

# D̄ynol™ superwetting surfactants

An innovative portfolio of  
superwetting solutions

The secret weapon.



D̄ynol™  
superwetting  
surfactants



## A range of solutions to help you solve your most difficult-to-wet problems

Air Products is an industry leader in offering specialty additive solutions to the coatings, the inks, the adhesives and various other industries. Our unique defoamers, dispersants and wetting agents provide the formulator with solutions that are quick, efficient and easy to deploy. We are now able to offer an extensive array of superwetters to help you solve even your most difficult-to-wet surface problems. Such wetting challenges are often compounded by application under demanding conditions, such as high coating speeds or rapid drying. Our offerings include both siloxane-based and siloxane-free products, products that provide exceptionally low dynamic and low equilibrium surface tensions and products that can aid in film coalescence. Superwetters—the secret weapon that should be on every formulator's bench.

## Superwetting – overcoming difficult-to-wet surfaces

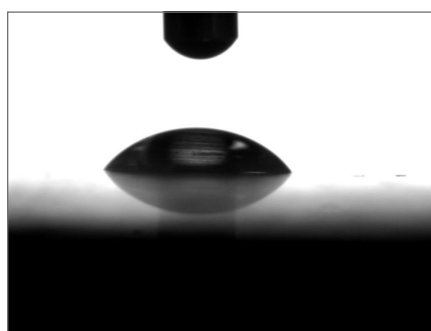
Formulators have long used surfactants to reduce the surface tension of formulations to enable the formulations to wet the surface to which they are applied, whether these are paint formulations applied to dry-wall, ink formulations applied to foil, or adhesive formulations applied to textiles. As the surface tension of water is 72 mN/m, and typical substrate surface energies are in the realm of 35-45 mN/m, in order to reduce the surface tension of aqueous formulations a wide variety of surfactants, whether nonionic, anionic or cationic, are well known and commonly used.

But what happens when the surface tension of the substrate falls well below the typical 35 mN/m range where traditional surfactants are no longer effective? Such low-energy surfaces might include plastic, wood or even poorly prepared or oil-contaminated metal surfaces. For these situations, the chemist often turns to a limited

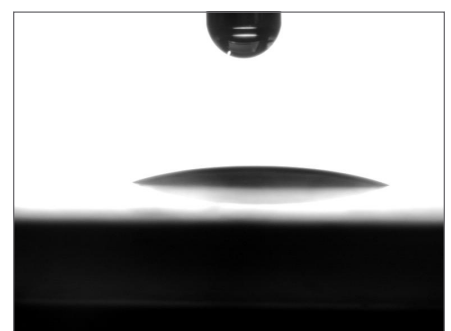
number of options, such as silicone surfactants and fluorosurfactants. However, the undesirable attributes of these two solutions (such as recoatability issues or down-stream contamination) make these options less than desirable in many situations.

**Figure 1** depicts the extremely low contact angles achieved with a 0.1 wt% solution of organic superwetter Dýnol 360 surfactant on low energy substrates compared to a traditional siloxane surfactant often used for wetting. On the oily metal surface, Dýnol 360 surfactant provided a lower contact angle and superior wetting. Similarly, Dýnol 360 surfactant provided low contact angles on other hydrophobic substrates like polyethylene and polycarbonate. The ability of Dýnol 360 surfactant to wet the surface very quickly and provide low contact angles allows formulators to develop coatings that can effectively wet out the most difficult-to-wet substrates.

