ANGUS® CHEMICAL COMPANY

ZOLDINE® XL-29SE CROSSLINKER

Multifunctional Carbodiimide Designed for Use as a Low-Temperature Crosslinker for Carboxylated Polymers

Key Performance Advantages

- Chemical resistance
- Abrasion, chemical and block resistance
- High-temperature resistance
- Salt spray resistance

Paints & Coatings

ZOLDINE® XL-29SE Crosslinker can be added directly to most waterborne formulations with mild agitation.

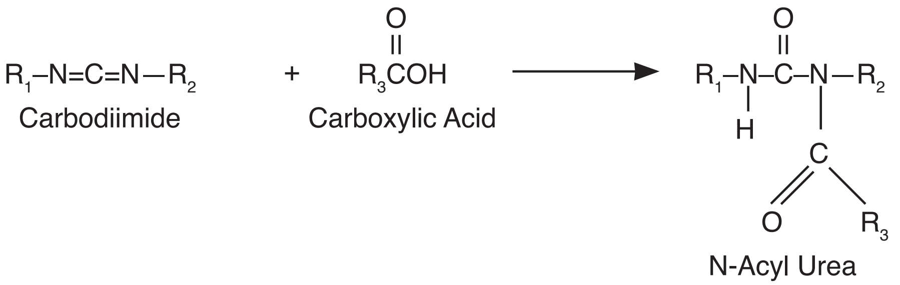
ZOLDINE XL-29SE Crosslinker finds utility in coatings for wood, leather, plastics, waterborne inks, adhesives, and in waterborne coatings for metal. Depending on the application, this crosslinker can improve resistance to chemicals, abrasion, blocking, and high temperatures, as well as to salt spray and high humidity exposure.

Crosslinking Chemistry

Carbodiimides are a well known class of organic compounds with the general structure:

$$R_1{-}N{=}C{=}N{-}R_2$$

The crosslinking ability of these products is based on the reaction of carbodiimides and carboxylic acids forming N-acyl ureas:



Note that there is no byproduct from this reaction, and therefore, no effluent as a result of crosslinking with ZOLDINE XL-29SE Crosslinker. This reaction occurs slowly at room temperature with the carboxylic acid neutralized with a molar equivalent of an amine. Reactions of the carbodiimide group with hydroxyl or amine functionality are much slower than with carboxyl and are not involved in the crosslinking process with ZOLDINE XL-29SE Crosslinker.

Typical Properties

The following are typical properties of ZOLDINE XL-29SE Crosslinker; they are not to be considered as product specifications.

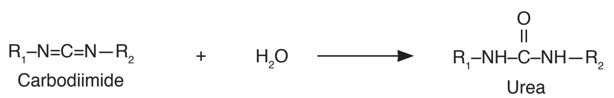
Form	Liquid
Appearance	Clear amber[1]
Total Solids, % by wt	50
Viscosity at 25°C, cP	100
Equivalent Weight, Solids Basis	410
Flash Point, Closed Cup, °F	114
Color, Gardner	4

(1) Prolonged storage at temperatures below 40°F can result in separation of insoluble components. Warming with agitation will regenerate the clear liquid.

Formulation Guidelines for Waterborne Systems

ZOLDINE™ XL-29SE Crosslinker can usually be added directly to waterborne formulations containing carboxylated polymers In some formulations, this can result in shocking the latex, resulting in gel specks in the coating. Preblending ZOLDINE XL-29SE Crosslinker with an equal volume of water, prior to addition to the formulation, will usually prevent this.

The useful lifetimes of these formulations will be limited by the hydrolysis of the carbodiimide group to urea in the presence of water, and therefore, require that these be two-component systems:



This hydrolysis is slowest at a pH of 8.5 to 9.0. Therefore, formulation potlife will be maximized by maintaining the pH in this range.

In general, formulation additives containing carboxylic acids or their salts should be avoided when using ZOLDINE XL-29SE Crosslinker. These materials can react with the crosslinker, thereby reducing the amount of carbodiimide functionality available for reaction with the carboxyl groups in the polymer. Consequently, additives, such as ammonium benzoate and carboxyl-functional dispersants, should be checked for their effect on crosslinker performance.

