Product information

ANCAMINE® 2712M

Curing Agent

DESCRIPTION

Ancamine 2712M curing agent is a modified polyamine curing agent intended for use as a curing agent for diluted liquid epoxy resin at ambient and low temperature application (10°C).

Ancamine 2712M curing agent is free of benzyl alcohol, facilitating zero volatile organic component and low emission coating and flooring formulations.

TYPICAL PROPERTIES

Property	Value	Unit	Method
Appearance	Yellow Liquid		
Colour (Gardner)	max 7	Gardner	ASTM D 1544-80
Viscosity @ 25°C	350-650	mPa.s	Brookfield DV+ Spindle 5
Specific Gravity	1.0		
Amine Value	500-560	mg KOH/g	Perchloric Acid Titration
Equivalent	95	Wt/{H}	
Recommended use Level	50	PHR	With Bisphenol A diglycidyl ether (EEW=190)

ADVANTAGES

- Fast cure and development of properties at ambient and low temperature
- High resistance to carbamation and water spotting
- High mechanical and chemical resistances
- Free of benzyl alcohol

APPLICATIONS

- Low emission coatings and flooring systems
- Chemically resistant, high solid and solvent-free coatings
- Industrial flooring applications

SHELF LIFE

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

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HANDLING PRECAUTIONS

Refer to the Safety Data Sheet for Ancamine 2712M curing agent.

TYPICAL HANDLING PROPERTIES*

Property	Value	Unit	Method
Use Level	50	PHR	
Viscosity @ 23°C	800-900	mPa.s	Brookfield DV+ Spindle 5
Gel Time (150g mix @ 23°C)	30-35	min	Techne GT-3 Gelation Timer
Thin Film Set Time 23°C	7.0	h	BK Drying Recorder Phase III
Gloss 20°/60°, 23°C	105/102		
Persoz Pendulum Hardness 23 °C, d1/d7	240/360	s	ASTM D 4366
Hardness 23°C, 16h/d7	80D/85D	Shore D	ASTM D 2240
Carbamation Resistance 23°C, 24h	5	Scale 1-5	ASTM D870
Thin Film Set Time 10°C	14.0	h	BK Drying Recorder Phase III
Gloss 20°/60°, 10°C	105/102		
Persoz Pendulum Hardness 10°C, d2/d7	135/275	s	ASTM D 4366
Hardness 10°C, 24h/d7	65D/85D	Shore D	ASTM D 4366
Carbamation Resistance 10°C, 2d	4	Scale 1-5	ASTM D 2240

* With Bisphenol A/F diglycidyl ether blend, Epodil® 748 Reactive Diluent diluted, EEW195, η 900 mPa.s

SUPPLEMENTARY DATA

Ancamine 2712M curing agent is the next generation product for the civil engineering (CE) market for use in industrial epoxy flooring applications. Ancamine 2712M curing agent provides fast cure speed at ambient and low temperature conditions; high resistance to carbamation under adverse conditions; high mechanical and chemical resistance and improved resistance to temperature exposure versus incumbent technology. In addition, Ancamine 2712M curing agent is free of benzyl alcohol, facilitating zero volatile organic component coating and flooring formulations.

Ancamine 2712M curing agent is designed for use with reactive diluent diluted, liquid epoxy resin based on diglycidyl ethers of bisphenol-A (DGEBA) and/or bisphenol-F (DGEBF). These resins are industry standards in the epoxy market for delivering a combination of high performance and excellent handling properties. An example of such resin is used in this technical datasheet and is based on an epoxy resin of bisphenol-A/F diluted with Epodil® 748 reactive diluent, with an epoxy equivalent weight (EEW) of 195 and neat viscosity in the range of 700-1,000 mPa.s.

