Progress beyond

APE-free Additive Solutions for Improved Stability and Open Time in Water-based Coatings

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OUTLINE

- Introduction of new APE-free Wetting Agent
- Performance Attributes in Various Formulations
  - -100% Acrylic High Quality Flat & Premium Semigloss
  - -Economy PVA Flat & Styrene/Acrylic Flat
  - -Color Stability across all Formulations
- Other Targeted Semigloss Properties
  - -Appearance & Color
- Features and Benefits
- What is Open Time?
- Introduction to Open Time Extender
  - - Acrylic SG Formulation with Photo of Improved Open Time
  - - Low VOC High Gloss Formulation Performance
  - - “0” VOC High Gloss Formulation Performance
- Other Formulation Work
  - - Masonry Paint: Lapping
  - - High Build Paint: Workability
- Features and Benefits

New Wetting Agent

Properties	Results
Characteristic	Non-ionic
Appearance	Clear liquid
Density, 20°C (g/cm3)	1.05
Active content (%)	50% approx.
Cloud point (°C)	18
pH	6.0- 8.0

KEY FEATURES:

- APEO-free
- 0 VOC (via Method 24)
- Very good stability –Heat Age and Colorant Addition
- Excellent color acceptance
- “drop in” for APE-containing wetting aids (adjusting for any solids differences)

APPLICATIONS

In coating formulations, 0.1-0.6% would be the best recommendation to ensure proper substrate wetting and overall performance

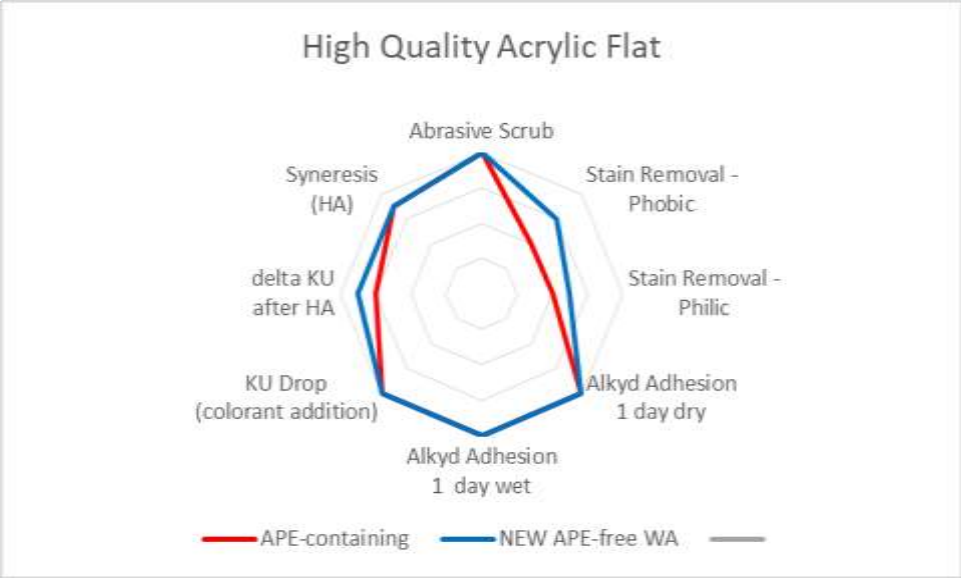
High Quality Flat Rx – 100% Acrylic

Grind	Lbs.	Gallons	Weight %
Water	200.0	24.00	17.84
Natrosol Plus 330	2.0	0.17	0.18
Neutralizer agent	1.5	0.19	0.13
In-can Preservative	1.5	0.17	0.13
Dispersant	8.0	0.78	0.71
Defoamer	2.0	0.28	0.18
Propylene Glycol	3.0	0.35	0.27
Universal TiO_2 (dry)	200.0	5.99	17.84
Nepheline Syenite	75.0	3.46	6.69
Calcined Clay	100.0	5.45	8.92
Matting Agent	25.0	1.30	2.23
Attapulgite	2.0	0.10	0.18
Letdown			
Water	54.8	6.58	4.89
100% Acrylic Binder	300.0	33.71	26.75
Coalescent	3.5	0.44	0.31
Defoamer	3.0	0.40	0.27
Neutralizing Agent	1.0	0.13	0.09
ICI Builder	10.0	1.15	0.89
KU Builder	10.0	1.15	0.89
Water	119.0	14.2	10.61
TOTAL	**1121.3**	**100.0**	**100.00**

PVC - %	50.5
Volume Solids - %	33.5
VOC	< 25 g/L

Wetting Aids were post-added to Rx at 0.3% (ai) level.

