ACRYSOL™ WS-68 Emulsion

Thermosetting Acrylic Polymer for Waterborne Industrial Enamels

Regional Product Availability

Asia-Pacific

Description

ACRYSOL™ WS-68 Emulsion is a thermosetting acrylic polymer supplied as a colloidal dispersion in water. When formulated with monomeric melamine resins, it facilitates the formulation of industrial baking enamels that offer excellent spray characteristics and film properties.

Key Features

- Excellent gloss and film image clarity
- Excellent sprayability for both conventional and electrostatic disc application
- High enamel solids in an aqueous gloss system
- Formulation latitude to offer a range of co-solvent levels low enough to meet anti-pollution requirements
- Good enamel stability
- Formulation simplicity

Typical Properties

(These properties are typical but do not constitute specifications).

Property	Typical Values
Appearance	Opaque, white to yellow liquid
Solids, by weight, %	38.0
Density (g/ml), wet	1.04
pH	7.2
Viscosity (Brookfield LV #2, 60 rpm , 25 °C), cps	< 210
Solvent, by wt.	Water / DMAE = 96 / 4
Freeze Thaw Stability	Passes 5 cycles

Pigmented Film Properties

The properties of pigmented enamels based on ACRYSOL™ WS-68 Emulsion compare favorably with other commercially available systems. Table I presents a detailed comparison of these properties.

To summarize, systems based on ACRYSOL WS-68 Emulsion / Cymel 303 Resin blends:

a. Demonstrate excellent results in accelerated weathering tests, overbake color, and hot water resistance tests versus a commercially available water-reducible alkyd/melamine system.

b. Demonstrate excellent results in accelerated weathering tests versus a commercially available solvent-borne alkyd/melamine system.

c. Have comparable film properties to other commercially available acrylic / melamine water-reducible enamels.

Table 1

Properties of Pigmented Films on Bonderite 1000 (30 min / 300°F Bake)

			Alkyd / Melamine	
	ACRYSOL™ WS-68 / Cymel 303 (0.2% PTSA)	Acrylic / Melamine Water Reducible	Water Reducible	Solvent Reducible
A. Mechanical and Appearance Properties				
Hardness, KHN	11	7	17	13
Hardness, Pencil	H	H	2H	H
Mandrel Flexibility (0 = no effect; 10 = failure)	0 / 0	0 / 2	10 / 10	0 / 0
Impact, (Rev./Dir.) in.-lbs	< 2 / 25	< 2 / 25	< 2 / 20	< 2 / 20
Print, 180°F (2 psi / 2 hrs)	V. Light	Light	Trace	V. Light
Gloss, 20° / 60°	85 / 95	68 / 95	74 / 96	62 / 87
Color (K) Initial	6.1	5.5	9.5	5.0
Overbake 2 hrs / 400°F	10.3	6.8	60.4	9.1
Adhesion Tape / crosshatch, % fail	0	0	< 5	< 5
B. Resistance and Accelerated Weathering Properties				
100 MEK rubs, % fail	0	0	0	0
Staining (30 min)				
Ink	Trace	Lt. Mod.	None	Lt. Mod.
Grape Juice	None	None	None	None
Mustard	None	None	None	None
Chemical Resistance (30 min)				
10% KOH	No effect	No effect	No effect	No effect
5% Acetic acid	No effect	No effect	No effect	No effect
Glacial acetic acid	Softens	Softens	Softens / blisters	Softens
Boiling water resistance (30 min immersion)	No effect	No effect	Dull / tacky	No effect
Humidity (1000 hrs, 95% RH, 95°F)	No effect	No effect	-	No effect
Accelerated Weathering - QUV 500hrs, % 20° gloss retained	81	76	2	2

Suggested Cure Schedules

The film properties reported in Table 1 were determined on films baked 300°F / 30 min but the following cure schedules have been found to give equivalent properties where faster line speeds are required.

325°F / 15 min

350°F / 10 min

375°F / 5 min

Other cure schedules can be evaluated to meet specific line conditions.

