

CYTEC

Surface Specialties



MODAFLOW[®] and ADDITOL[®]

Flow and Leveling Additives

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Cytec Surface Specialties manufactures and markets a broad range of technically innovative products for applications in key coating markets such as architectural and construction, automotive, graphic arts, general industry, wood and paper, and plastics.

A leader in environmentally-friendly coating technologies, we are a total solutions provider, offering an extensive range of high-performance products, supported by a high level of technical expertise.

Product Range

Cytec Surface Specialties offers a comprehensive product range, including many cutting-edge technologies that have earned leading positions in their target markets. These are divided into three main groups:

- Liquid Coatings Resins and Additives
- Radcure and Powder Resins
- Adhesives, Bonding and Formulations

Cytec Surface Specialties leads in:

- UV/EB curable systems
- Powder coating resins
- Waterborne alkyds
- Waterborne epoxies
- Waterborne resin systems for automotive primer surfacer, basecoats and clearcoats

Global Presence

Headquartered in Brussels (Belgium), Cytec Surface Specialties operates ISO-certified manufacturing facilities and distribution centers worldwide.

Our ten technology centers—located in Europe, Asia, and North America—offer customers ready access to world-class technical support and applications research.

We also have sales offices in more than 30 countries, enabling us to provide responsive service around the globe, and to help our customers identify and profit from emerging opportunities.

Cytec Industries Inc.

Cytec Industries is a specialty chemicals and materials technology company with sales of about \$3 billion USD. Its growth strategies are based on developing technologically advanced customer solutions for global markets including: aerospace, coatings, mining, plastics and water treatment.



2 | Introduction

Paints and coatings serve to provide both protection and decorative appeal to a substrate. Surface defects, which detract from the appearance of the coating, may also compromise the protection of the substrate. For many years, flow and leveling additives have been formulated into coating and ink systems to enhance film properties by eliminating surface imperfections.

Advances in coating technology, such as high solids, low volatile organic compound (VOC) systems, waterborne coatings, UV and free radical cure systems, and powder coatings, have reduced or eliminated the ability of organic solvents to overcome the effects of poor substrate wetting and flow. A key challenge to the development of new waterborne coatings is the control of many types of surface defects inherent to waterborne systems. Further, the resins which have been developed for these coatings often exhibit poor wetting and flow characteristics, increasing the frequency of surface defects. These trends have resulted in a greater reliance on flow modifiers to provide flow and leveling to the coating surface.

Our MODAFLOW[®] and ADDITOL[®] flow and leveling agents offer versatility in solving a wide range of coating surface problems in liquid, powder, and energy cure systems.

The addition of MODAFLOW[®] or ADDITOL[®] flow and leveling additives can significantly improve the properties and performance of unmodified coating systems:

- Improve flow and leveling
- Eliminate craters and fisheyes
- Reduce orange peel and pinholes
- Enhance substrate wetting
- Facilitate air and volatile release
- Aid in pigment dispersion
- Maintain substrate and recoat adhesion
- Improve slip, and therefore, mar resistance

The use of MODAFLOW[®] and ADDITOL[®] brand flow and leveling additives results in smoother films with fewer imperfections and better appearance compared to unmodified coatings. The excellent flow and leveling characteristics of these products enable the application of thinner coatings, improving performance while gaining material savings. This combination has made MODAFLOW[®] and ADDITOL[®] products a necessary ingredient in many modern surface coating formulations.



Note: The numerical values and/or other data in the tables, graphs and figures included in this document are based on samples tested and are not guaranteed for all samples or all applications. Such numerical values and data are intended as guides and are not product specifications or product usage recommendations.

Flow and leveling additives perform many functions in a coating. They are primarily used to reduce or eliminate surface defects such as craters, fisheyes, orange peel and pinholes. This is achieved by enhancing the wet-out, flow and leveling of the uncured film. These additives may also be used to facilitate air release, aid pigment dispersion and improve substrate wetting to promote optimal flow and leveling. Surface defects result from either too little or too much flow in a coating. Most of the surface defects develop during the application of the coating material on the substrate.

One very significant parameter is the surface tension or rather, surface tension differences of the involved materials. The source of such surface tension differences can be within the system itself, (e.g. solvent evaporation or the cross-linking reaction of the resin) or from external causes, such as overspray, dust particles, or contamination of the substrate.

Surface craters and fisheyes result from insufficient wetting of the substrate by the wet or molten paint. Surface defects also result from surface tension difference induced flow (see

Figure 1). This surface tension driven flow is induced in the presence of low surface tension contaminants such as oil, silicone, greasy dust, gels and overspray, composition changes and thermal gradients. When there are differences in surface tension, material flows from areas of low surface tension to areas of higher surface tension.

In order to achieve good substrate wetting, the liquid paint must have a surface tension equal to or lower than the substrate. High solids coating systems, such as oil free polyester/melamines, wet poorly due to the high surface tension (40-60 dynes/cm) of the resins and the use of polar solvents. Flow and leveling additives, such as **MODAFLOW[®] Resin**, exhibit a surface tension (32 dynes/cm) much lower than the resin vehicles, thereby promoting substrate wetting.

Substrate wetting is even more of a problem in waterborne coatings due to the very high surface tension of water (72 dynes/cm). Solutions of **ADDITOL[®] VXW 6503**, **ADDITOL[®] VXL 4930**, and **MODAFLOW[®] AQ 3025** exhibit surface tensions much lower than that of water, helping to facilitate substrate wetting in waterborne coatings.

FIGURE 1

Low surface tension contaminant induces flow toward areas of higher surface tension, leaving a void such as a crater or fisheye.

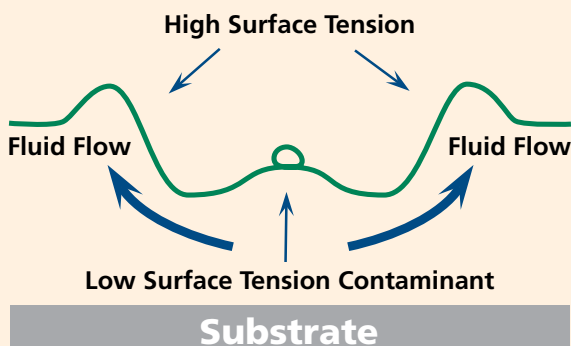
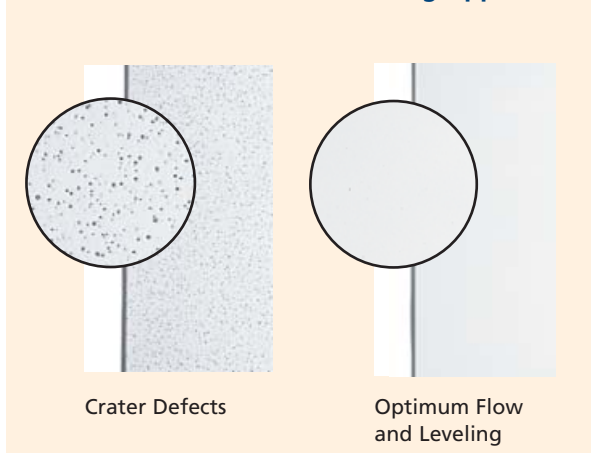


FIGURE 2

Effect of Flow Modifier on Coating Appearance



4 Mode of Action

The addition of **ADDITOL[®] VXW 6503** or **MODAFLOW[®] AQ 3000** in a water reducible polyester coating produces a dramatic reduction in surface craters (See Figure 2).

Two basic chemistries, polyacrylate and silicone, are used to control flow and leveling in coatings.

Depending on their chemical structure, modified polysiloxanes can strongly reduce the surface tension of the liquid paint. They are used for improving the substrate wetting and as anti-cratering additives. Silicone additives can also improve the surface slip of the dried paint film, increase the scratch resistance, and reduce the blocking tendency.

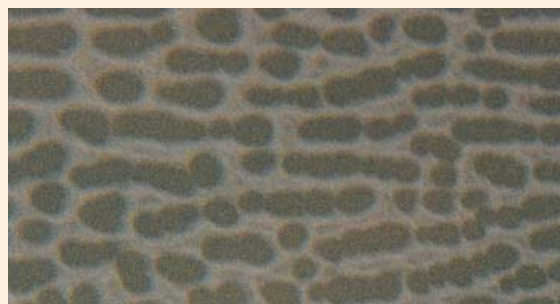
In contrast, polyacrylates function by migrating to the coating surface and equalizing surface tensions across the coating film. They are mainly used for the improvement of leveling. In addition, polyacrylates can also improve the defoaming properties.

