

Ancamine® 2739 Curing Agent

DESCRIPTION

Ancamine 2739 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 2739 curing agent is free of alkyl-substituted phenol, facilitating in low volatile organic component coating and flooring formulations and allows the use in emission compliant systems.

Compared to Ancamine® 2712M curing agent, Ancamine 2739 curing agent offers long pot-life whilst retaining cure speed and through cure and providing enhanced UV durability.

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 alkyl-substituted phenol

APPLICATIONS

- Emission compliant coatings and flooring systems
- Chemically resistant, high solid and solvent-free coatings
- Industrial flooring applications

SHELF LIFE

At least 24 months from the date of manufacture in the original sealed container at ambient temperature.

PACKAGING AND HANDLING

Refer to the Safety Data Sheet for Ancamine 2739 curing agent.

TYPICAL PROPERTIES

Appearance	Yellow liquid
Colour¹ (Gardner)	max 3
Viscosity² @ 25°C, [mPa.s]	350-650
Specific Gravity	1.0
Amine Value³ (mg KOH/g)	525-575
Equivalent Wt/{H}	95
Recommended use Level⁴ [PHR]	45-50

TYPICAL HANDLING PROPERTIES⁵

Gel Time⁶ (150g mix at 23°C), [min]	70-90
Gel Time⁶ (150g mix at 35°C), [min]	30
Thin Film Set Time⁷ 23°C, [h]	8.5
Gloss 20°/60°, 23°C	103/102
PersoZ Pendulum Hardness⁸, d1/d7, 23°C [s]	190/320
Hardness⁹, 16 h/7 days, 23°C [Shore D]	75D/85D
Wet Patch Early Water Resistance¹⁰, d1, 23°C	5
Thin Film Set Time⁷ 10°C, [h]	17.0
Gloss 20°/60°, 10°C	103/102
PersoZ Pendulum Hardness⁸, d2/d7, 10°C [s]	80/220
Hardness⁹, 24 h/7 days, 10°C [Shore A/D]	80A/84D
Wet Patch Early Water Resistance¹⁰, d2, 10°C	4

Footnotes:

- (1) ASTM D 1544-80
- (2) Brookfield DV+ Spindle 5
- (3) Perchloric Acid Titration
- (4) With Bisphenol A diglycidyl ether (EEW=190)
- (5) With Bisphenol A/F diglycidyl ether blend, Epodil® 748
Reactive Diluent diluted, EEW195, n 900 mPa.s
- (6) Techne GT-3 Gelation Timer
- (7) BK Drying Recorder Phase III
- (8) ASTM D 4366
- (9) ASTM D 2240
- (10) ASTM D 870

SUPPLEMENTARY DATA

Ancamine 2739 curing agent is the next generation product for the civil engineering (CE) market for use in industrial epoxy flooring applications. Ancamine 2739 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, the composition of Ancamine 2739 curing agent facilitates zero volatile organic component (VOC) coating and flooring formulations with very low emissions.

Ancamine 2739 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.

