

Advanced Materials

Waterborne Epoxy Systems for Coatings

Selector Guide





Waterborne Epoxy Systems

For over 25 years, Huntsman has been a global leader in the development and improvement of waterborne epoxy resins and hardeners for ambient cure coatings. Although the technology has been around for many years, great advances have occurred in the last decade. Gone are the days where additive suppliers had little or any knowledge of waterborne epoxy systems. Today, the combination of Huntsman high-performance waterborne resins and hardeners, with fit-for-purpose additives and co-solvents, gives formulators the opportunity to get the highest performance you can expect from epoxy and still adhere to environmental regulations at the same total cost.

Regulatory initiatives to meet clean air standards continue to be the main impetus for coating formulators to consider waterborne epoxy systems. This aggressive regulatory environment is nothing new and has been the case for over 20 years, since the passing of the Clean Air Act in 1990. Today, the US Environmental Protection Agency (EPA), Ozone Transport Commission (OTC), California Air Resources Board (CARB) and South Coast Air Quality Management District (SCAQMD) continue to set more and more restrictive limits on the Volatile Organic Compound (VOC) content in architectural and industrial maintenance (AIM) coatings. However, there is a change in the air again. New drivers for change are now being exercised by asset owners and architects, creating a high demand for green and sustainable products that can be certified. No longer is it just a legislative requirement that is pushing for change, but consumer demand. The benefits of waterborne epoxy systems versus conventional epoxy systems are now quite often the deciding factor in coating selection by decision makers. For example, we have found many cases where the following benefits have been the key factors in favor of waterborne epoxy systems:



- Ultra low VOC
- Very low odor
- Non-flammable/non-combustible
- Fast dry and re-coat
- Ease of cleanup (no solvents needed)
- Balanced overall performance properties

If these types of benefits can be obtained at an equivalent or slightly increased cost, owners and contractors will always choose waterborne systems. The key aspect for proper performance and ultimately, user satisfaction, is the proper selection of epoxy resin and curing agent for the targeted application and substrate.



Applications

Huntsman Waterborne Epoxy Resins and Epoxy Curing Agents can be used in a variety of coating applications which currently use solvent-based, high-solids or solvent-free coating systems. In fact, waterborne epoxy coatings are fast becoming the first choice for formulators in such market segments as:

- Transportation
 - DIY Floor Coatings
 - Industrial Maintenance
- Applications for High-Performance Asset Protection

Obtaining high-performance formulations, and ultimately success in these markets, requires knowing your targeted application, identifying the substrate, and selecting the most appropriate resin and hardener combination. A general-purpose

waterborne epoxy system that covers all applications and substrates and provides the ultimate high performance is not feasible. Therefore, if success is to be reached, proper time must be taken to identify the criteria that are critical to quality. An essential step is understanding the application, which determines the substrate to be coated. For most applications there are two substrates that are most common: cementitious or metal.