**Figure 1: 0.1% Dýnol 360 surfactant aqueous solution, oily metal surface, 10 sec wetting time, 23 °C**



Traditional siloxane surfactant



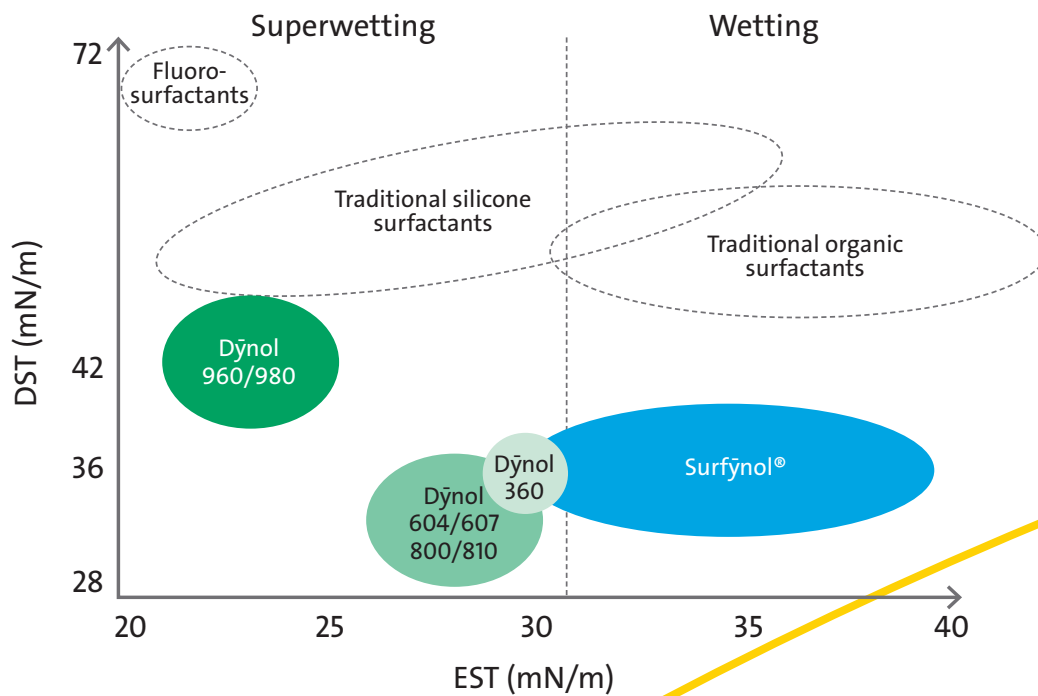
Dýnol 360 surfactant

## Don't forget to consider both the dynamic and the equilibrium components of surface tension

Equilibrium surface tension, or the surface tension that is measured when a solution attains an equilibrium state, is a familiar physical property to most formulators. However most processes are far from equilibrium situations, whether it is a coat of paint being sprayed onto a wall, a fountain solution providing dampening to a printing plate, an adhesive being roller-applied to a release-liner, or even the changes occurring in the last few seconds as a carrier medium evaporates from a coating. For these situations it is the dynamic surface tension that plays a major role in enabling the formulation to perform as intended.

While traditional silicone surfactants and fluorosurfactants can achieve very low equilibrium surface tensions, their dynamic surface tension reduction is often lacking as they are unable to quickly migrate to the new interfaces that are created under dynamic conditions. Air Products has designed the architecture of the surfactant molecules to offer a portfolio of products that can provide a variety of low equilibrium and dynamic surface tensions. In addition, many of these products have been designed to be no foam or low foam and to aid the coalescence of films by reducing the minimum film formation temperature (MFFT).

Figure 2: Comparison of the Dýnol superwetter surfactants in terms of dynamic and equilibrium surface tension with other well-known surfactants



# A portfolio of superwetting options to choose from

Air Products is proud to offer four different classes of superwetters, the Dýnol 300, 600, 800 and 900 series. Each of these products has different attributes based on the nature of the superwetting surfactant molecules employed, resulting in a portfolio of superwetters that can solve almost any difficult-to-wet surface challenge.

