Epoxy Curing Agents and Modifiers

ANQUAMINE® 287 Waterborne Curing Agent

DESCRIPTION

Anquamine 287 curing agent is a novel water-based epoxy curing agent designed for use in two part epoxy systems with standard liquid and modified liquid epoxy resins without the addition of emulsifiers. It provides superior performance in a wide range o f applications.

Anquamine 287 based primers exhibit excellent adhesion to green concrete and penetration properties that outperform other water-based curing agent technology. It also can be formulated into a cementitious epoxy floor with excellent moisture permeability and thermal shock resistance.

ADVANTAGES

- Superior performance in cementitious epoxy flooring
- Excellent adhesion to green concrete
- Low formulation viscosity allows excellent penetration of concrete substrate
- Fast drying time and quick return to service
- Zero-VOC
- Mixes easily with water and resin
- Can be brushed, rolled or spray applied
- Good through-cure
- Easy to clean up

APPLICATIONS

- Cementitious epoxy flooring
- Primer/sealer for green concrete
- Concrete curing compound
- Primer for old and new concrete

SHELF LIFE

At least 12 months from the date of manufacture in the original sealed container at ambient temperatures.

STORAGE AND HANDLING

Refer to the Safety Data Sheet for Anquamine 287 curing agent.

TABLE 1: TYPICAL PROPERTIES

Appearance	Amber to greenish liquid
Color (Gardner) [3]	12
Viscosity[1] @ 77°F, mPa*s [2]	400-1,000
Specific Gravity[4] @ 77°F (g/cm³)	1.08
Amine Value (mg KOH/g)	155-175
Equivalent Wt/{H}	240
Total Solids Content, % by Wt	49-51
Recommended Use Level (phr, EEW=190)	125

TABLE 2: TYPICAL HANDLING PROPERTIES

Pot Life @ 77°F (h)	60-75
Thin Film Set Time @ 77°F (h):	
Set to Touch	1
Hard-dry	5

Footnotes:

(1) ASTM D 445-83, Brookfield, RVTD, Spindle 4

(2) 1 mPa*s = 1 cPs

(3) ASTM D 1544-80

(4) ASTM D 1475-85

SUPPLEMENTAL DATA PRIMER FOR GREEN CONCRETE

Anquamine 287 curing agent-based primer formulations meets the ASTM 309 requirement (water loss of 0.55 kg/m^2 maximum) for use as a concrete curing compound. Unlike traditional sealers, a sealer based on this product does not need to be removed before applying additional floor coatings.

Following is a recommended formulation for an Anquamine 287 curing agent-based primer for application on green concrete:

		Parts by Weight
Part A	Liquid Epoxy Resin (EEW=190)	190
Part B	Anquamine 287 Curing Agent	240
	DI Water	190

To develop the formulation, mix the liquid epoxy resin into the Anquamine 287 curing agent. This will result in a thick emulsion. Mix the emulsion thoroughly, and then add the water slowly in four portions, making sure that each portion is properly incorporated before the next one is added. The primer will now be 50% solids in water. It may be thinned with additional water to 40% solids if desired.

The resin may be diluted with Epodil™ 746 or Epodil 748 diluents (preferred), or other glycidyl ether diluents. In this example, the resin used was a combination of a Bisphenol-A/Bisphenol-F resin (60/40 by weight) diluted with 18-20% Epodil 746 diluent.

The resulting emulsion can be brushed or rolled onto the concrete. It can also be sprayed or applied with a squeegee.

The bond strength results shown below were obtained after applying the above primer formulation to freshly poured concrete (24 hours after the trowel and broom finish and three days from pour to allow for the mild shot blast finish). When the primer was applied, the concrete surface was damp but not wet (i.e., no puddles were visible).

Anquamine 287 curing agent has been designed for application on green concrete to seal the surface and to improve the physical properties of the concrete by allowing proper hydration. Its use on metal surfaces has not been studied other than to determine the reverse and forward impact resistance.

