Surfynol® DF-110C/D/L Defoamers
Molecular Defoamers with wetting power

Description
Surfynol DF-110C, Surfynol DF-110D, Surfynol DF-110L molecular defoamers are highly effective, non-ionic organic products. They do not contain silicone, silica or fluoro products. These three defoaming/de-air entraining agents are useful for a wide variety of applications where foam prevention or foam elimination is necessary without causing surface defects.

Advantages
- Outstanding long-lasting foam control
- Defect-free foam control
- Effective against microfoam
- Good dynamic wetting
- Silicone, silica and fluoro free
- Effective against phosphates, proteins and other foam stabilizing species
- Non-ionic surfactant
- Non micellar, no cloud point
- Excellent shelf life stability over a wide range of physical conditions
- Chemical stability from pH 3 to 13
- Synergistic with conventional defoamers
- Surfynol DF-110C is VOC free (EU regulations)
- Surfynol DF-110C and DF-110D are HAPs¹ free
- Alkyl phenol ethoxylates (APE) free
- Wide compounding latitude

Formulation Guidance
Typical use levels of Surfynol DF-110 C/D/L defoamer range from about 0.2 to 3.0 wt. % in many formulations. For specific use and formulation guidance, please contact us at one of the offices listed on the back of this brochure.

Applications
- Coatings
  - Automotive OEM and refinish
  - Architectural coatings
  - OEM, DIY and UV wood
  - Industrial maintenance
  - Metal and paper
  - High Solids
- Graphic Arts
  - Printing inks
  - Overprint varnishes
  - Fountain solutions
  - Plate cleaners
- Adhesives
- Latex dipping
- Dye and pigment synthesis
- Pigment grinding
- Oil and gas processing
- Cleaning products
- Metalworking fluids
- Cements, mortars and grouts
- Agricultural adjuvants
- Waste water treatment

¹ Hazardous air pollutants are those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects. The 1990 Clean Air Act Amendments direct the US EPA to set standards for all major sources of air toxics.
Table 1  Typical Chemical, Physical and Performance Properties2

<table>
<thead>
<tr>
<th></th>
<th>Surfynol DF-110C</th>
<th>Surfynol DF-110D</th>
<th>Surfynol DF-110L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Clear Liquid</td>
<td>Clear Liquid</td>
<td>Clear Liquid</td>
</tr>
<tr>
<td>Color</td>
<td>Colorless to pale yellow</td>
<td>Colorless to pale yellow</td>
<td>Colorless to pale yellow</td>
</tr>
<tr>
<td>Activity</td>
<td>20</td>
<td>32</td>
<td>20</td>
</tr>
<tr>
<td>Solvent</td>
<td>Poly Ethylene Glycol</td>
<td>Di propylene Glycol</td>
<td>Ethylene Glycol / Di propylene Glycol</td>
</tr>
<tr>
<td>Viscosity at 25°C</td>
<td>53 mPa.s</td>
<td>180 mPa.s</td>
<td>32 mPa.s</td>
</tr>
<tr>
<td>Density at 20°C</td>
<td>1.050 kg/l</td>
<td>0.99 kg/l</td>
<td>1.033 kg/l</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>&gt; 250°C</td>
<td>200°C</td>
<td>199°C</td>
</tr>
<tr>
<td>pH (20 wt.% in distilled water)</td>
<td>8.5</td>
<td>7</td>
<td>7.3</td>
</tr>
<tr>
<td>Vapour Pressure at 20°C</td>
<td>&lt; 0.01 kPa</td>
<td>0.2753 kPa</td>
<td>1.3300 kPa</td>
</tr>
<tr>
<td>VOCs5 (EPA Method 24)</td>
<td>8 wt.%</td>
<td>50 wt.%</td>
<td>52 wt.%</td>
</tr>
<tr>
<td>VOC (European solvent and paint directives)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Solubility in water</td>
<td>0.03 wt.%</td>
<td>0.03 wt.%</td>
<td>0.03 wt.%</td>
</tr>
<tr>
<td>HLB4</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Equilibrium Surface Tension6 at 0.1 wt.% active, 25°C</td>
<td>28.9 mN/m</td>
<td>31.2 mN/m</td>
<td>28.9 mN/m</td>
</tr>
<tr>
<td>Dynamic Surface Tension7 at 0.1 wt.%, 6 b/s, 25°C</td>
<td>48.3 mN/m</td>
<td>53 mN/m</td>
<td>49.8 mN/m</td>
</tr>
<tr>
<td>Initial Ross-Miles Foam Height at 0.1 wt.% active, 25°C</td>
<td>0 mm</td>
<td>0 mm</td>
<td>0 mm</td>
</tr>
</tbody>
</table>

