

Epoxy Curing Agents and Modifiers

Anquamine[®] 401 Curing Agent

Description

Anquamine 401 waterborne curing agent is a modified aliphatic amine supplied at 70% solids in water. It is intended for use with Liquid Epoxy Resin (EEW=190) and waterborne epoxy dispersions in two-component, ambient-cure, waterborne epoxy coatings. Anquamine 401 curing agent can also be utilized with different types of epoxy resin depending upon the properties desired.

Advantages

- Excellent gloss and gloss retention
- Good color
- Excellent stain resistance
- Excellent hardness development
- Rapid dry time
- No induction time
- Very low odor
- Easy clean up

Applications

- Floor and wall coating sealers, primers, and topcoats
- Industrial maintenance, general metal, and transportation primers and topcoats

Storage Life

At least 24 months from the date of manufacture in the original sealed container at ambient temperature. Store away from excessive heat and humidity in tightly closed containers. Do not freeze.

Typical Properties

Appearance	Amber Liquid
Color ¹ (Gardner)	11–12
Viscosity ² @ 77 °F (cP)	30,000
Specific Gravity ³	1.09
Density (lb/gal)	9.11
Flash Point ⁴ (°F)	>200
AHEW (theoretical)	200
Nonvolatile (%)	70
Volatile Content	Water

Use Levels*

	PHR
Liquid Epoxy (EEW=190)	65–80
Semi-Solid Epoxy (EEW=245)	50–60
Solid Epoxy (EEW=530–715)	15–30
Ancarez AR550	15–30

* Anquamine 401 curing agent is often formulated with 30–60% excess epoxy.

Typical Cure Schedule

2 to 10 days at ambient temperatures.

Handling Precautions

Refer to the Material Safety Data Sheet for Anquamine 401 curing agent.

1. ASTM D 1544-80
2. ASTM D 445-83, Brookfield, RVTD, Spindle 4
3. ASTM D 1475-85
4. Seta flash, closed cup

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Supplementary Information

Anquamine® 401 is designed for use with solid epoxy resin dispersions, liquid epoxy resin dispersions or with liquid epoxy resin. As illustrated below, several different epoxy resin dispersions can be used depending on the properties desired and the end-use application.

Formulating Guidelines

Anquamine® 401 curing agent can be utilized with a variety of solid epoxy resin dispersions to produce corrosion resistant primers; high gloss enamels; concrete primer and concrete paint for a variety of end user requirements. For development of optimum coating performance, the following formulation guidelines should be employed whenever possible.

Stoichiometry

Using an excess of epoxy resin is recommended in order to provide the balance of properties—maximum hydrophobicity accompanied by hardness and solvent resistance—which are the desired properties for primers and topcoats. If increased chemical resistance is required, reducing the level of excess epoxy resin is recommended. However this is likely to have an adverse effect on the water resistance of the coatings. Using a range of 60-90% excess epoxy is recommended for maximum corrosion resistance. Table 1 below summarizes the positive influences of changing the stoichiometric ratio of curing agent and epoxy resin.

Table 1
Positive Influences of Changing the Stoichiometry

Increase in Epoxy Resin	Increase in Curing Agent
Pot Life	Dry Speed
Salt Fog Resistance	Stain Resistance
Humidity Resistance	Solvent Resistance
Water Resistance	Higher Gloss
Alkali Resistance	Flexibility
Acid Resistance	Abrasion Resistance

Coalescing Agents

The use of coalescing agents is critical for optimum coating compatibility and film formation under a wide range of cure conditions and greatly impacts the aesthetic and performance parameters of the coating. A combination of hydrophobic and hydrophilic solvents is typically recommended to assist in keeping the film open longer and promoting water release. Recommendations for hydrophobic coalescing agents, which remain in the film and aid, flow, air release and open time are benzyl alcohol, ethylene glycol phenyl ether (EPH) and propylene glycol phenyl ether (PPh). For hydrophilic agents which promote water release from the film, PM solvent, ethylene glycol propyl ether (EP) and propylene glycol propyl ether (PnP) are recommended. Typical hydrophobic solvent levels are 3% based on system resin solids.

Pigments and Pigment Dispersion

Anquamine 401 is an excellent pigment dispersant. Its excellent inherent pigment wetting and its high dilutability make it an ideal vehicle for pigmentation. If Anquamine 401 is pigmented it is recommended that co-solvents are added to the curing agent prior to addition of extra water to aid viscosity reduction. Epoxy resin dispersions may also be pigmented, offering good formulating latitude. During the pigmentation process, system stability and ease of mixing pigmented resin and curing agent components are greatly enhanced by incorporation of a pigment wetting agent. The optimum level is dependent upon the PVC and the oil absorption of the pigments used in the paint formulation. Suitable wetting agents include Disperbyk 190 and Surfynol CT-111. The recommended addition level is in the 1–3% range based on total pigment weight. Typical PVC levels for the primers and gloss enamels are 35% and 15–20% respectively.

Flash Rust

Water-based primers may present flash-rust when applied over sandblasted steel, to eliminate this phenomenon we recommend small additions of flash-rust inhibitors and excellent results were obtained adding a 10% aqueous solution of sodium nitrite (NaNO_2) to the Part B (curing agent) side in the amount of 2 pounds of solution per 100 gallons of paint (or around 1.2% by weight).

Mixing and Application

Thoroughly mix the A and B side components for 1–2 minutes until a uniform consistency is achieved. For high-gloss finishes, no induction time is needed. However, for maximum humidity and corrosion resistance, allow the mixed paint to induct for 15–30 minutes.

For conventional spray, the mixed paint can be reduced to application viscosity with water.