Performance Data: HQ Flat Rx – 100% Acrylic



New APEO-free WA provides:

- Slightly better Heat Age Stability
- Slightly better stain removal
- Comparable scrub and adhesion

* 50% PVC/33.5% VS; <25g/L VOC

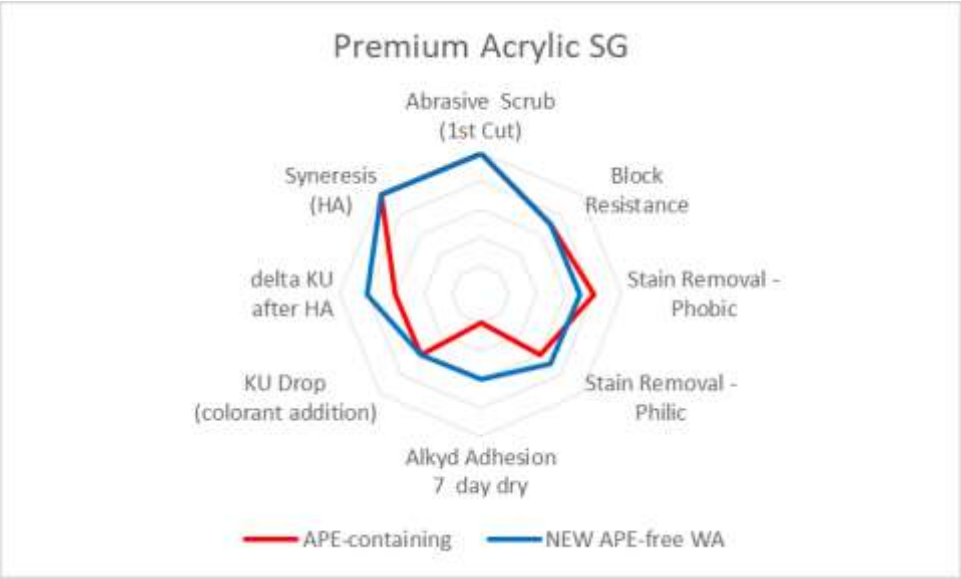
Premium Semigloss Rx – 100% Acrylic

Grind	Lbs.	Gallons	Weight %
100% Acrylic Binder	500.0	56.18	47.65
Defoamer	2.0	0.28	0.19
Propylene Glycol	3.0	0.35	0.29
While Mixing, add the following:			
Dispersant	7.0	0.76	0.67
Slurry Universal Grade TiO_2	320.0	16.49	30.51
Defoamer	2.0	0.28	0.19
Water	108.0	12.93	10.30
In-can preservative	1.5	0.18	0.14
Water	20.0	2.40	1.91
Plasticizer	3.0	0.37	0.29
Coalescent	3.0	0.38	0.29
Mix well, then add the following:			
Neutralizing Agent	1.0	0.13	0.10
ICI Builder	21.0	2.42	2.00
KU Builder	8.0	0.92	0.76
Water	49.4	5.93	4.71
TOTAL	**1048.9**	**100.0**	**100.00**

PVC - %	22.2%
Volume Solids - %	35.1%
VOC	< 25 g/L

Wetting Aids were post-added to Rx at 0.3% (ai) level.

Performance Data: Premium SG Rx – 100% Acrylic



New APEO-free WA provides:

- Improved Heat Age Stability
- Improved alkyd adhesion
- Comparable scrub & stain

