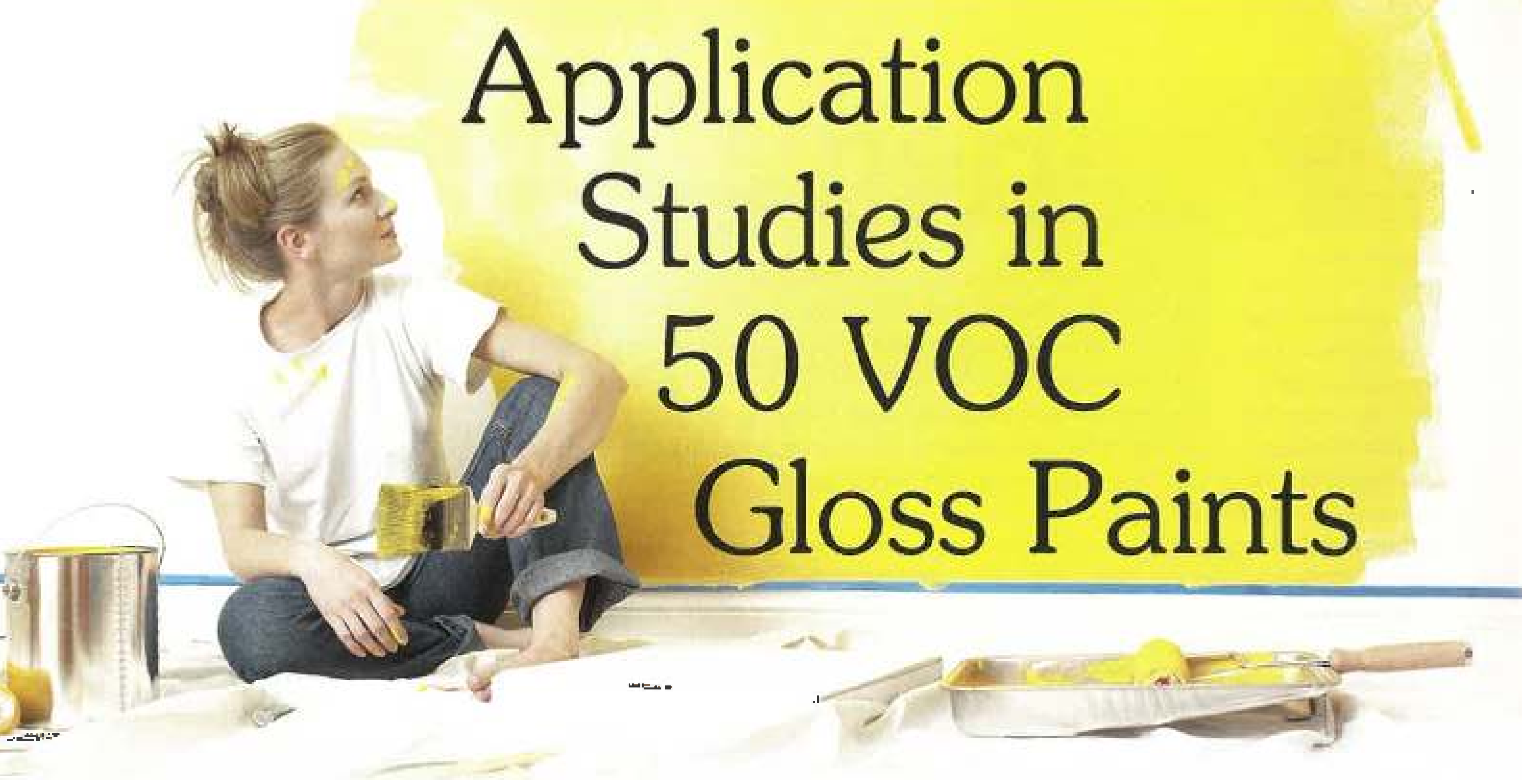

Application Studies in 50 VOC Gloss Paints

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Gloss paints which have been formulated to meet the 50 gram/liter regulations may require new formulation and application techniques to optimize appearance. Many Coatings manufacturers are concerned that painting techniques which have been used with higher VOC aqueous or solvent paints may give poor appearance in these low VOC paints, especially in the areas of brushed flow and open time. A study has been conducted to determine the optimum rheology, formulation space, and painting techniques to use in applying 50 VOC gloss paints. Suggestions for 50 VOC high gloss formulations with improved application properties and slight modifications of several common application techniques are presented in this article. Together, these techniques can give excellent professional quality finishes in VOC-compliant gloss paints.

INTRODUCTION

In order to comply with the California South Coast Air Quality Management District 50 gm/liter VOC regulations for architectural gloss paints, many companies are evaluating binders designed for use at low VOC. Many paint manufacturers are concerned that the lower levels of glycol in these paints may lead to open time and flow issues and customer complaints. While professional painters may be able to adapt their painting techniques if necessary, the Do-It-Yourself (DIY) painter needs paints which can be applied easily and give an excellent painted finish with a variety of tools and techniques.

The purpose of these application studies was to characterize the application properties of 50 VOC gloss paints and optimize formulations or application techniques to give the best possible appearance. A test for brushed flow out during dry was used to identify several key formulating factors

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which can affect appearance. Optimized 50 VOC gloss formulations were compared to several commercial 150 VOC and 250 VOC gloss latex paints. The results of these studies indicate that an excellent finish is obtainable in 50 VOC paints through a combination of formulation techniques and some slight modifications of traditional application methods.