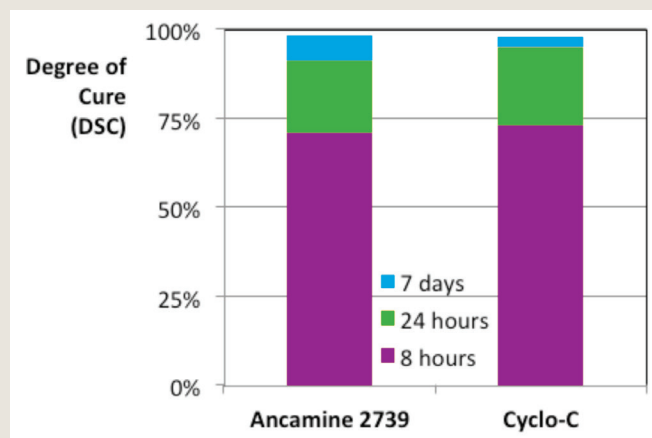
The supplementary data outlines several product features of Ancamine 2739 curing agent in combination with diluted epoxy resins. As a point of reference, performance of Ancamine 2739 curing agent is benchmarked against incumbent (benzyl alcohol containing) cycloaliphatic amine curing agents, "Cyclo-A", "Cyclo-B" and "Cyclo-C". Cyclo-A is an industrial standard cycloaliphatic curing agent for winter cure performance; Cyclo-B is an industrial standard cycloaliphatic curing agent for ambient temperature conditions; Cyclo-C is an alternative for Cyclo-A and Cyclo-B, allowing low temperature cure down to 10°C while offering working time, aesthetics and cure speed in between both standards. Cyclo-C has broad applicability in both CE and coatings for metal application. Starting point formulations using Ancamine 2739 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 2739 curing agent provides rapid conversion with epoxy resins to full cure (100%) at ambient and sub-ambient temperature conditions, comparable to Cyclo-C 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 2739 CURING AGENT IN COMBINATION WITH EPODIL 748 REACTIVE DILUENT DILUTED DGEBA/F EPOXY RESIN



HANDLING AND CURE SPEED

Clear coatings based on Ancamine 2739 curing agent provide fast cure at both ambient and low temperature conditions (10°C) and are comparable to Cyclo-C 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-B and Cyclo-C. Considering, a minimal shore D50 is required for early "walk-on", Ancamine 2739 curing agent based epoxy systems meet this condition between 1 and 2 days cure at 10°C condition.

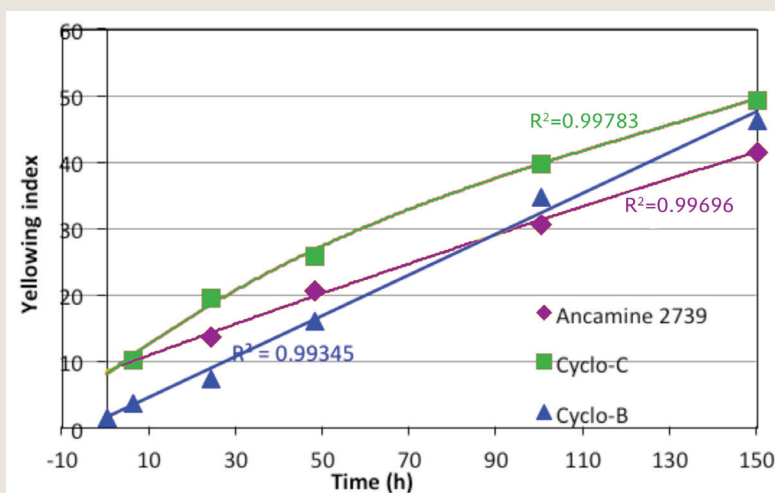
TABLE 1: HANDLING AND CURE SPEED PROPERTIES OF ANCAMINE 2739 CURING AGENT IN COMBINATION WITH EPODIL 748 REACTIVE DILUENT DILUTED DGEBA/F EPOXY RESIN

DGEBA/F/Epodil 748, EEW195, n 900 mPa.s			Ancamine 2739	Cyclo-B	Cyclo-C
AHEW/{H}			95	115	95
Ambient Temperature (23°C)					
Gelation Time, 150g mix		minute	75	80	30
Mix Viscosity		mPa.s	630	600	425
TFST	Phase 2 / Phase 3	h	7.0/9.5	8.5/11	7.0/7.5
PersoZ Pendulum	Day 1 / Day 7	s	185/300	90/290	75/220
Shore D Build	16h / 24h / Day 7	Shore D	70D/80D/85D	71A/55D/71D	55D/67D/81D
Low Temperature (10°C)					
TFST	Phase 2 / Phase 3	h	15/17	16/20	16/20
PersoZ Pendulum	Day 2 / Day 7	s	75/200	50/210	35/100
Shore D Build	24h / 48h / Day 7	Shore D	70A/78D/83D	--/42D/70D	80A/73D/75D