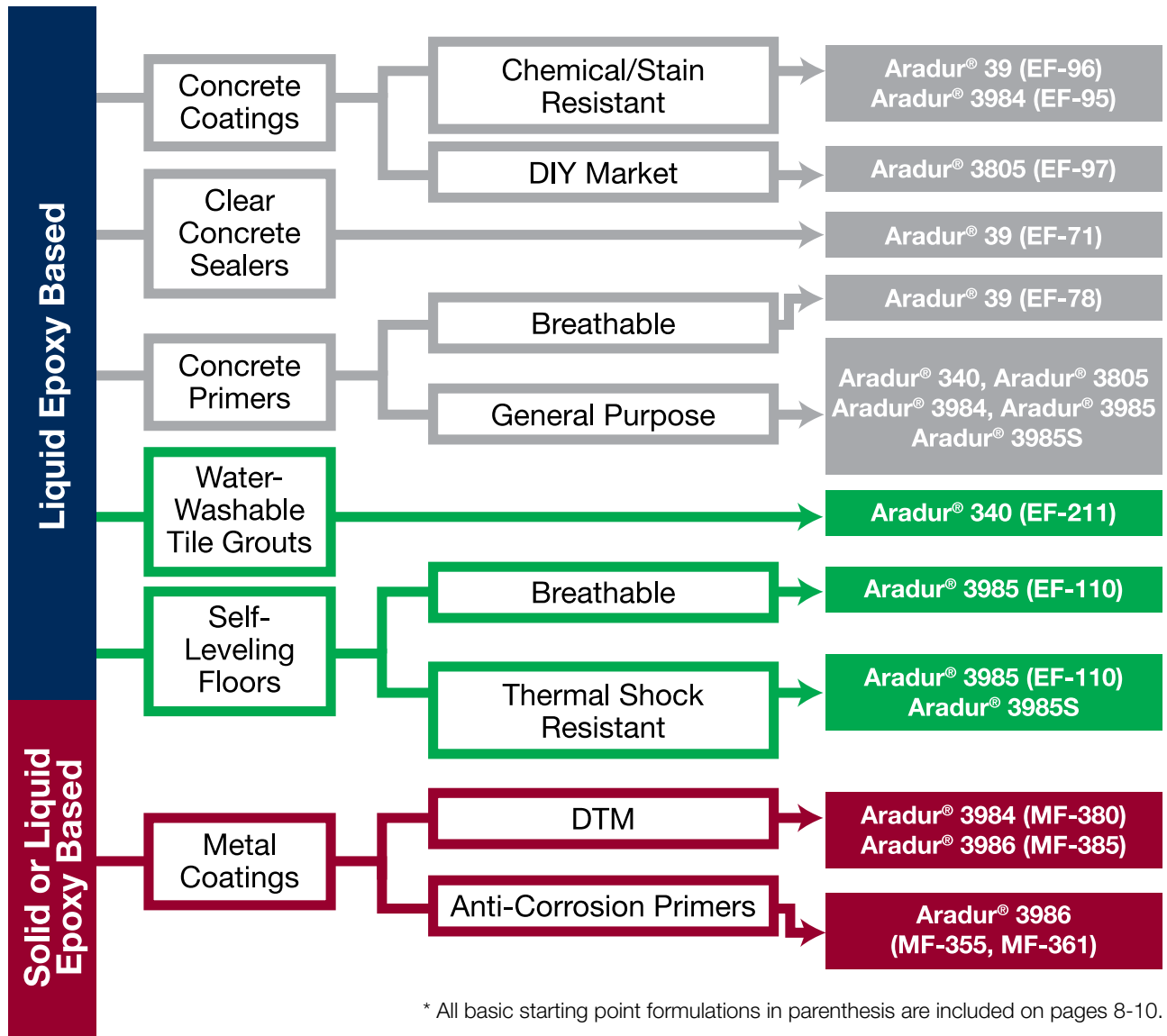
Cementitious – Found in basements, garages, warehouses, institutional and recreational facilities, etc. Due to the nature of concrete and the various stages of age, preparation, moisture content, and environmental exposure, waterborne epoxy coatings based on liquid epoxy resins have been found to be most beneficial and economical.

Metal – Found in transportation, agricultural/construction equipment, and industrial maintenance applications such as tanks, stadiums and hospitals, etc. Metal protection requires use of appropriate resins and hardeners and good formulation skills to provide optimum corrosion resistance. The selection of either liquid resins or solid epoxy dispersions has been found to be the best choice.

The following waterborne epoxy systems selector chart will help provide formulators with the right Huntsman epoxy resin and curing agent combination for the desired application and substrate. In addition, the starting-point formulations in this brochure offer useful suggestions for the selection of appropriate additives and fillers.



**Waterborne Epoxy Systems
Selector Chart**



* All basic starting point formulations in parenthesis are included on pages 8-10.



Waterborne Epoxy Systems

Huntsman offers a wide range of waterborne curing agents, waterborne epoxy resins and liquid epoxy resins that are well-suited for many applications. The following information should be used as the first step in the selection of the right product for the right application.