BACKGROUND ON TEST METHODS

Drying of latex paints is a highly complex process. It has been commonly observed that the film does not dry uniformly across the surface but occurs via a moving drying front. Holten-Anderson and Hansen[1] proposed that the initial rate-limiting step during dry is the transport of evaporating water through the vapor phase at the surface of the film and away from the drying film. The moving drying front may reflect the area of the film where the vapor phase above the film is the least concentrated, and where evaporation can occur most readily. Another complexity is that the evaporation of the water is accompanied by changes in the ionic nature of the serum phase and in the ratio of water to slower evaporating water-soluble cosolvents or surfactants, which can affect the rheology of the partially dry paint. In the final phase of dry, the interdiffusion of polymer particles leading to coalescence can be affected by many environmental, polymer composition, and formulating variables. Eckersley and Rudin[2c] point out that drying and coalescence are not necessarily concurrent processes and that there is not a clear relationship between fusion kinetics and drying kinetics. Many methods[2] of measuring drying have been proposed and used to investigate aspects of the drying of paints, and much work[3] has been done to develop models and suggest mechanisms for the reported data.

One important property which has not been widely tested is how well the brushed paint flows out as the film is drying. A gloss or semigloss paint with longer flow out during dry will usually look better (with fewer brushmarks) after the final smoothing strokes of the brush, and defects will be easier to repair by rebrushing before the paint is dry.

OPEN TIME AND WET EDGE TESTS

Two of the common tests used to try to evaluate drying time are open time and wet edge. These are designed to rank paints for their performance on specific appearance defects which are related to the dry of the extreme edge of the paint film. For the purposes of this article, the wet edge is considered to be the time until the extreme edge of a drying film of paint can no longer be reworked with a fresh coat of paint and a line of dried paint is visible under the rebrushed area. Open time is used to mean the time until the extreme edge of an X marked in a drying film begins to show through a brushed second coat of paint.

Wet edge is a common problem in applying paint to a six-panel door or windows where the perimeter of an area is to be painted and finished by brushing back into the partially dried beginning area. Relative to solvent-based paints, which have wet edge of longer than 20 minutes, most latex paints (even at 250 VOC) are quite poor for this property, with wet edge times of less than three minutes. Even if the paint is being applied rapidly by an experienced painter, the application time for a typical job (such as painting the styles and rails of a six panel door) often takes longer than the typical latex paint wet edge time. Wet edge problems can be reduced through application technique, however. Painting up to but not over natural breaks in the substrate and, if necessary, masking off adjacent areas to avoid overlapping coats of paint may be the most effective way of avoiding wet edge when painting with latex paints.

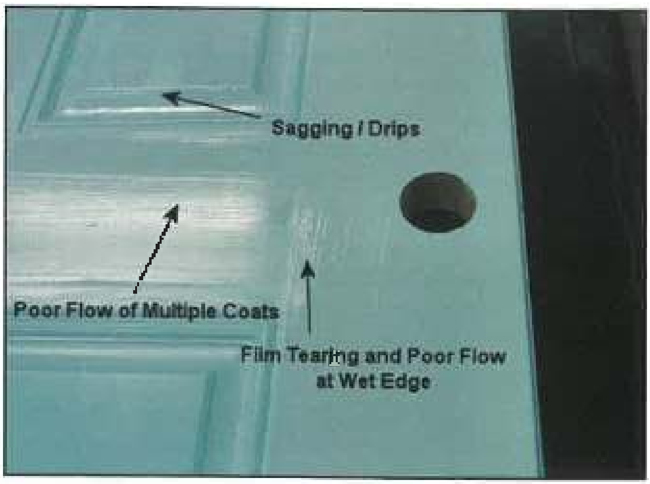
The open time test is considered a measure of the amount of time that a film defect in the middle of a painted area can be repaired. Although the open time tests on latex paints are usually slightly longer than the wet edge times (by 2–3 min), the differences in most latex paints (up to just 5 min at the longest) are still small relative to actual application times. Formulation variables were not found to have a large effect on this property. In tests on an acrylic gloss paint, volume solids (32% to 36%) did not affect open time while glycol level (50 and 250 g/L) had only a small effect, increasing the open time from just 1 to 2 min (*Table* 1).

Table 1—Effect of VOC and Volume Solids on Application Properties

Paint: 19.3% PVC Gloss with 0.5 gal X-100, 0.9% Tamol 2001

VOC	Vol Solids	KU/ICI	Leneta Flow	Leneta Sag	Brushed Flow	Open Time (Min)	Brushed Flow Out Line Count Per Inch 3.5 Mils Wet/6 Min Dry
50	32%	97/1.5	10	14	6	1	18
250	32%	96/1.5	10	18	5	2	17
50	36%	100/1.5	10	16	6	1	21
250	36%	96/1.5	10	18	6	2	16

Figure 1—Common latex paint application problems on six-panel doors.



In addition, no correlation was found between the open time and brushed flow during dry, so the speed of dry at the extreme edge of a film is not a good predictor of how long or how well a paint will blend back into a drying film without brushmarks as defects are repaired. As will be discussed later, defects in a painted film might be reduced with application technique or, in some cases, are better handled by allowing the paint to dry, then wet sanding and applying a second coat. In addition, some optimized low-VOC gloss formulations were found that have very good brushed flow out during dry, which makes repairing defects by rebrushing much less visible (*Table 5*).

