# EnviroGem® 360 Surfactant

## Low Foam Superwetting and Coalescing Surfactant

EnviroGem 360 surfactant is a low foam superwetting and coalescing surfactant. It is a 100% active, solvent-free liquid used in a wide variety of waterborne applications, including wood, metal, and plastic coatings, and fountain solutions. This unique, multifunctional additive offers superior dynamic surface tension reduction and wetting, outstanding defect-free foam control and excellent stability in systems ranging in pH from 3–13. EnviroGem 360 surfactant also helps to lower the minimum film formation temperature (MFFT) of a system while aiding in coalescence, allowing formulations to comply with stringent environmental and VOC requirements. Typical physical properties of EnviroGem 360 surfactant are shown in Table 1 and typical performance properties are shown in Table 2 (see next page).

### Features

- Low-viscosity, easy-to-handle liquid
- Temperature and pH stable (3–13)
- Zero VOC in Europe; low-VOC in US
- APE- and HAPs-free
- Inherently biodegradable

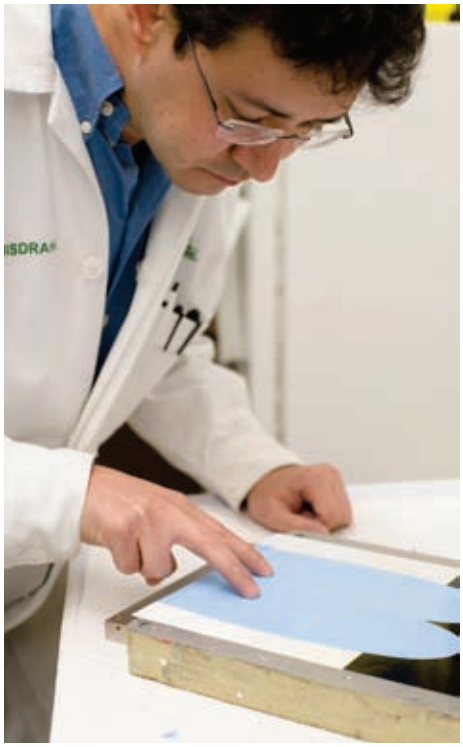
### Benefits

- Provides extremely low equilibrium and dynamic surface tension
- Exhibits excellent foam control properties
- Provides fast wetting and low contact angles on low-energy substrates such as plastics
- Lowers minimum film formation temperature and improves film coalescence
- Outperforms fluorosurfactants by greatly reducing dynamic surface tension
- Outperforms silicone surfactants in acrylic and polyurethane-acrylic hybrid wood finishes
- Eliminates need for a defoamer in fountain solution formulations

**Table 1**

**EnviroGem 360 Surfactant: Physical Properties**

| | |
|---|---|
| Appearance at Ambient Temperature | Clear Liquid |
| Color (APHA) | <300 |
| Activity (%) | 100 |
| Viscosity (mPa·s at 22 °C) | 90 |
| Relative Density at 20 °C | 1.01 |
| Flash Point (°C, Pensky-Martens Closed Cup) | 175 |
| HLB | 3–4 |
| pH (5% in 1:1 water: 2-propanol) | 6–7 |
| Boiling Point (°C) | 355 |
| Vapor Pressure (kPa at 25 °C) | $6.4 \times 10^{-7}$ |
| Wt % VOC (U.S. EPA Method 24) | 2.7 |
| VOC (European Solvent and Paint Directives) | 0 |



## Suggested Applications for EnviroGem 360 surfactant

EnviroGem 360 surfactant has broad utility and is recommended for use in many water-based applications including:

### Wood Coatings

EnviroGem 360 surfactant helps to provide improved wetting, flow and leveling, and foam control with excellent aesthetic properties.

### Plastic Coatings

EnviroGem 360 surfactant provides a defect-free and transparent coating, reducing or eliminating the need for defoamers.

### Low-VOC Coatings

EnviroGem 360 surfactant helps meet the latest VOC regulations by replacing coalescing solvents, reducing the MFFT and providing excellent substrate wetting without foam generation.