Orange peel typically occurs during application of the paint onto the substrate. Continued flow and leveling are required prior to cure to diminish the orange peel effect in the dry coating. Poly-acrylates such as **MODAFLOW[®] 2100** and **ADDITOL[®] XL 480** were developed to promote leveling and reduce orange peel, thus producing smooth surfaces with high distinctness of image (DOI).

Orange peel may also develop during solvent evaporation and baking of paint films. Surface tension gradients develop with changes in temperature, concentration and viscosity. Material flow induced by solvent evaporation and baking create the uneven surface. Solvent evaporation also induces the formation of Bénard cells, which

FIGURE 3

Photo of Bénard Cells Formed as a Result of Surface Tension Driven Flow

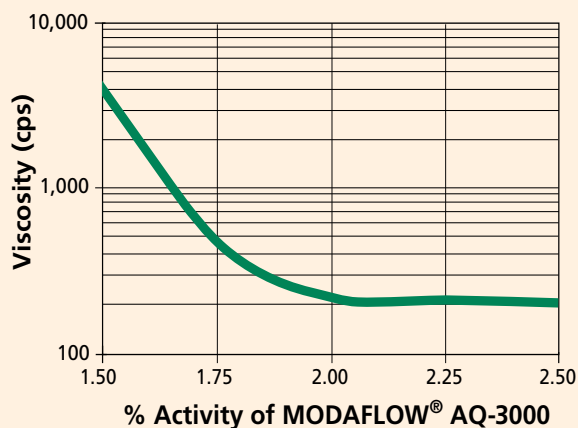


result from vortex circulation and change in viscosity. (See Figure 3) The surface active nature of the flow and leveling additives tend to minimize these effects by maintaining an even surface tension across the coating surface.

Figure 4 shows the effectiveness of **MODAFLOW[®] AQ 3000** as a pigment dispersant for TiO_2 . The dramatic reduction in viscosity, at a wide range of dispersant levels, shows the ability of **MODAFLOW[®] AQ 3000** to wet-out and disperse the pigment particles at a 75% loading of TiO_2 . **MODAFLOW[®] AQ 3000** has been

FIGURE 4

Pigment Dispersant Demands for Titanium Dioxide



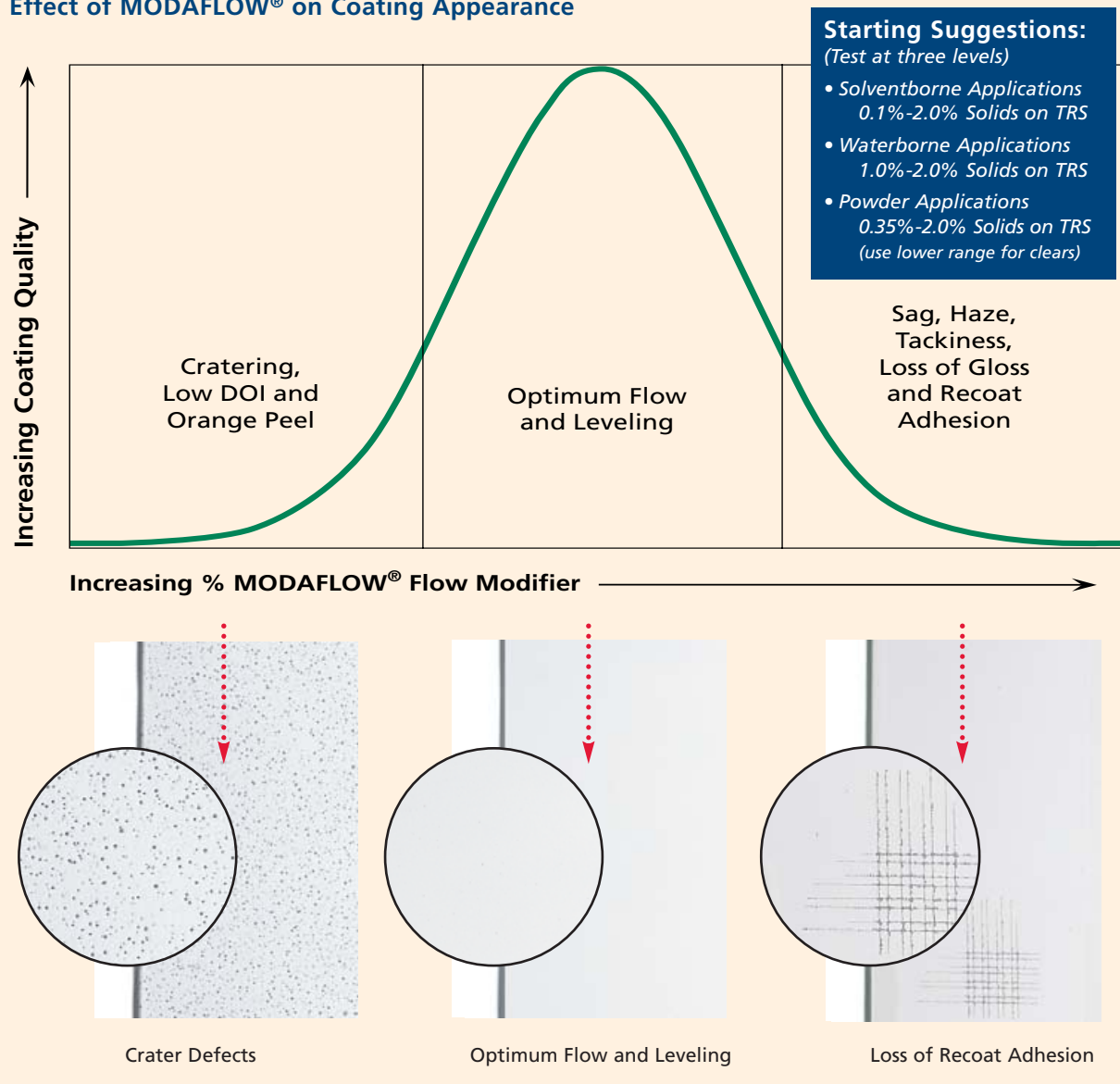
75% loading Ti-Pure R-960 TiO_2 (DuPont Company)
Formulation: AQ-3000/Pigment/Water

found to be effective in forming a very good dispersion when used in place of a portion of the pigment dispersing aid. Due to the mode of action of flow and leveling additives, they should be evaluated at several different levels to determine the optimum concentration for that particular formulation. The inherent chemical structure of a flow and leveling additive will significantly

affect its concentration/performance profile. Flow and leveling additives differ greatly in their ability to affect surface tension and promote leveling. The effect of MODAFLOW® usage level on coating quality is shown in Figure 5. Additional guidance on use levels for MODAFLOW® and ADDITOL® products is provided in the application section of this brochure.

FIGURE 5

Effect of MODAFLOW® on Coating Appearance



6 | General Description

Solventborne Additives

We manufacture a family of flow and leveling agents for solventborne, waterborne, and powder coating applications. For solventborne coating applications, the following products are available:

	% Active
ADDITOL® XL 121	14%
ADDITOL® 123N	50%
ADDITOL® XL 425	80%
ADDITOL® XL 460/21LG	21%
ADDITOL® XL 480	70%
ADDITOL® XL 490	100%
ADDITOL® VXL 4930	40%
MODAFLOW® Resin	100%
MODAFLOW® 2100	100%
MODAFLOW® 9200	100%
MULTIFLOW® Resin	50%



Waterborne Additives

For waterborne applications, the following products are available:

	% Active
ADDITOL® XL 123N	50%
ADDITOL® XW 329	50%
ADDITOL® XW 390	50%
ADDITOL® XW 395	58%
ADDITOL® VXL 4930	40%
ADDITOL® VXW 4971	50%
ADDITOL® VXW 6214	57%
ADDITOL® VXW 6503	50%
MODAFLOW® AQ 3000	50%
MODAFLOW® AQ 3025	25%

These products have been used effectively in systems containing the following resins:

- Epoxy
- Urethane
- Acrylic
- Phenolic
- Polyester
- Melamine
- Silicone Modified
- Alkyd
- EVA Co-polymers
- Cellulosic

Powder Additives

In powder coating applications, the following products have been prepared by absorbing the flow modifier on a silica base:

	% Active
MODAFLOW® Powder III	65%
MODAFLOW® Powder 2000	65%
MODAFLOW® Powder 6000	65%

Call Cytec Surface Specialties for additional details on our powder additives.