REPAIR PERFORMANCE/LAPPING

Repair performance (sometimes also called lapping) is the amount of time that a brush mark from a wet brush applied across a brushed drying coat of paint will flow out to form a single-coat film. The end point for this test can be the time until film tearing at the edge of the brushmarks or the time to double coat (with visible brushmarks from the first coat). There is often not a clearly defined point where the second coat no longer blends into the first coat or when film tearing starts. The repair performance test is also dependent on brushing technique—brushed thickness of the first coat, second coat pressure, and amount of paint used to reload the brush can all affect the result. This variability in the test can make it difficult to accurately rank paints with small improvements in this property.

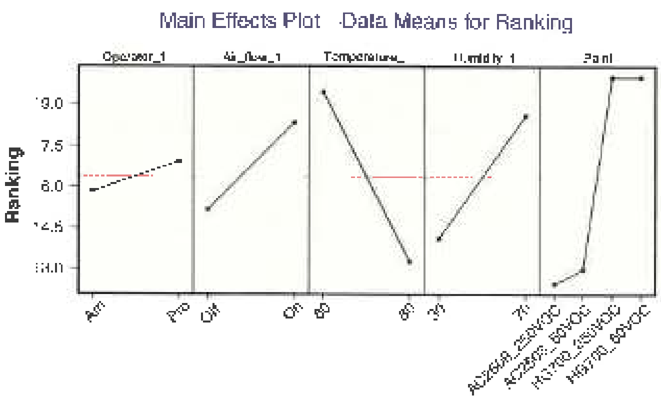
In a study[4] of propylene glycol levels in paints, Cooke et al. reported that glycol levels below 13% on total weight of paint had little effect on lapping times. This minimum level of glycol necessary for improved lapping is higher than is in many of the commercial gloss paints on the market today. Even in coalescent-free gloss latex paints, the maximum propylene glycol level at 150 VOC is approximately 5% on total paint weight. Improvements in lapping time were found as the glycol level increased from 13% up to about 30% of the total paint weight; however, the increase even at that elevated level of glycol was modest (12 to 21 min at 30% glycol), and the authors were doubtful that even at the longer lapping times, the latex paints would have totally satisfactory application properties. They also found that thicker films (testing 4, 6, and 8 mils wet film thickness) gave longer lapping times but mentioned that the thicker films were more difficult to apply evenly.

SIX-PANEL DOOR BRUSHOUTS

Brushouts on six panel doors are often used to try to rate a paint's application properties. Despite wide use in the industry, these brushout tests on six-panel doors are unreliable as predictors of paint performance. The tests can have poor repeatability for unskilled painters since large, relatively complex areas are being painted and small differences in brush loading, speed of brushing, or number of strokes to smooth the paint can have a large effect on the appearance. In addition, there is no widely accepted way of grading the relative importance and severity of different defects (*Figure* 1) in the final appearance of six-panel doors. Since several of these defects are related to poor brushed flow as the paint dries, improving this property should give better overall appearance for six-panel doors.

A study[5] was run to evaluate the effect of different environmental, formulation, and application variables on the six-panel door test. In this study four paints were tested. They were 50 and 250 VOC gloss paints made with either a surfactant stabilized binder

Figure 2—Main effects from six-panel door application study.



(Rhoplex HG-700) or a colloidally stabilized binder (Rhoplex AC-2508). Eight six-panel doors were painted by two operators with different skill levels (amateur and pro) under two different sets of environmental conditions (high temperature/low humidity/with air flow or low temperature/high humidity/without air flow).

As expected, there were important two-way interactions found between operator skill level and the environmental conditions of temperature and humidity. The less skilled painter was less able to achieve good final appearance on these six-panel doors under higher temperature and lower humidity environmental conditions. One unexpected finding was that for a single painter and one set of environmental conditions, little difference was found in the appearance of a finished door comparing 50 and 250 VOC gloss latex paints made with the same binder (*Figure* 2).

BRUSH DRAG

The change in brush drag with time has also been investigated as a way of estimating rheology changes during dry.[6] In order to assess the utility of the method, several paints at varying VOC levels were tested by this method. This test was done with a floating platform attached to a stress meter that held a panel with a wet drawdown. At set time intervals, five brush strokes were made down the center of the panel and the deflection of the platform was recorded. Although accurate measurements of the deflection could be made, the repeatability of the measurements was relatively poor, probably due to slight differences in the angle of the brush, the downward pressure of the brush, or the speed of the brush stroke. Nevertheless, with some refinement, the test method may prove useful to measure changes in the application properties of the paints as they dry. For paints with different thickener packages and various flow additives, it remains to be seen if the measured increases in brush drag as the films dry are directly related to brushed flow.

RHEOLOGICAL CHANGE IN LATEX FILMS DURING DRY

Several studies[7,8] have evaluated changes in rheology as the films dry. Changes in the composition of the serum phase (higher cosolvent as the water evaporates and changes in the ionic strength) may affect rheology. Molenaar et al. and the study by Lofflath and Gebhard both found that the monobutyl ether of ethylene glycol had a large effect in lowering viscosity of the drying film compared to other water-soluble glycol ether coalescents. In addition, both studies also found a lowering of film viscosity during dry at higher pH. Molenaar suggests that these lower viscosities during dry correlate to observed better flow and worse sag resistance. Both studies indicate that relatively low viscosities for longer times during dry may be possible through raw material optimization.

BRUSHED FLOW OUT TEST

The brushed flow out test is a simple test which was developed to rate how well the paint flows out as the film is drying. The test measures how long a paint will take to set up and the length of time that the final smoothing brush strokes will flow out well, giving a relatively smooth, glossy film with few remaining brush marks. The test is also an indicator of how well minor imperfections (such as runs) in the drying film can be repaired. This test was used to evaluate the effect of variables such as film thickness, volume solids, VOC, flow additives, and rheology modifiers on brushed application properties during dry.