### Fountain Solutions

EnviroGem 360 surfactant is efficient and effective not only at wetting printing plates but also at controlling foam and is nonaggressive to the printing press and its components.

*Table 2*

**Performance Characteristics**

| | |
|---|---|
| Water Solubility (wt %) | 0.06 (0.6 g/L) |
| Equilibrium Surface Tension[1] at 0.1 wt %, (mN/m) | 28 |
| Dynamic Surface Tension[2] at 0.1 wt %, 6 b/s (mN/m) | 35 |
| Initial Ross-Miles Foam Height[3] (cm) | 1.5 |
| Final Ross-Miles Foam Height[3] at 5 minutes (cm) | 0 |
| Draves Wetting[4] Time at 0.1 wt % (sec) | 3 |

[1]Measured using the Wilhelmy plate method at 25 ˚C.

[2]Measured using the maximum bubble pressure method at 25 ˚C.

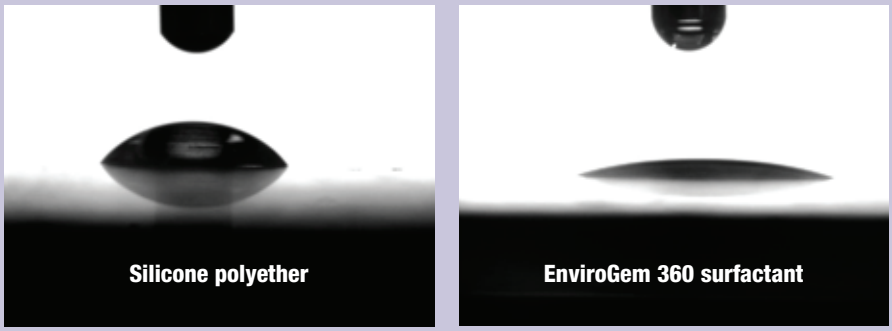
[3]ASTM D 1173, 25 ˚C, 0.1 wt % surfactant in water.

[4]ASTM D 2281, 25 ˚C, using a cotton skein.

*Figure 1*

**Contact Angle**

0.1 wt % aqueous surfactant solution, oily metal surface, 10 sec wetting time, 23 ˚C




A 0.1 wt % aqueous solution of EnviroGem 360 surfactant gives a 36˚ contact angle on Parafilm and a 40˚ contact angle on untreated polyethylene.

## Handling Precautions

Refer to the Material Safety Data Sheet.

## Formulation Guidance

Typical use levels range from 0.1–1.0 wt % (1–10 g/L) in many formulations. For specific use and formulation guidelines, please contact us at one of the offices listed at the end of this brochure.

## EnviroGem 360 Surfactant: Superior Wetting on Low-Energy Surfaces

Figure 1 depicts the very low contact angles achieved with a 0.1 wt % solution of EnviroGem 360 surfactant compared to a typical silicone polyether surfactant (used for wetting, flow and leveling in industrial coatings applications). On an oily metal substrate, the EnviroGem 360 surfactant provides a lower contact angle and superior wetting. Similarly, aqueous solutions of EnviroGem 360 surfactant give low contact angles on other hydrophobic substrates such as polyethylene, polycarbonate and other plastics. The ability of EnviroGem 360 surfactant to provide low contact angles allows formulators to develop formulations that effectively wet out the most difficult-to-wet substrates.

## Low-VOC Industrial Maintenance Coatings

In order to formulate waterborne coatings that meet both market-driven performance requirements and current stringent VOC regulations, formulators must carefully optimize their system. This includes choosing the appropriate polymer, surfactant, coalescing agent and additive package. EnviroGem 360 surfactant can be part of a strategy to reduce formulation VOCs by improving coalescence, reducing the minimum film formation temperature and providing excellent substrate wetting without generating foam.

Table 3 illustrates both a traditional (high-VOC) and a low-VOC (VOC <100 g/L) urethane-acrylic clear coat formulation. In the low-VOC formulation, the majority of the coalescing solvents have been removed and replaced with a much lower amount of EnviroGem 360 surfactant. This results in a low-VOC, highly coalesced, defect-free coating with excellent appearance, gloss, hardness and alcohol resistance (properties are shown in Table 4).