Waterborne Epoxy Curing Agents

Aradur® 39 Epoxy Curing Agent

is designed for concrete primers and coatings with high water vapor transmission rates to reduce the incidence of blistering on floors that are continuously damp, such as in low-lying areas. Combined with liquid epoxy resins, it offers rapid curing at both low (e.g. 5°C) and normal ambient temperatures over a wide humidity range, and excellent adhesion to dry, damp or wet concrete. Its high chemical and stain resistance makes it ideal for self-priming concrete floor coatings and clear sealers.

Aradur® 340 Epoxy Curing Agent

is a versatile product in that it performs well for both construction and metal coating applications. It can be used to formulate a variety of epoxy systems including primers for metal

or concrete, direct-to-metal coatings, adhesives and water-washable tile grouts. Such systems display good adhesion, color stability and flexibility.

Aradur® 3805 Epoxy Curing Agent

is ideal for do-it-yourself (DIY), user-friendly waterborne epoxy coatings due to its long pot life, easy application properties and long open time. This product can be easily formulated for garage floor coatings having good hardness development, abrasion resistance, excellent adhesion to both dry and damp concrete and stable gloss over the course of its four-hour pot life.

Aradur® 3984 Epoxy Curing Agent

can be used in coating applications where good aesthetic properties, chemical resistance and rapid cure are required. Its versatility allows the formulator to prepare high-performance architectural coatings for concrete floors and walls, floor toppings (e.g., broadcast floors), and coatings for metal with one curing agent.

Aradur® 3985 Epoxy Curing Agent

is the epitome of versatility. It can be formulated as a universal concrete system: a rapid-curing, breathable

primer; a self-leveling cementitious flooring; and a topcoat. These systems can be formulated to have a visible end-of-pot life, unlike most water based systems. It can also be used as a “green” concrete primer, thermal-shock resistant flooring, tile grouts, and as a concrete curing compound.

Aradur® 3985 S Epoxy Curing Agent

is the faster curing version of Aradur® 3985 epoxy curing agent. It is designed for lower temperature flooring applications, such as those for walk-in refrigerators and freezers. It can also be used for rapid curing floorings for fast return to service, reaching walk-on hardness within 12 hours.

Aradur® 3986 Epoxy Curing Agent

is designed for heavy-duty corrosion resistance comparable to solvent-based epoxy systems, and with several advantages: low VOC, low odor and fast dry properties. It can be used with both liquid epoxy resins and waterborne solid epoxy resin dispersions for the formulation of primers and direct-to-metal applications. It offers long pot life, excellent adhesion, and good impact resistance. It can also be formulated for a visible end-of-pot life.

Waterborne Epoxy Curing Agents

Product	Viscosity @ 25°C, [cP]	H+ Active Equivalent ² [g/eq]	Density @ 25°C [lb/gal, (g/cm ³)]	Typical Mix ratio ³ [g/100g]	Color [Gardner]	Solids Content [%]
Aradur® 39	12,000 – 20,000	335	8.9 (1.07)	150 – 200	≤ 5	49 – 51
Aradur® 340	18,000 – 23,000	210	8.7 (1.04)	110	≤ 12	49 – 51
Aradur® 3805	Z – Z4 ¹	270	9.0 (1.08)	144	≤ 9	59 – 61
Aradur® 3984	5,000 – 15,000	150	8.8 (1.06)	75 – 85	≤ 8	78 – 82
Aradur® 3985	1,000 – 6,000	265	8.7 (1.05)	140	≤ 6	53 – 57
Aradur® 3985 S	3,000 – 8,000	265	8.7 (1.05)	140	≤ 6	54 – 56
Aradur® 3986	15,000 – 35,000	415	8.8 (1.06)	222	≤ 6	39 – 41

¹ Gardner Holdt Viscosity. ² As supplied. ³ With Araldite® GY 6010 Liquid Epoxy Resin

Waterborne Epoxy Resins

Araldite® PZ 3901 Epoxy Resin

is a dispersion of a solid epoxy resin in water and 2-propoxyethanol at 55% (wt.) solids. It is designed for ambient cure, two-component epoxy systems for light duty industrial maintenance primers and coatings for metal, concrete, wood and certain plastics.