* 22% PVC/35% VS; <25g/L VOC

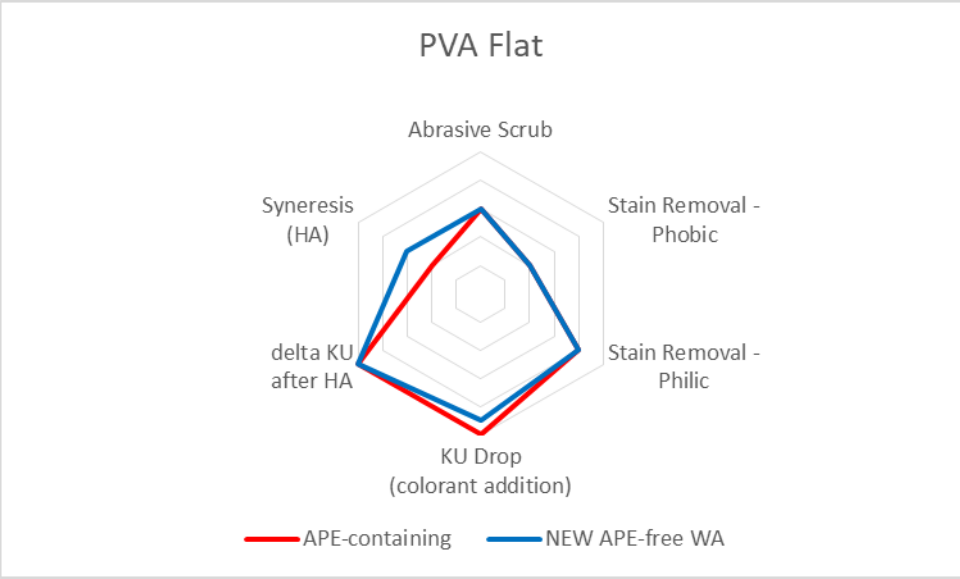
Economy PVA Flat

Grind	Lbs.	Gallons	Weight %
Water	250.0	30.00	22.48
Natrosol Plus 330	2.0	0.17	0.18
Neutralizing Agent	1.5	0.19	0.13
In-can preservative	1.5	0.17	0.13
Dispersant	8.0	0.78	0.72
Defoamer	2.0	0.28	0.18
Propylene Glycol	3.0	0.35	0.27
Universal TiO_2 (dry)	100.0	3.00	8.99
CaCO3 #10 White	100.0	4.41	8.99
Nepheline Syenite	100.0	4.61	8.99
Calcined Clay	100.0	5.45	8.99
Matting Agent	25.0	1.30	2.25
Letdown			
Water	100.0	12.00	8.99
PVA Binder	125.0	14.04	11.24
Plasticizer	2.0	0.25	0.18
Neutralizing Agent	4.0	0.51	0.36
Defoamer	3.0	0.40	0.27
HASE Thickener	23.0	2.61	1.80
Water	162.0	19.48	14.84
TOTAL	**1112.0**	**100.00**	**100.00**

PVC - %	70.5%
Volume Solids - %	28.5%
VOC	~12 g/L

Wetting Aids were post-added to Rx at 0.3% (ai) level.

Performance Properties: Economy PVA Flat



New APEO-free WA provides:

- Comparable overall performance with slightly better syneresis resistance

* 70.5% PVC/28.5% VS; ~ 12g/L VOC

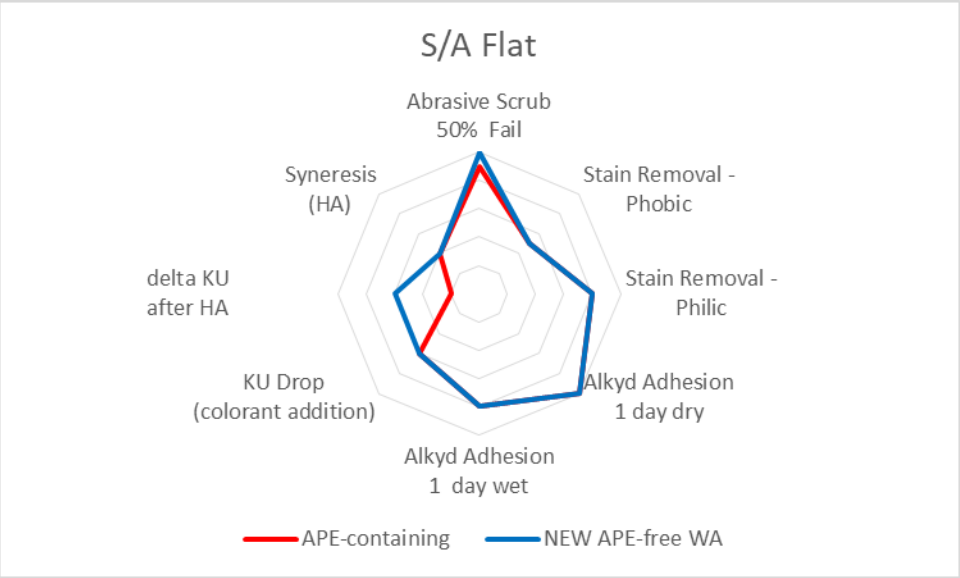
Economy Styrene/Acrylic Flat

Grind	Lbs.	Gallons	Weight %
Water	250.0	30.00	21.58
QP-15000	3.0	0.26	0.26
Neutralizing Agent	0.5	0.06	0.04
Biocide	2.0	0.23	0.17
Dispersant	8.0	0.74	0.69
Defoamer	1.0	0.14	0.09
Propylene Glycol	5.0	0.58	0.43
Universal $Ti0_2$ (dry)	80.0	2.40	6.91
Calcium Carbonate	225.0	9.96	19.42
Talc	75.0	3.22	6.47
Calcined Clay	125.0	6.81	10.79
Letdown			
Water	50.0	6.00	4.32
Sty/Acrylic Binder	130.0	15.20	11.22
Plasticizer	4.0	0.50	0.35
Coalescent	4.0	0.51	0.35
Neutralizing Agent	2.0	0.25	0.17
Defoamer	2.0	0.27	0.17
HASE Thickener	20.0	2.27	1.73
Water	172.0	20.60	14.85
TOTAL	**1158.5**	**100.00**	**100.00**

PVC - %	76.0%
Volume Solids - %	31.2%
VOC	35 g/L

Wetting Aids were post-added to Rx at 0.3% (ai) level.