Salts of strong acids—nitrates, phosphates, and sulfonates, for example—will not interfere with the crosslinker. Nonionic surfactants and dispersants can also be used in formulations containing ZOLDINE XL-29SE Crosslinker.

ZOLDINE XL-29SE Crosslinker is effective with carboxylated polymers for use in numerous applications. Typically, levels of 5 to 10 percent by weight and cure conditions of several days at room temperature or minutes at elevated temperature are required. It should be noted that ZOLDINE XL-29SE Crosslinker does not react the same with every carboxylated polymer. Therefore, latexes and formulation variables (viscosity, solids, cosolvents, etc.) should be investigated thoroughly.

Applications

ZOLDINE XL-29SE Crosslinker has proved useful in a wide variety of waterborne coatings end uses and related applications. Some typical applications and the benefits provided by the crosslinker are:

Application	Benefit
Coatings for Plastics	Improved Chemical Resistance
Leather Coatings	Improved Abrasion and Block Resistance
Waterborne Adhesives	Improved High-Temperature Resistance
Waterborne Inks	Improved Chemical and Block Resistance
Waterborne Alkyds	Improved Salt Spray Resistance
Wood Coatings	Improved Chemical Resistance

Crosslinker Performance Properties

Water-Reducible Polyurethanes

ZOLDINE XL-29SE Crosslinker has been found especially useful in improving the solvent resistance and durability of waterborne polyurethanes, such as those supplied by Sanncor; Reichhold; NeoResins; Permuthane, Inc.; Bayer; Sovereign; and others. At levels of 2 to 5 percent by weight on solids, solvent resistance of a 1-mil dry film is dramatically improved, even when the films are cured at ambient conditions, as shown in Table 1. Three of the urethanes evaluated—Bayhydrol 110, Neorez R-960, and Sancure 847—are somewhat resistant to MEK double rubs, even in the uncrosslinked state, but still improve considerably when ZOLDINE XL-29SE Crosslinker is added. However, immersion of these uncrosslinked films in MEK results in complete dissolution of the polymers. The crosslinked systems swell but do not dissolve, indicating that ZOLDINE XL-29SE Crosslinker is effective in improving the solvent resistance of these urethanes. It should be noted that although different operators may get different numerical values for resistance to MEK double rubs, the degree of improvement over the uncrosslinked system is reproducible. The maximum crosslinking performance is observed at a 1/1 mole ratio of carbodiimide to carboxyl.

Table 1

Film Properties[1] of Polyurethane Dispersions Crosslinked with ZOLDINE XL-29SE Crosslinker

	MEK Double Rubs	
Polyurethane Dispersion	**Uncrosslinked**	**5 PHR XL-29SE**
Bayhydrol 110[2]	120	300+
Neorez R-960[3]	110	300+
Q-Thane QW-14[4]	40	300+
Sancure 847[5]	225	300+
Spensol L-54[6]	50	170

(1) 1-mil films cured 30 min at 85°C (2) Bayer (3) NeoResins (4) Sovereign Specialty Chem. (5) Sanncor Industries (6) Reichhold

Carboxyl-Functional Latexes

ZOLDINE XL-29SE Crosslinker is an effective crosslinker of carboxylated emulsion polymers for use in numerous applications. Typically, levels of five to 10 percent by weight and cure conditions of several days at room temperature or minutes at elevated temperature are required. It should be noted that ZOLDINE XL-29SE Crosslinker does not react the same with every carboxylated polymer. Therefore, latexes and formulation variables (viscosity, solids, cosolvents, etc.) should be investigated thoroughly.

Table 2
Film Properties[1] of Commercial Latexes Crosslinked with ZOLDINE XL-29SE Crosslinker

	MEK Double Rubs	
Latex	**Uncrosslinked**	**5 PHR XL-29SE**
Joncryl 538[2]	40	54
Neocryl A-622[3]	15	23
Neocryl A-655[3]	15	30
RHOPLEX* WL-81	25	35
RHOPLEX WL-96	18	32
UCAR* Latex 443	47	130
UCAR Latex 4620	25	60

(1) 1-mil films cured 30 min at 85°C (2) S.C. Johnson (3) NeoResins

Urethane/Latex Blends

The use of ZOLDINE XL-29SE Crosslinker with latex/urethane blends is an effective way of achieving a significant degree of crosslinking, while maintaining lower cost than the ZOLDINE XL-29SE Crosslinker plus waterborne urethane system.