The brushed flow out test method is a variation on the repair performance and open time tests. In this brushed flow out test method, a lengthwise drawdown is made on a black Leneta scrub panel, then allowed to dry for a set amount of time (usually 1, 4, 7, and 10 min) in a controlled environment room (71°F, 50% RH). After the drying period, a quality 1.5-inch brush which had been dipped into paint then wiped off (so that, ideally, no additional paint would be deposited or taken up from the drying area) was used to make five light, quick brush marks across the panel. The panels were allowed to dry and then were rated by counting the visible brush marks in the center one-inch of the brushed area using a low angle light source. A paint with excellent brushed flow would have just five to seven broad, gradual hills in the center one-inch section of the brushed area, while paints with poor brushed flow out would have many sharply defined lines and line counts per inch of 25 to 35. Results at different time intervals can be plotted to get a curve showing how well the paint flows out during drying.

Table 2—Effect of ICI and KU Viscosity on Brushed Flow Out (Line Count Per Inch, 3.5 Mils Wet Film Thickness)

4 Min Dry Time		
High/Low Shear Viscosity	90 KU	105 KU
1.2 p	7	8
2.1 p	10	12
7 Min Dry Time		
High/Low Shear Viscosity	90 KU	105 KU
1.2 p	12	12
2.1 p	18	17

Table 3—Effect of Rheology Modifier, Dispersant, and Surfactant on Application Properties

50 VOC Gloss Formulation with Traditional ICI Building HEUR Thickener

Tamol 2001 Dispersant Level (%)	X-100 Level (Gal)	RM-2020 NPR	RM-8W	KU/ICI	Leneta Flow	Leneta Sag	Brushed Flow	Open Time (Min)	Brushed Flow Out Line Count Per Inch 3.5 Mils Wet/7 Min Dry
0.50	0	30	10	112/1.4	10	18	6	1	20
0.50	0.5	30	12	113/1.5	9+	15	6	1	16
1.50	0	35	12	110/1.5	10	14	7	1	24
1.50	0.5	35	14	109/1.5	10	13	7	1	23

50 VOC Gloss Formulation with KU Efficient, ICI-Building HEUR Thickener

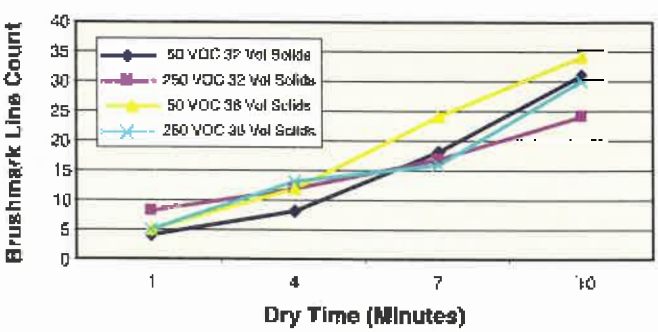
Tamol 2001 Dispersant Level (%)	X-100 Level (Gal)	RM-5000	RM-8W	KU/ICI	Leneta Flow	Leneta Sag	Brushed Flow	Open Time (Min)	Brushed Flow Out Line Count Per Inch 3.5 Mils Wet/7 Min Dry
0.50	0	23	8	112/1.5	9+	13	7	1	20
0.50	0.5	23	9	111/1.5	9+	12	7	1	11
1.50	0	28	10	109/1.5	10	11	8	1	8
1.50	0.5	28	12	108/1.5	10	10	8	1	5

In general, most latex paints had good flow out at 4 min but relatively poor flow out at 7 to 10 min; however, some important exceptions were found with excellent flow even at 7 min dry (*Table* 3). It is important to note that the brushed flow out test is insensitive to viscosity changes between 90 and 105 KU (for a particular binder and thickener system) but it is somewhat sensitive to large differences in high shear viscosity, especially at longer dry times. Gage R&R studies of this test showed significant variation between different operators, which could be a result of brushing technique. For a single operator, however, the test had good repeatability.

EXPERIMENTAL

Two sets of paints were made for evaluation by conventional open time tests and the brushed flow out test method. In all these paints, the binder used was an ambient temperature crosslinking acrylic binder designed for 50 VOC gloss paints, Rhoplex™ HG-706. The paints were made at 19.4% PVC with a universal grade

Figure 3—Effect of volume solids and VOC on brushed flow out with time.



of titanium dioxide, Ti-Pure™ R-706. In the first set of paints, the paints were thickened with a combination of HEUR thickeners Acrysol™ RM-2020NPR and Acrysol SCT-275, but thickener levels were adjusted to test formula variations at low and high VOC (varying propylene glycol level), low and high volume solids, low and high ICI viscosity, and low and high KU viscosity.