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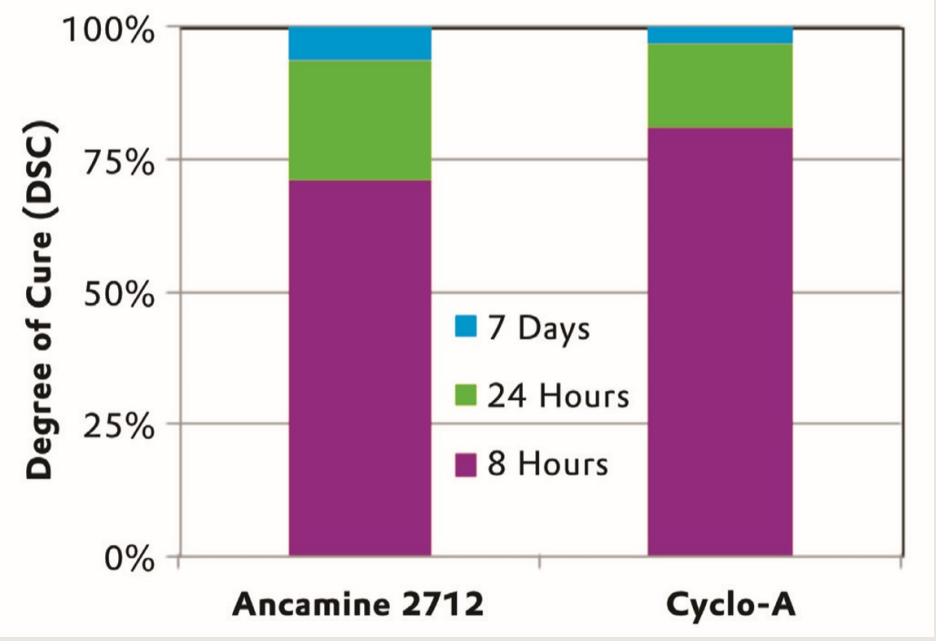
The supplementary data outlines several product features of Ancamine 2712M curing agent in combination with diluted epoxy resins. As a point of reference, performance of Ancamine 2712M is benchmarked against incumbent cycloaliphatic amine curing agents, “Cyclo-A” and “Cyclo-B”, both of which contain benzyl alcohol. Cyclo-A is an industrial standard cycl oaliphatic curing agent for winter cure performance; Cyclo-B is an industrial standard cycloaliphatic curing agent for ambient temperature conditions. Starting point formulations using Ancamine 2712M curing agent are included at the end of the technical datasheet. Table 1 summarizes the basic properties of the curing agents evaluated in this technical datasheet.

PRODUCT FEATURE BENEFITS IN CLEAR COATINGS AND CASTINGS

Rate of conversion by Differential Scanning Calorimetry (DSC)
Ancamine 2712M curing agent provides rapid conversion with epoxy resins to full cure (100%) at ambient and sub-ambient temperature conditions, comparable to Cyclo-A curing agent. Figure 1 illustrates the degree of cure as determined by DSC (ramp 10°C/min) of resin-amine mixtures cured at ambient temperature. This feature is of particular use for use in industrial flooring application where ultimate performance depends on development of mechanical, chemical and thermal resistance properties.

FIGURE 1: DEGREE OF CURE OF ANCAMINE 2712M CURING AGENT IN COMBINATION WITH EPODIL 748 REACTIVE DILUENT DILUTED DGEBA/F EPOXY RESIN



Handling and cure speed
Clear coatings based on Ancamine 2712M curing agent provide fast cure at both ambient and low temperature conditions (10°C) and are comparable to Cyclo-A curing agent. This is supported by cure speed results using a BK Drying Time Recorder as shown in Table 1. In addition, the fast cure speed also results in rapid mechanical property build in both coatings and thick castings. This is demonstrated by the rapid early Persoz pendulum hardness development and Shore D build compared to Cyclo-A and Cyclo-B. Considering, a minimal shore D50 is required for early "walk-on", Ancamine 2712M curing agent based epoxy systems meet this condition within 24 h at 10°C condition. As a result, Ancamine 2712M curing agent is particular suitable for use in industrial flooring applications where rapid return to service is required at both ambient and low temperature curing conditions.