## Dýnol Superwetting Surfactant Family Attributes

	300 Series	600 Series	800 Series	900 Series
Lowers MFFT/aids coalescence	●			
Flow & leveling				●
Low/zero foam	●	D604	●	
Siloxane free	●	●	●	
Provides lowest DST			●	
Provides lowest EST				●
APE free	●	●	●	●

## Application Selector Guide

- Primary recommendations
- Secondary options

Coating type	360	604	607	800	810	960	980
Wood coatings	●			●	○	○	●
Plastic coatings	●			●	○	●	○
Inks and flexible film substrate	○			○	●	●	○
Overprint varnishes					○	○	●
Metal coatings	○		○	○	○	○	●
Adhesives – film & PSA	○		●	○	○		
Adhesives – wood	●				○		
Adhesives – lamination	○			●	●		
Epoxy systems			○	○	●	○	○
Fountain solutions	○		●	○	○	○	○
Curtain coatings	●			●	●	○	○
Primers	○			●	○		
Architectural coatings	●			●			●
Industrial coatings	○	○		○		○	●
Auto – CED	○		○	○			
Auto – primer	○	●	○	●			
Auto – base coat	○	●	●	●	○		
Auto – clear coat	●	○	●	○		○	●
Auto – uni coat	●	○	●	○		○	●
Auto – plastic coat	●	●	●	●	○	○	●

Application type							
Brush/roller	●			●		●	○
Airless/air assisted spray	○			●		○	●
HVLP/conventional spray	●	●	○	●	●	●	○
Curtain coating			●			○	●
Flow/dip			●			○	●



# D̄ynol™ 300 series surfactants

In order to formulate low-VOC waterborne coatings, the formulator must carefully select the optimum wetting package. With less solvent to help flow, leveling, and appearance of the coatings, formulating defect-free systems presents quite the challenge. The D̄ynol 300 series of superwetting surfactants can be used in a wide range of resin chemistries, including one- and two-component systems. This family of products can be part of your strategy to reduce formulation VOCs by improving coalescence, reducing the minimum film formation temperature and providing excellent substrate wetting without generating foam.

## D̄ynol 360 surfactant

---

D̄ynol 360 surfactant is a low-foam, superwetting and coalescing surfactant for difficult-to-wet substrates. This surfactant can aid in the formation of low-VOC coatings by lowering minimum film formation temperature (MFFT). Additionally, D̄ynol 360 surfactant has broad utility and is recommended for use in many waterborne applications including low-VOC plastic and wood coatings and fountain solutions. This unique, multifunctional additive is designed to provide superior dynamic surface tension reduction and wetting, outstanding defect-free foam control and excellent stability in systems ranging from pH 3–13.

**Figure 3** highlights the poor surface appearance of a typical clear coat formulation on polycarbonate. The surface defects seen with the silicone surfactant/defoamer combination consists of significant cratering in the film. In contrast, the D̄ynol 360 containing system provides a defect-free and transparent surface while decreasing the amount of needed defoamer.

**Figure 4** details how D̄ynol 360 surfactant can aid in the formulation of low-VOC coatings by lowering the MFFT. The addition of less than 1% of D̄ynol 360 surfactant to a urethane acrylic hybrid resin provided significant MFFT reduction. Using D̄ynol 360 surfactant did not detrimentally effect coating performance and it can enable formulators the flexibility to reduce the amount of solvent in their system while maintaining coalescence and excellent physical properties.

Fountain solutions are used in lithographic printing to dampen the printing plate to prevent the non-image area from accepting ink. D̄ynol 360 surfactant is a more efficient and effective multifunctional wetting agent than the traditional surfactants used in fountain solutions because it can greatly reduce surface tension under both equilibrium and dynamic conditions and control foam better than the traditional surfactants as well. **Figure 5** shows how D̄ynol 360 surfactant provided better foam control than traditional surfactants while being nonaggressive to the printing press and its components.