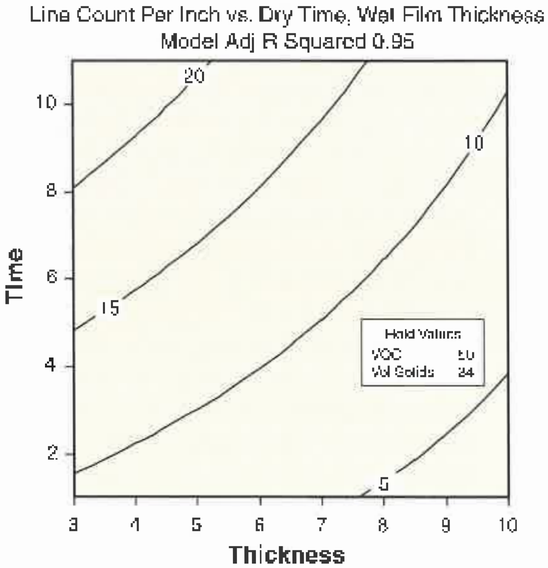
A second series of paints was made to evaluate the effect of rheology modifiers and flow additives on brushed flow out. In this set of paints, the ambient temperature crosslinking binder, Rhoplex HG-706, was also used but was formulated at 50 gm/L VOC, 19.4% PVC, and 34% volume solids. The rheology modifier Acrysol RM-2020NPR was compared to a new generation HEUR rheology modifier designed to give more KU efficiency at equivalent ICI, Acrysol™ RM-5000. Both these paints used Acrysol RM-8W as the HEUR KU builder. Since some surfactants and dispersants can affect brushed flow, high and low levels of nonionic surfactant (Triton™ X-100, a 13.5 HLB octyl phenol ethoxylate) and dispersant (Tamol™ 2001, a hydrophobic copolymer dispersant) were also evaluated.

RESULTS AND DISCUSSION

VOC and Volume Solids

A small study was run with the factors volume solids (32–36%) and VOC (50–250 VOC, varying propylene glycol levels) (*Table* 1). In the standard wet edge tests, there was little difference (just one to two minutes) across this formulating latitude. This result was unexpected since lower volume solids and higher VOC paints with more glycol were expected to have longer open time. The fact that there was little difference across this latitude may indicate that the formation of the extreme drying edge, an extremely thin film, may

Figure 4—Brushed flow out tests: HEUR-thickened 50 VOC gloss paints time of dry versus film thickness.



not depend greatly on the amount or type of solvent in the latex paint. The higher Leneta sag found at high VOC may indicate that there was some polymer swelling at the high level of propylene glycol.

In the brushed flow out test with time (*Figure* 3), volume solids and VOC were found to have only a minor effect. The fact that VOC had only a minor contribution to this property indicated that 50 VOC gloss paints may lose brushability on drying only slightly faster than 250 VOC gloss paints. Possible polymer swelling at high glycol levels (from the Leneta sag results) may have reduced the brushed flow out for the 250 VOC paints slightly, but the effect of this swelling was probably small since all the paints had excellent Leneta flow.

EFFECT OF FILM THICKNESS

When the brushed flow out test was run on the same series with the additional factors of film thickness and drying time, these new factors had by far the largest influence on the flow of the paint as it dried. The importance of time and film thickness reflects the common observation that the best technique for applying latex paint is to put down relatively thick films quickly. These HEUR-thickened gloss paints had good brushed flow out at slightly high film thicknesses. Both 50 VOC and 250 VOC gloss paints had fair to good brushed flow out at up to 6 min if the wet film thickness was 5 mils or greater (*Figures* 4 and 5). Thicker films applied quickly may be possible for professional painters who know how to avoid sag problems, however this will be difficult for most DIY painters. Therefore, other solutions are needed to get good application properties.

HIGH AND LOW SHEAR VISCOSITY

Since changes in low and high shear viscosity can affect brushed application, a series of HEUR-thickened 50 VOC paints were tested with varying ICI (1.2–2.1 p) and KU (90–105 KU). Interestingly, there was no effect of low shear viscosity on brushed flow out with time—the brushed flow out was not worse at higher KU (*Table* 2). The high shear viscosity did affect the brushed flow out slightly—higher ICI gave slightly worse flow out, especially at longer dry times. This was unexpected since higher ICI usually gives thicker films in brushed application. This may be a result of the way the test was run. Since the brushed flow out test is run with a very light smoothing stroke of the brush and without an excess of paint on the brush, the higher ICI may not have given thicker films under the brush. The slightly worse brushed flow out at higher ICI may have been a result of the difference in the relative amounts of the two HEUR thickeners (Acrysol 2020NPR and Acrysol SCT-275) used to reach the desired KU and ICI. If so, this would mean that rheology modifier selection would be a large factor in the brushed flow out property.

As expected, higher ICI did give slightly thicker films in a natural spread rate brush out test and the higher KU gave a slightly better brush loading and improved sag resistance. Increasing ICI and KU to 1.8 and 100 KU seemed to give a good balance of brushed feel and slightly better brushed appearance, but again the improvements were relatively modest.

Figure 5—Effect of Flm thickness and VOC on brushed flow out of 36% volume solids gloss paints (11 min dry: 10x magnification).