EnviroGem 360 surfactant aids in the formulation of low-VOC coatings by lowering minimum film formation temperature (MFFT). Figure 2 illustrates the impact of EnviroGem 360 surfactant on MFFT. The addition of less than 1% of EnviroGem 360 surfactant to a urethane acrylic hybrid resin gives significant MFFT reduction. EnviroGem 360 surfactant has no detrimental effects on coating performance, unlike other coalescing agents. EnviroGem 360 surfactant offers formulators the flexibility to reduce the amount of solvent in their system while still maintaining coalescence and excellent physical properties.

*Table 3*

***VOC Reduction in Clear Coat Formulations***

| Ingredient | High-VOC (220 g/L) Wt % | Low-VOC (95 g/L) Wt % | Function |
|---|---|---|---|
| Urethane-Acrylic Hybrid Dispersion (1)* | 90.28 | 96.62 | Resin |
| EnviroGem 360 surfactant | 0 | 0.87 | Coalescing and Wetting |
| Di(propylene glycol) dimethyl ether (2) | 5.49 | 0 | Coalescing Solvent |
| Di(propylene glycol) n-butyl ether (3) | 2.15 | 1.80 | Coalescing Solvent |
| Trimethyl pentanediol monoisobutyrate (4) | 1.93 | 0 | Coalescing Solvent |
| Tri(propylene glycol) n-butyl ether (5) | 0 | 0.61 | Coalescing Solvent |
| Surfactant (6) | 0.05 | 0 | Wetting |
| Organomodified Polysiloxane (7) | 0.10 | 0.10 | Foam Control |

*Supplier references on page 8

*Table 4*

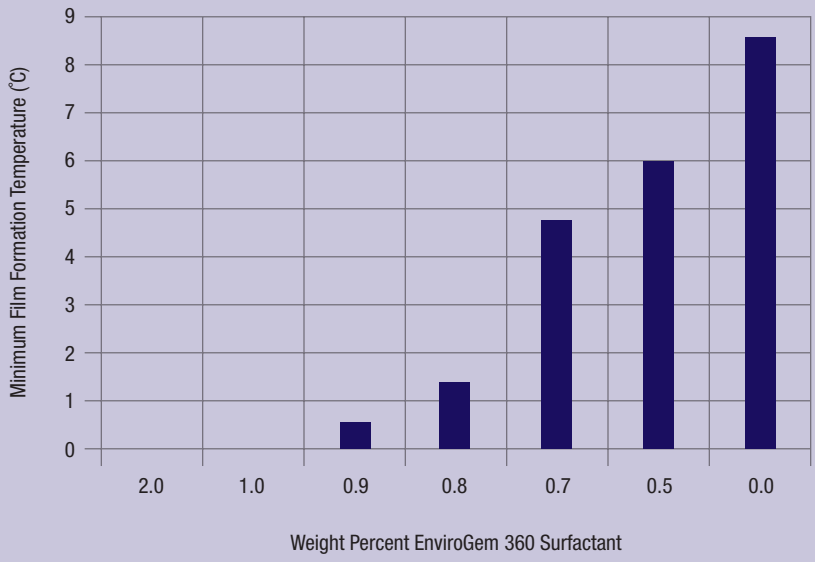
***Performance of Low-VOC Urethane-Acrylic Hybrid Dispersion***

| Property | High-VOC Formulation | Low-VOC Formulation |
|---|---|---|
| Appearance* | Very Good | Good |
| 60˚ Gloss | 95 | 92 |
| Persoz Hardness (sec) ASTM D 4366 | 159 | 136 |
| Isopropyl Alcohol Double Rubs ASTM D 5402 | 50 | 65 |

*Films drawn down on steel panels with a #60 wire wound rod.

*Figure 2*

***MFFT Reduction in a Urethane Acrylic Clear Coat***




Surfactant use level is wt % on urethane-acrylic hybrid emulsion.