ACCELERATED UV RESISTANCE

Coatings based on Ancamine 2739 curing agent provide good UV stability over time when compared to Cyclo-C curing agent. This is demonstrated in Figure 2 where the yellowing index was measured as a function of exposure time. Yellowing was determined following ASTM E313 method, which describes the yellowing index as a 1-dimensional evaluation of the lightness-yellowness of the material colour. Yellowing data of the coatings was determined following ASTM G154 and D4587-05, with main difference that no condensation cycle was applied (UV mode only). Clear coats were applied onto S-36 panels (Q Panel Lab Products) at a dry film thickness of $150 \pm 5 \mu\text{m}$ and left to cure for 14 days prior to testing.

FIGURE 2: YELLOWING INDEX OVER TIME OF CLEAR COATINGS BASED ON ANCAMINE 2739 CURING AGENT MIXED WITH EPODIL 748 REACTIVE DILUENT DILUTED DGEBA/F EPOXY RESIN (UV MODE ONLY)



MECHANICAL PROPERTIES

Mechanical strength properties of epoxy castings were determined using a floor mounted dual column materials testing machine (Instron 3382) equipped with 100 kN load cell and LVDT deflector sensor in compressive mode. Tests were conducted according to ASTM D695 at 2.5 mm/min cross-head speed. Epoxy castings (25x25x25 mm) 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 2739 curing agent and diluted epoxy resins provide high compressive strength as shown in Table 2. Compared to conventional cycloaliphatic technology, Ancamine 2739 curing agent provides >40% higher compressive strength in conjunction with 25-30% increased modulus. The retention of strain versus Cyclo-B and -C demonstrates that Ancamine 2739 curing agent provides a durable protection to concrete. Formulations based on Ancamine 2739 curing agent introduce floorings with increased resilience and mechanical resistance.

FIGURE 3: AVERAGE COMPRESSIVE STRENGTH (ASTM D695) OF ANCAMINE 2739 CURING AGENT

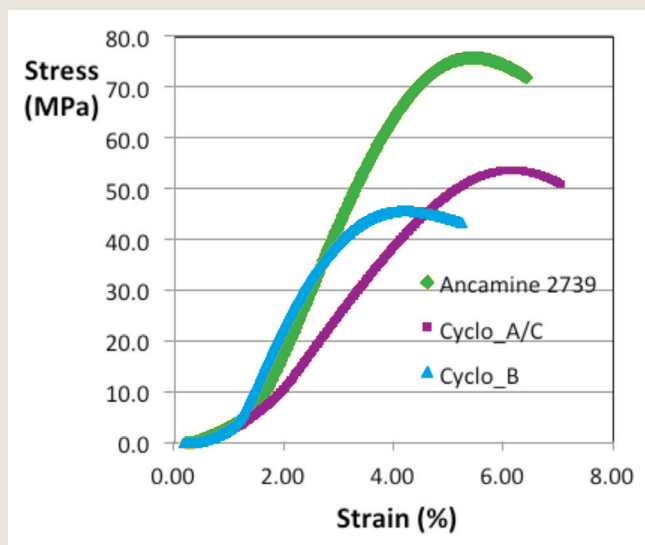


TABLE 2: COMPRESSIVE STRENGTH (ASTM D695) OF ANCAMINE 2739 CURING AGENT IN COMBINATION WITH EPODIL 748 REACTIVE DILUENT DILUTED DGEBA/F EPOXY RESIN

DGEBA/F/Epodil 748, EEW195, n 900 mPa.s		Ancamine 2739	Cyclo-B	Cyclo-C
Compressive strength	MPa	76 (1)	45 (1)	53 (1)
Compressive modulus	GPa	2.41 (0.10)	1.90 (0.10)	1.36 (0.10)
Strain*	%	4.4	3.4	5.0

* using corrected zero-strain point for toe region.