TABLE 3: BOND STRENGTH (IN PSI) TO GREEN CONCRETE WITH VARIATION IN TIME AND CONCRETE FINISH

Cure Time	Concrete Finish					
	Steel Troweled		Broom Finished		Shot Blast Finished	
	Primer	Unprimed Control	Primer	Unprimed Control	Primer	Unprimed Control
1 Day	369	Not done	Not done	Not done	Not done	Not done
7 Days	462	Not done	348	155	286	140
30 Days	564	Not done	405	109	385	278
90 Days	357	Not done	357	78	366	241

Note: For the steel troweled finish, the concrete formulation had a water/cement ratio of 0.4, while the broom and shot blast finishes had a water/cement ratio of 0.6. The concrete formulations used can be made available upon request.

SUPPLEMENTAL DATA
DEEP PENETRATING PRIMER

Following is a recommended formulation for an Anquamine 287 curing agent-based deep penetrating primer for application on concrete:

		Parts by Weight
Part A	Liquid Epoxy Resin (EEW=190)	80
Part B	Anquamine 287 Curing Agent	100
Part C	DI Water	360

To develop the formulation, mix the liquid epoxy resin into the Anquamine 287 curing agent. This will result in a thick emulsion. Mix the emulsion thoroughly, and then add the water slowly in four portions, making sure that each portion is properly incorporated before the next one is added. The primer will now be 24% solids in water.

The resulting emulsion can be brushed or rolled onto the concrete. It can also be sprayed or applied with a squeegee. With a very low viscosity of 10 cP, the penetration of this Anquamine 287 curing agent based primer is much deeper than standard water based epoxy primer.

The bond strength results shown below were obtained after applying the above formulation to old concrete block. When the primer was applied, the block was free of contamination and no additional surface preparation technique was applied

TABLE 4: BOND STRENGTH (IN PSI) TO CONCRETE WITH MODE OF FAILURE

Primer Cure Time	Bond Strength	Mode of Failure
7 days @ 77°F	400	Substrate
30 days @ 77°F	400	Substrate

It is important in the above formulation that the Anquamine 287 is not diluted prior to mixing with the epoxy resin. By doing this the viscosity becomes too low for the curing agent to be able to emulsify the resin and produce a viable coating. A two component primer formulation can be made by adding a thixotropic agent to the curing agent along with dilution.

Following is the recommended formulation for a 2K Anquamine 287 curing agent based primer for application on concrete:

		Parts by Weight	Supplier
Part A	Liquid Epoxy Resin (EEW=190)	50	Various
Part B	DI Water	36.5	
	Polyphobe® TR-115	3.54	Coatex, Inc.
	Anquamine 287 Curing Agent	60	Evonik

To develop the formulation, mix the Polyphobe into the water and then add in the Anquamine 287 curing agent. This will have to sit at least overnight. After proper conditioning time, mix the liquid epoxy resin into the Anquamine 287 mixture. This will result in an emulsion. Mix the emulsion thoroughly. The primer will now be 54% solids in water and can be further diluted with water if desired.

SUPPLEMENTAL DATA
CEMENTITIOUS EPOXY FLOORING

Anquamine 287 curing agent can be used with liquid epoxy resin and cement containing aggregates to formulate a self leveling grade or trowel grade flooring. Key advantages of such formulations are:

- Rapid development of hardness even at lower temperature with a 50% reduction in time to foot traffic compared to traditional cementitious urethane-based flooring
- Longer pot life (up to 4 times) compared to traditional cementitious urethane-based flooring formulations
- Good workability and easy clean up
- Moisture insensitivity
- Excellent moisture permeability compared to typical cementitious urethane-based flooring
- Good surface appearance compared to pinhole issues with traditional cementitious urethane-based flooring
- Good chemical resistance
- Good thermal shock resistance
- Good hot oil resistance

Following is a starting point formulation for self leveling floors:

		Parts by Weight	Supplier
Part A	Liquid Epoxy Resin (EEW=190)	22.0	Various
Part B	Anquamine 287 Curing Agent	27.7	Evonik
	Surfynol® TG Surfactant	1.5	Evonik
PartC	Type 1 White Portland Cement	27.7	Various
	Medium aggregate (~25 AFS GFN) - #2 Q-ROK®	15.89	US Silica
	Coarse aggregate (~15 AFS GFN) - #3 Q-ROK®	37.92	US Silica
	Fine aggregate (~60 AFS GFN) – NJ 60 Sand	29.79	US Silica

Thoroughly mix A and B sides to make an emulsion, then slowly add C side while mixing to ensure the aggregate blend is thoroughly mixed and completely wetted.

