.1 pph solid resin. For EPI-REZ Resin 5003-W-55, a suggested dicy level is 5.0-8.2 pph solid resin. And for EPI-REZ Resin WD-510, a suggested dicy level is 5.0-8.2 pph solid resin.

Those applications which require a highly crosslinked resin system, such as structural applications, would use higher dicy levels. When the application requires improved moisture resistance, such as for fiber sizings or finishes, lower levels of dicy, which is hygroscopic, should be used. Lower dicy levels may also be used when full epoxide cure is not required.

Imidazoles are the preferred accelerators for dicy since they promote higher Tg values and better moisture resistance than tertiary amine catalysts. A typical level of 2-methyl imidazole (2-MI) catalyst is 0.1 to 0.2 pph solid resin. Higher levels can be used for improved cure response with a resulting shorter pot life.

When EPIKURE™ Curing Agent 3253 substitution for 2-MI is made in the EPI-REZ Resin 3522-W-60 formulation, it meets the ingredient requirements of FDA regulation 21 CFR 175.300 Polymeric Coatings. If the end product is intended for contact with food, it must comply with the extraction limitations imposed by 21 CFR 175.300. Hexion has not run such tests and cannot convey any assurance as to the final suitability of these formulas under that regulation.

**Mixing Instructions** The epoxy resin products should be at room temperature (65-90°F) prior to formulating.

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Heat the deionized or distilled water to 150-175°F (65-80°C). Add the dicyandiamide to the warm water and agitate until completely dissolved. Additional heating may be necessary to maintain the 150-175°F temperature. When dissolution is complete, add the accelerator. Add the warm dicyandiamide/accelerator solution to the epoxy dispersion and agitate slowly at room temperature until well mixed (30-60 minutes). The mixing process with EPI-REZ Resin WD-510 may require more thorough agitation. If the dicyandiamide solution cools and begins to crystallize before it is added to the dispersion, it should be reheated to 150-175°F. An induction period of at least one hour is suggested before using the varnish mixture. Because of the low viscosity and multiphase nature of these systems, continuous agitation may be required to maintain formulation homogeneity.

Typical Varnish Properties Table 3 / Varnish Properties

	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>
Gel time at 340°F (171°C), seconds	140	120	132	140	160
Estimated pot life, days	>4	>4	1	1	>4

**Fiber Impregnation** For fiber impregnation or prepreg production, optimum conditions must be established for each manufacturing line since commercial equipment varies considerably with respect to air velocity, fabric tension, and varnish squeeze off devices.

The example formulations described above were prepared to allow impregnation of 7628 style woven fiberglass cloth to 40-43% resin content. Additional water dilution is recommended for applications such as fiber sizings or finishes where less resin add-on is needed.

Fiberglass prepreg properties are described in Table 4.

**Cured State Properties** Laminates were constructed from 8 plies of 8" x 8", 7628-style prepreg pressed for 60 minutes at 340°F (171°C) and 150 psi. Mechanical, thermal and electrical properties of these laminates are described in Table 4.

Prepreg and Laminate Properties Table 4 / Prepreg and Laminate Properties

	<u>A</u>	<u>B</u>	<u>C</u>	<u>E</u>
	EPI-REZ 3522-W-60	EPI-REZ 5520-W-60	EPI-REZ 5003-W-55	EPON 1002F <sup>1</sup>
<b>Prepreg</b>				
B-Stage conditions, minutes at °F	10 at 250	10 at 250	15 at 325	15 at 250
Prepreg gel time, seconds at 340°F	83	60	33 <sup>2</sup>	67
<b>8-Ply Laminates <sup>3</sup></b>				
Resin content, %	40	41	40	39
Glass transition (T <sub>g</sub> ) by DMA, °C <sup>4</sup>	98	108	186	121
<b>Flexural Strength at 23 °C</b>				
lengthwise, psi	60,670	62,800	65,100	69,860
crosswise, psi	51,070	46,510	58,580	53,950

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Dielectric constant at 1 Mhz, 23 °C	5.35	5.38	5.61	5.14
Dissipation factor at 1 Mhz, 23 °C	0.025	0.027	0.025	0.020
Volume Resistivity at 23 °C, ohm-cm	1.5x10 <sup>15</sup>	1.0x10 <sup>15</sup>	5.6x10 <sup>14</sup>	1.0x10 <sup>15</sup>
Moisture Absorption, % 1 hour at 15 psi steam	1.16	1.12	0.81	0.75
MEK Absorption, % 30 minute soak	1.12	1.73	0	1.40

1 At 65% solids in MEK.

2 Prepreg slightly tacky at room temperature.

3 Eight plies of 8"x8" prepreg pressed 60 minutes at 340 °F and 150 psi.

4 Tg measured on DuPont 982 Dynamic Mechanical Analyzer in the vertical mode at a heat rate of 5°C per minute.

Storage Recommendations regarding storage conditions can be obtained by visiting our web site at [www.hexion.com](http://www.hexion.com)

#### General Information

These are starting formulations and are not proven in the user's particular application but are simply meant to demonstrate the efficacy of the products and to assist in the development of the user's own formulation. It is the user's responsibility to fully-test and qualify the formulation, along with the ingredients, methods, applications or equipment identified herein ("Information"), by the user's knowledgeable formulator or scientist, and to determine the appropriate use conditions and legal restrictions, prior to use of any Information.

#### Safety, Storage & Handling

Please refer to the MSDS for the most current Safety and Handling information.

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