Figure 3: Improved properties on polycarbonate

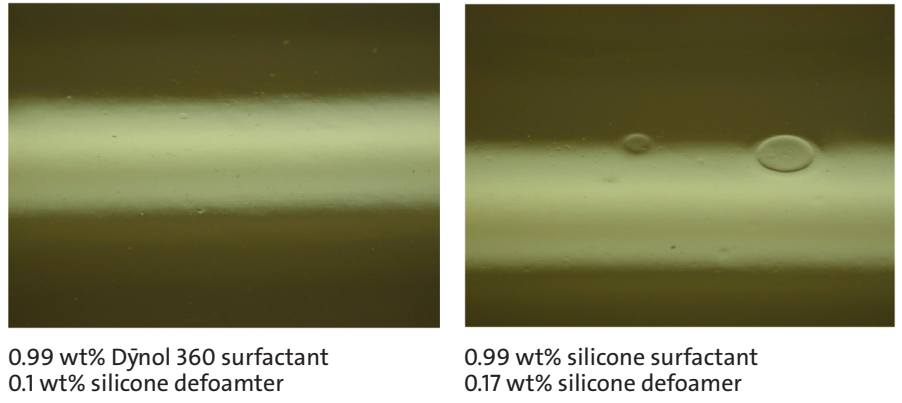


Figure 4: MFFT reduction in a urethane acrylic clear coat

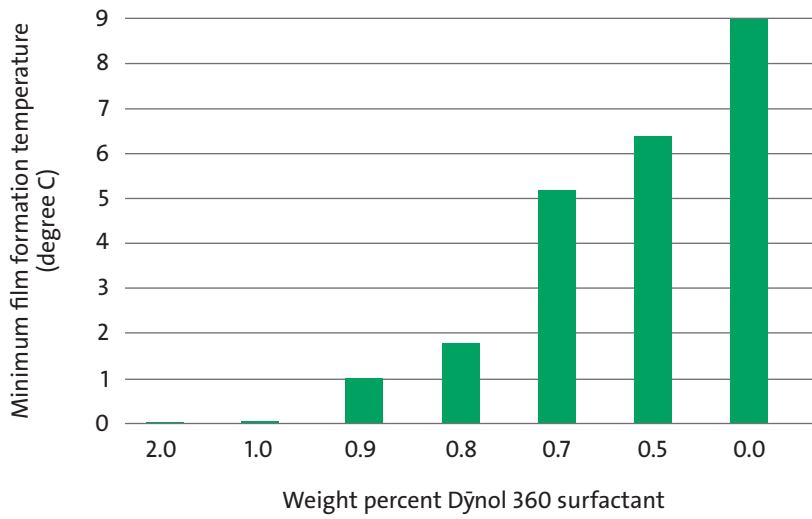
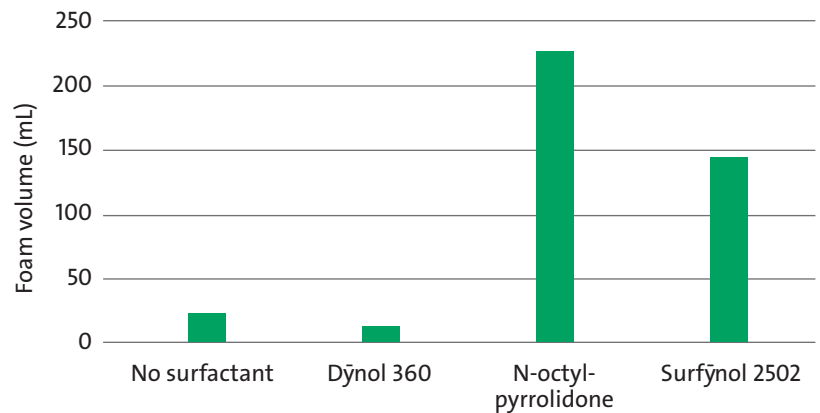


Figure 5: Foam control in air sparge test in press-ready fountain solution concentrate (containing 1 wt% surfactant) diluted to 4.7 wt% in water