The starting point formulation can be further optimized to achieve desired handling and/or physical properties by using accelerating or retarding agents as well as adjusting the aggregate blend, adjusting the water to cement ratio, and using other flow control additives. Some of these modifications were attempted and resulting data is provided in the information below.

The starting point formulation was tested for key handling and performance properties including hardness development, chemical resistance, thermal shock resistance, and moisture vapor permeability.

Hardness Development: The Anquamine 287 curing agent-based formulation demonstrates excellent hardness development with foot traffic allowable on the floor in as little as 4 hours. This is a 50% reduction compared to standard cementitious urethane based flooring. Lowering the water to cement ratio will further quicken the hardness development in the formulation.

	2 hr	4 hr	8 hr	24 hr	2 day	5 day	7 day
Shore D @ 25°C	45	53	70	71	73	73	80
Shore D @ 5°C	—	—	—	63	71	71	80

Compressive Strength: The ultimate compressive strength of the Anquamine 287 curing agent-based formulation is 5400 psi compared to ~7500 psi for the standard urethane based flooring. Although this number is lower it is still much higher than concrete alone and will provide adequate protection to the concrete flooring underneath. Similar to hardness development the compressive strength of the Anquamine 287 curing agent based formulation can be increased by adjusting the formulation. Compressive strength can be increased by lowering the water to cement ratio or by using different grades of cement which achieve higher compressive numbers than Type 1 White Portland Cement.

Chemical and Stain Resistance: A chemical resistance study was performed using a standard spot test method and a standard immersion test method.

Spot test (ASTM D1308): Several products/chemicals were placed on a sample of the starting point formulation after a 7 day cure. The chemicals were covered by watch glass. After twenty-four hours at 22°C, the exposed area was examined for physical damage.

Products/Chemical	Observation
Mustard	Slight darkening
Ketchup	No damage to the exposed surface
Lactic acid	No damage to the exposed surface
Vinegar	No damage to the exposed surface
Lemon juice	No damage to the exposed surface

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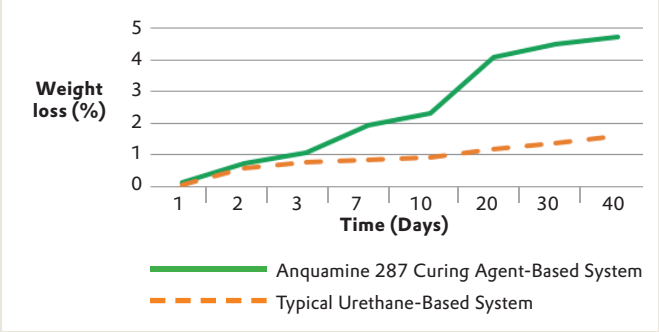
Immersion test (ASTM G20-10): Samples of the starting point formulation after a 7 day cure were fully immersed in the following chemicals for twenty-four hours at 25°C. The samples were tested for Shore D hardness, immersed in the chemical for 24 hours, removed from the chemical and tested for Shore D hardness after a 24 hour recovery period.

Products/Chemical	Hardness, Shore D
Initial	72
10% acetic acid	69
30% nitric acid	72
Sodium hypochlorite	72
60% perchloric acid	71

Water Vapor Permeability: Following the ASTM E96 -95 test method (wet cup), accelerated moisture vapor permeability was tested at 40°C. For this test, 3/8" thick samples were used following a 7 day cure. The following chart shows that the Anquamine 287 curing agent-based model formulation has better permeability than typical cementitious urethane-based system.



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