Performance Properties: Economy S/A Flat



New APEO-free WA provides:

- Improved Heat Age Stability
- Comparable scrub, stain, and adhesion

* 76 % PVC/31.2% VS; ~ 35 g/L VOC

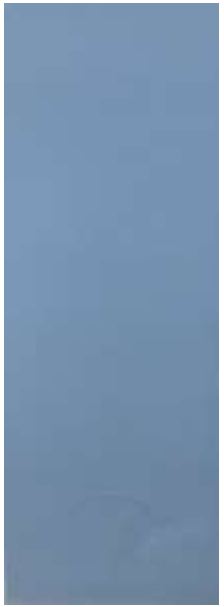
Color Stability

100% Acrylic Flat **100% Acrylic Semigloss** **Economy PVA Flat** **Economy S/A Flat**

Delta e: 0.28

Delta e: 0.90

Delta e: 0..30



Delta e: 0.10

New APE-free Wetting Agent provides comparable color acceptance and stability vs APE-containing wetting aid in all chemistry binders and various PVC/VS formulations

More Acrylic Semigloss Formulation Data

Grind	Lbs.	Gallons	Weight %
Water	150.00	18.01	14.37
Neutralizing Agent	1.00	0.13	0.10
Propylene Glycol	10.00	1.16	0.96
Defoamer	3.00	0.41	0.29
Dispersant	4.00	0.40	0.38
Neutralizing Agent	3.00	0.32	0.29
Nepheline Syenite	25.00	1.15	2.39
Universal TiO_2 (dry)	225.00	6.75	21.55
Attapulgite	3.00	0.15	0.29
Letdown			
100% Acrylic Binder	480.00	54.24	45.98
Defoamer	3.00	0.41	0.29
Water	33.30	4.00	3.19
Coalescent	5.00	0.63	0.48
KU Builder	12.60	1.45	1.21
ICI Builder	8.70	1.02	0.83
Water	77.40	9.29	7.41
TOTAL	**1044.00**	**99.52**	**100.00**

PVC - %	24.0
Volume Solids - %	33.5
VOC	< 50 g/L

Wetting Aids were post-added to Rx at 0.3% (ai) level.

Appearance & Color Stability Properties

Surfactant	New APEO-free WA	APE-containing
Viscosity, KU	102	100
Viscosity, ICI	1.0	1.0
Viscosity, KU - Tinted	90	81
Δ KU (Ku drop)	12	19
Contrast Ratio, 3 Mils	0.975	0.979
Reflectance	94.1	93.9
Gloss: $20^0/60^0$	43./31.5	5.2/32.1
Sag Resistance; 4-24 mils	12	12
Flow & Leveling	10	10

New APEO-free Wetting Agent provides improved resistance to KU loss upon colorant addition while maintaining all other appearance properties compared to APE-containing WA in an Acrylic Semigloss formulation

Color Acceptance Performance

Surfactant	New APEO-free WA	APE-containing WA
Color Acceptance - Brush Method		
Lamp Black	0.13	0.2
Red Iron Oxide	0.38	0.39
Color Acceptance – Rub Up		
Lamp Black	0.23	0.07
Red Iron Oxide	0.35	0.4
Color Float: 10 = Best		
Lamp Black	8	7
Red Iron Oxide	7	6

New APEO-free Wetting Agent provides comparable color acceptance vs. APE-containing WA in an Acrylic Semigloss formulation

Summary

NEW APEO-free Wetting Agent is an excellent replacement for APE-containing surfactants:

- Compatible with all latex chemistries
- Works across very broad formulation spaces

NEW APEO-free Wetting Agent can deliver:

- Improved Stability – both to Heat Age and upon addition of colorant resulting in more long term stable formulations
- Comparable appearance and resistance properties across various binder chemistries and formulation spaces

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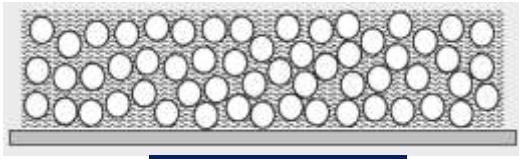
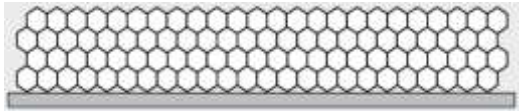
Open Time vs. Drying Time



APPLICATION

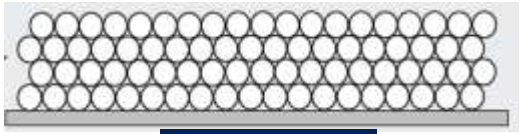
Water excluded

Particle deformation

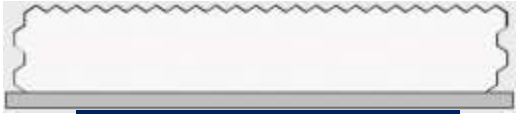


DRYING TIME

"Coating Workability"



OPEN TIME



PARTICLE DIFFUSION & COALESCENCE

Definition of open time: The interval that a paint remains wet and workable before it begins to set.