Solventborne and Radiation Cure Systems

The polyacrylate flow and leveling agents for solventborne coatings are generally soluble in higher molecular weight alcohols, aromatics, and other polar and non-polar solvents. The solubility of MODAFLOW[®] Resin and MODAFLOW[®] 2100 in various organic solvents is shown in Table 1. In most situations, the flow agent can be used as de-livered; however, the highly viscous MODAFLOW[®] Resin can be cut in solvents or heated to ease handling and mixing. MULTIFLOW[®] Resin, consisting of a 50% solution of MODAFLOW[®] Resin in xylene, is offered to provide greater ease of handling. The lower viscosities of MODAFLOW[®] 2100, MODAFLOW[®] 9200, and many ADDITOL[®] products allow them to be formulated into coatings as supplied. (See Fig. 6)

TABLE 1*

Solubility¹ of MODAFLOW[®] Products

Solvent	MODAFLOW [®] Resin	MODAFLOW [®] 2100
n-Butyl Acetate	S	S
n-Butyl Alcohol	S	S
Butyl Carbitol	S	S
Carbon Tetrachloride	•	S
Ethanol	I	I
Ethyl Acetate	S	S
Hexane	S	S
Methanol	I	I
Methyl Ethyl Ketone	S	S
Methyl Isobutyl Ketone	S	S
Dimethyl Esters ² (mixed grades)	S	S
n-Propanol	S	S
Propylene Glycol Methyl Ether	S	S
Propylene Glycol Methyl Ether Acetate	S	S
Isopropanol	S	S
Toluene	S	S
Water	I	I
Xylene	S	S

Key: S=Soluble I=Insoluble

* The data in this table is based on samples tested and not guaranteed for all samples or applications.

1. 50% solutions agitated 1 hour at room temperature.
2. At 10% solution.

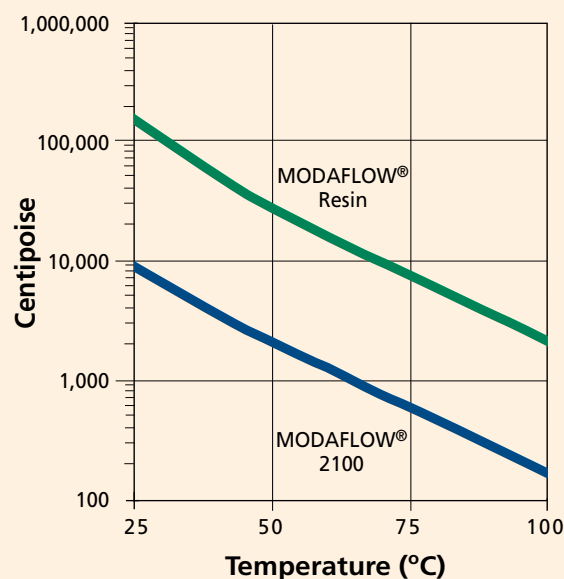
Waterborne Systems

The flow and leveling additives for waterborne systems are compatible at effective use concentrations with many thermoset and thermoplastic resins. They may be incorporated into waterborne coatings either by addition to the pigment grind or letdown component of the formulations.

When formulating, a portion of the flow additive, resin, and water may be held back for incorporation into a letdown component. Many of the waterborne formulations shown in this publication are condensed, and based on a post-addition of the flow modifier to develop performance information at different concentrations.

FIGURE 6

MODAFLOW[®] Resin Flow Modifiers Brookfield Viscosity vs. Temperature



8 Formulation Tips

In some instances, the flow modifier may replace some of the cosolvents, surfactants, wetting and dispersing agents, or defoamers typically used in waterborne coatings. Some surfactants affect the moisture sensitivity of the coating; reducing their concentration may boost the water resistance of the cured film. Thus, when evaluating the effectiveness of a flow additive in an existing system, removal of some or all of the other additives may reduce the cost and improve the performance of the coating.

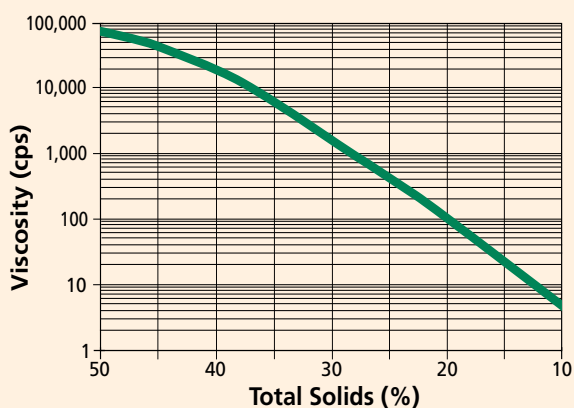
Many of the waterborne flow and leveling additives have infinite dilution in water and can be cut either in water or a mixture of water and solvent to ease handling and mixing. Dilution with water is recommended versus heating to reduce viscosity. (See Figure 7) Note: MODAFLOW® AQ 3025, at 25% active, is a lower viscosity version of MODAFLOW® AQ 3000.

The MODAFLOW® and ADDITOL® family of flow and leveling additives offer a broad range of characteristics to the formulation. MODAFLOW® products do not contain silicone which may impair intercoat or recoat adhesion, whereas some of the ADDITOL® products are silicone-based for particularly difficult substrate wetting problems. Polyacrylate-based ADDITOL® and MODAFLOW® products are thermally stable* with very good resistance to outdoor weatherability.

Several MODAFLOW® and ADDITOL® products comply with the U.S. Food and Drug Administration (FDA) regulations for use in packaging contact applications. For more detailed information, see the Health, Safety & Product Handling section in this publication.

FIGURE 7

MODAFLOW® AQ-3000 Viscosity vs. % Solids



* Thermally stable up to a temperature of 204°C, as determined by thermogravimetric analysis (TGA) as a weight loss versus temperature profile at a heating rate of 10°C/min.

Architectural Coatings

MODAFLOW® AQ 3000 may allow the formulator to reduce system solvent content and the level of additives in a paint formulation. The vinyl acrylic latex paint shown in Table 2 illustrates the use of MODAFLOW® AQ 3000 in place of surfactants, dispersants and coalescing aids, which have been shown at times to adversely affect coating appearance and performance. In addition, the level of cosolvent was significantly reduced resulting in a 33% reduction in VOC.

TABLE 2

Vinyl Acrylic Latex Gloss Paint

	Wt.		
Formulation	1	2	3
Pigment Grind			
Distilled Water	13.8	7.5	20.0
Propylene Glycol	30.2	30.2	20.0
MODAFLOW® AQ-3000			10.0
Dispersant		5.8	
Antifoam	1.0	1.0	1.0
Preservative	0.5	0.5	0.5
Surfactant		0.5	
Amine Buffer	1.0	1.0	1.0
Titanium Dioxide	130.0	130.0	130.0
Letdown			
Distilled Water	12.5	12.5	18.0
Vinyl Acrylic Latex	233.5	233.5	233.5
Coalescent	10.0	10.0	
Surfactant	0.5	0.5	
Thickener, Premix ¹	99.0	99.0	99.0
Antifoam	1.0	1.0	0.5
Ammonia (adjust pH)	1.5	1.5	1.5
Total	534.5	534.5	535.0

1. Water, solvent and rheology modifier.

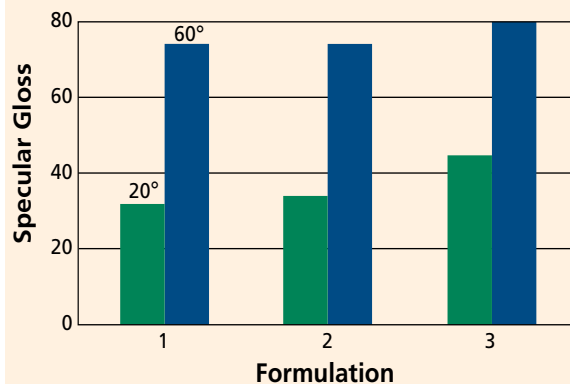
Based on the formulations shown, a 33% reduction in VOC is achieved between the typical and recommended starting point formulations when AQ-3000 is added to the mix:

Formulation	VOC Content	
1	1.30 lbs./gal.	156 g/L
2	1.26 lbs./gal.	151 g/L
3	0.84 lbs./gal.	101 g/L

Gloss may also be improved with the addition of MODAFLOW® AQ 3000. Figure 8 shows a significant increase in gloss when MODAFLOW® AQ 3000 is incorporated into the formulation.