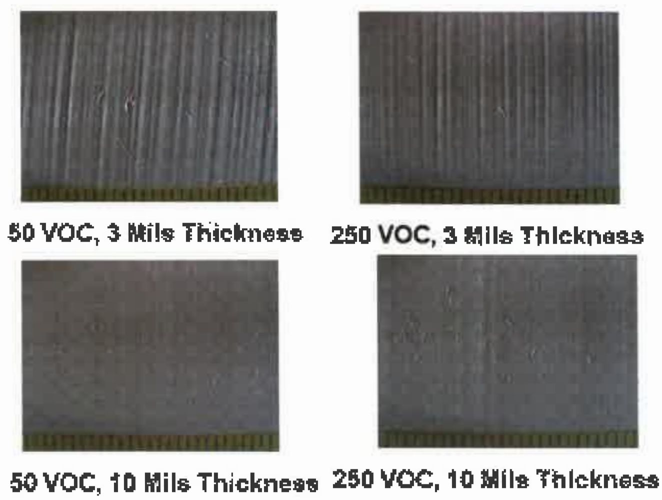
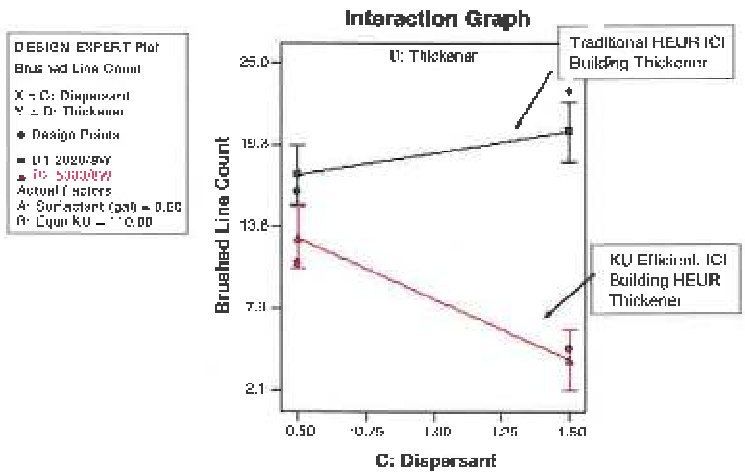


Figure 6—Interaction of thickener type and dispersant level: brushed flow out test (3.5 mils wet film thickness and 7 min dry time). Adj. R squared 0.83.



g/L. In this series, the high shear viscosity was kept constant at 1.5 p and the paints were tested at either 90 or 110 KU.

For these paints, brushed flow out was evaluated at a single film thickness—3.5 wet mils—and tested for brushed flow out at 3 min intervals. Results for this series were intriguing. The nonionic surfactant had only a slight effect on the brushed flow out but the HEUR type and level of hydrophobic copolymer dispersant had a very large effect. The new KU efficient, ICI-building HEUR thickener had marked synergy with the level of dispersant (*Figure* 6). At 1.5% of the dispersant on pigment, the 50 VOC paints with this thickener had brushed flow out that was as very good in 3.5 mil wet films for up to 10 min.

FLOW ADDITIVES AND RHEOLOGY MODIFIERS

A second experimental series was run to evaluate the effect of several ingredients which can affect brushed flow. These paints were also based on the ambient temperature-curing acrylic polymer and were thickened with a combination of a KU building HEUR thickener, Acrysol RM-8W, and either the traditional ICI building HEUR thickener, Acrysol RM-2020NPR, or the new generation HEUR rheology modifier designed to give better KU efficiency and flow at equivalent ICI, Acrysol RM-5000. Varying levels of a hydrophobic copolymer dispersant, which is sometimes used as a flow additive, and a 13.5 HLB nonionic octyl phenoxy polyethoxy ethanol surfactant were evaluated. These were all 19.4% PVC, 34% volume solids gloss paints formulated at 50

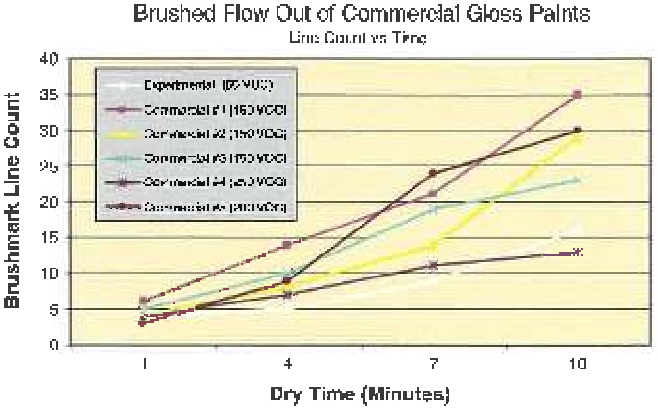
Standard tests such as Leneta flow, Leneta sag, and brushed application were also run (*Table* 3). For the gloss paints tested, no correlation with the brushed flow out during dry was found with Leneta flow since all paints tested were excellent for Leneta flow. No correlation was found with brushed application, either, probably because slight differences in applied film thickness in different areas of the panel had a large effect on the brushed flow of the paint. On the other hand, we did see an inverse relationship with the Leneta sag: paints with excellent brushed flow out at longer dry times usually had lower Leneta sag. Leneta sag was slightly low with this combination of ingredients and was rated as 9 at 90 KU and 11 at 108 KU. Nevertheless, these gloss formulations with exceptional flow at extended dry times indicate that excellent application properties are possible even at low VOC.

Table 4—Comparison of the Experimental 50 VOC Gloss Paint to Commercial Latex Gloss Paints

	Exp. Paint HG706 / RM5000	Comm. #1	Comm. #2	Comm. #3	Comm. #4	Comm. #5
VOC	50	150	150	150	250	200
KU	107	105	110	108	99	103
ICI	1.5	1.4	2.0	2.4	1.6	2.1
10 Minute Brushed Flow Out[a]	*16*	*35*	*29*	*23*	*13*	*30*
Leneta Flow	10	10	10	10	10	10
Leneta Sag	11	12	13	11	11	14
Wet Edge (min)[b]	2	4	3	2	2	4
Brushed Application Coverage[c]	400	430	380	420	370	400
Brushed Application Flow[d]	8	6	9	7	7	7

(a) 3.5 wet mils DD, dry 10 minutes, 5 brush strokes, # of brush marks/inch. Lower numbers indicate better brushed flow out.
(b) 3.5 wet mils DD, draw line in middle, 10 strokes of a wet brush each minute, record time to first appearance of drying edge.
(c) Natural spread rate, 1.5 inch brush, Leneta spreading rate chart, 100 cm^2
(d) Visual rating 1-10. 10 is a smooth surface with no brushmarks.