2 These are typical properties only and do not constitute product specifications.
3 Brookfield HADVII+C/P cone/plate viscometer, HA#CP41 at 10 rpm.
5 Volatile organic compounds (VOCs) were determined using EPA Reference Method 24 and ASTM D 2369.
6 Measured using the Wilhelmy plate method, mN/m = dyne/cm.
7 Measured using the maximum bubble pressure method.

Molecular Defoamers

Molecular defoamers are surface-active agents that break foam at the molecular level rather than through incompatibility. Typically, foam-causing components stabilize foam because of ionic forces, hydrogen bonding and van der Waals forces. In aqueous systems, molecular defoamers function to destabilize the foam lamella by disrupting these forces, thus causing the foam to collapse (see Figure 1).

When absorbed at the foam interface, molecular defoamers reduce the surface elasticity of bubbles to prevent their stabilization. They also reduce surface viscosity of the foam lamella and increase the liquid drainage rate. These combined effects further enhance the defoaming ability of molecular defoamers.

Since molecular defoamers are surface-active, their ability to control foam does not depend on incompatibility and they offer long lasting foam control. Many conventional defoamers require an optimal droplet size in order to achieve optimal defoaming. Over time, their droplet sizes change due to aggregation or dispersion, resulting in a loss of foam control effectiveness. Contrary to this, molecular defoamers remain active in the system, leading to consistent for mulation performance. They also do not cause surface defects, as one would expect from a silicone/silica-based defoamer.

Table 2 : General Defoamer performance comparison

<table>
<thead>
<tr>
<th>Defoamer Type</th>
<th>Knockdown Foam Control</th>
<th>Macro Foam Control</th>
<th>Micro Foam Control</th>
<th>Defoamer Longevity</th>
<th>Compatibility and ease of Handling</th>
<th>Wetting Defect* Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica-based</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Moderate</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Silicone</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Good</td>
<td>Moderate</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Typical Organic</td>
<td>Moderate</td>
<td>Good</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Good</td>
</tr>
<tr>
<td>Surfynol DF-110C/D/L</td>
<td>Moderate</td>
<td>Good</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Good</td>
</tr>
</tbody>
</table>

*Defects such as fisheyes, craters, retractions, etc.
Surfynol DF-110C/D/L Defoamers offer Good Wetting Properties in High Speed Applications

The ability to reduce the surface tension of water is important because it enables the wetting of water-based systems on low surface energy substrates. In many processes, new surfaces are rapidly generated and the surfactant must quickly migrate to the interface to prevent film retraction and other surface defects. These products reduce surface tension at high surface creation rates. Dynamic surface tension of some typical defoamers and Surfynol DF-110C/D/L defoamers is shown here for 0.1 wt % aqueous solutions (Figure 2).