TABLE 1: HANDLING AND CURE SPEED PROPERTIES OF ANCAMINE 2712M CURING AGENT IN COMBINATION WITH EPODIL 748 REACTIVE DILUENT DILUTED DGEBA/F EPOXY RESIN

DGEBA/F / Epodil 748, EEW195, η 900 mPa.s			Ancamine 2712M curing agent	Cyclo-A curing agent	Cyclo-B curing agent
AHEW/[H]			95	95	95
Ambient Temperature (23°C)					
Gelation time, 150g mix		minutes	29	26	81
Mix Viscosity		mPa.s	750	550	750
TFST	Phase 2 / Phase 3	h	5.0 / 6.5	4.5 / 5.5	8.5 / 11
Persoz Pendulum	Day 1 / Day 7	s	170 / 325	100 / 300	90 / 290
Shore D Build	16h / 24h / Day 7	Shore D	70D/77D/77D	65D/72D/75D	71A/55D/71D
Low Temperature (10°C)					
TFST	Phase 2 / Phase 3	h	10 / 13	14 / 16	16 / 20
Persoz Pendulum	Day 1 / Day 7	s	100 / 250	40 / 90	50 / 210
Shore D Build	16h / 24h / Day 7	Shore D	50D/74D/76D	50D/68D/73D	20A/42D/70D

Mechanical properties
Mechanical strength properties of epoxy castings were determined using a dual column material testing machine (Instron, model 4206-006) equipped with 104 kN load cell. Tests were conducted according to ISO 604. For recording compressive strength data of cubes of 25x25x25 mm, the machine was equipped with compressive plates and a Dynamic 25/50 mm GL Extensiometer and operated at 2.5 mm/min cross-head speed. All epoxy castings were prepared at 23°C and left to cure for 7 days prior to testing.

High compressive strength is paramount for epoxy systems used in industrial floorings in order to protect the concrete structure and avoid structural damages. Epoxy castings based on Ancamine 2712M curing agent and diluted epoxy resins provide excellent compressive strength as shown in Table 2. Compared to conventional cycloaliphatic technology, Ancamine 2712M curing agent provides >80% higher compressive strength in conjunction with 25-60% increased modulus. In addition, the retention of strain versus Cyclo-A demonstrates that Ancamine 2712M curing agent provides a durable protection to concrete. Formulations based on Ancamine 2712M curing agent introduce floorings with increased resilience and mechanical resistance.

TABLE 2: COMPRESSIVE STRENGTH DATA OF ANCAMINE 2712M CURING AGENT IN COMBINATION WITH EPODIL 748 REACTIVE DILUENT DILUTED DGEBA/F EPOXY RESIN

DGEBA/F / Epodil 748, EEW195, η 900 mPa.s		Ancamine 2712M curing agent	Cyclo-A curing agent	Cyclo-B curing agent
Compressive strength	MPa	95 (3)	51 (3)	52 (3)
Compressive modulus	GPa	1.55 (50)	1.11 (50)	1.27 (50)
Strain	%	6.6	5.6	4.9