Figure 7—Comparison of the experimental 50 VOC gloss paint to commercial gloss paints for brushed flow out with time.



COMPARISON TO COMMERCIAL GLOSS PAINTS

A comparison to five different commercial gloss latex paints ranging in VOC from 150 g/L to 250 g/L was run with an optimized 50 VOC gloss formulation. In this test, the experimental 50 VOC paint (*Table* 5) was a 19.4% PVC, 34% volume solids gloss formulation based on an ambient temperature crosslinking acrylic polymer and thickened with a combination of Acrysol RM-8W and the new KU efficient, ICI-building HEUR thickener, Acrysol RM-5000, to 108 KU and 1.5 p. The experimental paint had 1.5% of the hydrophobic copolymer dispersant on pigment and 0.5 gal of the 13.5 HLB nonionic surfactant.

All the paints were 99 to 110 KU in viscosity but there was a significant variation in high shear viscosity: the commercial paints ranged from 1.4 to 2.4 p. All the commercial paints had excellent Leneta flow and the Leneta sag varied from 11 to 14. Only slight differences were found in the open time, ranging from 2 min at the low end to 4 min for the best of the paints. No correlation was found between the open time and either the brushed application flow or brushed flow out with time. The commercial paints and the experimental paints were all fair-to-good for brushed application (*Table* 4).

In the brushed flow out test, the experimental 50 VOC paint with the KU efficient, ICI building HEUR rheology modifier was better at 7 and 10 min than the commercial 150 and 200 VOC gloss paints and was equal to the commercial 250 VOC gloss paint (*Figures* 7 and 8). These experiments suggest that painters experienced in the application of conventional gloss latex paints should be able to apply 50 VOC gloss paints with equal success.

NOTES ON APPLICATION TECHNIQUES

As the results of the standard open time tests suggest, in painting tests of six-panel doors, the open time even of commercial 250 VOC gloss latex paints was not long enough to prevent disruption of film at the lapped area. The solution to this problem may be in technique rather than formulation. Web sites for DIY painters[9] suggest painting these six-panel doors in sections and not brushing around an inlayed panel and back into a partially dried area. Using natural breaks in the substrate and painting just up to the break, but not over it (and into other partly dried painted areas) is a key to improving appearance. To do this, it may be necessary to mask areas of the substrate to keep from going over the natural breaks—an additional step for a DIY painter, but one which may be unnecessary for experienced painters who can brush out a fine line.

Alternate application techniques were evaluated for large flat areas (a 10 ft^2 flat panel was tested) without natural breaks. In brushed application on such large areas, technique plays a large role in the appearance of the paint; however, the problems seem to come from uneven application of the paint rather than lapping or open time problems. Applying the new brushed area a few inches away from the previously painted area means that the paint has to be stretched to cover the

Figure 8—Brushed flow out of commercial gloss paints at 10 min dry (3.5 mils wet film thickness; 10x magnification).

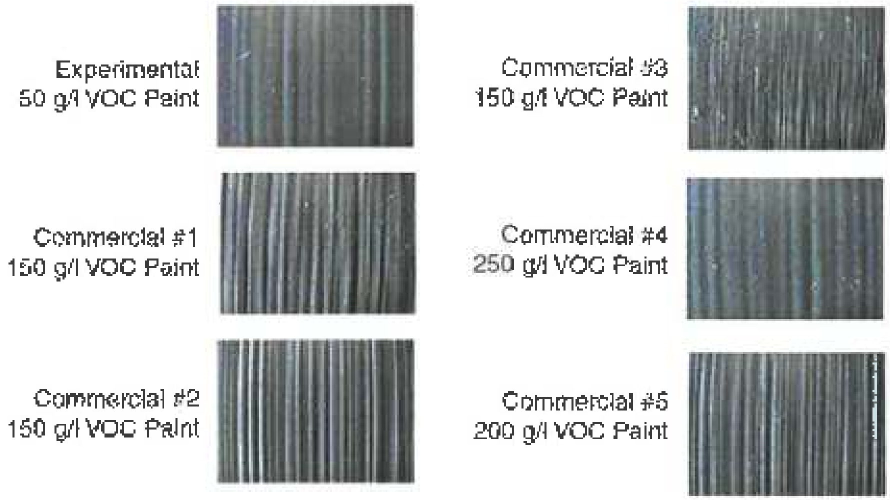


Table 5—Experimental 50 VOC Gloss Formulation

Formulation 71827-29A16 Based on Rhoplex HG-706 and Acrysol RM-5000

Material Name	Lb	Gal	Level
Grind			
Water	50.08	6.00	
Tamol 2001	7.86	0.89	1.50% Disp.
Ammonia (28%)	2.00	0.27	
Triton CF-10	1.00	0.11	
BYK-022	1.00	0.12	
Ti-Pure R-706	220.00	6.59	19.32% PVC
Let Down			
Rhoplex HG-706	584.10	66.00	
Texanol	7.93	1.00	3.02% Coal
Water	100.17	12.00	
Dynol 604	0.50	0.06	
BYK-024	1.00	0.12	
Propylene glycol	6.00	0.69	
Triton X-100	4.44	0.50	
Acrysol RM-5000	28.00	3.22	
Acrysol RM-8W	12.00	1.38	
Water	8.77	1.05	
Totals	1034.85	100.00	19.32% PVC