PRODUCT FEATURE BENEFITS IN FORMULATED EPOXY SYSTEMS

ACCELERATED EMISSION TESTING

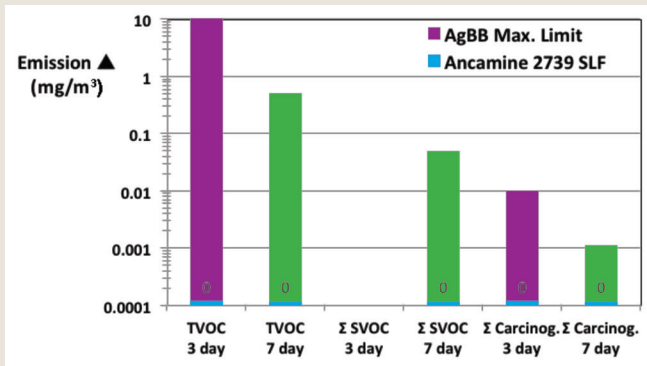
For the evaluation of emission components, ECA Report 18 [European Collaborative Action "Indoor Air Quality and Its Impact On Man", Evaluation of VOC emissions from building products; solid flooring materials (Report no. 18), EUR17334EN, European Commission, Joint Research Centre, Environment Institute, 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 $\mu\text{g}/\text{m}^3$, 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 $\geq 5 \mu\text{g}/\text{m}^3$ ranging between C_6 - C_{16}
- SVOC:- Slow-Volatile Organic Component $> \text{C}_{16}$ - C_{22}
- Σ SVOC:- Total SVOC, accumulated SVOC of products $\geq 5 \mu\text{g}/\text{m}^3$ with $> \text{C}_{16}$ - C_{22}

Ancamine 2739 curing agent has been designed to allow negligible VOC coating and flooring formulations with extremely low emissions during service life. Start Formulation 3 based on Ancamine 2739 curing agent was submitted to emissions testing following AgBB scheme and rated accordingly. It should be noted that the maximum allowed emission limits after 7 and 28 days cure, respectively, are 5% and 10% of the 3 day limits. The flooring sample was applied at 2.5 mm/m² thickness and evaluated for emissions after 3 and 7 days cure at 23°C and 50% relative humidity (RH).

Figure 4 summarizes the emission testing results after 3 and 7 days cure. Start Formulation 3 based on Ancamine 2739 curing agent demonstrated negligible emissions with nil detection of TVOC, SVOC or carcinogenic substances. Floorings based on Ancamine 2739 are ideal for use in the electronics industry or where low odour and tainting is of importance. Examples include schools, hospitals and nursing homes where inhabitants and users experience either prolonged exposure to flooring emissions or simply require additional care.