FIGURE 8

Effect of MODAFLOW® AQ 3000 on Gloss Vinyl Acrylic Latex



Automotive Finishes

In addition to providing excellent flow and leveling, MODAFLOW® 2100 and MODAFLOW® 9200 augment the high gloss and excellent distinctness of image (DOI) of clear automotive topcoats. (See Table 3) Both products are silicone-free, and at normal use concentrations (0.1-1.0% on total resin solids (TRS)), will not interfere with the intercoat adhesion or recoatability.

TABLE 3
Automotive OEM Clearcoat with VIACRYL® VSC 2955

Raw Materials		Wt.
VIACRYL® VSC 2955/65SNA	(1)	47.1
MAPRENAL® VMF 3615/80B	(1)	16.6
Tinuvin 292	(2)	0.5
Tinuvin 1130	(2)	0.5
Aromatic 150	(3)	5.75
Aromatic 100	(3)	5.75
MPAC*		5.75
Xylene		10.5
n-Butanol		4.5
MODAFLOW® 9200	(1)	0.22
Total		97.17

*MPAC = propylene glycol methyl ether acetate

Dilute to spray viscosity with:
XMPAC/Aromatic 100 1:1 to 15 sec., Din. #4
XMPAC = 1 part xylene to 1 part MPAC
Bake 150°C, 20 min.

Film Properties

Gloss: 20°/60°: 100/100
Pendulum Hardness: 156 sec., König
Xylene resistance
(drop on for 10 min., scratch with nail): > 10 min.
Overbake resistance (30 min./160°C) @ dE: 0.08

Amtec Test

1. Gloss 20° before test:	100
2. Gloss 20° after 10 cycles:	62
3. Gloss 20° after 10 cycles + 60°C/2 hrs:	72

(1) Cytec Surface Specialties (2) Ciba (3) ExxonMobil

Automotive Refinish Paints

MODAFLOW® 2100 and MODAFLOW® 9200 in solventborne formulas, and MODAFLOW® AQ 3000/3025 in waterborne formulas also give excellent results in automotive refinishing formulations. (See Table 4)

TABLE 4
Automotive Refinish Clearcoat with Fast Tack-Free Time, <2.1 VOC

Part A		Wt.
MACRYNAL® VSM	(1)	72.15
1004/75LGV2 (if solids 73.8%)		
1-chloro-4-(trifluoromethyl)-benzene (Oxsol 100)		10.00
Methyl Acetate		5.00
Tinuvin 292HP (HALS)	(2)	1.52
Tinuvin 384-2 (95%)	(2)	0.80
MODAFLOW® 9200	(1)	0.38
ADDITOL® VXW 5907	(1)	1.54
Metacure T-12	(3)	1.00
(1% in MPK)		
K-Kat 4205	(4)	1.51

Part B

Tolonate HDT-LV (Rhodia)	21.36*
or Desmodur N-3300	22.76*
(May want to use 1.1 excess isocyanate.)	*used OH# = 123
Solvent Mixture	26.00
Solvent Mixture, visc. adjustment	20-25

Solvent Mixture Components

	Wt.%
Acetone	49
1-chloro-4-(trifluoromethyl)-benzene	27
MPK	24

Properties

Initial Viscosity #4 Ford, sec.	17-19
VOC, lbs./gal. (calc.)	2.0
Solids (w, calc.), %	47.98
Solids (v, calc.), %	54.53
Pot Life, hrs.	1
Tack-Free Time, min.	~30
Film Build, mils	1.8-2.0

Sata NR2000 HPLV gun., 1.4 mm cap
The ADDITOL® VXW 5907 was added to eliminate air entrapment while keeping Part A transparent.

(1) Cytec Surface Specialties (2) Ciba (3) Air Products
(4) King Industries

Durable Urethane Coatings

1-and 2-component urethane coatings are well known for their excellent durability and high performance. Typical applications include marine, aircraft, and automotive coatings. Flow modifiers help improve flow and leveling, and

TABLE 5

2K WB Polyurethane White Topcoat Based on MACRYNAL® VSM 6299w/42WA

Part A		Lbs.	Gal.
MACRYNAL® VSM 6299w/42WA*	(1)	190.29	21.55
ADDITOL® VXW 6208	(1)	14.01	1.60
Surfynol CT-211	(2)	6.58	0.81
Kronos 2310	(3)	287.32	8.62
Water, deionized		56.48	6.78
Disperse to Hegman 7+			
MACRYNAL® VSM 6299w/42WA	(1)	286.73	32.47
Optiflo H 600	(4)	1.69	0.20
ADDITOL® VXW 4973	(1)	3.39	0.46
PM Acetate		22.59	2.85
MODAFLOW® AQ-3025	(1)	21.58	2.57
Water, deionized (for viscosity)			
Subtotal		890.65	77.91

Dimethylethanolamine/10% in water may be added to adjust pH between 7.4-7.9. Part A final viscosity = 1000-3500 cps (10 s-1 Brookfield R/S rheometer, 23°C).

*The viscosity and solids of the VSM 6299w should be found by checking the C of A.

Part B

Rhodocoat WT 2102	(5)	159.04	17.05
Proglyde DMM	(6)	36.50	5.04
Subtotal		195.54	22.09
Total		1086.19	100.00

Let **Part A** sit 12 hours after filtration. Add Part B to Part A with mechanical mixing. Mix for 3 minutes. Water is then added to reach spray viscosity (28-30 sec. #2 Zahn). Mix 2 minutes. Reduction water added before suggested time above may result in popping.

Paint Properties

VOC (lbs./gal., calc.)	1.43
VOC (g/L, calc.)	172
P/B	0.79
NCO/OH	1.5
Gloss (20°)	77

- | | |
|-------------------------------|------------------|
| (1) Cytec Surface Specialties | (2) Air Products |
| (3) Kronos | (4) Süd Chemie |
| (5) Rhodia | (6) Dow |

eliminate craters. The waterborne urethane formulation shown in Table 5 has outstanding flexibility, exterior durability, and gloss.

The use of MODAFLOW® AQ-3000 series in waterborne urethane coatings results in smoother films with fewer imperfections and better appearance compared to unmodified urethane systems. A representative exterior durable urethane coating is described in Table 6. Improved flow and crater control are illustrated in Figure 9.

TABLE 6

Clear Polyurethane Dispersion

	Wt. %	Solids
Polyurethane Dispersion	67.69	23.69
Resimene HM 2608 (1)	11.28	10.15
Distilled Water	20.30	
MODAFLOW® AQ-3000 (1)	0.67	0.33
Total	99.94	

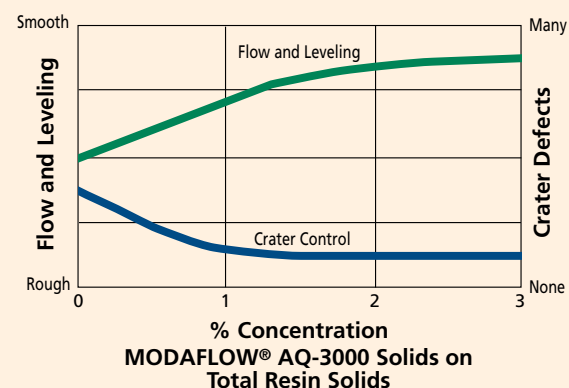
Bake Schedule: 120°C (250°F) for 30 Minutes Formulation Properties

Dry Film Thickness (DFT)	1 mil
PUD:Resimene (Wt.)	70:30
% Non-Volatiles (Wt.)	34.2
Viscosity, #2 Zahn	25-30 sec.

