Product information

ANQUAMINE® 100

Curing Agent

DESCRIPTION

Anquamine® 100 is a waterborne curing agent equally suitable for standard liquid epoxy resin and solid epoxy resin dispersions.

Anquamine® 100 combines in a unique way, fast drying with an extremely long pot life when used with liquid epoxy resin.

Anquamine® 100 curing agent provides 6-8 hours pot life with liquid epoxy resins and addresses the typically short pot life of 1-2 hours from current two component, water-based systems.

The ultra low viscosity of the curing agent dispersion provides the formulator with novel formulation options and handling advantages while the applicator will benefit from easier painting without roller pick-up. It allows the application of higher solids water-based coatings and reduces the number of coats required.

TYPICAL PROPERTIES

Property	Value	Unit	Method
Appearance	Opaque White Dispersion		
Colour	-	Gardner	ASTM D 1544-80
Viscosity @ 25°C	150-300	mPa.s	Brookfield RVTD, Spindle 4
Amine Value	90-110	mg KOH/g	Perchloric Acid Titration
Specific Gravity @ 25°C	1.05		
Total Solids Content	53-57	wt %	
Equivalent Wt/{H}	350		
Recommended use Level	180	PHR	

ADVANTAGES

- Very long pot life with liquid epoxy resin
- Extremely low viscosity
- Low colour and good retention of colour upon UV exposure

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APPLICATIONS

- Waterborne sealers and primers
- White top-coats
- Floor paints

SHELF LIFE

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

PACKAGING AND HANDLING

Refer to the Safety Data Sheet for Anquamine® 100 curing agent.

TYPICAL HANDLING PROPERTIES

Property	Value	Unit	Method
Pot Life @ 20°C	6-8	h	With Bisphenol A diglycidyl ether (EEW=190)
Thin Film Set Time			BK Drying Recorder; With Epires ER8 (EEW=195) (modified Bis-A/F epoxy resin)
Phase I @ 20°C	0.5	h	
Phase II @ 20°C	1.5	h	
Phase III @ 20°C	9.0	h	
Persoz Hardness			With Epires ER8 (EEW=195) (modified Bis-A/F epoxy resin)
1 day @ 20°C	150		
7 day @ 20°C	320		

TYPICAL PERFORMANCE PROPERTIES

Typical cure schedule **2-7 days**

SUPPLEMENTARY DATA

CURING AGENT CHARACTERISTICS: Anquamine® 100 curing agent is a new generation water- based technology employing a novel design approach. Conventional curing agents are based on water-soluble, hydrophilic amine technology which typically results in highly viscous products partly caused by inherent hydrogen bonding. As a consequence, curing agent formulation and processing at considerable cost are required to achieve appropriate handling and application characteristics.

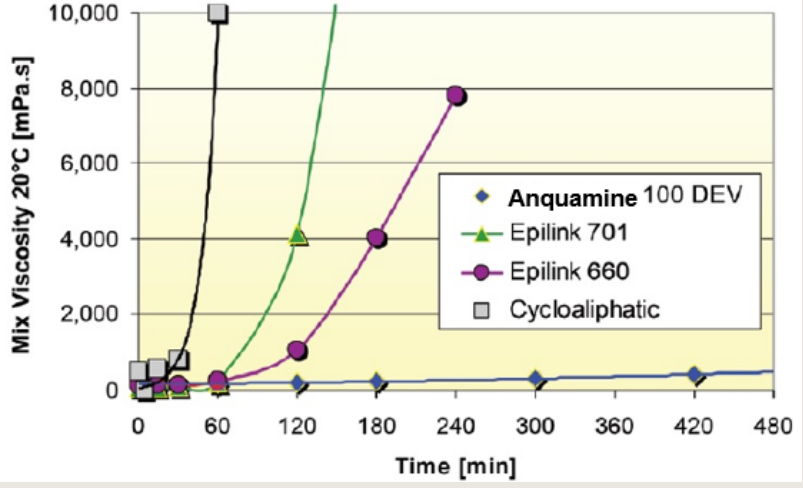
In contrast, Anquamine® 100 curing agent is based on a hydrophobic polyamine that exhibits reduced solubility in water and is available as a pre-dispersed amine. As the viscosity in a dispersed phase is nearly independent of molecular weight, Anquamine® 100 is an order of magnitude lower in viscosity compared to conventional water-based curing agent technology. The low viscosity (~200mPa.s) provides a product that is easy to handle and to apply and in that respect comparable to solvent free cycloaliphatic curing agent technology. Anquamine® 100 can be used to develop primers and transparent water-based epoxy coatings without further processing thereby achieving cost savings for curing agent formulation and re-packaging.