Latex film formation at the molecular level: the effect of coalescing aids on polymer diffusion, JCT, M. Winnik, etc., Vol 64, 51 – 61.

Open Time Extender

Properties

Appearance	Clear to hazy, slightly amber to yellow liquid
Specific gravity at 25°C (g/cm^3)	1.026 – 1.226
Active content (%)	Around 75.0
Pour point	5 approx.
pH (5% solution)	4.0 - 7.0
Viscosity at 25°C, spindle 4, 60 rpm (cPs)	5000 Max
Ionic character	Anionic and non ionic
VOC Content (g/L)	< 2.0
SVOC Content (g/L)	< 5.0

Key Features

- ✓ APEO-free
- ✓ Very low VOC and SVOC
- ✓ Low odor
- ✓ Extends open time and workability in:
  - Waterborne architectural coatings, Textured and high build coatings, Waterborne Screen Printing Inks,etc
- ✓ Wetting agent properties
  - -can help reduce/eliminate wetting agents in formulation
- ✓ Ecolabel and GS-11 Compliant
- ✓ Versatile utility of binders : acrylic, styrene acrylic, vinyl acetate, VEOVA
- ✓ Electrosteric stabilization

What is Open Time Extender and How Does it Function?

- OTE is a unique APEO-free and very low VOC/SVOC liquid additive, developed to aid open time and wet edge performance in waterborne coatings
- OTE utilizes a “patented hydrophobe technology” that slows latex particle to particle contact during the drying process thereby delaying initial coalescence

- OTE is typically added in the letdown stage of the formulation
  - Prefer to add as close as possible to the addition of binder and mixed thoroughly
  - Can be used in the grind stage to replace wetting agent

- Typical usage levels – recommend to start with 1% addition based on total formula weight

- Possible to reduce or eliminate:
  - Surface active agents
  - Solvents such as glycols – intended to extend open time