Good air flow across freshly painted areas will assist in water evaporation and improve dry speed.

Typical pot life is 3–6 hours. In gloss enamels, end of pot life is signaled by a visible loss of gloss in the dried film. Paint remains fluid beyond the pot life but loses coalescence and should be discarded. Do not mix expired paint with fresh paint.

Clean Up

Application tools can be cleaned with warm soap and water.

Corrosion Resistant Primer Formulations

Preliminary starting point formulation WB 401P1 is a fast drying anti-corrosive primer based on Anquamine 401 and Ancarez AR555.

**Fast Drying "Zero VOC"
Waterborne Metal Primer (WB 419P1)**

**Anquamine 401[®] Curing Agent
Waterborne Zero-VOC Enamel
Starting Point Formulation**

Part A				Weight
1	Curing Agent	Anquamine 401	Air Products	4.38
2	Filler	Talc # 400		5.94
3	Filler	Barite # 500		5.94
4	Pigment	TiO ₂		5.94
5	Pigment	Halox SZW-111	Halox	3.94
6	Filler	Mica # 325		0.88
7	Filler	Quartz		11.19
8	Solvent	Water		19.42
9	Additive	NaNO ₂ , 10% in water		1.20
10	Additive	Acrysol RM-8W		1.01
11	Additive	Surfynol DF62	Air Products	0.26

Part B				Weight
1	Resin	Ancarez AR555		35.00
2	Solvent	Water		3.97
3	Additive	Acrysol RM-8W		0.96

Total A + B 100.00

Mixing Ratio	Volume A:B	1:1
Density (g/mL)	Mix	1.35
Solid Content (Weight %)	Mix	56.74
Solid Content (Volume %)	Mix	42.58
PVC	%	35.65
Epoxy/Amine		1.23
VOC	g/L	0.8

Corrosion Resistance

Formulation WB 401P1, based on Anquamine 401 and Ancarez AR555, was evaluated for salt spray (ASTM B117) and salt water immersion (3.5% NaCl in water). The results obtained are presented in Table 2 and also on the pictures. Following 750hrs salt fog exposure, formulation WB 401P1 exhibit very good resistance.

Table 2

**Salt Spray Resistance and Salt Water Resistance
WB 491P1 [750 hrs.]**

Formulation	Scribe Creep	Field Blistering	Blister Size
Salt Spray	Few	Few	6 (small)
Salt Water Immersion	10	10	10

5% salt spray, cabinet temperature 35 °C—ASTM B-117, film thickness 100 µm

Rating: 10 = Best (no blisters), 0 = Worst

**Salt Spray and Salt Water Panels
After 1000 Hrs. Exposure**



Immersion in NaCl 3.5%
after 750 hours exposure



Salt spray after
750 hours exposure

Note: Corrosion performance may be enhanced by adding proper coalescing agents and increasing the VOC for the model formulation WB401P1.

A Side

	Pounds	Gallons	Supplier
Ancarez [™] AR555	594.9	65.37	Air Products

Add at slow speed a premix of:

Acrysol RM-8W	2.1	0.25	Rohm & Haas
De-ionized Water	8.8	1.06	
	605.8	66.70	

B Side

	Pounds	Gallons	Supplier
De-ionized Water	65.3	7.83	
Dee Fo PI-4	3.3	0.39	Ultra Additives
BYK-022	0.7	0.08	Byk Chemie
Anquamine 401	32.7	3.59	Air Products
Glacial Acetic Acid	1.0	0.12	

Mix until uniform, then add:

TR-92 Titanium Dioxide	250.0	7.35	DuPont
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Disperse to 7 Hegman, reduce speed then add:

De-ionized Water	58.1	6.97	
Anquamine 401	47.4	5.21	Air Products
BYK-341	2.0	0.25	Byk Chemie

Slowly add:

Acrysol RM-8W	12.0	1.38	Rohm & Haas
Acrysol RM-2020	2.0	0.22	Rohm & Haas
	474.0	33.30	

Formulation Properties:

VOC	Trace
Weight Solids (%)	59.4
Volume Solids (%)	47.3
PVC (%)	15.6
Mix Viscosity (KU)	1000
Pot Life (hr)	3
Set-to-Touch (min)	15
Dry-to-Touch (min)	30

Performance Attributes:

Zero VOC
Fast dry
Good tint stability
Good barrier properties

Anquamine 401[®] Curing Agent
Waterborne Fast Dry Concrete Primer
Starting Point Formulation

A Side

	Pounds	Gallons	Supplier
Ancarez™ AR555	595.78	65.38	Air Products

Add at slow speed a premix of:

Acrysol RM-8W	2.12	0.24	Rohm & Haas
De-ionized Water	<u>8.80</u>	<u>1.05</u>	
	606.70	66.70	

B Side

	Pounds	Gallons	Supplier
Anquamine 401	97.89	10.76	Air Products
De-ionized Water	163.05	19.55	
Dee Fo PI-4	3.50	0.41	Ultra Additives
BYK-341	2.00	0.25	Byk Chemie
Acrysol RM-8W	14.99	1.73	Rohm & Haas
Acrysol RM-2020	5.00	0.55	Rohm & Haas
Glacial Acetic Acid	<u>0.75</u>	<u>0.09</u>	
	287.20	33.30	

Formulation Properties:

VOC	Trace
Mix Viscosity (cP)	500
Weight Solids (%)	46.0
Volume Solids (%)	41.9
Pot Life (hr)	3
Set-to-Touch (min)	15
Dry-to-Touch (min)	30

Performance Attributes:

Fast dry
Long pot life
Good adhesion to concrete

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