Accelerated emission testing

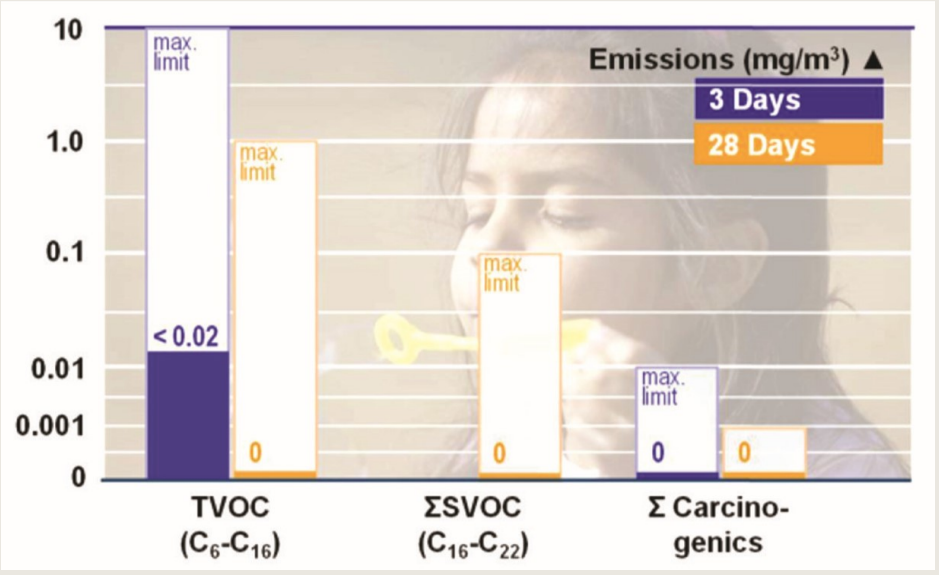
Ancamine 2712M curing agent is free of benzyl alcohol, facilitating zero volatile organic component coating and flooring formulations. For the evaluation of emission components, ECA Report 18 [European Collaborative Action "Indoor Air Quality and Its Impact On Man", Evaluation of VOC emissions from building products; solid flooring materials (Report no. 18), EUR17334EN, European Commission, Joint Research Centre, Environment Institute, 1997] defines the concept of "lowest concentration of interest (LCI)". LCI is defined as a critical level of emission of a single component reported in µg/m^3, below which a healthy indoor air quality for inhabitants and users during long-term continuous use is established. LCI values have been determined for many chemical substances and based on these values, the German AgBB committee has introduced an interpretation scheme [Ausschuss zur Gesundheitlichen Bewertung von Bauprodukten (AgBB), "Bewertungsschema für VOC aus Bauprodukten", Part 3, 1 March 2008].

This scheme validates the accumulated emission products at 3, 7 and 28 days after applying the flooring product. In accordance with EN-ISO 16,000 the following definitions are used:
VOC:- Volatile Organic Component ranging between C_6-C_{16}
TVOC:- Total VOC, accumulated VOC of products ≥ 5 µg/m^3 ranging between C_6-C_{16}
SVOC:- Slow-Volatile Organic Component > C_{16}-C_{22}
SSVOC:- Total SVOC, accumulated SVOC of products ≥ 5 µg/m^3 with > C_{16}-C_{22}

Start formulation 3 based on Ancamine 2712M curing agent was submitted to emissions testing following AgBB scheme and rated accordingly. The first measurement of the flooring sample was taken at three days after application and curing at 23 °C and 50% relative humidity (RH). Figure 2 shows less than 1% emission of VOC (C6-C16) components of the maximum norm and no detection of SVOC or carcinogenic substances. As a result of this extremely low emission, a second emission determination was taken after 7 days cure instead of the standard 28 days. It should be noted that the maximum allowed emission limits after 28 day are even more stringent; i.e. only 10% of the 3 day emissions are allowed. Start formulation based on Ancamine 2712M curing agent provided extremely low emissions after 7 days cure; nil detection of VOC, SVOC or carcinogenic substances.

These results clearly demonstrate that self levelling floors based on Ancamine 2712M curing agent exceed the AgBB criteria and can be categorized as a low emission flooring System.