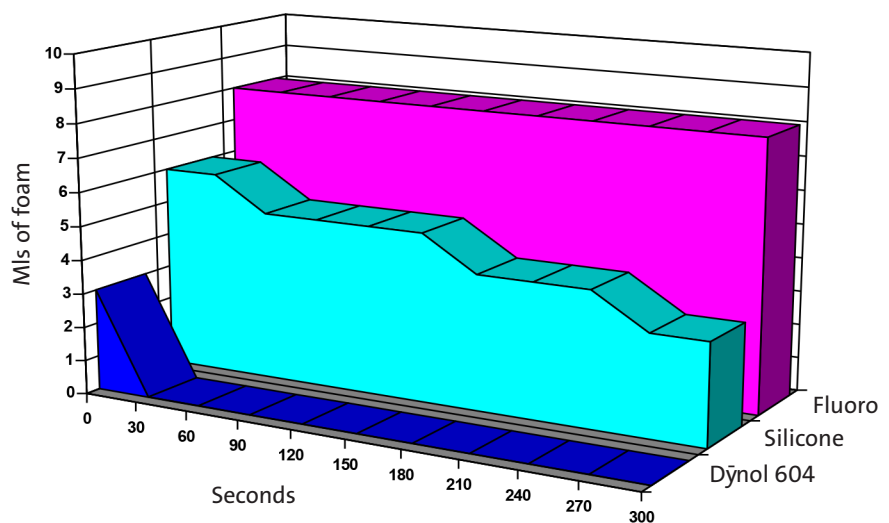
# D̄ynol™ 600 series surfactants

The D̄ynol 600 series surfactants are designed to provide wetting performance not achievable with traditional surfactants. Their ability to provide low equilibrium and dynamic surface tension and to rapidly migrate to newly formed interfaces during application enables coatings with excellent coverage over low-energy or contaminated surfaces. Additionally, due to their hydrophobic nature, the non-silicone D̄ynol 600 series superwetting surfactants are lower in foam, eliminate water sensitivity and intercoat adhesion issues often seen with nonacetylenic surfactants.

## D̄ynol 604 surfactant

D̄ynol 604 surfactant is designed to promote substrate wetting of waterborne systems such as coatings, inks and adhesives by effectively lowering both the equilibrium and dynamic surface tension of aqueous systems at a very low use level. D̄ynol 604 surfactant can be used in a wide range of resin chemistries including acrylics, 1 or 2 component polyurethanes and even epoxy systems. D̄ynol 604 surfactant is ideal for hydrophobic surfaces such as old paint layers and treated plastic surfaces and finds multiple uses in automotive applications from electrodeposition coatings to primers to topcoats. In these systems, D̄ynol 604 surfactant can provide long-lasting defoaming and wetting in a continuous circulating system while providing exceptional application and performance.

Figure 6: Ross-Miles foam comparison of high performance surfactants



Compared to a traditional fluorosurfactant, silicone surfactants or an acetylenic-based Surf̄ynol surfactant, D̄ynol 604 surfactant can achieve lower dynamic surface tension reduction. Additionally, as seen in **Figure 6**, D̄ynol 604 surfactant generated less foam than the alternative fluoro-based and silicone-based surfactants and rapidly broke foam that did form to leave a foam-free system.



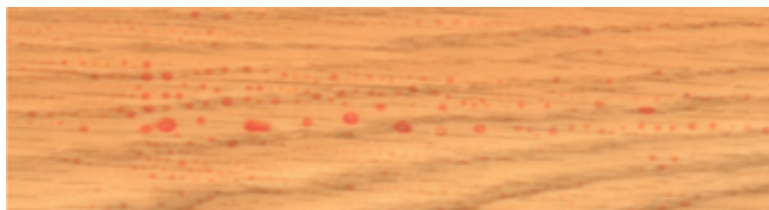


## Dýnol 607 surfactant

---

Based on Gemini surfactant technology, Dýnol 607 surfactant offers multifunctional performance as a low-foam wetting agent that can provide the excellent equilibrium and dynamic surface tension reduction associated with the Dýnol name while also demonstrating improved ease of incorporation and formulation compatibility over Dýnol 604 surfactant. Tests based upon comparative wetting performance data have shown Dýnol 607 surfactant to be an excellent replacement to conventional fluorosurfactants and a cost effective, nonpersistent alternative to new fluorosurfactant technology. As shown in **Figure 7**, Dýnol 607 surfactant effectively lowered dynamic surface tension and eliminated retraction when the floor polish was dynamically applied to PVC tiles with a sponge.