## Interior Wood Coatings

EnviroGem 360 surfactant helps to provide improved wetting, flow and leveling, and foam control for defect-free wood coatings with excellent aesthetic properties. The addition of EnviroGem 360 surfactant gives a beautiful appearance to floor refinish formulations (seen in Figure 3A). When EnviroGem 360 surfactant is used, the three-coat brush application of the interior wood formulation based on an acrylic resin (seen in Table 5) results in a defect-free surface. In comparison, at identical dosage, the combination of a silicone surfactant and silicone defoamer yields an imperfect surface (Figure 3B). While the coating's leveling is adequate, the silicone surfactant tends to stabilize micro foam while the silicone defoamer causes craters.

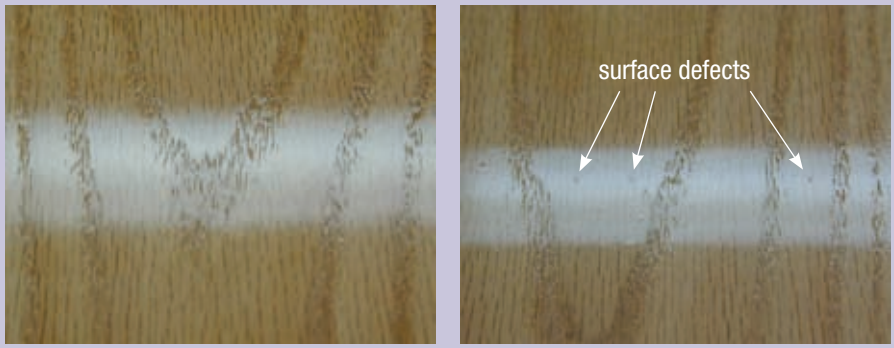
*Table 5*

***Floor Refinish Formulation***

| Ingredient | Use Level (Wt %) | Function |
|---|---|---|
| Acrylic Resin (8) | 88.22 | Resin |
| Water | 2.01 | Co-solvent |
| Di(propylene glycol)n-butyl ether (3) | 8.86 | Coalescing Solvent |
| EnviroGem 360 surfactant | 0.60 | Wetting |
| Surfynol MD-20 (9) | 0.3 | Defoaming |

*Figure 3*

***Improved Appearance of Interior Floor Refinish Formulation***




A. Wetting Agent = EnviroGem 360 surfactant
Defoamer = Surfynol MD-20

B. Silicone Surfactant
Silicone Defoamer

Formulation: NeoPac® E-125, 0.3 wt % Defoamer, 0.6 wt % Wetting Agent

*Table 6*

***Waterborne Styrene Acrylic Copolymer Plastic Clear Coat***

| Ingredient | Benchmark Use Level (Wt %) | EnviroGem 360 Use Level (Wt %) | Function |
|---|---|---|---|
| Acrylic Resin (10) | 58.32 | 58.32 | Resin |
| Water | 10.85 | 10.85 | Solvent |
| Butyl glycol | 13.53 | 13.53 | Coalescing Solvent |
| Butyl diglycol | 3.50 | 3.50 | Coalescing Solvent |
| Di(propylene glycol) methyl ether (11) | 3.50 | 3.50 | Coalescing Solvent |
| Rheology Modifier (12) | 5.83 | 5.83 | Thickener |
| Wax Emulsion (13) | 2.33 | 2.33 | Wax |
| EnviroGem 360 surfactant | 0 | 0.7 | Wetting/Foam Control |
| Sulfosuccinate surfactant (14) | 0.35 | 0 | Wetting Agent |
| Surfynol 104E surfactant (15) | 0.35 | 0 | Leveling Agent |
| Silicone Defoamer | 0.58 | 0 | Foam Control |

pH adjusted with Amietol® M21 at 0.86 wt % on formulation
VOC of total formulation = 180 g/L

## Coatings for Plastic Substrates

Table 6 shows a plastic clear coat formulation based on a typical styrene acrylic resin with a set of coalescing solvents using sodium dioctyl-sulfosuccinate as a wetting agent, an acetylenic diol as the leveling agent, and a dispersible modified silicone as the defoamer. Figure 4 highlights the poor surface appearance of this typical clear coat formulation on polycarbonate. The numerous surface defects consist mainly of leveling irregularities and craters. As clearly shown in Figure 4, EnviroGem 360 surfactant provides a defect-free and transparent surface, even eliminating the need for defoamers. When changing the nature of the substrate or its hydrophobicity, for example from polycarbonate to polypropylene oxide, EnviroGem 360 surfactant continues to provide a defect-free surface.