FIGURE 2: EMISSION TESTING RESULTS OF FORMULATION 3 BASED ON ANCAMINE 2712M CURING AGENT FOLLOWING AgBB TESTING SCHEME

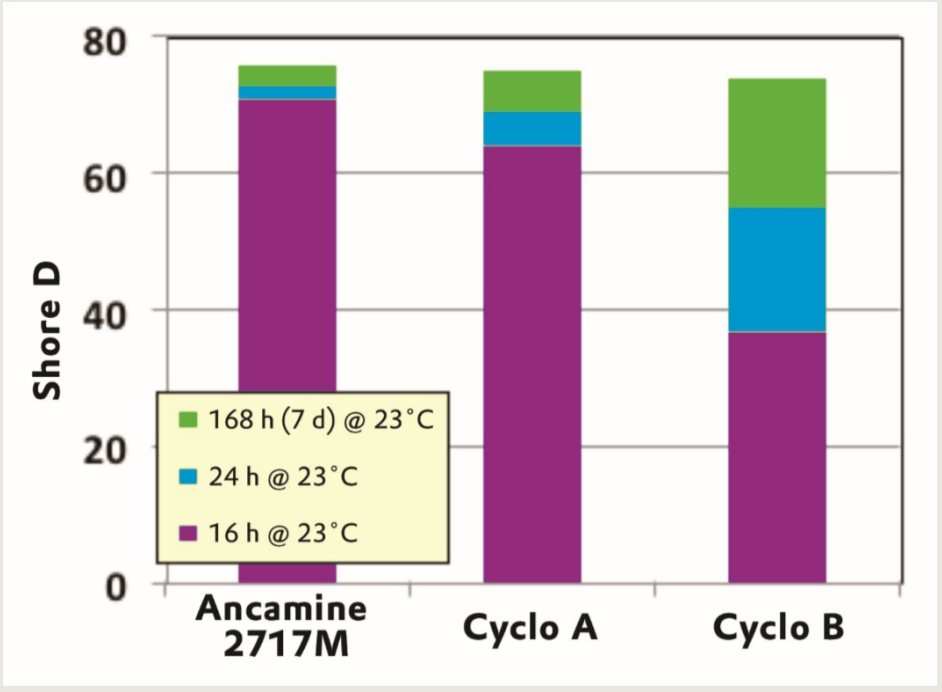


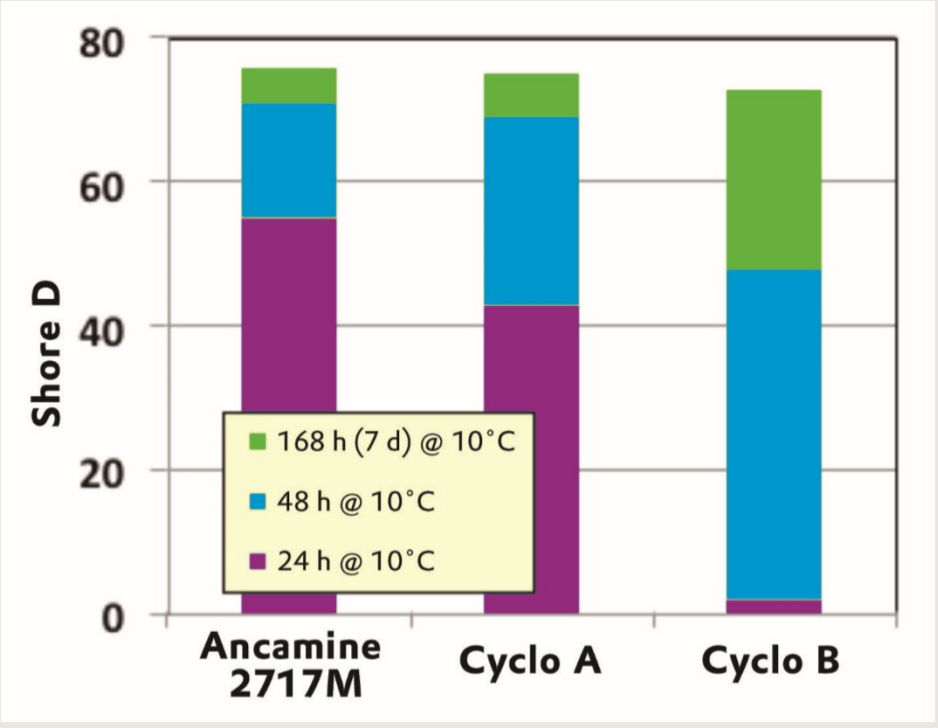
PRODUCT FEATURE BENEFITS IN FORMULATED EPOXY SYSTEMS

Fast cure speed for rapid 'walk-on'
Early Shore D floor hardness development, regardless of the cure conditions is critical for facilitating fast 'walk-on' times where short factory down-times limit refurbishment window. Typically, a Shore D50 development is considered required for walk-on. Figure 3 shows the Shore D development of self-leveller floors cured at 23°C (left) and 10°C (right) curing conditions.

Both at ambient and low temperature conditions, Ancamine 2712M curing agent based self-leveller floor provides rapid walk-on times, within 16 and 24 hours respectively after finishing flooring application. This cure performance is comparable to conventional fast-cure cycloaliphatic technology (Cyclo-A) and significantly faster than Cyclo-B.