**Figure 7: Elimination of retraction in floor polish**



Fluorosurfactant



Dýnol 607 surfactant

**Figure 7** shows pictures of a floor polish applied with a sponge on PVC tiles showing that Dýnol 607 surfactant eliminated retraction compared to a fluorosurfactant. The formulation contained an orange dye to facilitate visual observations.

# D̄ynol™ 800 series surfactants

The application of waterborne coatings and inks on difficult-to-coat substrates, such as wood, plastics, films and poorly prepared metal surfaces, presents significant challenges to the coatings formulator. The D̄ynol 800 series surfactants are targeted to maximize wetting and minimize defects like craters, fisheyes, orange peel and pinholes, while controlling foam generation in waterborne coatings, inks and adhesives. Due to their ability to reduce equilibrium and dynamic surface tensions, the 100% active, non-silicone, non-fluorinated D̄ynol 800 series surfactants are the optimum choice under diverse application conditions.

## D̄ynol 800 surfactant

---

When coating wood or plastic substrates by low shear methods, D̄ynol 800 surfactant can provide exceptional performance and a superior balance of properties compared to traditional surfactants. **Figure 8** illustrates a three-coat brush application of a model urethane-acrylic hybrid interior wood coating. By incorporating D̄ynol 800 surfactant into this formulation, improved wetting plus superior flow, leveling and foam control is achieved compared to the coating containing a traditional silicone surfactant.