Araldite® PZ 3921 Epoxy Resin

is based on a modified solid epoxy resin, resulting in a lower VOC content than conventional solid epoxy resin dispersions. It can be combined with carboxylate-functional acrylic resins to formulate two-component, waterborne acrylic-epoxy coating systems that are popular for high-performance architectural applications. Araldite® PZ 3921 epoxy resin provides superior scrub resistance and improved durability for use in commercial institutions and facilities. It can also be combined with Aradur® waterborne epoxy curing agents for a variety of applications on metal and concrete.

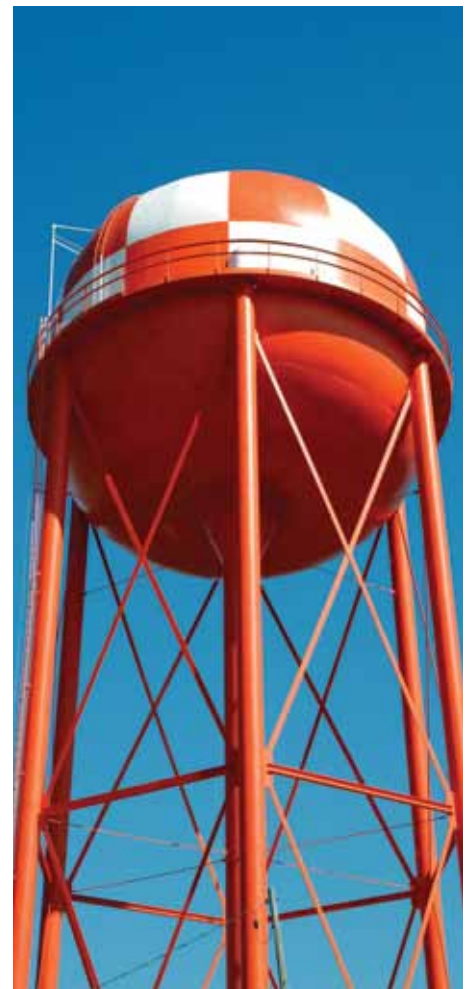
Araldite® PZ 3961-1 Epoxy Resin

is a newly developed, low-viscosity, solid epoxy resin dispersion. Its coatings show fast “lacquer” dry properties, good flexibility and impact resistance, and excellent adhesion to many substrates. Primers based on Araldite® PZ

3961-1 epoxy resin and Aradur® 3986 epoxy curing agent meet the stringent VOC requirements of the State of California for industrial maintenance and the demanding performance required of anti-corrosive primers.

Araldite® PZ 323 Epoxy Resin

is a solvent-free, aqueous emulsion of an epoxy phenol novolac (EPN) resin. It can be used to upgrade the chemical resistance, film properties and abrasion resistance of coatings based on solid epoxy resin dispersions. Typical applications for Araldite® PZ 323 epoxy resin systems include protective coatings, primers and sealers for steel, plaster, cement, concrete, cinder blocks, brick and similar substrates.



Waterborne Epoxy Resins

Product	Viscosity @ 25°C, [cP]	Epoxide Eq. Weight ¹ [EEW, g/eq]	Density @ 25°C [lb/gal, (g/cm ³)]	Solids Content [%]	Particle Size [µm]
Araldite® PZ 3901	7,000 – 20,000	515 – 555	9.0 (1.08)	53.5 – 56.5	< 1 (50%)
Araldite® PZ 3921	300 – 750	610 – 680 ²	9.0 (1.08)	49 – 51	0.8 – 1.3 (Median)
Araldite® PZ 3961-1	400 – 750	490 – 550	9.2 (1.10)	51 – 55	≤ 1
Araldite® PZ 323	Thixotropic	222 – 250	9.6 (1.15)	75 – 80	< 2

¹ On solids. ² As supplied



How to Calculate the Mixing Ratio

Epoxy – Amine Cure

Epoxy content of resin given as:

- Epoxy Index [Eq/kg]
- Epoxy Equivalent Weight [g/Eq]

$$[\text{Eq/kg}] = \frac{1000 \text{ g/kg}}{[\text{g/Eq}]}$$

Amine functionality (reactive groups) of hardener given as:

- H⁺ Active Equivalent [g/Eq]