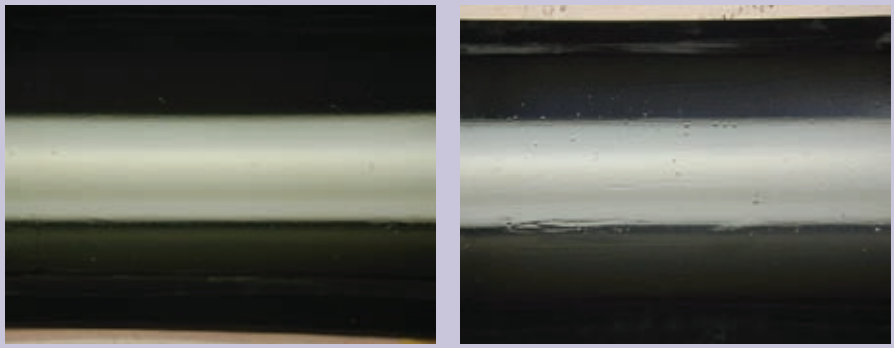
Table 7 summarizes key coatings properties. It is shown that EnviroGem 360 surfactant has no adverse effects on the coating's hardness or resistance to certain chemicals. Moreover, the EnviroGem 360 surfactant improves gloss, particularly at 20˚, as a result of the excellent flow and leveling it provides.

In Table 8, an overview of the effect of EnviroGem 360 surfactant on the wet and dry adhesion properties of this typical clear coat formulation applied on different plastic substrates can be seen. The formulation was evaluated on polypropylene (PP), polypropylene oxide (PPO), acrylonitrile-butadiene-styrene (ABS) and polycarbonate (PC). This table clearly shows that EnviroGem 360 surfactant maintains adequate adhesion of the clear coat to polypropylene oxide and polycarbonate and actually improves the adhesion of the clear coat to the acrylonitrile-butadiene-styrene substrate while eliminating the need for defoamers.

In summary, plastic coatings containing EnviroGem 360 surfactant outperform those containing silicone surfactants. EnviroGem 360 surfactant provides excellent wetting as well as outstanding flow and leveling on all the substrates tested and does not stabilize foam upon application, thus reducing or eliminating the need for defoamers. This results in defect-free coatings that display superior adhesion, gloss, water and chemical resistance.

**Figure 4**

***Improved Properties on Polycarbonate***



A. Surfactant = 0.7% EnviroGem 360
No Defoamer

B. 0.7% Total Surfactants
0.58% Silicone Defoamer

Neocryl A-662 Formulation

Films drawn down using a 0.003 Bird bar on PC sheet and cured at 75 ˚C for 30 minutes.

**Table 7**

***Plastic Coating Physical Properties***

| Property | 0.7% EnviroGem 360 No Defoamer | Benchmark Additives |
|---|---|---|
| 20˚ Gloss | 93 | 77 |
| 60˚ Gloss | 96 | 93 |
| Persoz Hardness | 326 sec | 323 sec |
| Isopropyl Alcohol Resistance | whitens, 1 h | whitens, 1 h |
| 0.1 *N* HCl Resistance | whitens, 1 h | whitens, 1 h |
| Suntan Lotion Resistance | whitens, 24 h | whitens, 24 h |

Neocryl A-662 Formulation

Films drawn down using a 0.003 Bird bar on polycarbonate sheets and cured at 75 ˚C for 30 minutes.

**Table 8**

***Adhesion on Plastic Substrates***

| Plastic Substrate | EnviroGem 360 No Defoamer | | Benchmark Additives | |
|---|---|---|---|---|
| | Dry | Wet | Dry | Wet |
| PP | 0A | 0A | 0A | 0A |
| PPO | 5A | 5A | 5A | 5A |
| ABS | 5A | 2A | 5A | 1A |
| PC | 5A | 5A | 5A | 5A |

ASTM D 3359, Method A, X Cut Tape Test.
Wet adhesion involved submersion of the panel for 1 week.
0 = no adhesion, 5 = 100% adhesion

Neocryl A-662 Formulation

Films drawn down using a 0.003 Bird bar and cured at 75 ˚C for 30 minutes.