**Figure 8: Brush applied wood coating**

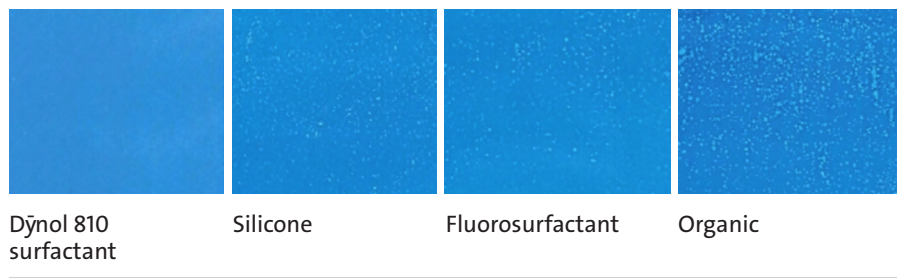


## Dýnol 810 surfactant

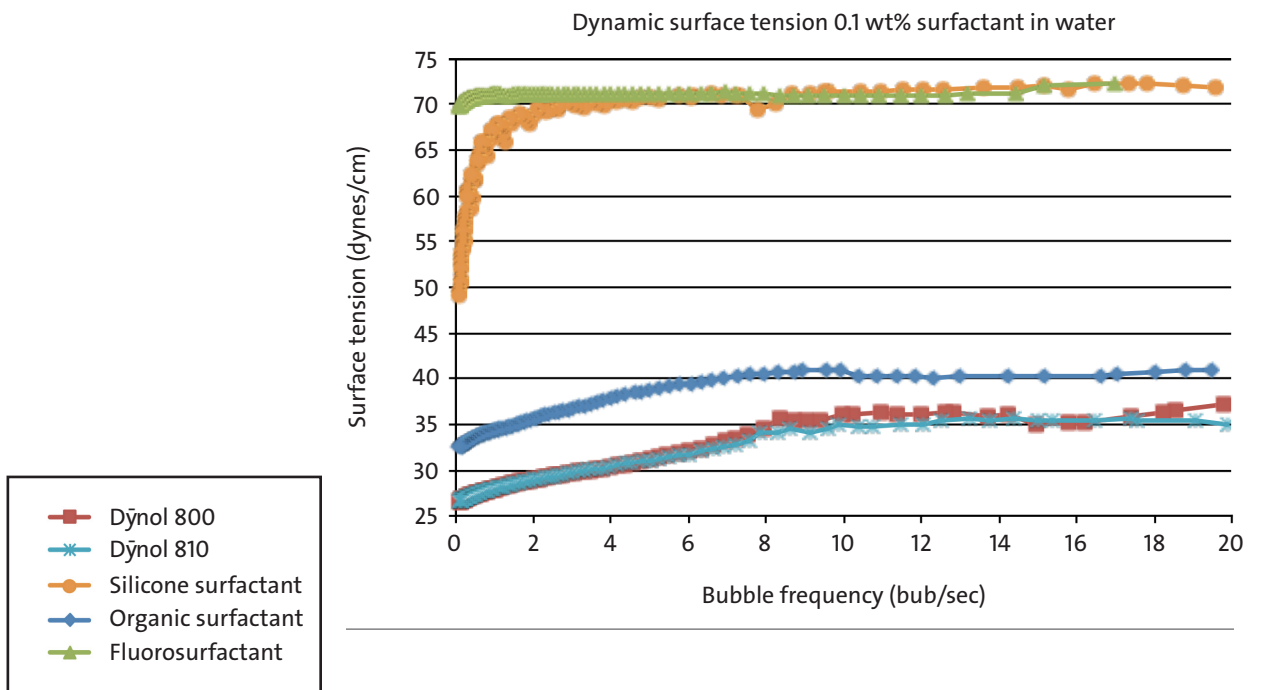
Dýnol 810 surfactant is specifically designed for waterborne printing inks and overprint varnishes. As seen in **Figure 9**, Dýnol 810 surfactant can be an excellent alternative for difficult-to-wet substrates that require good flow and leveling under high application speeds. Dýnol 810 surfactant can provide superior wetting and printability while maintaining excellent foam control over traditional organic, silicone and fluoro-based surfactants when it is used to print on film substrates such as oriented polypropylene or high-slip polyethylene.

**Figure 10** illustrates dynamic surface tensions of the Dýnol 800 series surfactants compared to traditional silicone-based, organic and fluorosurfactants.

**Figure 9: Blue packaging ink printed on polypropylene**



**Figure 10: Dynamic surface tension comparison of surfactants**



# D̄ynol™ 900 series surfactants

The D̄ynol 900 series surfactants are superwetting surfactants based on unique siloxane chemistries. Offering superior equilibrium and dynamic surface tension reduction, the D̄ynol 900 series surfactants play a critical role in achieving high-quality coatings under certain application techniques such as air-assisted or airless spray applied coatings and ink jet inks. Additionally, the D̄ynol 900 series surfactants can provide low foam performance, making them the products of choice for applications where foam cannot be tolerated. Because of their siloxane composition, these two products also provide flow and leveling properties.

## D̄ynol 960 surfactant

---

For hydrophobic substrates with very low surface energies, it is often difficult to achieve perfect wetting. Efficient dynamic and equilibrium surface tension reduction are key factors affecting final wetting performance. As shown in **Figure 11**, D̄ynol 960 surfactant offers these wetting benefits together with low foam and excellent compatibility, helping achieve a perfect appearance. **Figure 11** illustrates wetting performance of 1K polyurethane dispersion drawn down on a low surface tension PVC film at a wet thickness of 100µm. Due to the extremely low surface energy of the substrate, competitive siloxane wetting agents did not prevent dewetting of the coating, while D̄ynol 960 surfactant enabled excellent wetting of this hydrophobic substrate.