Table 3
Film Properties[1] of 80/20 Latex/Urethane Blends Crosslinked with ZOLDINE XL-29SE Crosslinker

	MEK Double Rubs	
Latex/Urethane Blend	**Uncrosslinked**	**5 PHR XL-29SE**
RHOPLEX WL-96 and Neorez R-960[2]	48	156
RHOPLEX WL-96 and Spensol L-51[3]	35	83
UCAR Latex 443 and Neorez R-960[2]	25	180
UCAR Latex 443 and Spensol L-51[3]	25	140

(1) 1-mil films cured 30 min at 85°C (2) NeoResins (3) Reichhold

Coatings for Metal

ZOLDINE™ XL-29SE Crosslinker effectively improves a coating's performance on metal substrates. Specifically, improvements in Cleveland humidity and salt spray can be seen at crosslinker levels as low as 5 phr (parts per hundred) resin. Higher crosslinker levels have been investigated with only marginal property improvements. Conversely, lower levels may provide adequate performance. In all cases, crosslinker levels should be optimized for each formulation.

These results can be seen using a variety of latexes, such as those from The Dow Chemical Company and NeoResins, or with water-reducible alkyds from such companies as Reichhold, Polynt, and Freeman. Another effective method is to blend a water-reducible alkyd with a latex followed by crosslinking with ZOLDINE XL-29SE Crosslinker.

By reacting with the carboxylic acid present on the backbone of water-reducible alkyds or latex polymers, the carbodiimide crosslinker renders the coating less susceptible to attack by moisture and corrosive environments.

The formulations shown here demonstrate how this carbodiimide crosslinker can improve humidity and corrosion resistance relative to an uncrosslinked formulation. They are starting formulations only and are not optimized.

Cleveland Humidity Tests

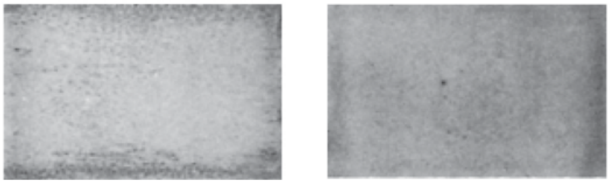
Formulas 1, 2, and 3 show improvements in Cleveland humidity with the use of ZOLDINE XL-29SE Crosslinker. All three formulations are based on Neocryl acrylic industrial coatings latexes from NeoResins. The third formulation also contained a water-reducible alkyd. The A-630 systems containing ZOLDINE XL-29SE Crosslinker performed very well at 120 hours of exposure, but showed some blistering. All crosslinked systems performed better than the uncrosslinked coating, which blistered, faded, and rusted, as shown in Table 4 and Figure 1.

Table 4
Effect of Cleveland Humidity Testing on Acrylic White Topcoat[1]

Property	Uncrosslinked	5 PHR XL-29SE
Blistering	Dense #8	Med Dense #8
Surface Rust	Moderate	None
Gloss Retention, %	–(2)	–(2)

(1) Neocryl A-630 Acrylic Resin (NeoResins). (Formula 1, pg 6) 1-mil DFT on Bonderite 1000 120-hr exposure
(2) Not measurable

Figure 1
Cleveland Humidity Test Panels of Acrylic White Topcoat[1] after 120 Hours



Control — 5 PHR XL-29SE

(1) Neocryl A-630 Acrylic Resin, 1-mil DFT on Bonderite 1000

Test results for the A-645 formulation are shown in Table 5. Results show the system using ZOLDINE XL-29SE Crosslinker performing well compared to the uncrosslinked system.

Table 5
Effect of Cleveland Humidity Testing on Acrylic White Topcoat(1)

Property	Uncrosslinked	5 PHR XL-29SE
Blistering	Med Dense #8	None
Surface Rust	None	None
Gloss Retention %	50	100

(1) Neocryl A-645 Acrylic Resin (NeoResins). 1-mil DFT on Bonderite 1000 1 20-hr exposure

The third formulation was a 70/30 blend of Neocryl A-645 and Kelsol 3905 water-reducible alkyd. In this case, ZOLDINE XL-29SE Crosslinker performed very well with no loss of gloss, while the uncrosslinked system faded, as shown in Table 6.