Formula

$$\text{Epoxy Index} \times \text{H}^+ \text{ Active Equivalent} = \text{g hardener/kg resin}$$

$$[\text{Eq/kg}] \quad [\text{g/Eq}]$$

Alternative Formula

$$\frac{100 \text{ g of resin}}{\text{EEW [g/Eq]}} \times \text{H}^+ \text{ Active Equivalent [g/Eq]} = \text{g hardener to cure 100 g of resin}$$

Basic Formulations

Formulation EF-71

Waterborne, Low VOC Clear Epoxy Sealer

Part A (Epoxy Resin)	Pounds	Gallons
Araldite® GY 6010 Epoxy Resin	169.00	17.24
Araldite® DY-D Epoxy Reactive Diluent	25.35	2.76
Total (Part A)	194.35	20.00
Part B (Hardener)		
Aradur® 39 Epoxy Curing Agent	390.04	43.83
Co-solvent	18.66	2.42
Benzyl Alcohol	5.09	0.64
Defoamer	4.24	0.68
Glacial Acetic Acid	7.80	0.90
Deionized Water	260.02	31.33
Leveling Agent	1.70	0.20
Total (Part B)	687.55	80.00
Formulation Total	881.90	100.00

Formulation Properties

Mix Ratio, vol (A : B)	1 : 4
Mixed Viscosity, 23°C, KU	
- Initial	73
- 1 hr	96
Solids Content, wt. %	44.2
Solids Content, vol. %	40.9
VOC, g/L (minus water)	98.5

Formulation EF-78

Waterborne, Low VOC Concrete Primer

Part A (Epoxy Resin)	Pounds	Gallons
Araldite® GY 6010 Epoxy Resin	124.37	12.69
Araldite® DW 0137-1 Black Coloring Paste	4.04	0.40
Araldite® DY-D Epoxy Reactive Diluent	18.66	2.03
Matting Agent	18.66	1.59
Leveling Agent	3.92	0.45
Co-solvent	18.66	2.38
Total (Part A)	188.30	19.54
Part B (Hardener)		
Aradur® 39 Epoxy Curing Agent	242.52	27.25
Pigment Dispersant	48.50	5.49
Defoamer	9.79	1.19
Titanium Dioxide	62.58	1.88
Barium Sulfate	125.18	3.42
Microcrystalline Silica	86.05	3.89
Co-solvent	13.61	1.84
Deionized Water	295.75	35.50
Total (Part B)	883.98	80.46
Formulation Total	1072.28	100.00

Formulation Properties

Mix Ratio, vol (A : B)	1 : 4
Mixed Viscosity, 23°C, KU	
- 15 min	87
- 1 hr	104
PVC, %	31.0
Pigment : Binder Ratio, wt	1.2
Solids Content, wt. %	55.3
Solids Content, vol. %	42.0
VOC, g/L (minus water)	89.8

Formulation EF-95

Waterborne, Low VOC Floor Coating

Part A (Epoxy Resin)	Pounds	Gallons
Araldite® GY 9615 Epoxy Resin	239.60	25.00
Total (Part A)	239.60	25.00
Part B (Hardener)		
Aradur® 3984 Epoxy Curing Agent	167.50	17.63
Deionized Water	322.88	38.76
Defoamer	7.51	0.90
Pigment Dispersant	12.89	1.46
Nepheline Syenite	53.69	2.47
Wollastonite	53.69	2.22
Titanium Dioxide	118.10	3.54
Co-solvent	39.73	5.22
Flow Modifier	3.86	0.46
Rheology Modifier	20.62	2.33
Total (Part B)	800.48	75.00
Formulation Total	1040.08	100.00

Formulation Properties

Mix Ratio, vol (A : B)	1 : 3
Mixed Viscosity, 23°C, KU	
- Initial	115
- 1 hr	94
PVC, %	17.6
Pigment : Binder Ratio, wt (solids)	0.6 : 1
Solids Content, wt. %	59.5
Solids Content, vol. %	49.0
VOC, g/L (minus water)	91.2