Anquamine® 100 curing agent coating formulations can be readily applied by spray, brush or roller. The same surface area can be coated in less time and roller-pick up of some water-based systems will be eliminated.

Additional benefits include a pot-life of up to 8 hours with liquid epoxy resin that provides a significantly prolonged application window by a factor of 4-8 compared to established water-based or solvent-free technology. A low colour with good yellowing resistance and improved acid and stain resistance are additional benefits that are associated with Anquamine® 100.

POT-LIFE: Anquamine® 100, when formulated with standard liquid epoxy resin, provides a pot life of up to 8hrs. A flat viscosity profile over a 6-8 hour period is achieved with excellent film formation properties throughout the pot life as expressed by a high and constant gloss and hardness. Other water-based curing agent technology for liquid epoxy resins, such as Epilink 660 or Epilink 701, only provide a pot life of 90-120 minutes with liquid epoxy resin (Figure 1). For comparison Figure 1 also shows pot life of a standard cycloaliphatic curing agent that provides a pot life of under an hour.

FIGURE 1: VISCOSITY PROFILES WITH EPIRES® ER8

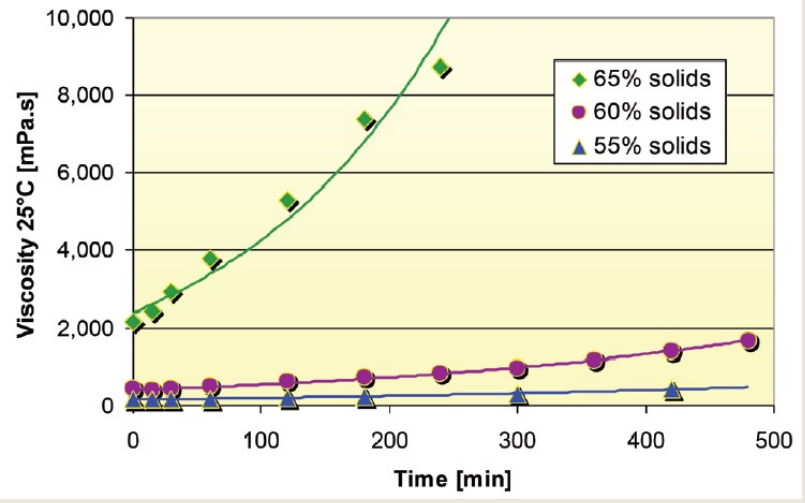


The long pot life of Anquamine® 100 of 8h has the potential to offer more working flexibility with regard to reducing the number of mixing operations during application and more efficient use of working crews. Additionally, the longer pot life is beneficial for wall coating application, application at higher temperatures and spray applications.

In order to achieve a 6-8h pot life with Anquamine® 100, attention has to be paid to the solids content of the formulation. The binder concentration must be < 60% solids to stay below the theoretical value of random closed packaging of spheres (63.7%) to avoid too close proximity of the emulsion particles that would then shorten the pot life. Above 60% solids, a steeper viscosity increase and shorter pot life is observed. The solids viscosity relationship is depicted in Figure 2.

A 6-8 hours pot life is observed in clear coatings and is also retained in a pigmented system such as the white topcoat formulation 1.2.3.10/AQ100. Unmodified as well as modified bisphenol A and bisphenol F based epoxy resins have been tested and exhibit similar performance. Epoxy resins evaluated include, Epires ER8 (Evonik) and $C_{12}/_{14}$-glycidyl ether (Epodil® 748) modified resins.