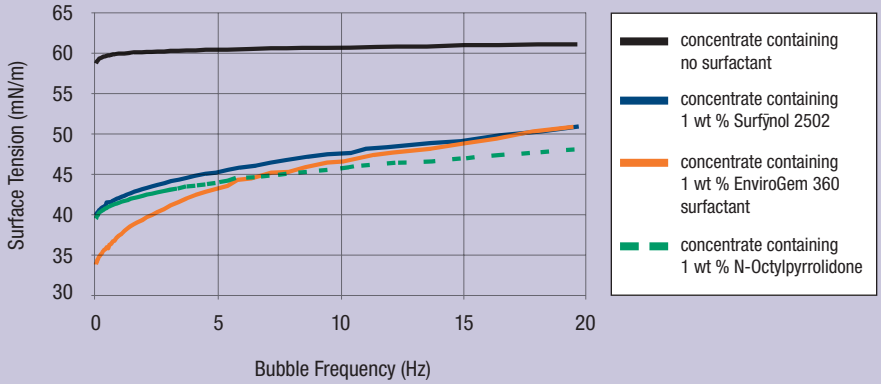
## Fountain Solutions

Fountain solutions are used in lithographic printing to dampen the printing plate in order to prevent the nonimage area from accepting ink. Wetting agents are necessary to reduce the surface tension of low- or no-alcohol containing fountain solutions and to allow them to wet the plate. Sometimes these surfactants create foam and are detrimental to the blankets, O-rings, feed lines and other parts of the printing press.

EnviroGem 360 surfactant is a more efficient and effective multifunctional wetting agent than the traditional surfactants used in fountain solutions. In Figure 5, it is shown that EnviroGem 360 surfactant greatly reduces surface tension under both equilibrium and dynamic conditions; this property leads to its ability to effectively wet out the plate. EnviroGem 360 surfactant also controls foam better than traditional surfactants (Figure 6) and is nonaggressive to the printing press and its components (Figures 7 and 8). These added benefits offer significant cost savings for your customers' production facilities.

***Figure 5***

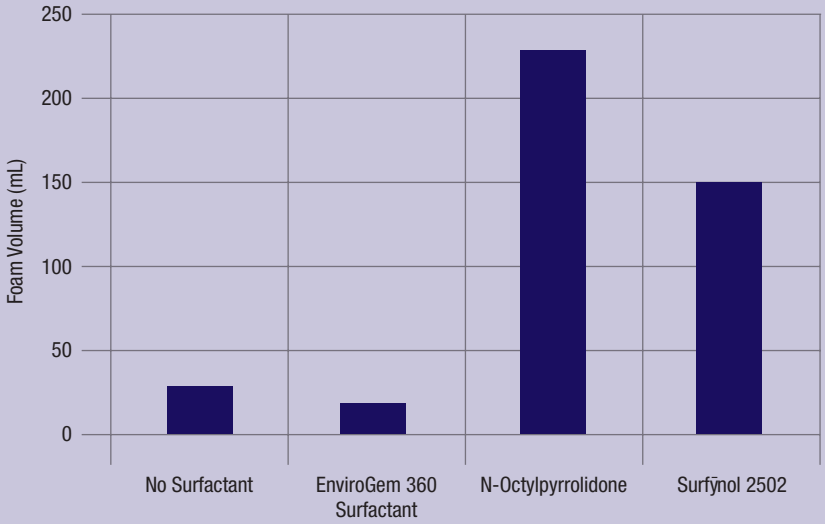
***Dynamic Wetting in Diluted Fountain Solution***




Press-ready fount prepared by diluting concentrate to 4.7 wt % in deionized water.
Dynamic surface tension measured on a Krüss BP2 Bubble Tensiometer.