(1) Cytec

FIGURE 9

Effect of Flow Modifier on Flow and Crater Control Exterior Urethane Coating Formulation



General Industrial Coatings

The appearance of general industrial polyester coatings will benefit from the use of acrylate flow and leveling additives such as ADDITOL[®] XL 490 and MODAFLOW[®] 2100. The formulation shown in Table 7 makes use of MODAFLOW[®] 2100 which was specifically developed to control surface defects in polyester systems. Typical use levels of 0.25% to 1.0% based on total resin solids are suggested for these applications. (See Figure 10)

FIGURE 10

Effect of Flow Modifier on Gloss General Industrial Coating Formulation

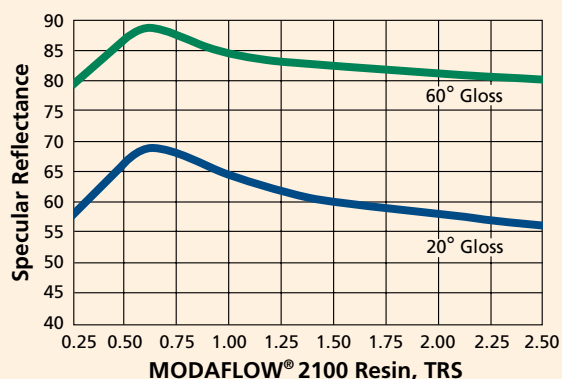


TABLE 7

Medium-Gloss White Polyester Baking Enamel with Resimene[®] CE-7103

Grind		Wt.
Polymac HS 57-5776 Polyester Resin	(1)	139.2
BYK-P 104 Pigment Dispersant	(2)	2.11
Ti-Pure R-960 Titanium Dioxide	(3)	211.4
Methyl Amyl Ketone		45.1
Grind to Hegman 7.5		
Polymac HS 57-5776 Polyester Resin		94.3
MODAFLOW [®] 2100	(4)	1.02
Letdown		
Resimene CE-7103	(4)	69.7
Nacure 5225	(5)	3.57
Nacure 2558	(5)	3.57
2-butanol		40.8
Aromatic 100		13.6
Isopar L (hold for viscosity)		30.6
Level 275	(6)	17.8
Mix at low speed 20 minutes		
Total		672.8

Flash: 15 min. **Bake:** 10 min. @ 250°F (121°C)

Formulation Properties

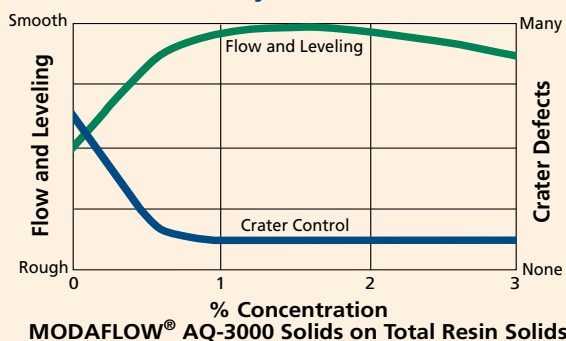
Viscosity Ford #4 Cup	50 sec.
Pigment:Binder Weight Ratio	0.85:1.0
Polyester:Amino Ratio	74:26
Catalyst solids on total resin solids	0.67
Substrate: Bonderite 1000 steel panels	(0.8 mm thick)
	Performance Results (after 72 hours)
Dry film thickness	1.1 mils
Tukon Knoop Hardness	7.6 KHN
Pencil Hardness	4H
MEK Double Rubs	200
60° Gloss	50

(1) Hexion	(2) Byk-Chemie
(3) DuPont	(4) Cytec Surface Specialties
(5) King Industries	(6) PPG

MODAFLOW® AQ-3000, MODAFLOW® AQ-3025 and ADDITOL® XW 395 flow and leveling additives provide effective flow and leveling control, and reduce surface defects for general industrial polyester coatings. In most polyester systems, concentrations of 0.5% to 2.0% additive solids on TRS are suggested as starting point levels. (Figure 11)

FIGURE 11

**Effect of Flow Modifier on Flow and Crater Control
Water Reducible Polyester**



Waterborne Polyester Baking Enamels

The appearance of general industrial waterborne coatings can benefit from the use of MODAFLOW® AQ-3000 or AQ-3025. Optimizing the concentration of these modifying flow and leveling agents can enhance gloss. (Figure 12) In the polyester coating shown in Table 8, concentrations of MODAFLOW® AQ-3025 and ADDITOL® XW 390 between 0.5% and 2.0% on TRS have been shown to optimize the gloss level.

FIGURE 12

**Effect of Flow Modifier on Gloss
Water Reducible Polyester**

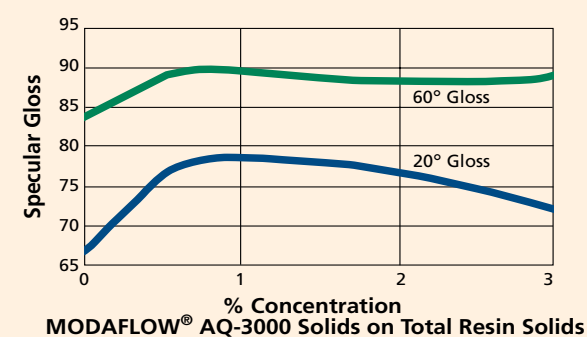


TABLE 8

**Waterborne High Gloss White Baking Enamel
Based on RESYDROL® AX 906w/35WA and
MAPRENAL® MF 921w/85WA**

Grind		Lbs.	Gal.
RESYDROL® AX 906w/35WA	(1)	92.58	10.48
ADDITOL® VXW 4909 (defoamer)	(1)	26.79	3.46
Arcosolv DPM	(2)	5.14	0.65
Mineral Spirit		3.09	0.47
Water deionized		5.03	0.60
Kronos 2310	(3)	152.60	4.58

Disperse to Hegman 7+

Letdown

RESYDROL® AX 906w/35WA	(1)	451.44	51.13
Arcosolv DPM	(2)	74.07	9.35
Mineral Spirit		14.4	2.2
Triethylamine		3.49	0.58
Dimethylethanolamine		4.08	0.56
ADDITOL® VXW 4934 (anti-settling agent)	(1)	30.86	3.78
Maprenal MF 921w/85WA	(1)	31.23	2.68
ADDITOL® XW 390	(1)	10.51	1.21
MODAFLOW® AQ-3025	(1)	17.35	2.01
Water deionized		52.17	6.27
Total		974.83	100.00

Dry Conditions

Bake 15 min./275°F

Paint Properties

pH (adjust with 20% dimethylethanolamine)	8.0 - 8.5
Viscosity, Thomas Stormer, ETS-1000/23°C	80 - 100 KU
Solids (wt.) %	42
Solids (vol.) %	31
PVC %	17.8
Pigment/Binder	0.7/1
VOC, lbs./gal.	2.80
VOC, g/L	335
(Sprayed on B1000 P95 at 1.2 dry mils.)	
Gloss 20°	76
Gloss 60°	96
Pencil Hardness	H - 2H
Salt Spray ASTM B117	250 (2mm creep)
Impact (F/R) in.-lbs.	120/40

(1) Cytec Surface Specialties (2) Lyondell (3) Kronos

Alkyd Enamel Coatings

MODAFLOW[®] and ADDITOL[®] flow and leveling additives are widely used for the manufacture of alkyd paints and coatings. Additives such as MODAFLOW[®] Resin can eliminate pinholes and enhance flow control in alkyd formulations for machinery, farm implements, and industrial maintenance applications. A starting point level for MODAFLOW[®] Resin is typically 0.25% to 1.0% on TRS in a solventborne formulation. Table 9 shows a waterborne alkyd enamel representative of a general metal or industrial formulation. ADDITOL[®] XW 395 prevents surface defects and enhances gloss by helping the coating develop an even surface tension across the film surface.

TABLE 9

Waterborne High Gloss Baking Enamel Using RESYDROL[®] AM 224w/40WA and Resimene[®] 747

Grind		Lbs.	Gal.
RESYDROL [®] AM 224w/40WA	(1)	128.54	14.56
Dimethylethanolamine		3.54	0.48
ADDITOL [®] VXW 6208	(1)	11.79	1.34
ADDITOL [®] VXW 4926	(1)	9.02	1.14
ADDITOL [®] XW 395	(1)	1.55	0.19
Arcosolv PM	(2)	11.79	1.54
Water deionized		31.85	3.82
Ti-Pure R-900	(3)	235.84	7.08

Grind to Hegman 7+

Letdown

RESYDROL [®] AM 224w/40WA	(1)	461.07	52.22
Dimethylethanolamine		2.95	0.40
Resimene 747	(1)	58.96	5.90
Water deionized		94.34	11.32
Total		1051.24	100.00

Dry Conditions

Bake 20 min./300°F

Paint Properties

Dilute approx. 5% with water to spray viscosity	
pH - Value	8.0 – 9.0
Viscosity, Zahn # 3 (sec.)	30 – 40
Solids (wt.) %	52
Solids (vol.) %	37
PVC %	19.2
Pigment/Binder	0.8/1
VOC, lbs./gal.	1.18
VOC, g/L	141
Spray B1000 P95, DFT = 1.2 mil:	
Gloss 20°	80
Gloss 60°	94
MEK Double Rubs	200+
Pencil Hardness ASTM D 3363	4H – 5H
Impact Direct/Indirect (inch-pounds)	160/160
Adhesion ASTM D 3359	5B
Salt Spray ASTM B 117 (hours)	500 (3mm creep)
Stability, RT (months)	6+

Note: For lower temperature cure, RESYDROL[®] AM 224w/40WA is also compatible with more reactive melamine resins, such as Resimene 717 or Resimene AQ-7550.