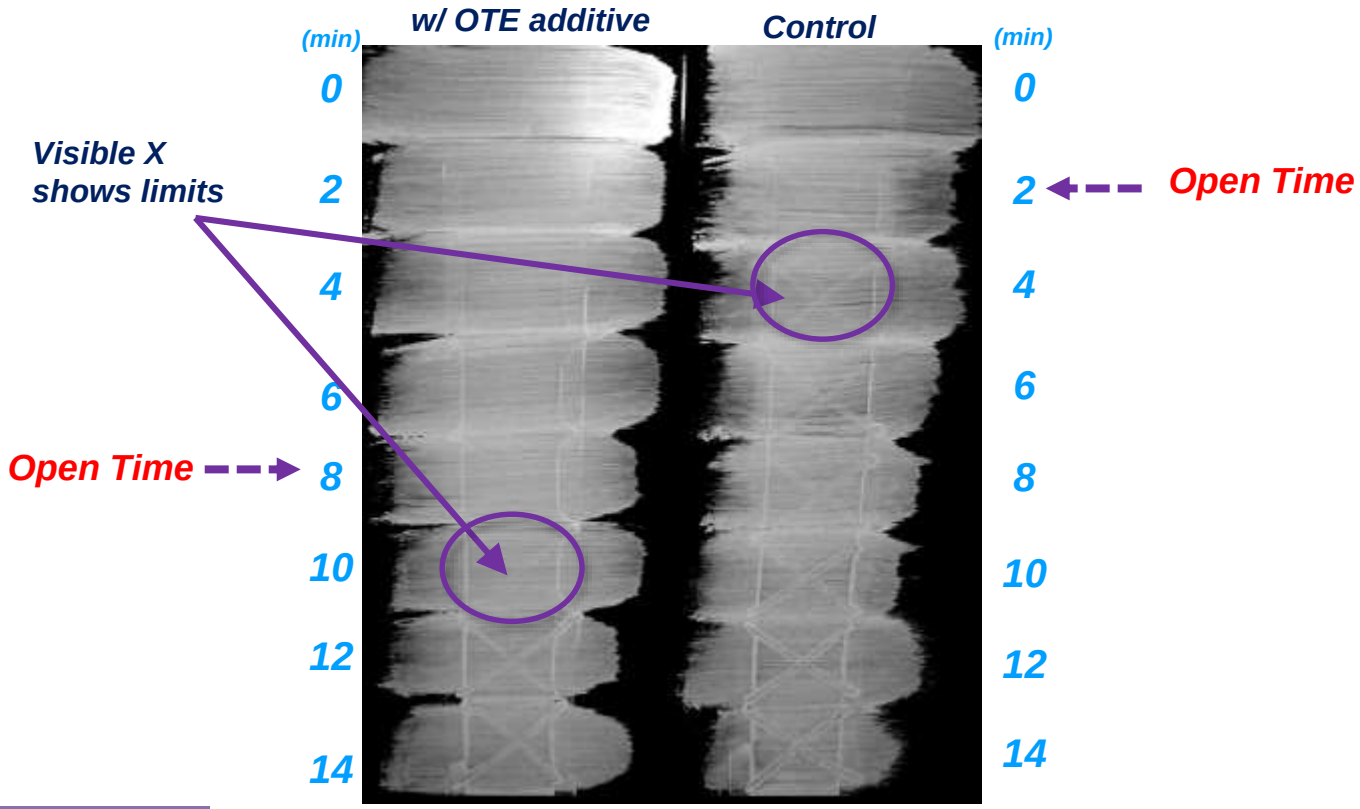
Acrylic Semi-Gloss Formulation Example

Acrylic Semi-Gloss Paint Formula		
Raw Materials	**Pounds**	**Gallons**
Pigment Grind		
Water	80.0	9.60
Dispersant (50%)	8.0	0.82
Neutralizing Agent	1.5	0.19
Defoamer	1.0	0.14
Universal TiO_2 (dry)	230.0	6.73
Attapulgite	5.0	0.25
Letdown		
Water	93.1	11.18
Acrylic Binder (50%)	480.0	54.24
OTE additive	AS REQUIRED	
Defoamer	3.0	0.42
ICI Builder	6.0	0.69
KU Builder	23.0	2.64
Water	100.0	12.00
Total	**1030.6**	**98.90**

Properties
Weight Solids, %: 47.80
Volume Solids, %: 34.80
PVC, %: 20.90
VOC, < 5g/L
Weight per Gallon, lbs: 10.40

In this example, 1.25% of OTE was used in the formulation

Acrylic SG Open Time Results with OTE additive



Method ASTM D7488

Acrylic Semigloss Paint Performance

Paint Properties	Control	With OTE additive
OTE Usage Level - % based on Total formula weight as is	0.00	1.25%
Gloss 20°/ 60° - 3 mils	37/72	38/71
Open Time – Minutes ASTM D7488	2	8
Scrub Resistance - Cycles ASTM D2486	>1000	>1000
Block Resistance - 10 = best ASTM D4946	6	6
Contrast Ratio – 3 mils	98.18	98.36
Stain Resistance - % removal ASTM D4828	Control	=
Heat Aged – 2 wks. @ 120 F; Δ KUs	15	9

Paint w/ OTE has improved Open Time and Stability while maintaining other properties

Acrylic High Gloss- Low VOC Formulation

Acrylic High Gloss Formula			
	PG Control	No PG	OTE-600
VOC (g/L)	**~ 100**	**~25**	**~25**
Raw Materials			
Acrylic HG Binder	584.1	584.1	584.1
Defoamer	1.0	1.0	1.0
OTE additive	0.0	0.0	**13.8**
PREMIX			
Propylene Glycol	**30.0**	**0.0**	**0.0**
Surfactant	4.4	4.4	4.4
Water	16.7	16.7	16.7
In-can Preservative	1.5	1.5	1.5
Dispersant	2.0	2.0	2.0
Neutralizing Agent	1.0	1.0	1.0
Then add			
Universal TiO_2 (dry)	285.0	285.0	285.0
Water	64.1	93.0	79.2
Coalescent	**7.9**	**7.9**	**7.9**
ICI Builder	30.0	31.1	31.1
KU Builder	3.0	3.0	3.0
Defoamer	2.0	2.0	2.0
Totals	**1032.7**	**1032.7**	**1032.7**