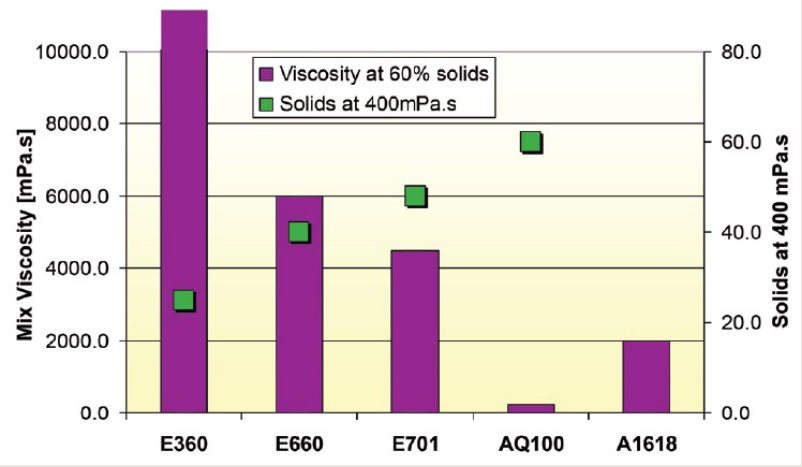
FIGURE 2: VISCOSITY PROFILES OF ANQUAMINE® 100 AT DIFFERENT BINDER SOLIDS WITH EPIRES ER8



VISCOSITY AND DILUTION EFFICIENCY: Anquamine® 100 has an extermly low viscosity of approx. 200 mPa.s which is more than an order of magnitude lower in comparison to conventional water-based curing agents. As a result the curing agent exhibits handling characteristics comparable to solvent free cycloaliphativ curing agent technology.
Anquamine® 100 can be used to develop primers and transparent water-based epoxy coatings without further processing thereby delivering improved cost savings for curing agent formulation and re-packing.

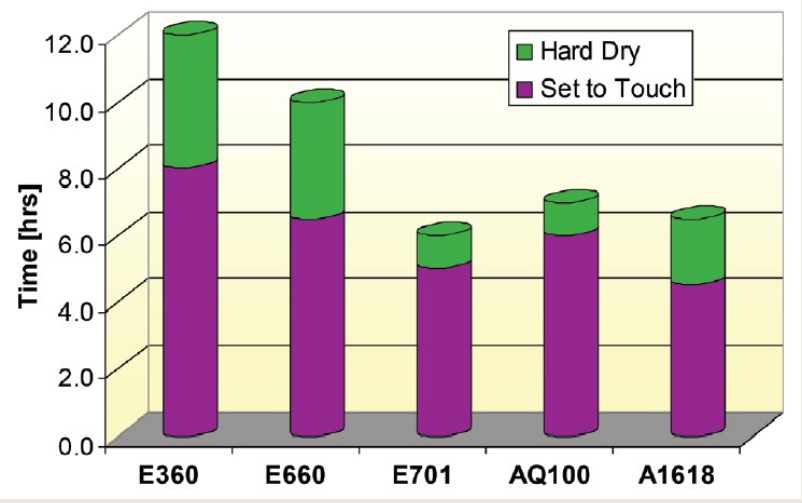
The benefits of the low curing agent viscosity also translate into low mix viscosity at same solids, which equate to a higher solids water-based system. A comparison of different water-based technologies is shown in Figure 3. Formulations based on Anquamine® 100 contain 25-50% more active binder at same application viscosity when compared to other water-based technology. A reduction of coats and time to yield the desired film thickness can be achieved. Since less water is required to evaporate from an Anquamine® 100 coating a higher film build can be achieved. Unfilled systems have cured up to a dry film thickness of 500µm with high transparency and without signs of water entrapment, thus providing application security and the possibility of application of transparent high film build water-based coatings. A transparent sealer on a stone carpet would be an application example.

FIGURE 3: MIX VISCOSITY COMPARISON AT 60% SOLIDS AND APPLIED SOLIDS AT 400PA.S (WITH EPIRES ER8)