Table 6
Effect of Cleveland Humidity Testing on 70/30 Acrylic/Water-Reducible Alkyd White Topcoat(1)

Property	Uncrosslinked	5 PHR XL-29SE
Blistering	Few #8	None
Surface Rust	None	None
Gloss Retention %	50	100

(1) Neocryl A-645 Acrylic Resin (NeoResins). Kelsol 3905 Alkyd Resin (Reichhold) 1-mil DFT on Bonderite 1000 200-hr exposure

Corrosion Resistance

The performance improvements in salt spray resistance provided by ZOLDINE XL-29SE Crosslinker are shown in Tables 7, 8, and 9.

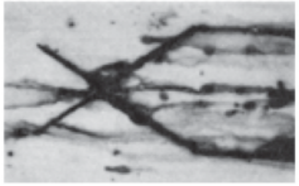
The first example was a white gloss topcoat formulation with RHOPLEX* WL-71 exposed for 100 hours. In this formulation, ZOLDINE XL-29SE Crosslinker showed better corrosion and blister resistance than the uncrosslinked control. Test results are shown in Table 7 and Figure 2.

Table 7
Effect of Salt Spray Exposure on Acrylic White Topcoat(1)

Property	Uncrosslinked	5 PHR XL-29SE
Scribe Corrosion(2)	3	8
Surface Corrosion(2)	6	10
Scribe Blistering	Med #2	Med #8
Surface Blistering	Med Dense #8	None

(1) RHOPLEX WL-71 Acrylic Resin (Formula 4, pg 7)
1-mil DFT on Bonderite 1000
5% Salt spray 100-hr exposure
(2) ASTM D1654, 10 = Best

Figure 2
Salt Spray Test Panels of Acrylic White Topcoat(1) after 100 Hours



Control

5 PHR XL-29SE

(1) RHOPLEX WL-71 Acrylic Resin, 1-mil DFT on Bonderite 1000, 5% Salt Spray

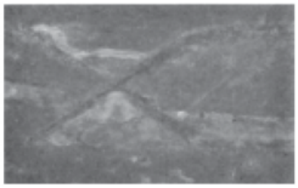
The next example was a Neocryl A-625 acrylic zinc phosphate primer exposed to salt spray for 200 hours. As shown in Table 8 and Figure 3, ZOLDINE XL-29SE Crosslinker performed better in corrosion and blister resistance than the uncrosslinked control.

Table 8
Effect of Salt Spray Exposure on Acrylic Zinc Phosphate Primer(1)

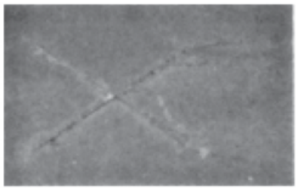
Property	Uncrosslinked	5 PHR XL-29SE
Scribe Corrosion(2)	5	9
Surface Corrosion(2)	8	10
Scribe Blistering	Med #2	Few #8
Surface Blistering	Med #4	None

(1) Neocryl A-625 Acrylic Resin (NeoResins). (Formula 5, pg 8) 1-mil DFT on Bonderite 1000 5% Salt spray 200-hr exposure
(2) ASTM D1654, 10 = Best

Figure 3
Salt Spray Test Panels of Acrylic Zinc Phosphate Primer(1) after 200 Hours



Control



5 PHR XL-29SE

(1) Neocryl A-625 Acrylic Resin, 1-mil DFT on Bonderite 1000, 5% Salt Spray

The last example was a 70/30 blend of Neocryl A-625 acrylic and Kelsol 3905 water-reducible alkyd in a white gloss topcoat formulation. ZOLDINE XL-29SE Crosslinker performed better than the uncrosslinked system. All systems had some blistering here, but ZOLDINE XL-29SE Crosslinker improved the level of corrosion resistance.

Table 9
Effect of Salt Spray Exposure on 70/30 Acrylic/Water-Reducible Alkyd White Topcoat(1)

Property	Uncrosslinked	5 PHR XL-29SE
Scribe Corrosion(2)	1	3
Surface Corrosion(2)	1	5
Scribe Blistering	Dense #2	Med. Dense #6
Surface Blistering	Dense #2	Med. Dense #6

(1) Neocryl A-625 Acrylic Resin (NeoResins)
Kelsol 3905 Alkyd Resin (Reichhold)
1-mil DFT on Bonderite 1000
5% Salt spray 100-hr exposure
(2) ASTM D1654, 10 = Best

The humidity and salt spray test results shown above illustrate how ZOLDINE XL-29SE Crosslinker can improve both Cleveland humidity and corrosion resistance of coatings for metal.