FIGURE 4: EMISSION TESTING RESULTS OF FORMULATION 3 BASED ON ANCAMINE 2739 CURING AGENT FOLLOWING AGBB TESTING SCHEME

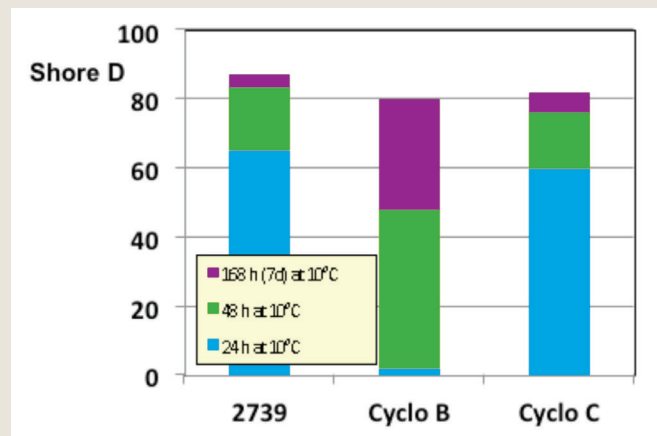
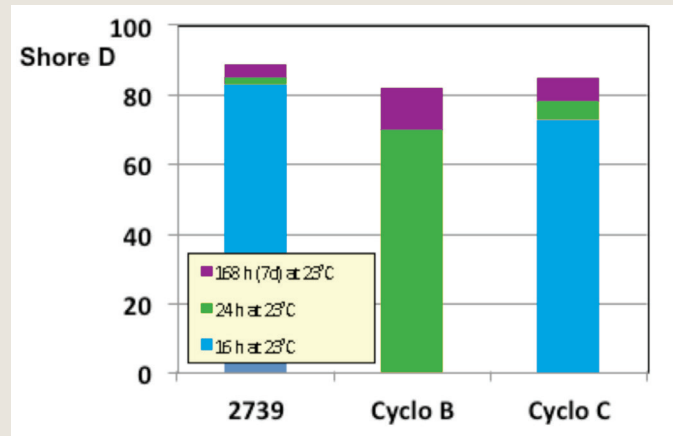


FAST CURE SPEED FOR RAPID ‘WALK-ON’

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 5 shows the Shore D development of self-leveller floors cured at 23°C (left) and 10°C (right) curing conditions.

Whilst not as fast as Cyclo-A, Ancamine 2739 curing agent based self-leveller floor provides rapid walk-on times, comparable to Cyclo-C. This facilitates the all-round use of Ancamine 2739 curing agent in flooring systems at ambient and low temperature conditions.

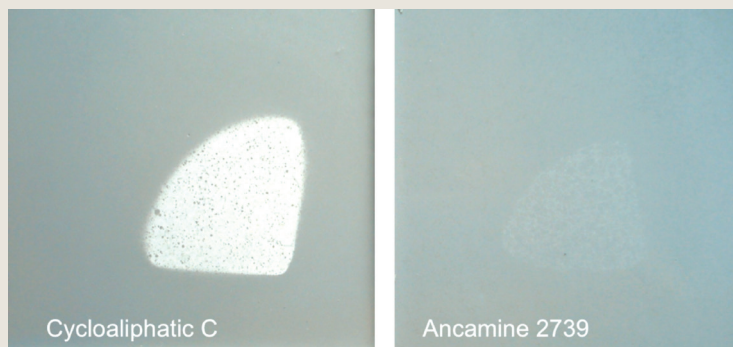
FIGURE 5: SHORE D HARDNESS DEVELOPMENT OF SELF-LEVELLER FLOORS CURED AT AMBIENT (LEFT) AND 10°C (RIGHT) TEMPERATURE CONDITIONS



HIGH CARBAMATION RESISTANCE UNDER ADVERSE CONDITION

Coatings based on Ancamine 2739 curing agent provide excellent carbamation resistance and early water resistance at ambient and low temperature (10°C) conditions. Self-leveller floor (SLF) Formulation 3 was left to cure for two days at 10°C after which it was exposed to water for 24 hours. The result in Figure 6 shows minimal carbamation, rated as 4 on a 1-5 relative scale (5= excellent, no visible marks) versus significant carbamation for conventional cycloaliphatic curing agent Cyclo-B and Cyclo-C (rating 1).

FIGURE 6: CARBAMATION RESISTANCE AFTER 48 H AT 10°C COMPARING SELF-LEVELLER FLOORS BASED ON ANCAMINE 2739 CURING AGENT WITH CYCLO-C CURING AGENT



TRADEMARK REFERENCE

Ancamine® 2739 Curing Agent Epodil® 748 Reactive Diluent Surfynol® DF-62 Defoamer Dynol™ 604 Surfactant	Evonik
Byk® 346; Byk®-A530	Byk Chemie GmbH
Tiona® 696	Millennium Chemicals
Kronos® 2160	Kronos International, Inc.
Blanc Fixe Micro®; Barytmehl F	Sachtleben Chemie GmbH
Elftex® 415 Pigment Black	Cabot Corporation