Enamel Stability

Enamels based on ACRYSOL™ WS-68 Emulsion / melamine blends offer a unique stability advantage, even when catalyzed over aqueous alkyd / melamine systems. In Table 2, a comparison of stability properties on oven aging is given.

Cured film properties of the heat-aged enamels based on ACRYSOL WS-68 Emulsion / melamine were unchanged when compared with those determined on freshly prepared samples. Enamels based on ACRYSOL WS-68 Emulsion / melamine are pH stable. The slight decrease in viscosity upon aging can be restored by the addition of a dilute solution of DMAE.

Table 2

Enamel Stability on Oven Aging Pigment / Binder = 40 / 60

	ACRYSOL™ WS-68 / Melamine (0.2% PTSA)	Water Reducible Alkyd / Melamine
Total solids, %	48.0	43.5
pH, initial	7.7	7.5
pH, After 7 days at 140°F	7.6	Gelled
Viscosity, sec (Ford 4 cup)		
Initial	27	24
After 7 days at 140°F	18	Gelled

FORMULATING GUIDELINES

Melamines

Care should be taken to select monomeric type melamines only. Polymeric types that were evaluated gave hard, brittle films with poor resistance properties. Examples of acceptable melamines were: Resimene 745, Cymel 301, and Cymel 303 resins

Viscosity Adjustment

Enamels made with ACRYSOL™ WS-68 Emulsion do not require external thickeners for viscosity control. Upward viscosity adjustments can be made easily and with quick equilibration by adding a dilute solution of a tertiary amine, dimethylaminoethanol (DMAE). This base comprises 4% of the solvent in which ACRYSOL WS-68 Emulsion is supplied. When added to the formulation, DMAE causes further swelling and solubilization of the minute colloidal particles.

The normal pH range is 7.6 to 7.8 for conventional spray formulations and slightly higher for electrostatic spray. To insure the water solubility of the resin, however, formulators should observe 7.4 as the minimum pH. Because formulation viscosity increases sharply with increased pH, viscosity adjustments should be made with a dilute (10% or 20 %) solution of DMAE in water. Enamels should be adjusted to a desired viscosity rather than to a given pH, because very small changes in pH can mean substantial changes in viscosity.

Cosolvents

In the ACRYSOL™ WS-68 Emulsion based formulations developed, the water / organic ratios range from 91.1 / 8.9 for conventional spray applications to 80.4 / 19.6 for electrostatic disc application by volume. Even at these low levels of cosolvent, ACRYSOL WS-68 Emulsion offers excellent substrate wetting without foam while adequately meeting antipollution requirements.

The cosolvents contained in the suggested formulations are n-butanol and 2-butoxyethanol and dipropylene glycol, although other exempt solvents are also compatible.

One important difference between the formulation designed for application by electrostatic disc and the conventional formulations is that the former contains dipropylene glycol. A non-solvent for the polymer, dipropylene glycol is a slowly evaporating diluent that prolongs the

open time of the enamel. This makes the special formulation well-suited to electrostatic spray equipment. In contrast, conventional aqueous formulations have a tendency to dry out on electrostatic discs and to produce films with a grainy, orange peel appearance.

Catalyst

p-Toluenesulfonic acid (pTSA) catalyzes the crosslinking reaction between ACRYSOL™ WS-68 Emulsion and the monomeric melamine resin. When added to the formulation at a level of 0.2 percent on binder solids, pTSA promotes complete cure in a 30-minute bake at 300°F.

Faster bake schedules suggested for complete cure are 15 minutes at 325°F, 10 minutes at 350°F, and 5 minutes at 375°F.

pTSA is added to the formulation as a solution in water after it is combined with equal parts of DMAE. The addition of pTSA as a DMAE salt overcomes a common problem in water-borne enamels. It prevents the flocculation and kickout that can occur if the catalyst is added in the acid form. It also lends exceptional stability to the wet formulation.