**Figure 11: Surfactant performance in a 1K polyurethane dispersion**



Siloxane 1

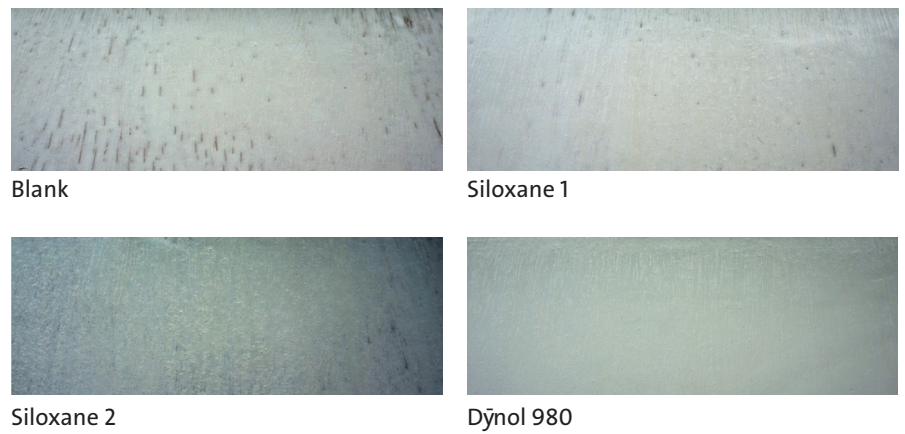
Siloxane 2

D̄ynol 960

## Dýnol 980 surfactant

Many siloxane-based wetting agents for waterborne wood coatings do not provide adequate wetting and produce too much foam. Dýnol 980 surfactant, however, can provide the formulator with optimal wetting, foam control and formulation compatibility as seen in **Figure 12**. An acrylic wood coating containing 0.2 wt% surfactant was spray applied onto wood at a wet film thickness of 100µm. Compared to other siloxane wetting agents, Dýnol 980 surfactant offered the best crack filling and foam control. The unique nature of Dýnol 980 surfactant can provide the formulator with defect-free wetting and premium flow and leveling not observed with traditional siloxane-based surfactants.

**Figure 12: Acrylic waterbased wood coating spray applied to wood**



## Typical Physical Properties of Dýnol Superwetting Surfactants

Product	Appearance	Type	Activity (%)	Viscosity (mPa·s, 21°C)	Specific Gravity (21°C)	Flash Point (°C)	Pour Point (°C)
Dýnol 360	Clear, colorless to yellow liquid	Organic	100	120	1.01	175	8
Dýnol 604	Amber liquid	Organic	100	290*	0.97	164	-14
Dýnol 607	Clear, yellow liquid	Organic	100	205*	1	164	-13
Dýnol 800	Clear, yellow liquid	Organic	100	250	0.98	188	5
Dýnol 810	Clear, yellow liquid	Organic	100	250	0.97	171	3
Dýnol 960	Clear, light yellow liquid	Siloxane	100	66	1	157	-10
Dýnol 980	Clear, light yellow liquid	Siloxane	100	145	1.01	166	-8

\*25°C

For more information,  
please contact us at:

**Corporate Headquarters**

Air Products and Chemicals, Inc.  
7201 Hamilton Boulevard  
Allentown, PA 18195-1501  
T 800-345-3148  
(Outside the U.S. and Canada  
+1-610-481-6799)  
F 610-481-4381  
cheminfo@airproducts.com

**Latin America**

Air Products and Chemicals, Inc.  
Latin American Region  
7201 Hamilton Boulevard  
Allentown, PA 18195-1501  
T +1-610-481-6799  
F +1-610-481-4381

**Air Products Brazil Ltda.**

Av. Francisco Matarazzo, 1400  
11° Andar-Cond. Edifício Milano  
Água Branca  
São Paulo SP  
Brazil  
T +55-11-38561700  
F +55-11-38561781

**Europe**

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

**Asia**

Air Products and Chemicals (China)  
Investment Co. Ltd.  
East Wing, Floor 4  
Building #88, Lane 887  
Zu Chongzhi Road  
Zhangjiang Hi-Tech Park  
Shanghai, 201203  
P.R. China  
T +86-21-38962000  
F +86-21-50805555

**Air Products Japan, Inc.**

21F MUZA Kawasaki Central Tower  
1310 Omiya-cho, Saiwai-ku  
Kawasaki City, Kanagawa  
212-8554  
Japan  
T +81-44-5421550  
F +81-44-5421521



tell me more  
[airproducts.com/coatings](http://airproducts.com/coatings)