Coatings for Wood

ZOLDINE XL-29SE Crosslinker can also improve a coating's performance on wood substrates, such as kitchen cabinets or wood floors. Specifically, improvements in block, print, mar, and solvent/chemical resistance can be seen at levels as low as 5 phr resin in typical waterborne kitchen cabinet finishes. Similar improvements, as well as enhanced abrasion resistance, are expected in coatings for wood flooring using waterborne urethane dispersions. Levels as low as 5 phr resin have been adequate in most cases. Higher levels have been investigated with only marginal improvements. Crosslinker level should be optimized for each formulation.

Property improvements can be seen in a variety of formulations containing latexes from Goodyear, NeoResins, and others, as well as waterborne urethane dispersions from NeoResins, Permuthane, Bayer, Reichhold, Sovereign, Sanncor, and others. The use of latex/urethane blends crosslinked with ZOLDINE XL-29SE Crosslinker may also prove to be an effective way of achieving required performance. Two formulations below demonstrate the effectiveness of ZOLDINE XL-29SE Crosslinker in improving the performance of wood kitchen cabinet coatings.

The formulations presented here demonstrate how a carbodiimide crosslinker can improve performance relative to an uncrosslinked formulation. They are starting formulations only and are not optimized.

Table 10 shows film properties of UCAR* 430 latex crosslinked with five phr of ZOLDINE XL-29SE Crosslinker. Significant improvements can be seen in mar resistance and block resistance, as well as slight improvements in print resistance and hardness.

Table 11 shows film properties of a Pliolite 7103 system crosslinked with five phr of ZOLDINE XL-29SE Crosslinker. In this case, we see significant improvements in block resistance and print resistance, as well as moderate improvements in stain resistance.

Table 10
Wood Coating Film Properties of UCAR 430 Latex Crosslinked With ZOLDINE XL-29SE Crosslinker(1)

Property	Uncrosslinked	5 PHR XL-29SE
Gloss, 20	63	47
Gloss, 60	87	80
Clarity	Very Good	Good
Mar (Fingernail)	Moderate	Slight
Block (0.5 lb/in2)(2)	6	9+
Print (1.0 lb/in2)(3)	4	5
Pencil Hardness	HB	F
NKCA Stain (24 hr)		
Vinegar	Very Slight	Very Slight
Lemon Juice	No Effect	No Effect
Orange Juice	No Effect	No Effect
Grape Juice	No Effect	No Effect
Catsup	Very Slight	Very Slight
Coffee	No Effect	No Effect
Olive Oil	No Effect	No Effect
Alcohol 100 Proof	No Effect	No Effect
Mustard (1 hr)	Moderate	Moderate

(1) Formula 8, pg 9
(2) Block Resistance: 0.5 lb/in2 at 50°C for 1.5 hr after the following schedule:
Application + 10-15 min flash + 5 min at 170°F + 1 hr 15 min air dry
(3) Print Resistance: 1 lb/in2 at 60°C for 1.5 hr – see above cure schedule.

Table 11
Wood Coating Film Properties of Pliolite 7103 Crosslinked with ZOLDINE XL-29SE Crosslinker(1)

Property	Uncrosslinked	5 PHR XL-29SE
Gloss, 20	78	74
Gloss, 60	93	93
Clarity	Good	Good
Mar (Fingernail)	Moderate	Moderate
Block (0.5 lb/in2)(2)	7	10
Print (1.0 lb/in2)(3)	0	6
NKCA Stain (24 hr)	Slight	No Effect
Vinegar	No Effect	No Effect
Lemon Juice	No Effect	No Effect
Lemon Juice	No Effect	No Effect
Orange Juice	No Effect	No Effect
Grape Juice	Slight	Very Slight
Catsup	Slight	No Effect
Coffee	No Effect	No Effect
Olive Oil	No Effect	No Effect
Alcohol 100 Proof	Very Slight	Very Slight
Mustard (1 hr)	Very Slight	Very Slight

(1) Formula 7, pg 9
(2) Block Resistance: 0.5 lb/in2 at 50°C for 1.5 hr after the following schedule:
Application + 10-15 min flash + 5 min at 170°F + 1 hr 15 min air dry.
(3) Print Resistance: 1 lb/in2 at 60°C for 1.5 hr – see above cure schedule.