Properties
PVC, %: 19.2
Volume Solids, %: 34.0
Weight per Gallon, lbs: 10.33

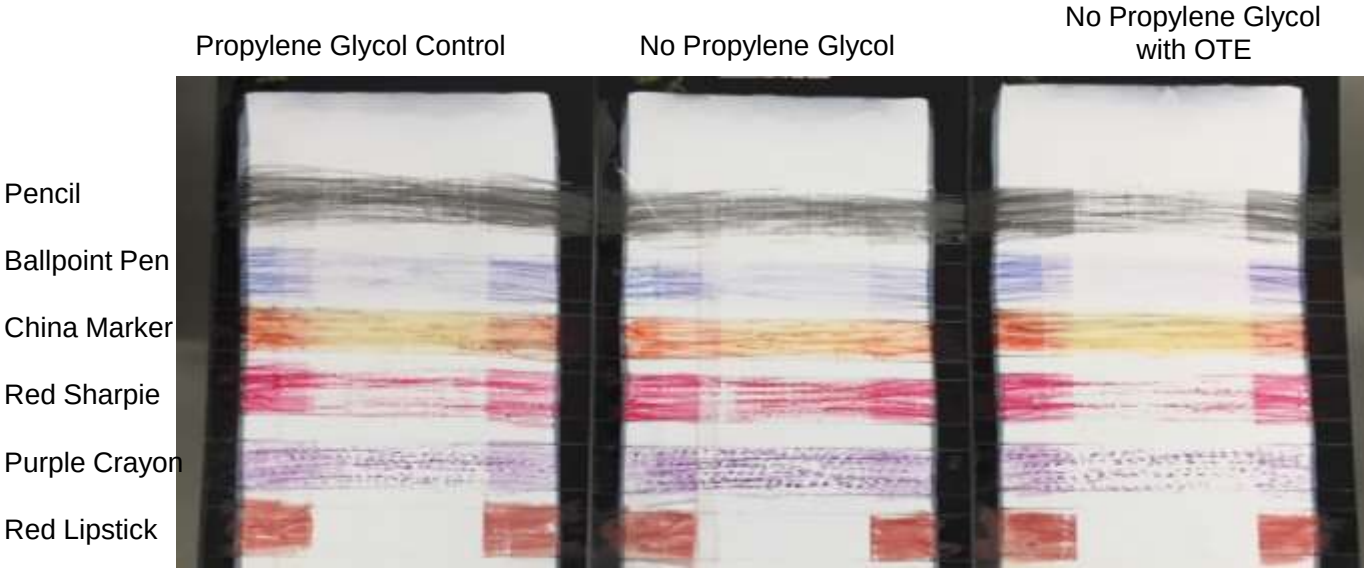
In this example, 1.0% of OTE additive was used in the formulation

Acrylic High Gloss- Low VOC Formulation

Paint Properties	Propylene Glycol Control	NO Propylene Glycol	With OTE additive
VOC (g/L)	**~100**	**~25**	**~25**
Usage Level - % based on total formula weight	3.0	0	1.0
Equilibrated Viscosity (KU/ICI/pH)	95/1.2/8.7	95/1.3/8.7	100/1.2/8.6
Gloss 20°/60° - 3 mils DD	43/80	30/80	43/80
Open Time – Minutes ASTM D7488 **(50% RH)**	**10**	6	**10**
Open Time – Minutes ASTM D7488 **(lower % Relative Humidity: 30%)**	**4**	NA	**8**
Scrub Resistance – Cycles ASTM D2486	424	406	504
Block Resistance - ASTM D4946; 10 = best	8	6	7
HH Stain Resistance - % removal Avg. Hydrophobic Avg. Hydrophilic	 64 70	 53 63	 **80** 71

Paint containing OTE additives maintains or improves Open Time compared to high VOC control, while delivering improved performance compared to NO PG control

Acrylic High Gloss- Low VOC Formulation Hydrophobic Stain Removal



Slightly Better Hydrophobic Stain Removal with 1% OTE additive in this formulation

Acrylic High Gloss – O VOC Formulation

Acrylic High Gloss Formula			
	PG Control	No PG	w/OTE
VOC (g/L)	**~ 100**	**~0**	**~0**
Acrylic HG Binder	584.1	584.1	584.1
Defoamer	1.0	1.0	1.0
OTE additive	**0.0**	**0.0**	**13.8**
Propylene Glycol	**30.0**	**0.0**	**0.0**
Surfactant	4.4	4.4	4.4
Water	16.7	16.7	16.7
In-can Preservative	1.5	1.5	1.5
Dispersant	2.0	2.0	2.0
Neutralizing Agent	1.0	1.0	1.0
Then add			
Universal $Ti0_2$ (slurry)	285.0	285.0	285.0
Water	24.7	24.7	24.7
Coalescent	**7.9**	**--**	**--**
Plasticizer		**7.9**	**7.9**
Water	23.4	51.8	57.6
ICI Builder	42.3	45.4	36.6
KU Builder	6.7	5.2	8.2
Defoamer	2.0	2.0	2.0
Totals	**1032.7**	**1032.7**	**1032.7**