***Figure 6***

***Foam Control in Air Sparge Test***




Press-ready fountain solution prepared by diluting concentrate (containing 1 wt % surfactant) to 4.7 wt % in deionized water.

**Figure 7**

***Swelling of Viton® or PVC***

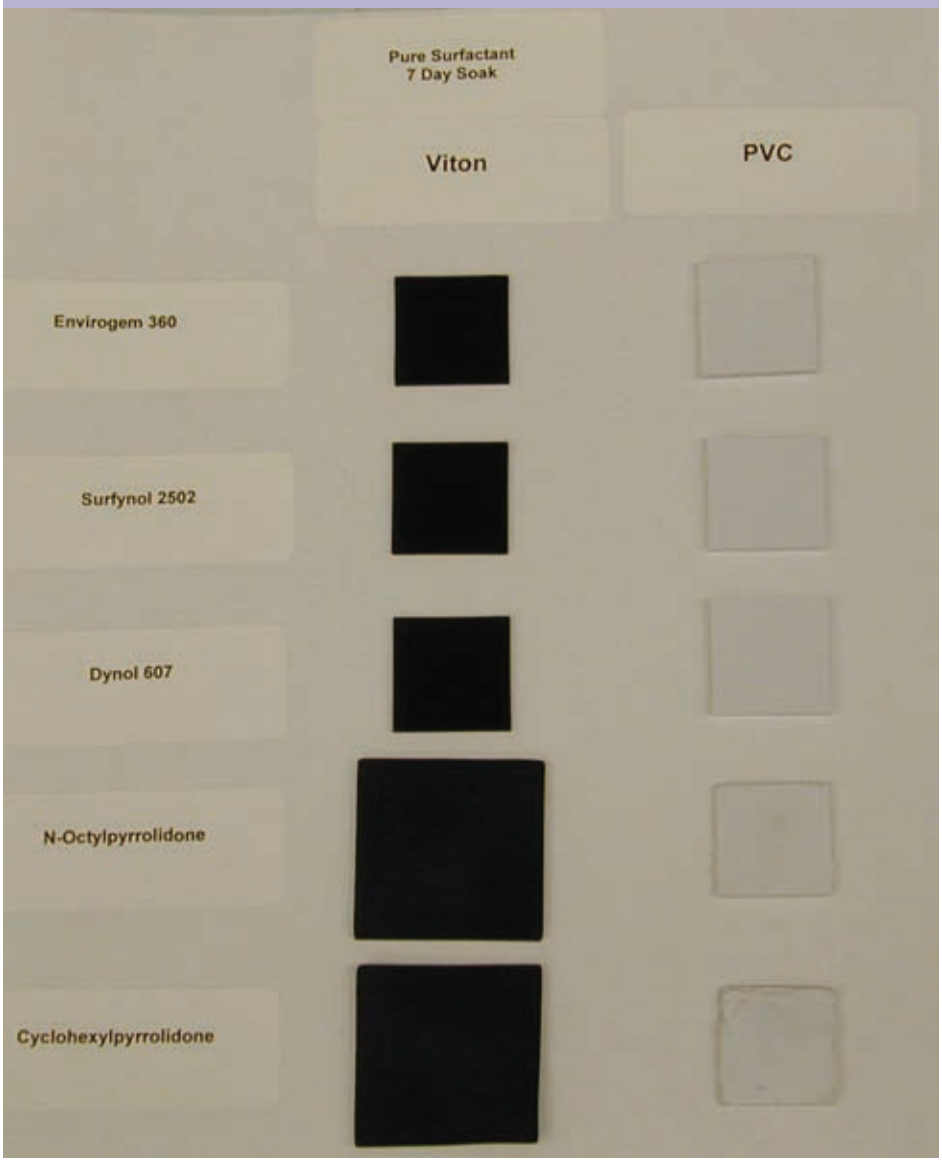
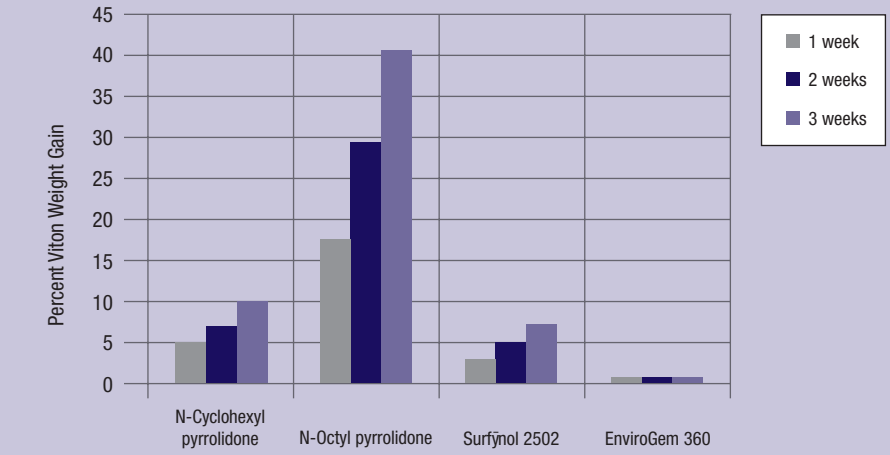