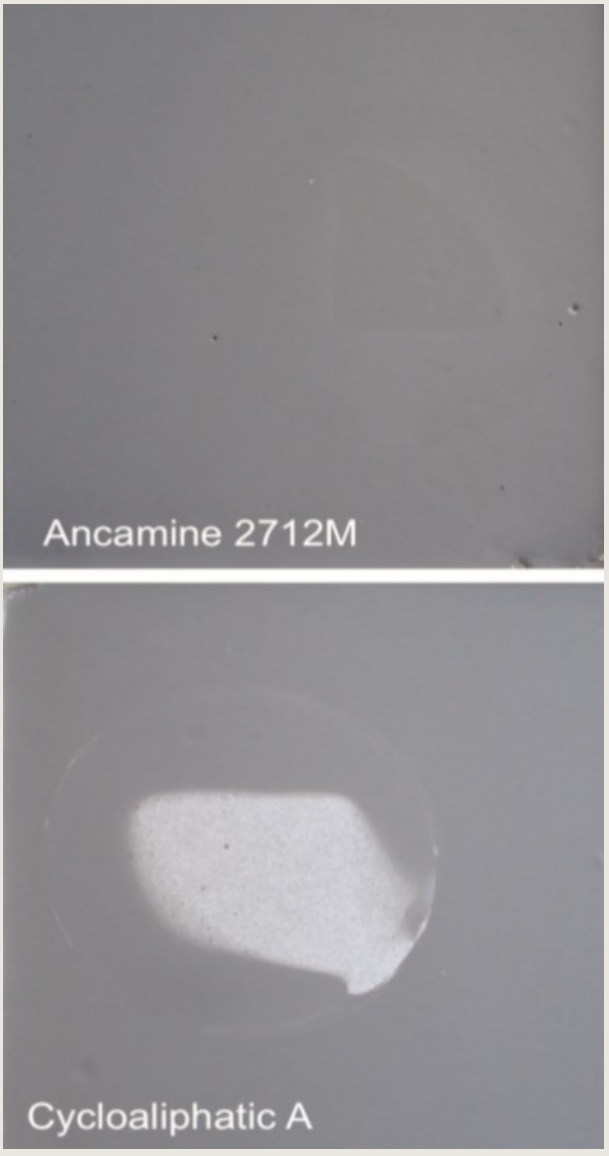
FIGURE 3: SHORE D HARDNESS DEVELOPMENT OF SELFLEVELLER FLOORS CURED AT AMBIENT (TOP) AND 10°C (BOTTOM) TEMPERATURE CONDITIONS





High carbamation resistance under adverse condition
Coatings based on Ancamine 2712M curing agent provide excellent carbamation resistance and early water resistance at ambient and low temperature (10°C) conditions. Self-leveller floor (SLF) Formulation 3 (see page 8) was left to cure for two days at 10°C after which it was exposed to water for 24 hours. The result in Figure 4 shows negligible carbamation, rated as 4 on a 1-5 relative scale (5= excellent, no visible marks) versus significant carbamation for conventional cycloaliphatic curing agent Cyclo-A and Cyclo-B (rating 2).