Formulations

The following should be regarded as starting point formulations that may be readily modified to meet specific performance requirements.

Metal

Formula 1

White Acrylic Topcoat – 15% PVC

Ingredients	Pounds (lbs.)	Gallons (L)
GRIND		
Water	44.0	5.25
TAMOL* 165 Dispersant	12.0	1.30
TRITON* CF-10 Nonionic Surfactant Defoamer(1)	1.60	0.18
Titanium Dioxide(2)	169.6	5.25
Grind to 7+ N.S. Hegman, then letdown the following:		
LETDOWN		
Acrylic Resin(3), 40% NV	648.6	76.47
Defoamer(4)	0.9	0.12
Flow Aid(5)	1.6	0.20
Sodium Nitrite (15% in water)	5.0	0.60
14% Aqueous Ammonium Hydroxide (to pH 8.5-9.0)	87.5	10.50
Water	As needed	As needed
Total	971.8	100.00
Add ZOLDINE XL-29SE Crosslinker at 5 phr (solids on solids) with mixing		

SUPPLIERS:
(1) Patcote 519 Defoamer (C.J. Patterson) or equivalent. (2) Ti-Pure R-960 Titanium Dioxide (DuPont) or equivalent.
(3) Neocryl A-630 Acrylic Resin (NeoResins) or equivalent. (4) Foamaster NS-1 Defoamer (Diamond Shamrock) or equivalent.
(5) Dow Corning DC-14 Flow Aid (Dow Corning) or equivalent.

Coating Properties	
Pigment Volume Concentration (PVC), %	15
Volume Solids, %	35

Formula 2

White Acrylic Topcoat – 15% PVC

Ingredients	Pounds (lbs.)	Gallons (L)
GRIND		
Water	44.0	5.25
TAMOL* 165 Dispersant	12.0	1.30
TRITON* CF-10 Nonionic Surfactant Defoamer(1)	1.60	0.18
Titanium Dioxide(2)	169.6	5.25
Grind to 7+ N.S. Hegman, then letdown the following:		
LETDOWN		
Acrylic Resin(3), 40% NV	741.2	87.20
Defoamer(4)	2.0	0.27
Flow Aid(5)	0.9	0.13
Sodium Nitrite (15% in water)	5.0	0.60
14% Aqueous Ammonium Hydroxide (to pH 8.5-9.0)	As needed	As needed
Water	As needed	As needed
Total	977.3	100.31
Add ZOLDINE XL-29SE Crosslinker at 5 phr (solids on solids) with mixing		

SUPPLIERS:
(1) Patcote 619 Defoamer (C.J. Patterson) or equivalent. (2) Ti-Pure R-960 Titanium Dioxide (Du Pont) or equivalent.
(3) Neocryl A-645 Acrylic Resin (NeoResins) or equivalent. (4) Colloid 643 Defoamer (Colloids) or equivalent.
(5) Dow Corning DC-14 Flow Aid (Dow Corning) or equivalent.

Coating Properties	
Pigment Volume Concentration (PVC), %	15
Volume Solids, %	35

Formula 3

White 70/30 Acrylic/Water-Reducible Alkyd Topcoat – 15% PVC

Ingredients	Pounds (lbs.)	Gallons (L)
GRIND		
Water-Reducible Alkyd Resin[1]	114.4	13.30
Butyl CELLOSOLVE* Solvent	8.0	1.06
28% Aqueous Ammonium Hydroxide	4.0	0.13
Defoamer[2]	2.0	0.24
Water	40.0	0.80
Titanium Dioxide[3]	169.6	5.25
Grind to 7+ N.S. Hegman, then letdown the following:		
LETDOWN		
Acrylic Resin[3], 42% NV	447.9	52.08
Butyl CELLOSOLVE Solvent	54.6	7.27
DOWANOL DPM Coalescent	24.4	2.96
Dibutyl Phthalate	9.4	1.08
Drier[5]	1.0	0.12
Drier[6]	1.0	0.12
Silicone Surfactant[7]	0.9	0.11
Sodium Nitrite (15% in water)	5.0	0.60
14% Aqueous Ammonium Hydroxide (to pH 8.5-9.0)	12.0	0.48
Water	78.8	9.46
Total	973.0	99.06
Add ZOLDINE XL-29SE Crosslinker at 5 phr (solids on solids) with mixing		