Volume Solids:	34.10%	**VOC:**	44
Weight Solids:	48.44%	**Dispersant:**	1.50%
Density:	10.35	**Coalescent:**	3.02%
pH:	8.8-9.2	**KU:**	105 ± 2KU
		ICI:	1.5p

Material	Function	Supplier
Tamol 2001	Dispersant	Rohm and Haas
Triton CF-10	Surfactant	Union Carbide
Ti-Pure R-706	Titanium Dioxide	DuPont
Texanol	Coalescent	Eastman
BYK-024	Defoamer	BYK-Chemie
Triton X-100	Surfactant	Union Carbide
Acrysol RM-5000	Rheology Modifier	Rohm and Haas
Acrysol RM-8W	Rheology Modifier	Rohm and Haas

unpainted area, and the effect is poor hiding in some areas and many brush marks due to the thinner film. In general, the appearance using this technique was unsatisfactory in a single coat and the coverage was very high (at 450 ft² per gallon). When each new brushed area was applied immediately adjacent to the previously painted area and when the final smoothing strokes were brushed back into the previously painted area, results were much better—the coats were thicker, the hiding was better, and the result was a much smoother film with fewer brush marks.

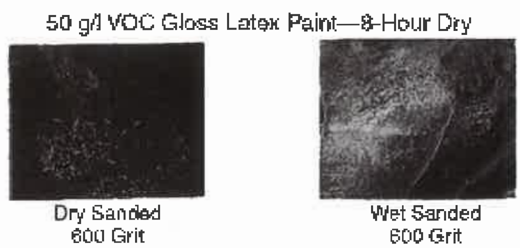
Rolling and backbrushing was also investigated as a possible way to apply thicker coats to large areas quickly. A foam roller was tested first since it was advertised as giving a smoother surface than a mohair roller. Although the roller stipple was slightly less than mohair rollers, the rolled surface was not smooth and backbrushing was necessary. The foam roller tended to push paint in front of it like a squeegee and the paint was stretched too far (the coverage was 380 ft² per gal). It also did not follow the slight curves and contours of the substrate very well. Overall, the results with the foam roller were unsatisfactory with poor hiding in some areas giving a blotchy appearance and backbrushing gave brush marks in thin areas.

The best results were obtained with a quarter inch nap mohair roller and backbrushing. The mohair roller seemed to deposit the paint very efficiently on the surface of the panel so that paint could not be easily stretched too far. Although the quarter-inch nap roller had to be reloaded frequently, the application time to roll and back brush was nearly the same as required to brush the same area. The good paint transfer meant that the wet film applied was relatively thick and backbrushing after rolling (about four minutes later) gave a smooth, even film with good hiding at 220 ft² per gallon (the panels were dried vertically and had only a little sag at that film thickness).

One of the interesting incidental findings from these studies was that, while almost all gloss latex paints are difficult to dry sand after an overnight cure, it was possible to easily wet sand some of these paints to a very smooth surface using a fine 500- to 600-grit sandpaper. Dry sanding latex paints after an overnight cure often forms eraser-like particles under the paper, clogs the paper, and scratches the surface of the paint, instead of forming a fine dust and cutting evenly into the paint film. With wet sanding, the sanded paints form a fine dust in the water (*Figure* 9).

Light wet sanding is an easy way to dull the gloss of the first coat, and wet sanding can be used to repair slight imperfections in a paint film before applying a second coat. Runs or sags in the paint should be repaired immediately if possible using light upward strokes of a brush and any brush marks (or any runs which were not caught early enough to be brushed out) can easily be wet-sanded smooth. Light wet sanding with 500 grit sandpaper can be used with care to remove large imperfections, while 600-grit paper can be used with more pressure and rubbing to smooth out a brushed surface.

Figure 9—Residue on sandpaper after wet and dry sanding.



Note that not all binders were found to be good for wet sanding after an overnight dry. Hydrophobic ambient temperature crosslinking gloss binders were one class of binder which was particularly good for wet sanding after overnight dry. Some binders tested were water-sensitive enough after an overnight dry that the wet sanding caused blistering.

CONCLUSIONS

A brushed flow out test was developed and can be used to characterize the flow of paints during dry. This new method can also give an indication of the ultimate application properties of latex paints.

From the open time and brushed flow out tests, it can be seen that VOC of gloss paints has little effect on brushed application properties and open time. The additional glycol in 250 VOC gloss paints did not significantly improve open time, appearance, or brushability compared to 50 VOC gloss paints. Therefore, 50 VOC gloss paints should be able to be applied with good results by painters used to applying conventional gloss latex paints.

Education may be needed to help DIY painters get satisfactory results with all kinds of gloss paints. The importance of using quality brushes, applying adequate film thicknesses quickly, brushing a substrate in sections, and wet sanding if needed should be stressed. All these techniques can help DIY painters achieve professional looking results with 50 VOC gloss paints as well as conventional gloss paints. These modifications of painting techniques will need to be communicated to the paint customers, either at point of sale, on the can label, or through on-line industry education efforts like the Paint Quality Institute.

Formulation of 50 VOC gloss paints can play a large role in application appearance. Factors like glycol level and volume solids did not improve application properties significantly. Using new KU efficient, ICI-building HEUR thickeners and optimizing the dispersant type and level and nonionic surfactant in 50 VOC gloss formulations are very promising leads for extended workability.

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