START FORMULATION 1: SOLVENT-FREE, WHITE TOPCOAT

A-Component			White Topcoat
1. Epoxy resin	Bisphenol-A/F epoxy resin, Epodil 748 diluted, EEW 195, n 900 mPa.s	Multiple	120.00
2. Leveling additive	Byk 346	Byk Chemie	1.25
3. Defoamer additive	Byk-A 530	Byk Chemie	1.10
4. Titanium dioxide	Tiona 696	Millennium Chemicals	23.30
5. Filler	Blanc Fixe Micro	Sachtleben Chemie	75.00
A-Component Manufacturing Procedure			
<ul style="list-style-type: none"> • Charge components 1-3 and mix until homogeneous at low shear • Charge component 4-5, 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 2739	Evonik	57.60
TOTAL			278.25
Application Procedure			
• After mixing part A and B, the formulation is ready to apply.			

TECHNICAL DATA

Mix Ratio A/B (wgt)	79:21	Potlife by Viscosity (min.)	~ 50
Mix Ratio A/B (volume)	70:30 (~ 2:1)		
Density Mixture (kg/l)	1.5	Gloss 20°/60°	104/104
PVC (%)	12.1	Persoz Hardness (s), day7	284
Viscosity Part A (mPa.s), 23°C	~2,000		
Mix Viscosity (mPa.s), 23°C	~1,500		

START FORMULATION 2: SOLVENT-FREE, GREY TOPCOAT

A-Component			Grey Topcoat
1. Epoxy resin	Bisphenol-A/F epoxy resin, Epodil 748 diluted, EEW 195, n 900 mPa.s	Multiple	120.00
2. Leveling additive	Byk 346	Byk Chemie	1.25
3. Defoamer additive	Byk-A 530	Byk Chemie	1.10
4. Titanium dioxide	Tiona 696	Millennium Chemicals	23.30
5. Filler	Blanc Fixe Micro	Sachtleben Chemie	75.00
6. Carbon Black	Elftex 415	Cabot Corporation	0.42
A-Component Manufacturing Procedure			
<ul style="list-style-type: none"> • 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			
7. Amine curing agent	Ancamine 2739	Evonik	57.60
TOTAL			278.25
Application Procedure			
<ul style="list-style-type: none"> • After mixing part A and B, the formulation is ready to apply. 			

TECHNICAL DATA

Mix Ratio A/B (wgt)	79:21	Potlife by Viscosity (min.)	~ 50
Mix Ratio A/B (volume)	70:30 (~ 2:1)		
Density Mixture (kg/l)	1.5	Gloss 20°/60°	104/104
PVC (%)	12.1	Persoz Hardness	284
Viscosity Part A (mPa.s), 23°C	2,000	Carbamation Resistance (Scale 1-5, 5=best)	5
Mix Viscosity (mPa.s), 23°C	1,300	Day 1, 23°C (wet patch)	

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, EEW 195, n 900 mPa.s	Multiple	20.93
2. Defoamer additive	Byk-A 530	Byk Chemie	0.23
3. Leveling additive	Byk 346	Byk Chemie	0.22
4. Titanium dioxide	Kronos 2160	Kronos International	4.06
5. Carbon Black	Elftex 415	Cabot Corporation	0.07
6. Filler	Blanc Fixe Micro	Sachtleben Chemie	19.18
A-Component Manufacturing Procedure			
<ul style="list-style-type: none"> 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 2739	Evonik	10.04
C-Component			
8. Sand	M34, d ₅₀ 170µ	S.C.R. Sibelco NV	45.34
TOTAL			100.00
Application Procedure			
<ul style="list-style-type: none"> 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°	96/102
Mix Ratio A/B (volume)	81:19 (~ 4:1)		
Density Mixture (kg/l)	1.9	Persoz Hardness Walk-on Time (h)	
PVC (%)	43.78		
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

EVONIK RESOURCE EFFICIENCY GMBH

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