SUPPLIERS:
(1) Kelsol 3905 Water-Reducible Alkyd Resin (Reichhold) or equivalent. (2) Patcote 519 Defoamer (C.J. Patterson) or equivalent.
(3) Ti Pure R-960 Titanium Dioxide (Du Pont) or equivalent. (4) Neocryl A-633 Acrylic Resin (NeoResins) or equivalent.
(5) Aquacat Drier (Ultra Additives) or equivalent. (6) Magnacat Drier (Ultra Additives) or equivalent.
(7) Silwet L-7001 Silicone Surfactant (Crompton) or equivalent.

Coating Properties	
Pigment Volume Concentration (PVC), %	15
Volume Solids, %	35

Formula 4

White Acrylic Topcoat – 15% PVC

Ingredients	Pounds (lbs.)	Gallons (L)
GRIND		
Water	44.00	5.25
TAMOL* 165 Dispersant	12.00	1.30
TRITON* CF-10 Nonionic Surfactant	1.6	0.18
Defoamer[1]	1.0	0.13
Titanium Dioxide[2]	169.6	5.25
Grind to 7+ N.S. Hegman, then letdown the following:		
LETDOWN		
RHOPLEX* WL-71 Acrylic Resin, 41.5% NV	651.3	87.20
Butyl CARBITOL* Solvent	40.5	0.27
Dibutyl Phthalate	27.0	0.13
Sodium Nitrite (15% in water)	5.0	0.60
14% Aqueous Ammonium Hydroxide (to pH 8.5-9.0)	1.0	0.12
Drier[6]	1.0	0.12
Silicone Surfactant[7]	0.9	0.11
Sodium Nitrite (15% in water)	5.0	0.60
14% Aqueous Ammonium Hydroxide (to pH 8.5-9.0)	12.0	0.48
Water	26.7	3.21
Total	971.8	100.00
Add ZOLDINE XL-29SE Crosslinker at 5 phr (solids on solids) with mixing		

SUPPLIERS:
(1) Patcote 519 Defoamer (C.J. Patterson) or equivalent.
(2) Ti-Pure R-960 Titanium Dioxide (Du Pont) or equivalent.

Coating Properties	
Pigment Volume Concentration (PVC), %	15
Volume Solids, %	35

Formula 5
Acrylic Zinc Phosphate Primer Topcoat – 32% PVC

Ingredients	Pounds (lbs.)	Gallons (L)
GRIND		
Water	80.0	9.60
TAMOL® 165 Dispersant	18.0	2.04
TRITON® CF-10 Nonionic Surfactant	1.0	0.13
Red Iron Oxide	250.0	5.84
Barytes #1[1]	125.6	3.43
Zinc Phosphate	50.0	1.92
Grind to 7+ N.S. Hegman, then letdown the following:		
LETDOWN		
Acrylic Resin(2), 45% NV	461.2	53.63
Butyl CELLOSOLVE® Solvent	68.5	9.12
Defoamer(3)	1.0	0.12
Sodium Nitrite (15% in water)	5.0	0.60
14% Aqueous Ammonium Hydroxide (to pH 8.5-9.0) 14% Aqueous Ammonium Hydroxide (to pH 8.5-9.0)	1.0	0.12
Water	108.2	12.98
Total	1168.5	99.41
Add ZOLDINE XL-29SE Crosslinker at 5 phr (solids on solids) with mixing		

SUPPLIERS:
(1) Barytes #1 (Pfizer)
(2) Neocryl A-625 Acrylic Resin (NeoResins) or equivalent.
(3) Foamaster NS-1 Defoamer (Diamond Shamrock) or equivalent.