Properties
PVC, %: 19.0
Volume Solids, %: 37.0
Weight per Gallon, lbs: 10.33

In this example, 1.0% of OTE additives was used in this formulation

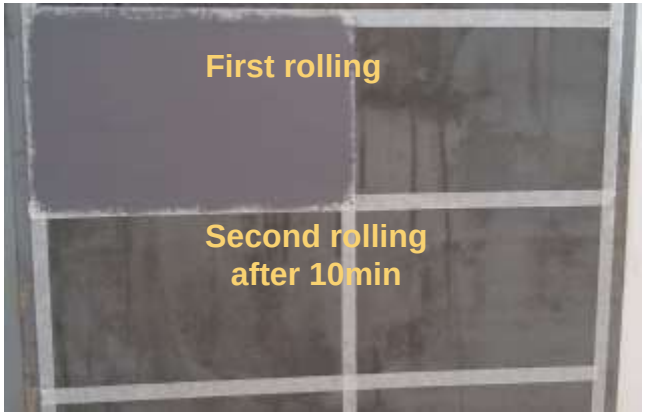
Acrylic High Gloss – O VOC Formulation

Paint Properties	Propylene Glycol Control	NO Propylene Glycol	With OTE
VOC (g/L)	**~100**	**~0**	**~0**
Usage Level - % based on total formula weight	3.0	0	1.0
Equilibrated Viscosity (KU/ICI/pH)	90/1.1/8.9	94/1.0/8.8	103/1.4/8.9
Gloss 20°/60° - 3 mils DD	52/79	55/81	62/82
DD Flow	7	8	8
DD Sag (mils)	12	12	10
Open Time – Minutes ASTM D7488 **(55% RH)**	**14**	**8**	**14**
Block Resistance - ASTM D4946; 10 = best	8	5	7
Dirt Pick-up Resistance (% reflectance retained)	98.4%	98.8%	98.8%

Paint containing OTE formulated to ~ 0 VOC, maintains open time relative to high VOC control while delivering comparable overall performance

Overlapping Improvement

- Tint the paints with desired colorants
- Make adhesive tape frame on cement substrate
- Apply the paint by roller, then peel off the tape immediately after rolling.
- After 10mins, re-roll the area.

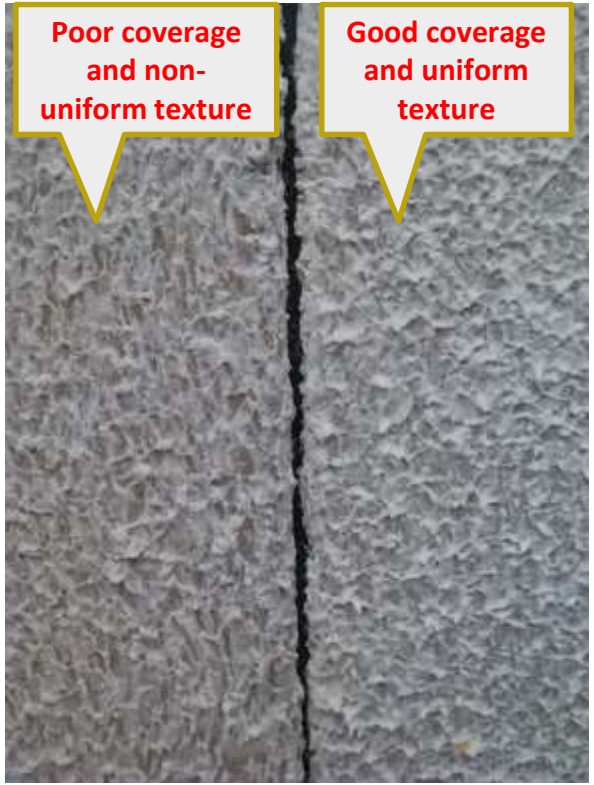


Control Formulation **w/ OTE additive**

High Build Coatings - Film Appearance & Workable Time

- Tint paints with colorant of choice
- Apply the paint by roller on sealed cement substrate
- After 10 minutes, re-roll the area

- Optimized formulation has much more uniform appearance and coverage
- Workable time of optimized formulation is longer than the control formulation without OTE



"as is" Formulation **w/ OTE additive**

OTE additive- A Sustainable Solution

- APEO-free and very low VOC-free additive
- ***Patented Technology***
- Enables formulation of high performing low to VOC-free coatings
  - Excellent alternative to Glycols
  - Versatile utility of binders: acrylic, styrene acrylic, vinyl acetate, VEOVA
- Low odor additive solution
- Longer workability, improved flow and leveling
- Maintains and improves other paint properties
  - Improved “brush clogging”
- Design sustainable coatings for Green Seal (GS-11) or EU Ecolabel compliance

Thank You

Questions??

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Progress beyond