(1) Cytec Surface Specialties

(2) Lyondell

(3) DuPont

Epoxy Polyamine Enamels

MODAFLOW[®] Resin imparts effective leveling and improved substrate wetting in epoxy coatings. In most solventborne epoxy-amine and epoxy-polyamide systems, concentrations of 0.01% to 0.1% MODAFLOW[®] Resin (or 0.02% to 0.2% MULTIFLOW[®]) based on total solids are suggested as starting point levels for evaluations. An example of an epoxy-amine formulation is shown in Table 10.

TABLE 10

Black Epoxy-Amine Enamel with MULTIFLOW[®]

Component A		Lbs.
Raven 1250	(1)	13.6
Epi-Cure 3115-X-70	(2)	101.5
PM Acetate		40.6
Grind with steel ball mill for 48 hours		
Letdown		
Epi-Cure 3115-X-70	(2)	30.4
n-Butanol		17.9
PM Acetate		191.2
MULTIFLOW [®]	(3)	0.53
Component B		
Epon 1001-CX-75	(2)	227
Resimene 920	(3)	13.6
Xylene		177.2
Total		813.53

Paint Properties

(DFT=1.0-1.5 mil on B-1000 panel, cured at 121°C 10 min.)

Gloss 60°:	99
Orange Peel:	9.5
DOI:	99

(1) Columbian (2) Resolution (3) Cytec Surface Specialties

Acrylic Enamel Coatings

Waterborne polyol enamel coatings are readily formulated with MODAFLOW[®] AQ 3025 or ADDITOL[®] flow and leveling agents. In Table 11, a 1K formulation is shown with ADDITOL[®] VXL 4930. The resulting coating has high gloss. This ADDITOL[®] can be incorporated at 0.05-0.3% additive (as supplied) on total paint. ADDITOL[®] VXL 4930 contains silicone and will improve a coatings' slip property and scratch resistance.

TABLE 11

Waterborne Enamel with VIACRYL[®] VSC 6800w and MAPRENAL[®] MF 915

Part I		Wt.
VIACRYL [®] VSC 6800w/47WA	(1)	111.44
Kronos 2310	(2)	104.32
Surfynol 104E	(3)	4.32
ADDITOL [®] XL 250	(1)	3.36
ADDITOL [®] VXL 4930	(1)	0.48
Diacetone Alcohol		15.36
Isopar H	(4)	4.32
Part II		
VIACRYL [®] VSC 6800w/47WA	(1)	97.06
MAPRENAL [®] MF 915/751B	(1)	42.91
Texanol	(5)	7.8
Proglyde DMM	(6)	9.72
Water Dist.		27.2
Dynapol 1203 (45.0% active)	(7)	1.45
(0.5% on TRS)		

Mix Part I using high speed mixer to 7 Hegman, then add Part II (premixed). Mix at slow speed for 15.0 min., then filter through a fine mesh filter. Hold formulation overnight before using (foam).

Cure Conditions

No flash; 20.0 min. @ 60°C then 25.0 min @ 135°C.

Film Build:	1.6 mils
20° Gloss:	80
60° Gloss:	92
MEK DR:	200

Using PM solvent instead of diacetone alcohol produces popping.

(1) Cytec Surface Specialties (2) Kronos (3) Air Products
 (4) ExxonMobil (5) Eastman (6) Dow
 (7) Degussa

Concrete Coatings

A recent addition to our product line, MODAFLOW[®] 9200, has excellent compatibility with many solventborne and 100% solids systems. It improves the gloss and leveling characteristics of a coating without any negative influence on recoatability, adhesion, and the clarity in both the dry film and the wet coating solution. Application fields include concrete coating (e.g. epoxy), automotive refinish (2K urethane) and graphic arts (UV/EB). The 100% epoxy formulation for flooring shown in Table 12 has outstanding gloss, clarity and DOI.

TABLE 12

100% Epoxy Glaze Coat for Seamless Flooring

Component A		Lbs.
Epon Resin 828	(1)	92.0
Heloxy Modifier 8	(1)	8.0
MODAFLOW [®] 9200	(2)	1.37
Component B		
Epi-cure Curing Agent 3370	(1)	37.0
Total		138.37

Film Properties

(3 mil wet drawdown on Leneta Card, properties measured on black background)

Gloss 20°:	103
Orange Peel:	9.3
DOI:	98

(1) Resolution Performance Products (2) Cytec Surface Specialties

In water-based epoxy-amine systems, concentrations of 0.5% to 2.0% MODAFLOW[®] AQ-3025 on TRS are suggested as starting point levels for evaluation. MODAFLOW[®] AQ-3025 imparts effective leveling and improved substrate wetting in an epoxy coating (See Table 13).

TABLE 13

Gray Topcoat for Concrete Based on BECKOPOX[™] EP 147w, VIACRYL[®] VSC 6265w and BECKOPOX[™] EH 623w

Part A	Disperse in the following order:	Lbs.	Gals.
BECKOPOX [™] EH 623w/80WA	(1)	192.86	21.05
D. I. Water		192.86	23.15
Dehydran 1620	(2)	1.45	0.18
Raven 500	(3)	2.53	0.17
Ti-Pure R-960	(4)	181.88	5.46
Arcosolv PM	(5)	25.22	3.29
(add slowly during grind phase)			

Disperse to Hegman 7+

Letdown

Arcosolv PM	(5)	4.63	0.60
D. I. Water		134.99	16.21
Dehydran 1620	(2)	1.45	0.18
MODAFLOW [®] AQ-3025	(1)	5.80	0.69
VIACRYL [®] VSC 6265w/40WA	(1)	78.44	9.02
Subtotal		823.64	80.00

Part B

BECKOPOX [™] EP 147w	(1)	182.95	18.76
Arcosolv PM	(5)	9.38	1.22
Subtotal		190.80	19.98
Total		1008.45	100.00

Dry Conditions

Air dry – room temperature

Paint Properties

pH - Mixed Value	10.6
Viscosity, cPs	
(Brookfield RV, Spindle #4 @ 12 rpm)	770-850
Solids (wt.) %	54.93
Solids (vol.) %	44.70
PVC %	12.60
Pigment/Binder	0.49
VOC, lbs./gal.	0.79
VOC, g/L	94.6
Lbs. solvent per applied gallon	0.39
WPG	10.14
Mileage	717 sq.ft./gal. @ 1 dry mil
Amine/Epoxy	1.02
Drying Time, BK Drytime Recorder, 3 mil wet	
Set to Touch	15 min.
Tack Free	45 min.
Dry Hard	3.5 hrs.
Pencil Hardness after 9 days	H-2H

(1) Cytec Surface Specialties (2) Cognis
(3) Columbian Chemicals (4) DuPont (5) Lyondell

Coil Coating Applications

A typical coil coating formulation is provided in Table 14. For polyester resin systems, including high solids polyester applications, MODAFLOW® 2100 is suggested for flow and leveling at a use level of 0.1% - 1.0% on TRS.