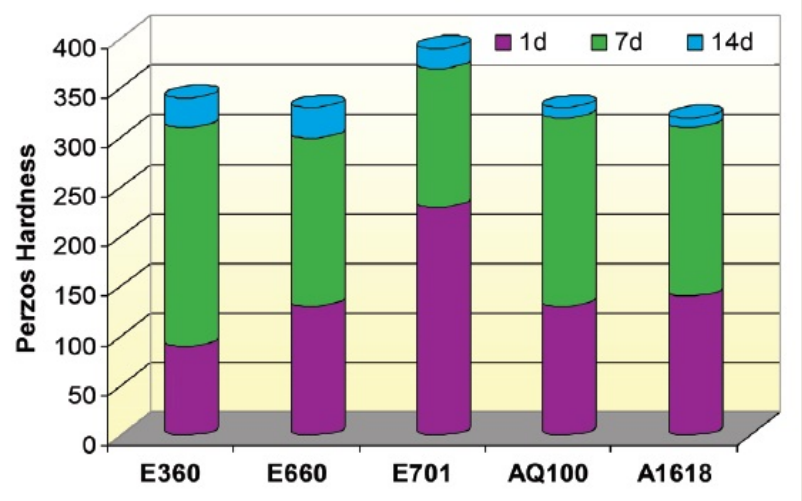
CURE SPEED: In addition to the long workable life, Anquamine® 100 based coatings also exhibit the added features of rapid drying and crosslinking. These properties can be attributed to the high molecular weight of the Anquamine® 100 dispersion. Drying times of Anquamine® 100 curing agent are between established 2nd and 3rd generation water-based curing agent technology (e.g., Epilink® 660 and Epilink® 701) and superior compared to first generation water-based polyamide technology (e.g., Epilink® 360). Drying is also comparable to solvent free cycloaliphatic systems as depicted in Figure 4.

FIGURE 4: DRYING TIMES OF WATER-BASED AND SOLVENT FREE SYSTEMS; EPIRES ER8 (20°C, 60% RH)



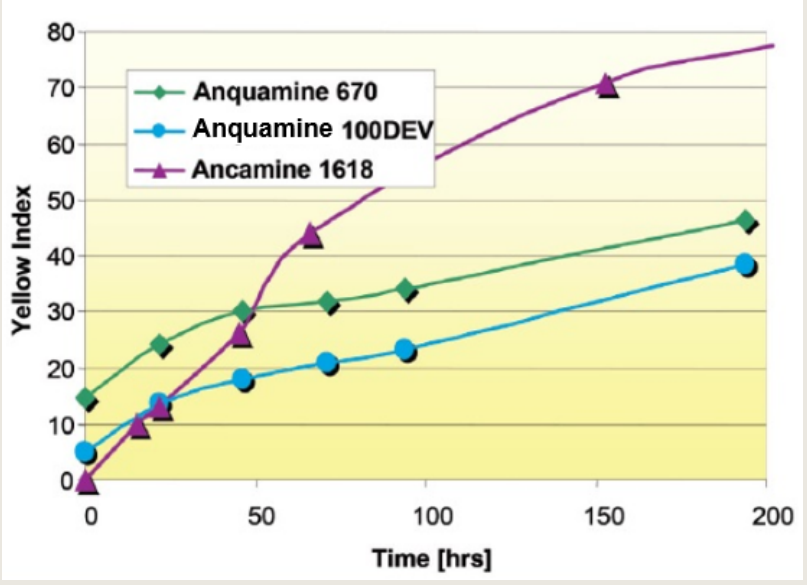
The fast drying of Anquamine® 100 DEV is also confirmed by a fast crosslinking process as indirectly measured as Persoz hardness development (Figure 5). The hardness development is comparable to second generation water-based technology or conventional solvent free cycloaliphatic technology.

FIGURE 5: PERSOZ HARDNESS DEVELOPMENT WITH EPIRES ER8 (20°C; 60% RH)



UV STABILITY: Anquamine® 100 exhibits a low initial colour and cures in trans-parent and clear epoxy coatings. Yellowing upon UV exposure is a commonly known weakness of solvent free and water-based epoxy technology. Accelerated weathering benchmarking with QUVA exposure of Anquamine® 100 against other water-based technology and solvent free cycloaliphatic technology shows that Anquamine® 100 exhibits improved UV stability (Figure 6).

FIGURE 6: YELLOWING BEHAVIOUR OF WATER-BASED AND SOLVENT FREE CLEAR COATINGS UPON QUVA RADIATION



CHEMICAL AND STAIN RESISTANCE: Anquamine® 100 has been benchmarked for chemical spot and stain resistance against established water-based epoxy coating technology. Clear coatings of 75 µm (DFT) wer cured for 14 days and the individual chemicals of foodstuffs were placed onto the coating covering an area of approx. 2x2cm. Spots were covered with a watch glass to avoid ecaporation. After specified time intervals chemicals were washed off ans the coating insprected for damage ans rated accordingly. Results of the chemcial resistance are shown in Table 1 and results of the stain resistance are shown in Table 2.