Defoamer

The use of n-butanol offers adequate defoaming. Formulators are encouraged to test other commercial defoamers for alternate choices.

Suggested Starting Point Formulations

Five starting point formulations based on ACRYSOL™ WS-68Emulsion are presented at the end of this publication:

Formulation	Description	Application Method
WS-68-1	Ball Mill Gloss White Enamel	Conventional Spray
WS-68-2	Sand Mill Gloss White Enamel	Conventional Spray
WS-68-3	Sand Mill Gloss Black Enamel	Conventional Spray
WS-68-4	Sand Mill Gloss White Enamel	Electrostatic Spray
WS-68-5	Cowles Gloss White Enamel	Electrostatic Spray

Application

One of the major advantages of enamels based on ACRYSOL™ WS-68 Emulsion is the ease with which they can be sprayed. They atomize finely and resist sagging. Their spraying properties are excellent, similar to those obtained with solvent-borne systems, and match or surpass those of other water reducible coatings made with high levels of cosolvents. Additionally, enamels made with ACRYSOL WS-68 Emulsion offer less sensitivity during spray application to variations in ambient conditions (temperature/relative humidity).

Electrostatic Disc Spray

Technical personnel have conducted highly successful field trials using Ransburg electrostatic disc equipment to apply ACRYSOL™ WS-68 Emulsion based enamels. From this work a set of optimum application conditions (Table 3) was developed.

Formulations WS-68-4 and WS-68-5 were designed for application by disc spray equipment.

These coatings differ from the accompanying air spray formulations on several counts. They include extra DMAE and have reduced solids content. They also contain dipropylene glycol as was noted earlier.

Table 3 **Application Conditions and Equipment for Electrostatic Disc Spray**

Use Enamel Modified with Slow Evaporating Non-Solvent to Prolong Set Time and Prevent Orange Peel.	
Raise Enamel Viscosity to Prevent Sagging	
Ransburg Disc size / Speed	15 inch / 3600 rpm or 8 inch / 18000 rpm
Feed Rate	100 cc / minute
Conveyor Speed	12 feet / minute
Target Distance	19 inches
Note: Check with equipment supplier for proper grounding instructions and other requirements for safe operation with water-borne enamels.	

Air Spray

A similar set of optimum conditions has been developed for air-spray application. These conditions (Table 4) are intended to offer a coating with a dry film thickness of approximately 1 mil.

Formulations designed for application by air spray appear in the formulation section: Formulations WS-68-1, WS-68-2, and WS-68-3.

Ambient conditions during air spraying affect flow properties and set times of the finish. To compensate for differences in temperature and humidity, several of the variables in Table 4 can be controlled. Among these are air pressure, liquid feed rate, and distance from spray gun to substrate. Spray coatings should also be allowed to air-dry for about 5 minutes to flash off water and cosolvent before baking.

Table 4 **Application Conditions and Equipment for Air Spray**

Spray Gun	DeVilbiss-type MBC
Tip Needle	AV-15EX
Air Cap	No. 30
Line Pressure	60 psi
Temperature	74 – 80 °F
Relative Humidity	35 – 70%
Feed	Open three turns
Distance	10 inches
Number of Passes	2
Air-Dry Time (Vertical)	5 minutes
Bake	30 minutes / 300°F

Table 5 Troubleshooter's Guide

Identification and Solution of Potential Problems That May Be Encountered During Evaluation of Enamels Based on ACRYSOL™ WS-68 Emulsion		
Problem	Cause	Cure
Blistering	Film too thick	Apply 1.2 mils maximum
	Insufficient air-dry	Flash 5 minutes before baking
Cratering	Contamination	Use clean substrate and equipment and formulate with Silicone L-5310
	Defoamer	Use n-Butanol
Frosting	Excess catalyst	Use 0.2% PTSA on binder. Omit catalyst if baking 325 °F
Sagging / Orange Peel	Viscosity too low / too high	Adjust up with 10% DMAE or down with water
	Spraying electrostatic formulation with conventional equipment? Vice versa	Use correct formulation
Poor Flexibility / Poor Resistance	Incorrect melamine type	Use only highly alkylated melamine