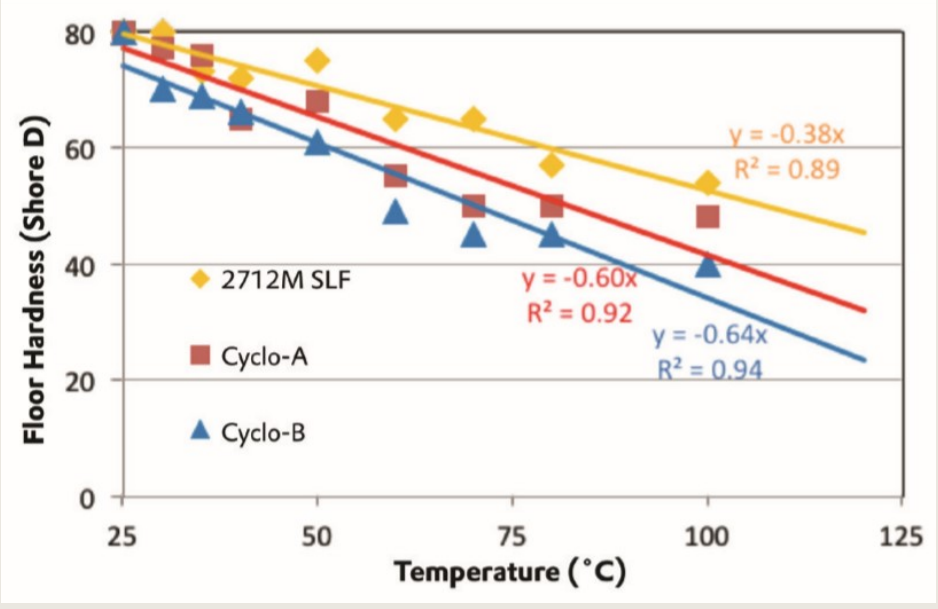
FIGURE 4: CARBAMATION RESISTANCE AFTER 48 H AT 10°C COMPARING SELF-LEVELLER FLOORS BASED ON ANCAMINE 2712M CURING AGENT WITH CONVENTIONAL CYCLOALIPHATIC CURING AGENT TECHNOLOGY



Improved heat deflection and Shore D retention upon high temperature exposure
Rectangular bars (dimensions length.width.depth = 120x13x9 mm)of self-leveller floor Formulation 3 were casted out and tested for heat deflection properties following 7 days cure at ambient temperature. Heat deflection temperature (HDT) was tested according to ASTM D648 using a Ceast HDT/Vicat 6510/000 apparatus in three-fold. The test specimen rests on two supports (d=90 mm) and is loaded by a loading nose charged with 1.1 kg load (11 MPa) midway between the supports. The specimen is deflected to 0.15 mm (0.2% strain) while applying a temperature ramp of 50°C/hour.

Ancamine 2712M curing agent is free of benzyl alcohol. As such, formulated systems based on Ancamine 2712M curing agent provide improved resistance to heat and elevated temperature compared to conventional cycloaliphatic technology. Using the HDT procedure described above, selfleveller floor formulation 3 based on Ancamine 2712M curing agent provides a 20% improvement in heat resistance compared with Cyclo-A and Cyclo-B. In addition, self-leveller Formulation 3 provides 25-50% higher Shore D hardness retention at exposure temperature compared with Cyclo-A and Cyclo-B. This is illustrated in Figure 5.

FIGURE 5. SHORE D RETENTION OF SELF-LEVELLER FLOORS EXPOSED TO ELEVATED TEMPERATURE



TRADEMARK REFERENCE

Evonik	Ancamine® 2712M Curing Agent Epodil® 748 Reactive Diluent Surfynol® DF-62 Defoamer DynolTM 604 Surfactant
Byk Chemie	Tiona® 696
Kronos International, Inc.	Kronos® 2160
Sachtleben Chemie GmbH	Blanc Fixe Micro®
Cabot Corporation	Elftex® 415 Pigment Black

START FORMULATION 1: SOLVENT-FREE, WHITE TOPCOAT

A-Component			**White Topcoat**
1. Epoxy resin	Bisphenol-A/F epoxy resin, Epodil 748 diluted, EEW 195, η 900 mPa.s	Various	100.0
2. Defoamer additive	Surfynol® DF62	Evonik	0.68
3. Titanium dioxide	Tiona® 696	Millennium Chem.	50.0
4. Filler	Blanc Fix Micro®	Sachtleben Chemie	25.0

A-Component Manufacturing Procedure

• Charge components 1-2 and mix until homogeneous at low shear

• Charge component 3-4, mix until homogeneous at low shear; then grind pigments at high speed (10-20 m/s) to yield particle size less than 25 µm. Ensure temperature during grinding is kept < 50°C

B-Component			
5. Amine curing agent	Ancamine 2712M curing agent	Evonik	50.0
TOTAL			255.68