**Figure 8**

***Viton® Weight Gain***




Percent Viton Weight Gain After Soaking in Surfactant-Containing Fountain Solution Concentrates

## *Supplier References*

(1) Hybridur® 870 – Air Products

(2) Proglyde® DMM – Dow Chemical

(3) Dowanol® DPnB – Dow Chemical

(4) Texanol® Ester Alcohol – Eastman Chemical

(5) Dowanol® TPnB – Dow Chemical

(6) BYK®-333 – Byk-Chemie

(7) BYK®-024 – Byk-Chemie

(8) NeoPac® E-125 – DSM NeoResins

(9) Surfynol® MD-20 – Air Products

(10) NeoCryl® A-662 – DSM NeoResins

(11) Dowanol® DPM – Dow Chemical

(12) Acrysol® ASE-60 – Rohm and Haas

(13) Aquacer® 513 – Byk-Chemie

(14) Dapro® W-77 – Elementis

(15) Surfynol® 104E – Air Products

(16) Dehydran® 1293 – Cognis

## *For More Information*

If you would like additional information or technical assistance in preparing specific formulations, write or call Air Products and Chemicals, Inc. at the following locations.


**Air Products and Chemicals, Inc.**
Performance Solutions
7201 Hamilton Boulevard
Allentown, PA 18195-1501 U.S.A.
Tel 800-345-3148
(Outside the U.S. and Canada 610-481-6799)
Fax 610-481-4381
www.airproducts.com/surfynol

**Latin America**

**Air Products and Chemicals, Inc.**
Latin American Region
7201 Hamilton Boulevard
Allentown, PA 18195-1501 U.S.A.
Tel 610-481-3553
Fax 610-481-8170

**Air Products and Chemicals de México S.A. de C.V.**
Pasaje Interlomas No. 16
Col. San Fernando La Herradura
Interlomas
Huixquilucan, Edo. De México
C.P. 52760
México
Tel 52-55-5246-0400
Fax 52-55-5246-0448 and 52-55-5246-0449

**Air Products Brazil Ltda.**
Av. Francisco Matarazzo, 1400
11° Andar – Cond. Edifício Milano
Água Branca
São Paulo, SP
Brazil
Tel 55-11-3856-1700
Fax 55-11-3856-1781

**Europe**

**Air Products Chemicals Division Europe**
Air Products Nederland B.V.
Kanaalweg 15, P.O. Box 3193
3502 GD Utrecht
Netherlands
Tel 31-30-2857100
Fax 31-30-2857111

**Asia**

**Air Products Japan, Inc.**
21F MUZA Kawasaki Central Tower
1310 Omiya-cho, Saiwai-ku
Kawasaki City, Kanagawa 212-8554
Japan
Tel 81-044-542-1550
Fax 81-044-542-1528

**Air Products Asia, Inc.**
Room 6505-7, Central Plaza
18 Harbour Road
Wanchai, Hong Kong
Tel 852-2527-0515
Fax 852-2527-1957




# tell me more
**www.airproducts.com/surfynol**




120-07-027-GLB