Gloss White Enamel

WS-68-1 Suggested Starting Point Formulation

Material Name	Weight (g)	Function
Ball Mill Grind		
Tiona RCL-9	480.0	Rutile titanium dioxide
ACRYSOL™ WS-68	126.3	Emulsion
Water	149.4	Diluent
Butyl CELLOSOLVE™	21.4	Cosolvent
n-Butanol	20.0	Cosolvent
DMAE	2.9	Tertiary amine
Sub-total	800.0	
Letdown		
Ball Mill Grind	326.4	
ACRYSOL™ WS-68	567.0	Emulsion
Water	48.0	Diluent
n-Butanol	6.9	Cosolvent
Silicone L-5310 (30% in Butyl CELLOSOLVE™)	1.9	Surfactant
DMAE (10% in water) Add slowly with good agitation to achieve desired viscosity	5.1	Tertiary amine
Cymel 303	58.7	Resin
PTSA (10%) (10 PTSA / 10 DMAE / 80 Water)	5.8	Catalyst
Total	**1020.0**	
Expected Enamel Properties		
Solids, %	48	
Pigment / Binder Ratio	40 / 60	
Acrylic / Melamine Ratio	80 / 20	
% Catalyst (PTSA) on Binder solids	0.2	
Water / Organic Ratio, by volume	91 / 9	
pH	7.7	
Viscosity, sec (No. 4 Ford Cup)	23	
VOC, g/l	124	

WS-68-2 Suggested Starting Point Formulation

Gloss White Enamel

Material Name	Weight (g)	Function
Sand Mill (30 Minutes)		
Cymel 303	63.0	Resin
OROTAN™ 731A	4.2	Dispersant
DMAE (20% in water)	5.0	Tertiary amine
Butyl CELLOSOLVE™	10.4	Cosolvent
Iso-propanol	5.6	Cosolvent
Water	101.8	Diluent
Tiona RCL-9	210.0	Rutile titanium dioxide
Sub-total	400.0	
Letdown		
Sand Mill Grind	373.0	
ACRYSOL™ WS-68	618.4	Emulsion
Water	4.0	Diluent
DMAE (20% in water)	10.8	Tertiary amine
Silicone L-5310 (30% in Butyl CELLOSOLVE™)	2.0	Surfactant
PTSA (10%) (10 PTSA / 10 DMAE / 80 Water)	5.8	Catalyst
n-Butanol	6.0	Cosolvent
Total	**1020.0**	
Expected Enamel Properties		
Solids, %	48	
Pigment / Binder Ratio	40 / 60	
Acrylic / Melamine Ratio	80 / 20	
% Catalyst (PTSA) on Binder solids	0.2	
Water / Organic Ratio, by volume	91.1 / 8.9	
pH	7.6	
Viscosity, sec (No. 4 Ford Cup)	25	
VOC, g/l	121	

WS-68-3 Suggested Starting Point Formulation

Gloss Black Enamel

Material Name	Weight (g)	Function
Sand Mill (30 Minutes)		
Cymel 303	135.6	Resin
OROTAN™ 731A	1.2	Dispersant
Butyl CELLOSOLVE™	21.0	Cosolvent
Iso-propanol	21.0	Cosolvent
Water	84.0	Diluent
DMAE (20% in water)	1.5	Tertiary amine
Raven 1035	35.7	Carbon black
Sub-total	300.0	
Letdown		
Sand Mill Grind	150.3	
ACRYSOL™ WS-68	715.5	Emulsion
PTSA (10%) (10 PTSA / 10 DMAE / 80 Water)	6.8	Catalyst
Silicone L-5310 (30% in Butyl CELLOSOLVE™)	2.2	Surfactant
n-Butanol	5.2	Cosolvent
Total	**880.0**	
Expected Enamel Properties		
Solids, %	40.7	
Pigment / Binder Ratio	5 / 95	
Acrylic / Melamine Ratio	80 / 20	
% Catalyst (PTSA) on Binder solids	0.2	
Water / Organic Ratio, by volume	89.8 / 10.2	
pH	7.6	
Viscosity, sec (No. 4 Ford Cup)	23	
VOC, g/l	130	