Application Procedure

• After mixing part A and B, the formulation is ready to apply

TECHNICAL DATA

Mix Ratio A/B (wgt)	78:22	Potlife by Viscosity (min.)	-20
Mix Ratio A/B (volume)	48:22 (~2:1)		
Density Mixture (kg/l)	1.4	Gloss 20°/60°	106/104
PVC (%)	11.5	Persoz Hardness, day7	300
Viscosity Part A (mPa.s), 23°C	-2,000	Walk-on Time (h) by Thumb-Twist Dry Time	7
Mix Viscosity (mPa.s), 23°C	-1,000		

START POINT FORMULATION 2: SOLVENT-FREE, GREY TOPCOAT

A-Component			**Grey Topcoat**
1. Epoxy resin	Bisphenol-A/F epoxy resin, Epodil 748 diluted, EEW 195, η 900 mPa.s	Various	100.0
2. Defoamer additive	Surfynol® DF62	Evonik	0.68
3. Titanium dioxide	Tiona® 696	Millennium Chem.	50.0
4. Carbon black		Local Supplier	0.35
5. Filler	Blanc Fix Micro®	Sachtleben Chemie	25.0

A-Component Manufacturing Procedure

• Charge component 1-2 and mix at low shear until homogeneous

• Charge components 3-5, mix until homogeneous at low shear; then grind pigments at high speed (10-20 m/s) to yield particle size less than 25 µm. Ensure temperature during grinding is kept < 50°C

B-Component			
6. Amine curing agent	Ancamine 2712M curing agent	Evonik	50.0
TOTAL			226.03

Application Procedure

• After mixing part A and B, the formulation is ready to apply

TECHNICAL DATA

Mix Ratio A/B (wgt)	78:22	Potlife by Viscosity (min.)	-20
Mix Ratio A/B (volume)	48:22 (~2:1)		
Density Mixture (kg/l)	1.4	Gloss 20°/60°	106/104
PVC (%)	11.5	Persoz Hardness	300
Viscosity Part A (mPa.s), 23°C	2,300	Walk-on Time (h) by Thumb-Twist Dry Time	7
Mix Viscosity (mPa.s), 23°C	1,000		
		Carbamation Resistance (Scale 1-5, 5=best) Day 1, 23°C (wet patch)	5

START FORMULATION 3: SOLVENT-FREE, GREY SELF LEVELING FLOOR (SLF)

A-Component			**Grey SLF**
1. Epoxy resin	Bisphenol-A/F epoxy resin, Epodil 748 diluted, EEW195; η 900 mPa.s	Various	20.0
2. Defoamer additive	Surfynol® DF-62	Evonik	0.45
3. Wetting additive	Dynol™ 604	Evonik	0.90
4. Titanium dioxide	Kronos® 2160	Kronos International	4.05
5. Carbon black	Elftex® 415	Various	0.07
6. Filler	Barytmehl F	Sachtleben Chemie	19.53

A-Component Manufacturing Procedure

• Charge components 1-3 and mix at low shear until homogeneous

• Charge components 4-6, mix until homogeneous at low shear; then grind pigments at high speed (10-20 m/s) to yield particle size less than 25 µm. Ensure temperature during grinding is kept < 50°C

B-Component			
7. Amine curing agent	Ancamine 2712M curing agent	Evonik	10.0
C-Component			
8. Quartz Sand 0.1-0.3 mm	Local	Various	45.0
TOTAL			100.0

Application Procedure

• After mixing part A, B and C, the formulation is ready to apply

TECHNICAL DATA

Mix Ratio A/B (wgt)	90:10	Gloss 20°/60°	85/100
Mix Ratio A/B (volume)	81:19 (~4:1)		
Density Mixture (kg/l)	1.9	Persoz Hardness	
Pigment: Binder Ratio (wt:wt)	2.2 : 1	Walk-on Time (h)	
Viscosity Part A (mPa.s), 23°C	3,300	- by Shore D (5 mm, 23°C)	<16
		- by Shore D (5 mm, 10°C	24
		Carbamation Resistance (Scale 1-5, 5=best)	
		- Day 1, 23°C (wet patch)	5
		- Day 2, 10°C (wet patch)	4

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