Good solvent resistance is observed for all water-based systems, however, a marked improvement in acid resistance is noticeable with Anquamine® 100. Acid resistance, particularly organic acid (e.g. acetic acid) resistance are known limitations of water-based epoxy coatings. The results of the benchmarking show that Anquamine® 100 based coatings remain intact upon sulphuric acid (10%) and dilute acetic acid (3%) exposure, whereas other water-based systems show severe failures.

TABLE 1: CHEMIVALS SPOT RESISTANCE 1H AND 18H EXPOSURE; CURED WITH EPIRES® ER8

	Anquamine® 100		Epilink® 701		Anquamine® 401	
	1h	18h	1h	18h	1h	18h
Toluene	+	+	+	+	+	+
Ethanol	+	+	+	+	+	+
Sulphuric acid (10%)	+	+	+	+	H	B
Acetic acid (3%)	+	+	H	B	H	B
Acetic acid (10%)	B	B	B	B	B	B

+ = no change; H=haze; B=blisters

A natural benefit of the improved acid resistance is that Anquamine® 100 shows ,arkedly better stain resistance against common foodstuffs, which contain low level of acid substances. Mustard, ketchup and red wine stain resistance are substances worth highlighting. Anquamine® 100 coatings are virtually unaffected after exposure whereas other water-based systems have been significantly attacked.

TABLE 2: STAIN RESISTANCE 18H EXPOSURE; CURED WITH EPIRES® ER8

	Anquamine® 100	Anquamine® 670	Anquamine® 401
Coffee	no change	slight stain	slight stain
Ketchup	no change	yellow stain	stain/blisters
Mustard	no change	yellow stain	stain/blisters
Red Wind	slight stain	yellow stain	yellow stain

STORAGE AND STABILITY: Anquamine® 100 curing agent is a hydrophobic dispersion of a polymeric amine with a narrow particle size distribution of ~800nm. It exhibits good storage stability of 12 months at ambient temperature. Storage for long periods above 35°C should be avoided to prevent accelerated settlement. If a soft settlement is formed it can be easily stirred up without negative impact on product and coating performance. Anquamine® 100 has been tested for freeze-thaw stability in accordance with ASTM D2243-95. After five cycles of freeze/thaw, particle size is unaffected and no settlement is formed. Clear coat performance evaluation as measured by surface appearance, gloss, drying speed and hardness development remains unchanged.

FORMULATING GUIDELINES

Unlike with many other waterborne curing agents, pre-dilution with additional water to achieve acceptable handling is not required with Anquamine® 100. For primers and clear coatings no further dilution is required due to the low viscosity of Anquamine® 100 curing agent. This should allow for a reduction of formulation and processing costs compared to conventional water-based systems. After mixing with liquid epoxy resin the addition of water at the job site may be required dependent on final application requirements. The amount of water required is dependant upon the type of formulation used.

When pigmenting the Anquamine® 100 curing agent it is recommended to use a high speed dispenser/dissolver to effectively disperse the pigments. Anquamine® 100 is shear and heat stable but in order to prevent excessive evaporation of water, mixing temperatures above 60°C should be avoided. Depending on the filler loading in the formulation it could be advantageous to disperse the required amount of pigment/filler in only part of the curing agent to achieve sufficiently high shear forces for dispersing, and post-add the other part of the curing agent thereafter. It is recommended to disperse at high speed for 15 minutes, to check the fineness of the grind and to add reminder of the curing agent and water if necessary. The low viscosity will facilitate the incorporation of fillers.

Alternatively a resin free grind can be used for greater formulation versatility. Formulation details are available on request.

EPOXY RESINS: Anquamine® 100 curing agent exhibits exceptionally good compatibility with liquid epoxy resins as well as with pre-dispersed solid epoxy resins. Liquid epoxy resins based on bisphenol A or bisphenol F are equally suitable in unmodified or modified form and provide most cost effective formulation options. Reactive diluent modified epoxy resins will improve handling and formulating, especially at low temperatures, but typically they will adversely affect cure speed, hardness development and chemical resistance. For faster dry speed and faster walk-on time the use of pre-dispersed solid epoxy resins such as Ancarez® AR550 (Evonik) is preferred.

PIGMENTS: Excellent results have been obtained with Kronos 2160 and Dupont's R960 titanium dioxide pigments. Further work is in progress to evaluate other pigment grades and will be available on request.