Formulation EF-96

Waterborne, Low VOC Floor Coating

Part A (Epoxy Resin)	Pounds	Gallons
Araldite® GY 9615 Epoxy Resin	183.98	20.00
Total (Part A)	183.98	20.00
Part B (Hardener)		
Aradur® 39 Epoxy Curing Agent	306.32	34.42
Deionized Water	272.29	32.67
Defoamer	2.82	0.34
Pigment Dispersant	11.91	1.35
Nepheline Syenite	34.04	1.57
Wollastonite	34.04	1.41
Titanium Dioxide	98.70	2.96
Co-solvent	37.44	4.89
Flow Modifier	3.23	0.38
Total (Part B)	800.79	80.00
Formulation Total	984.77	100.00

Formulation Properties

Mix Ratio, vol (A : B)	1 : 4
Mixed Viscosity, 23°C, KU	101
PVC, %	14.0
Pigment : Binder Ratio, wt (solids)	0.5
Solids Content, wt. %	52.2
Solids Content, vol. %	43.1
VOC, g/L (minus water)	94.6

Basic Formulations

Formulation EF-97

Waterborne, Do-It-Yourself Floor Coating

Part A (Epoxy Resin)	Pounds	Gallons
Araldite® GY 9667 Epoxy Resin	168.94	18.35
Co-solvent	12.49	1.65
Total (Part A)	181.43	20.00
Part B (Hardener)		
Aradur® 3805 Epoxy Curing Agent	212.43	23.61
Deionized Water	365.73	43.81
Defoamer	5.10	0.62
Flow Modifier	3.06	0.36
Pigment Dispersant	15.82	1.79
Nepheline Syenite	40.85	1.88
Wollastonite	40.85	1.69
Titanium Dioxide	137.88	4.14
Co-solvent	12.64	1.72
Leveling Agent	2.05	0.28
Total (Part B)	836.41	80.00
Formulation Total	1017.84	100.00

Formulation Properties

Mix Ratio, vol (A : B)	1 : 4
Mixed Viscosity, 23°C, KU	93
PVC, %	18.4
Pigment : Binder Ratio, wt (solids)	0.7
Solids Content, wt. %	51.9
Solids Content, vol. %	43.3
VOC, g/L (minus water)	168.4

Formulation EF-110

Waterborne, Matte Self-Leveling Flooring

Part A (Epoxy Resin)	Pounds	Gallons
Araldite® GY 6010 Epoxy Resin	127.41	13.00
Total (Part A)	127.41	13.00
Part B (Hardener)		
Aradur® 3985 Epoxy Curing Agent	182.00	20.80
Air Release	12.13	1.80
Defoamer	9.10	1.08
Deionized Water	46.17	5.54
Titanium Dioxide	121.34	3.64
Barium Sulfate	121.34	3.32
Deionized Water	69.27	8.31
Total (Part B)	561.35	44.49
Part C (Filler)		
White Portland Cement	91.00	6.50
Silica Sand	315.50	21.52
Fine Aggregate	254.82	14.49
Total (Part C)	661.32	42.51
Formulation Total	1350.08	100.00

Formulation Properties

Mix Ratio, vol (A : B)	0.15 : 1
PVC, %	67.4
Filler : Binder Ratio, wt	4:1
Solids Content, wt	84.5
Solids Content, vol	74.7
VOC, g/L (minus water)	18.1

Formulation EF-211

Water-cleanable, Epoxy-based Tile Grout

Part A (Resin Portion)	Pounds	Gallons
Araldite® GY 9615 Epoxy Resin	155.00	16.85
Emulsifier	7.83	1.09
Cleaning Aid	10.87	1.55
Rheology Modifier	6.08	0.69
Total - Part A	179.78	20.18
Part B (Hardener Portion)		
Aradur® 340 Epoxy Curing Agent	110.60	12.71
Aradur® 3984 Epoxy Curing Agent	43.48	4.94
Accelerator 960-1	4.64	0.57
Surfactant	11.13	1.29
Deionized Water	138.30	16.60
Total - Part B	308.15	36.12
Part C (Filler Portion)		
Fumed Silica	33.91	1.85
Silica sand	925.30	41.87
Total - Part C	959.21	43.72
Formulation Total	1447.14	100.02