Coating Properties	
Pigment Volume Concentration (PVC), %	32
Volume Solids, %	35

Formula 6
White 70/30 Acrylic/Water-Reducible Alkyd Topcoat – 15% PVC

Ingredients	Pounds (lbs.)	Gallons (L)
GRIND		
Water-Reducible Alkyd Resin[1]	114.4	13.30
Butyl CELLOSOLVE® Solvent	8.0	1.06
28% Aqueous Ammonium Hydroxide	4.0	0.13
Defoamer[2]	2.0	0.24
Water	40.0	4.80
Titanium Dioxide[3]	169.6	5.25
Grind to 7+ N.S. Hegman, then letdown the following:		
LETDOWN		
Acrylic Resin[4], 45% NV	414.8	48.22
Butyl CELLOSOLVE Solvent	31.7	4.22
Drier[5]	1.0	0.12
Drier[6]	1.0	0.12
Defoamer[7]	1.0	0.12
Filming Aid[8]	4.0	0.60
Sodium Nitrite (15% in water)	5.0	0.60
14% Aqueous Ammonium Hydroxide (to pH 8.5-9.0)	5.0	0.65
Total	978.5	100.67
Add ZOLDINE XL-29SE Crosslinker at 5 phr (solids on solids) with mixing		

SUPPLIERS:
(1) Kelsol 3905 Water-Reducible Alkyd Resin (Reichhold) or equivalent. (2) Patcote 519 Defoamer (C.J. Patterson) or equivalent.
(3) Ti Pure R-960 Titanium Dioxide (Du Pont) or equivalent. (4) Neocryl A-625 Acrylic Resin (NeoResins) or equivalent.
(5) Aquacat Drier (Ultra Additives) or equivalent. (6) Magnacat Drier (Ultra Additives) or equivalent.
(7) Foamaster NS Defoamer (Cognis) or equivalent. (8) Dow Corning 14 Filming Aid (Dow Corning) or equivalent.

Coating Properties	
Pigment Volume Concentration (PVC), %	15
Volume Solids, %	35

Formula 7

Styrene/Acrylic Clear Lacquer – 35% Solids

Ingredients	Pounds (lbs.)	Gallons (L)
Pre-mix the following:		
Butyl CARBITOL* Solvent	77.2	9.70
Plasticizer(1)	30.8	3.30
Defoamer(2)	3.0	0.39
Surfactant(3)	3.0	0.35
Add with stirring:		
Styrene/Acrylic Resin(4), 45.7% NV	674.8	76.59
Adjust pH to 8.5 to 9.0 with 14% Aqueous Ammonium Hydroxide	80.6	9.68
Water	As needed	As needed
Total	869.4	100.01
Add ZOLDINE XL-29SE Crosslinker at 5 phr (solids on solids) with mixing		

SUPPLIERS:
(1) Santicizer 160 Plasticizer (Solutia) or equivalent. (2) Drew Y-250 Defoamer (Drew Chemicals) or equivalent.
(3) Surfynol 1 04E Surfactant (Air Products) or equivalent. (4) Pliolite 7103 Styrene/Acrylic Resin (Goodyear) or equivalent.

Coating Properties	
Weight Solids %	35

Formula 8

UCAR* 430 Latex Styrene/Acrylic Clear Lacquer – 26% Solids

Ingredients	Pounds (lbs.)	Gallons (L)
UCAR 430 Latex	523.2	57.50
Butyl CARBITOL* Solvent (50% in water)	80.73	9.91
UCAR EHC Filmer	11.7	1.5
Tributoxyethyl Phosphate(1)	11.7	1.51
Defoamer(2)	4.9	0.67
Synthetic Thickener SCT*-275	18.4	2.14
Water	As needed	As needed
Total	876.1	100.31
Add ZOLDINE XL-29SE Crosslinker at 5 phr (solids on solids) with mixing		

SUPPLIERS:
(1) Tributoxyethyl Phosphate – KP-140 (FMC) or equivalent.
(2) Troykyd D999 Defoamer (Troy Chemical) or equivalent.

Coating Properties	
Weight Solids %	29

Contact Information

angus.com

North America
+1-844-474-9969

Latin America
+55-11-4700-8427

Western Europe
+49-69-38-079-1799

Central and Eastern Europe
+49-69-38-079-1799

Middle East and Africa
+49-69-38-079-1799

Indian Subcontinent
+000-800-440-5098

Greater China
+86-40-0881-1243

Japan and Korea
+81-34-477-4961
+82-23-483-6665

Southeast Asia, Australia and New Zealand
+66-2787-3335
+65-6723-1010

ANGUS CHEMICAL COMPANY

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