ADDITIVES: For best transparency and compatibility non-silicone defoamers are recommended. For good compatibility and defoaming molecular defoamers like Surfynol DF-70, Surfynol 110D or Surfynol 440 (Evonik) are suitable. Stronger silicone defoamers can provide better defoaming properties that may be required in higher PVC formulations, however can have a negative impact on compatibility.
Foamex 810 (Tego) has been found suitable.

In filled systems pigment settlement may occur over time and the incorporation of rheology modifiers is recommended. Associative polymers such as Aquaflow NLS-200 (Herkules) have good thickening efficiency and pseudoplastic rheology upon application of shear. Alternatively Acrysol RM 8W (Rohm&Haas) can be used.

TINTING: Anquamine® 100 shows very good pigment compatibility and exhibits good performance with a range of commercially available tinting systems. The AQUA-CHEM® water-based tinting system (Degussa) as well as a tinting system from BICCS (Netherlands) have been tested and found suitable without pigment flooding or floating problems.

White Top-Coat (Roller, Brush and Spray) — Waterborne (1.2.3.10/AQ100)

Nb.	A-Component	Parts	Type	Supplier
1.	Anquamine® 100	40.00	Curing Agent	Evonik
2.	Surfynol CT-141	1.50	Dispersant	Evonik
3.	Foamex 810	0.05	Defoamer	Tego
4.	Kronos 2160	26.00	Titanium dioxide	Kronos
5.	Blanc fix micro	10.00	Baryte	Sachtleben
6.	Plastorit Super	4.00	Filler	Kremer
7.	Talc 10M2	4.00	Talc	Luzenac
8.	Anquamine® 100	6.00	Curing Agent	Evonik
9.	Surfynol 440	0.50	Defoamer	Evonik
10.	Aquaflow NLS-200	2.00	Rheology modifier	Hercules
11.	Water	5.95	Diluent	Local
		100.0		

Remarks:

- Charge components 1-3 and stir homogeneous
- Add pigment and fillers
- Grind at approx. 10-20 m/s for 15min
- Add remaining components at low shear rate

Nb.	B-Component	Parts	Type	Supplier
8.	Ancarez® RZ4305	25.00	Epoxy Resin	Evonik
	TOTAL	**125.00**		

After mixing Part A and B water can be added to adjust for application viscosity.

After mixing Part A and B for approximately 5 minutes formulation is ready for application.

The formulation exhibits excellent sag resistance. Wet film thickness of up to 300µm has been applied on vertical substrate without noticeable sagging.

Mixing ratio	weight	100: 25	Potlife	h	6-8
	volume	100:37	Gloss (60°)		80
Density (g/ml)	- Part A	1.59	BKDry time 23°c		
	- Part B	1.08	Phase I	h	0.5
	-Mix	1.45	Phase II	h	3.0
			Phase III	h	6.5
Solid Content (Weight %)	- Part A	72.3	Persoz Haardness		
	- Part B	100.0	1 day		120
	-Mix	79.9	7 days		270
Solid Content (Volume %)	- Part A	56.0			
	- Part B	100.0			
	-Mix	68.0			
PVC	%	20.5			

Clear Coating and Primer (Concrete) — Waterborne (1.2.1.10/AQ100)

Nb.	A-Component	Parts	Type	Supplier
1.	Anquamine® 100 DEV	99.8	Curing Agent	Evonik
2.	Surfynol DF-62	0.2	Defoamer	Evonik
		100.0		

The use of a defoamer is optional.

Nb.	B-Component	Parts	Type	Supplier
3.	Ancarez® RZ4305	55.00	Epoxy Resin	Evonik
	TOTAL	**155.00**		

After mixing Part A and B water can be added to adjust for application viscosity.

After mixing Part A and B for approximately 5 minutes formulation is ready for application.

Mixing ratio	weight	100:55	Potlife	h	6-8
	volume	100:55	Gloss (20°)		90
Density (g/ml)	- Part A	1.05	BKDry time 20°C		
	- Part B	1.08	Phase I	h	0.5
	-Mix	1.06	Phase II	h	1.5
			Phase III	h	9.0
Solid Content (Weight %)	- Part A	59.9	Persoz Hardness		
	- Part B	100.0	1 day		120
	-Mix	71.7	7 days		270
Solid Content (Volume %)	- Part A	53.5			
	- Part B	100.0			
	-Mix	69.9			

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