Formulation Properties

Filler : binder ratio	3.8 : 1
Density	14.47 lb/gal
Pot life (2.2 lb. mass), 23°C	2-3 hr
Mixing ratio Part A : Part B, vol	0.56 : 1.0
Mixing ratio Part A : Part B, wt	0.58 : 1.0
Solids Content (wt / vol)	85.1% / 74.0%
VOC Content (minus water), g/L	5.6

Formulation MF-361

Waterborne, Corrosion Resistant Primer

Part A (Epoxy Resin)	Pounds	Gallons
Araldite® PZ 3961-1 Epoxy Resin	458.00	50.00
Total (Part A)	458.00	50.00
Part B (Hardener)		
Aradur® 3986 Epoxy Curing Agent	146.00	16.53
Pigment Dispersant	22.85	2.61
Defoamer	12.68	1.53
Deionized Water	90.5	10.86
Calcium Metasilicate	104.74	4.33
Magnesium Silicate	85.69	3.66
Nepheline Syenite	20.95	0.97
Titanium Dioxide	66.65	2.00
Barium Sulfate	76.17	2.08
Leveling Agent	3.80	0.42
Flash Rust Inhibitor	9.50	1.02
Rheology Modifier	34.25	3.98
Total (Part B)	673.78	50.00
Formulation Total	1131.78	100.00

Formulation Properties

Mix Ratio, vol (A : B)	1:1
Mixed Viscosity ¹ , 23°C, KU	
- Initial	95
- 1 hr	95
- 3 hr	98
- 4 hr	100
PVC, %	30.3
Pigment : Binder Ratio, wt	1.2 : 1
Solids Content, wt%	62.4
Solids Content, vol%	48.1
VOC, g/L (minus water)	78.4
Tack-free / Dry-thru time ² , 23°C/50RH (30' induction time)	1.0/5.5

Basic Formulations

Formulation MF-380

Waterborne, Direct-to-Metal Coating

Part A (Epoxy Resin)	Pounds	Gallons
Araldite® PZ 3901 Epoxy Resin	543.50	59.73
Defoamer	4.0	0.52
Pigment Dispersant	12.50	1.42
Titanium Dioxide	235.00	7.06
Deionized Water	86.00	10.32
Co-solvent	7.50	0.95
Total (Part A)	888.50	80.00
Part B (Hardener)		
Aradur® 3984 Epoxy Curing Agent	60.90	6.65
Deionized Water	100.80	12.10
Co-solvent	9.90	1.25
Total (Part B)	171.60	20.00
Formulation Total	1060.10	100.00

Formulation Properties

Mix Ratio, vol (A : B)	4 : 1
Mixed Viscosity, 23°C, KU	89
PVC, %	16.3
Pigment : Binder Ratio, wt (solids)	0.7
Solids Content, wt. %	55.7
Solids Content, vol. %	43.4
VOC, g/L (minus water)	163.1

Please consult your Huntsman representative for other starting-point formulations offered.

Formulation MF-385

Waterborne, Direct-to-Metal Coating

Part A (Epoxy Resin)	Pounds	Gallons
Araldite® PZ 3961-1 Epoxy Resin	514.47	55.92
Defoamer	3.78	0.45
Pigment Dispersant	11.86	1.35
Titanium Dioxide	222.46	6.68
Deionized Water	65.00	7.80
Co-solvent	7.06	0.89
Rheology Modifier	16.49	1.93
Total (Part A)	857.23	75.02
Part B (Hardener)		
Aradur® 3986 Epoxy Curing Agent	160.89	18.28
Deionized Water	43.41	5.21
Co-solvent	13.12	1.66
Total (Part B)	201.01	25.15
Formulation Total	1058.54	100.17

Formulation Properties

Mix Ratio, vol (A : B)	3 : 1
Mixed Viscosity, 23°C, KU	62
PVC, %	16.6
Pigment : Binder Ratio, wt (solids)	0.7
Solids Content, wt. %	54.4
Solids Content, vol. %	41.7
VOC, g/L (minus water)	142.3



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