TABLE 14

Chromate-Free Exterior Coil Primer with DUROFTAL™ VPE 7186 & Resimene® HM-8205

Component		Wt.
DUROFTAL™ VPE 7186/60SNBMPAC	(1)	121.33
Aromatic 200	(2)	12.60
EEP	(3)	13.79
SANTOSOL® DME-1	(1)	14.00
1,6-hexanediol		6.24
Mix until diol dissolves		
Aerosil 200	(4)	1.26
Kronos 2310 TiO ₂	(5)	74.48
Barium Sulfate	(6)	24.64
Aluminum Silicate, ASP Ultrafine	(7)	39.20
Halox 650	(8)	6.16
Grind to Hegman 7 with vertical bead mill		
Duroftal VPE 7186/60SNBMPAC	(1)	123.20
MODAFLOW® 2100	(1)	1.20
Resimene HM-8205	(1)	15.27
2-Butoxyethanol		18.50
Nacure 3327	(9)	2.69
Total		474.56

Bake Primer

Oven:	560 °F (293 °C)
PMT:	450 ± 10 °F (232 °C)
Dwell:	30 seconds
Film Build:	0.2 mil
MEK Double Rubs:	20
With PVDF top coat:	(0.8 mil)
T-Bend:	OT
Cross-hatch Tape Test:	no loss
MEK Double Rubs:	200+
QUV Exposure on Scribed Panel:	4000 hours (> 166 days)

(1) Cytec Surface Specialties (2) ExxonMobil (3) Eastman
 (4) Degussa (5) Kronos (6) Solvay
 (7) Engelhard (8) Halox (9) King Industries

Appliance Topcoat

MODAFLOW® Resin or MODAFLOW® 2100 have long been used in conventional solids coil coating systems. A typical starting point formula (over primer) with high impact and good chemical resistance for an appliance topcoat is provided in Table 15.

TABLE 15

White Flexible Coil Coating (High Temp.)

Component		Wt. %
Dynapol LH 830-02	(1)	40.00
Aerosil 200	(1)	0.20
Kronos 2310	(2)	28.00
SANTOSOL® DME-1	(3)	3.00
2-butoxyethanol		4.80
Grind to: Fineness 10-12 micrometers		
Dynapol LH 830-02	(1)	8.00
Resimene CE-7103	(3)	5.10
Nacure 2558	(4)	0.50
MODAFLOW® 2100	(3)	0.60
2-butoxyethanol		9.80
Total		100.00

Formulation Details

Polyester/Melamine Weight Ratio:	85/15
Percent Catalyst (TRS):	0.37

Curing Conditions

Dwell Time/Temp:	17 sec. @ 382°C (720°F)
Peak Metal Temperature:	232 ± 5°C
Substrate:	Aluminum (0.63 mm thick), titanium conversion treatment, BetzDearborn Permatreat 1021B
Panel placed at 45° angle. Care must be taken to achieve a uniform temperature across the panel due to the short dwell time.	

Film Properties

Dry Film Thickness:	22-23 µm
Gloss (60°):	98
MEK Resistance:	> 200 double rubs
Pencil Hardness:	HB - F
Impact Test (Forward):	70 in-lb (max. for aluminum)
T-Bend Adhesion/Crack Free:	OT
Heat Aging (16 hrs. @ 80°C):	OT

(1) Degussa (2) Kronos (3) Cytec Surface Specialties
 (4) King Industries

Deck Stain

To properly wet out difficult-to-wet substrates such as pressure-treated wood, silicone-containing flow and leveling additives are frequently used due to their ability to reduce the surface tension of a coating. As shown in the deck stain formula in Table 16, ADDITOL® XW 329 is used to improve both the slip and the flow out of the coating. Other additives useful for substrate wetting include ADDITOL® VXL 4930 and ADDITOL® VXW 6503.

TABLE 16
**Waterborne Semi-Transparent Deck Stain
Based on RESYDROL® AY 586w/45WA**

Basic Formula		Lbs.	Gal.
RESYDROL® AY 586w/45WA	(1)	365.11	42.95
Mineral Spirits		24.19	3.68
Arcosolv DPM	(2)	24.19	3.06
Triethylamine		3.70	0.61
ADDITOL® VXW 6206	(1)	3.70	0.41
ADDITOL® XL 250	(1)	9.87	1.20
ADDITOL® XL 297	(1)	2.77	0.36
ADDITOL® VXW 6210	(1)	1.26	0.16
ADDITOL® XW 329	(1)	2.44	0.30
Polyphase 662	(3)	7.39	0.85
Tinuvin 1130	(4)	4.62	0.47
Tinuvin 292	(4)	2.77	0.33
Acrysol RM-8W	(5)	3.02	0.33
Acematt TS 100	(6)	15.20	0.83
Water deionized		370.32	44.46
Total		840.55	100.00

Natural Clear

Super Seatone Trans-Oxide Yellow (7) 3.36 0.32

Dry Conditions Air dry – minimum of two coats is recommended for optimal appearance and durability.

Paint Properties

pH – Value (adjustment with Ammonia/28%) 8.0 – 9.0
Viscosity, Zahn 2 (sec.) 20 – 30

Basic Formula

Solids (wt.) %	24
Solids (vol.) %	22
PVC %	3.8
Pigment/Binder	0.08/1
VOC, lbs./gal.	2.03
VOC, g/L	243

Natural Clear

Solids (wt.) %	24
Solids (vol.) %	22
PVC %	4.0
Pigment/Binder	0.09/1
VOC, lbs./gal.	2.04
VOC, g/L	244
Drying Time, BK Drytime Recorder	3 mil wet (hour)
Set to Touch	0.5
Tack Free	1.5
Dry Hard	2.5
Dry Through	7.5
Early Water Resistance (hrs.)	3

(1) Cytec Surface Specialties (2) Lyondell (3) Troy Chemical Corp
(4) Ciba (5) Rohm & Haas (6) Degussa
(7) Noveon

Interior Primer

A synergistic effect can sometimes be obtained when acrylic and silicone flow and leveling agents are used together. In the waterborne, low VOC trim enamel formula below (Table 17), MODAFLOW® AQ 3025 and ADDITOL® VXW 6503 eliminate brush mark, enhance gloss, and provide excellent leveling.

TABLE 17
**High Gloss Trim Enamel Based on
RESYDROL® VAF 6111w/60WA**

Pigment Paste		Lbs.	Gals.
Deionized water		82.70	9.93
ADDITOL® VXW 6208	(1)	17.25	1.97
Propylene glycol		7.97	0.92
ADDITOL® VXW 6210	(1)	3.62	0.47
Ti-Pure R-706	(2)	329.37	9.89
ADDITOL® VXW 6388	(1)	1.70	0.20
Total		442.61	23.38

Disperse to Hegman 7+. Hold until required.

Letdown

RESYDROL® VAF 6111w/60WA	(1)	553.79	62.15
ADDITOL® VXW 6206 (1:1 in water)	(1)	10.26	1.18
21% Cobalt Hydroxy Ten-Cem	(3)	1.04	0.11

Mix 10 min., then add the following:

ADDITOL® VXW 6210	(1)	2.81	0.37
ADDITOL® VXW 6503	(1)	4.34	0.52
MODAFLOW® AQ 3025	(1)	21.70	2.58
Arcosolv PnB	(4)	15.58	2.13
Pigment paste (from above)		442.61	23.38
Tint-Ayd WD 2018	(5)	0.34	0.04

Adjust viscosity with the following:

ADDITOL® VXW 6388	(1)	6.78	0.78
Deionized water		56.41	6.77
Total		1115.66	100.00

Dry Conditions Air dry – room temperature

Paint Properties

pH (adjust with 60:40 Ammonia/AMP-95)	7.0 - 8.8
Viscosity, Stormer, KU	75 - 85
Viscosity, Brookfield, cps	650 - 900
Solids (wt.) %	62
Solids (vol.) %	49
PVC %	20
Pigment/Binder	0.9
VOC, lbs./gal.	0.64
VOC, g/l	76.15
Lbs. solvent per applied gallon	0.34
WPG	11.16
Mileage, sq.ft./gal. @ 1 dry mil	777
Drying Time, BK Drytime Recorder	3 mil wet
Set to Touch	25 min.
Tack Free	3 hrs.
Dry Hard	5 hrs.
Dry Through	11 hrs.

1.5 mil Dry Film Thickness on B100

20° Gloss	50
60° Gloss	85
Pencil Hardness, 1 week	HB - F
Pencil Hardness, 4 months	HB - F
Pendulum Hardness, 1 week (Persoz, sec)	48
Pendulum Hardness, 4 months (Persoz, sec)	119
% Opacity (1.5 mil on Leneta)	98%

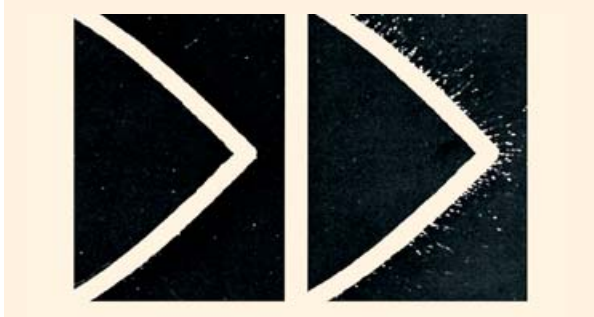
(1) Cytec Surface Specialties (2) DuPont (3) OMG
(4) Lyondell (5) Elementis Specialties

Printing Inks

MODAFLOW[®] and ADDITOL[®] flow and leveling additives improve the adhesion and sharpness of image in silk-screen or flexographic inks.