WS-68-4 Suggested Starting Point Formulation

Gloss White Enamel for Electrostatic Disc Spray

Material Name	Weight (g)	Function
Sand Mill (30 Minutes)		
Cymel 303	94.5	Resin
OROTAN™ 731A	6.0	Dispersant
Butyl CELLOSOLVE™	12.0	Cosolvent
Iso-propanol	7.5	Cosolvent
Water	130.0	Diluent
DMAE (10% in water)	15.0	Tertiary amine
Tiona RCL-9	315.0	Rutile titanium dioxide
Sub-total	580.0	
Letdown		
Sand Mill Grind	250.1	
ACRYSOL™ WS-68	428.9	Emulsion
Water	68.6	Diluent
Dipropylene glycol	75.0	Cosolvent
Silicone L-5310 (30% in Butyl CELLOSOLVE™)	1.4	Surfactant
DMAE (10% in water)	132.0	Tertiary amine
PTSA (10%) (10 PTSA / 10 DMAE / 80 Water)	4.0	Catalyst
n-Butanol	10.0	Cosolvent
Total	**970.0**	
Expected Enamel Properties		
Solids, %	35	
Pigment / Binder Ratio	40 / 60	
Acrylic / Melamine Ratio	80 / 20	
% Catalyst (PTSA) on Binder solids	0.2	
Water / Organic Ratio, by volume	80.4 / 19.6	
pH	8.4	
Viscosity, sec (No. 4 Ford Cup)	45	
VOC, g/l	372	

WS-68-5 Suggested Starting Point Formulation

Gloss White Enamel for Electrostatic Spray Application

Material Name	Weight (g)	Function
Cowles Grind		
ACRYSOL™ WS-68	12.4	Emulsion
Water	26.5	Diluent
DMAE (10% in water)	3.3	Tertiary amine
OROTAN™ 731A	2.7	Dispersant
TRITON™ X-114	2.0	Surfactant
n-Butanol	4.1	Cosolvent
Mix the above ingredient, the add slowly:		
Tiona RCL-9	134.5	Rutile titanium dioxide
Sub-total	285.5	
Letdown		
Premix - Water	108.1	Diluent
Premix - **Butyl CELLOSOLVE™**	4.7	Cosolvent
n-Butanol	6.3	Cosolvent
ACRYSOL™ WS-68	414.0	Emulsion
Silicone L-5310 (30% in Butyl CELLOSOLVE™)	1.4	Surfactant
Cymel 303	40.4	Resin
Dipropylene glycol	74.7	Cosolvent
DMAE (10% in water)	131.8	Tertiary amine
PTSA (10%) (10 PTSA / 10 DMAE / 80 Water)	4.0	Catalyst
Total	**970.9**	
Expected Enamel Properties		
Solids, %	35	
Pigment / Binder Ratio	40 / 60	
Acrylic / Melamine Ratio	80 / 20	
% Catalyst (PTSA) on Binder solids	0.2	
Water / Organic Ratio, by volume	81.4 / 18.6	
pH	8.4	
Viscosity, sec (No. 4 Ford Cup)	43	
VOC, g/l	362	

Handling Precautions

Before using this product, consult the Material Safety Data Sheet (MSDS)/Safety Data Sheet (SDS) for details on product hazards, recommended handling precautions and product storage.

Storage

Store products in tightly closed original containers at temperatures recommended on the product label.

Disposal

Dispose in accordance with all local, state (provincial) and federal regulations. Empty containers may contain hazardous residues. This material and its container must be disposed in a safe and legal manner.

It is the user's responsibility to verify that treatment and disposal procedures comply with local, state (provincial) and federal regulations. Contact your Dow Coating Materials Technical Representative for more information.

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