The silk-screen printing process requires that the ink be forced through the unblocked openings in the screen to be transferred to the substrate. If the ink is sticky, there is a tendency to form strings that fall back on the substrate as the screen is lifted. (See Figure 13) This undesirable effect is known as stringing or haloming. Air bubbles originating from the screen are also a potential cause of crater defects. Silk-screen inks dry by solvent evaporation, oxidation, free radical cure, or a combination of mechanisms. The addition of MODAFLOW[®] and ADDITOL[®] products can promote flow and leveling to improve ink appearance.

FIGURE 13



Flexographic printing is an extension or modification of the aniline printing process. These inks dry rapidly and multiple color printing is achieved with only one pass through the press. MODAFLOW[®] Resin or MODAFLOW[®] 2100 may be applied in solvent based flexographic inks to improve the transfer of ink from the well to the distribution roll, and over the rubber image which prints on the substrate. The MODAFLOW[®] AQ-3000 series and ADDITOL[®] XW 395 are suggested for use in water-based flexo applications.

Improved appearance has been achieved in inks based on acrylic and polyester resins over metal or plastic substrates. Energy curable inks (UV, e-beam) are gaining increased market acceptance due to their inherently low organic compound emission. Suggested use levels for MODAFLOW[®] and ADDITOL[®] flow modifiers in ink applications range from 0.1% to 1.0% by weight based upon the total formulation.

TABLE 18

MODAFLOW[®] for Ink Applications

For:	Solvent		Aqueous
Ink System	MODAFLOW [®] or MULTIFLOW [®] Resin	MODAFLOW [®] 2100, 9200	MODAFLOW [®] AQ-3000, AQ-3025
Flexo (Solvent)	•	••	
Flexo (Water)			•
Polyester Based	•	••	••
Acrylic Based	•	••	••
Silk Screen	••	•	
High Visc. Applications	••		•
Moderate Visc. Applications	•	••	•
Low Visc. Applications	•	••	•
Ultraviolet Applications	•	••	
Waterborne Applications			••

• Recommended •• Strongly Recommended

* The recommendations provided in this table are made for consideration by users, and users assume all risk of accepting or not accepting those recommendations.

UV Overprint Varnish

Appearance is probably the most important property of many graphic art coatings. For overprint varnishes, high gloss, DOI and clarity are the fundamental requirements. MODAFLOW[®] 9200 has been shown to provide good flow and leveling properties without causing haze in many UV OPV formulas (Table 19). MODAFLOW[®] 9200 can also be used in many heat-sealable coatings because it does not contain silicone.

TABLE 19

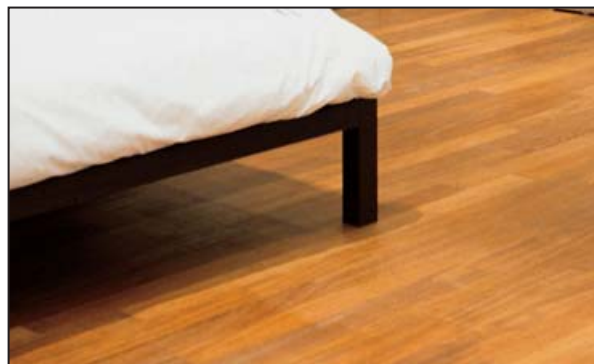
UV Overprint Varnish with MODAFLOW[®] 9200

Component	Parts	
EBECRYL [®] 600 (epoxy acrylate)	(1)	20-25
Trimethylolpropane Triacrylate (TMPTA)	(1)	35-45
Dipropylene Glycol Diacrylate (DPGDA)	(1)	15-25
EBECRYL [®] P115 (amino acrylate)	(1)	8-12
ADDITOL [®] BP (photoinitiator)	(1)	5-7
MODAFLOW [®] 9200	(1)	0.5
MeHQ (Stabilizer)		0.1
Properties		
Viscosity (cps)		200-300
Gloss 60°		>90

(1) Cytec Surface Specialties

UV Industrial Coatings

The low viscosity and good compatibility with polyesters and acrylates of MODAFLOW[®] 2100 and MODAFLOW[®] 9200 are good options for flow control in UV systems. Typical use levels are <1.0% by weight.



Toxicity

Many MODAFLOW[®] and ADDITOL[®] products have been subjected to acute toxicity and mutagenicity studies. Details on specific coverage of individual studies are available upon request. For more information on each product, consult the current Material Safety Data Sheet (MSDS) which will be provided by Cytec.

FDA Status

The current FDA status of MODAFLOW[®] and ADDITOL[®] flow modifiers is provided in Table 20. These products may be used in certain indirect food contact applications. These applications are regulated by the U.S. Food and Drug Administration (FDA) under Title 21 of the Code of Federal Regulations. The formulator is responsible for complying with the regulations subject to the provisions of 21 CFR 175.105, 175.300, 176.170, 176.180, 177.1010 and 177.2600.

Storage

Environments of high heat and humidity should be avoided. The ideal storage temperature is

between 40°F (4°C) and 100°F (38°C). Keep away from sparks and flame. Avoid freezing temperatures for water-borne products.

Shelf Stability

The shelf lives of the MODAFLOW[®] and ADDITOL[®] products can vary depending on storage conditions. Typically, the MODAFLOW[®] and ADDITOL[®] products for solventborne systems have a shelf life of four years and one year, respectively. On the other hand, MODAFLOW[®] and ADDITOL[®] products for waterborne systems have a guaranteed shelf life of one year when stored between 4-38°C (40-100°F).

National Sanitation Foundation (NSF) Approval

MODAFLOW[®] and ADDITOL[®] additives have been used in coatings for potable water and sewage systems. Per NSF Standard 61 guidelines, the final coating formulation is evaluated to performance requirements for the specific use or application. Visit website www.nsf.org for more information.

TABLE 20

MODAFLOW[®] and ADDITOL[®] Flow Modifiers - Regulated Under FDA Title 21 of the Code of Federal Regulations

Product	175.105	175.300	176.170	176.180	177.1010	177.2600
ADDITOL [®] XW 395	Yes	Yes ^{1,2}	Yes ^{1,2}	Yes ^{1,2}	No	Yes
ADDITOL [®] XL 480	Yes	Yes ¹	Yes	Yes	Yes	Yes ¹
MODAFLOW [®] Resin	Yes	Yes	Yes	Yes	Yes	Yes
MODAFLOW [®] 2100	Yes	Yes ¹	Yes	Yes	Yes	Yes
MODAFLOW [®] AQ-3000	Yes	Yes ²	Yes	Yes	No	Yes ²
MODAFLOW [®] AQ-3025	Yes	Yes ²	Yes	Yes	No	Yes ²
MODAFLOW [®] 9200	Yes	No	Yes	Yes	No	No
MULTIFLOW [®] Resin	Yes	No	No	Yes	Yes	Yes

1. Providing that the finished can coating complies with the end test specifications of 177.1010.
 2. Providing that all of the salting amine evaporates under application and curing conditions.

Contact Us

Cytec Surface Specialties Inc. North America

1950 Lake Park Drive
Smyrna, GA 30080 U.S.A.

Tel.: 1 800 433 2873
Fax: 1 770 970 8391
customerservicena@cytec.com

Cytec Surface Specialties S.A./N.V. Europe

Square Marie Curie 11
B 1070 Brussels
Belgium

Tel.: ++32 2 560 45 11
Fax: ++32 2 560 45 21
surfsspec@cytec.com

Cytec Surface Specialties (Shanghai) Co Ltd Asia Asia Pacific / China

Junyao International Plaza
No. 789, Zhao Jia Bang Road
Xuhi District, Shanghai 200032

Tel.: 86-21-64228920
Fax: 86-21-64228980
china@cytec.com

Global Product Referral

Tel.: 1 800 652 6013 (USA)
Tel.: 1 973 357 3193 (Outside USA)
custinfo@gm.cytec.com

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