Table 3

<table>
<thead>
<tr>
<th>Pigment Grind Defoaming of a Blue Dispersion</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Phthalo Blue Presscake¹</td>
<td>63%</td>
</tr>
<tr>
<td>Vancryl 68S²</td>
<td>32%</td>
</tr>
<tr>
<td>Isopropanol</td>
<td>5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ink density (kg/l)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unagitated Control</td>
<td>1.15</td>
</tr>
<tr>
<td>Agitated Control</td>
<td>0.50</td>
</tr>
<tr>
<td>Surfynol DF-110D² uselevel 0.1%</td>
<td>0.83</td>
</tr>
<tr>
<td>Surfynol DF-110D³ uselevel 0.2%</td>
<td>1.14</td>
</tr>
</tbody>
</table>

¹ Sun Chemical
² UCB Surface Specialties
³ Defoamer use level: as supplied on total grind formulation

Surfynol DF-110C/D/L Molecular Defoamer Provides Excellent Defoaming during Pigment Grind Processes

Surfynol DF-110C, Surfynol DF-110D and Surfynol DF-110 L defoamers can be used during the pigment dispersion step to control foam generated due to high shear milling. Excess foam during milling extends grind times and decreases dispersion efficiency. Surfynol DF-110C, Surfynol DF-110D and Surfynol DF-110 L defoamers are typically used between 0.2% and 1.0% on total formula during pigment dispersion. (See Table 3.) These defoamers can also be incorporated in the letdown of a printing ink for sustained foam control. Unlike traditional silicone and oil-based defoamers, use of Surfynol DF-110C/D/L defoamers will not cause print defect problems since they are surface active molecules. In addition, these products will not swell photopolymer plates.
Outstanding Foam Control in Water Based Ink Systems

Many resins used in the printing ink industry can generate undesirable foam. Most commodity surfactants used for wetting and printing characteristics promote and stabilize excessive foam, which in turn, can create printing problems. Surfynol DF-110C/D/L defoamers provide significant better foam control than conventional mineral and silicone oil defoamers. They also improve film appearance (better ink transfer, reduction of craters & pinholes) without negative side defects as seen with conventional defoamers.

Surfynol DF-110C/D/L Defoamers are Effective at Foam Elimination in Cleaning Applications

During washing cycles, the washing temperature might not always be achieved when foam is generated by the cleaning equipment. Typical defoamers used for elevated temperature cleaning may not be effective at ambient temperatures. Problems may arise as foam can decrease the cleaning efficacy of the equipment in areas where warm or hot water is not present. Molecular defoamer Surfynol DF-110D shows efficacy at ambient temperatures and elevated temperatures enabling more application latitude of cleaners.
Automotive Refinish Primer: Defect Prevention

Surface tension differences between the liquid and the substrate can cause liquid retraction and surface defect like cratering. This phenomenon can be reduced by selecting the appropriate surfactant/defoamer package. Molecular Defoamers like Surfynol DF-110 C/D/L can meet this need by providing effective surface tension reduction (Figure 5) as well as effective defoaming alone or in combination with a conventional defoamer.

Surfynol DF-110C/D/L Defoamers are Effective against Microfoam

When isocyanate reacts with water it forms carbon dioxide gas. CO₂ bubbles may become stabilized in the formulation and lead to defects to the final products. Molecular defoamers like Surfynol DF-110D are very effective in eliminating microfoam and allow bubbles to rise to the surface where common defoamers can attack the residual macro foam. Figure 6 shows a two component iso-cyanate system reacted in the presence of water where the silicone defoamer is ineffective against micro and macrofoam. The mineral oil defoamer is highly effective against macrofoam but ineffective against microfoam. The molecular defoamer is very effective against microfoam and would have excellent synergy with the mineral oil defoamer in such systems.
For Samples or 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.

**Europe**

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

**Latin America**

**Air Products and Chemicals, Inc.**
Latin American Region  
7201 Hamilton Boulevard  
Allentown, PA 18195-1501  
Tel +610-481-5986  
Fax +610-481-5817

**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 +52-5246-0400  
Fax +52-5246-0448 and 5246-0449

**Air Products Brazil Ltda.**
Praça Radialista Manoel de Nobrega, 65  
Casa Verde  
02517-160 São Paulo-SP  
Brazil  
Tel +55-11-3856-1700  
Fax +55-11-3856-1781

**Asia**

**Air Products J apan, Inc.**
21F MUZA Kawasaki Central Tower  
1310 Ohmiya-cho, Saiwai-ku  
Kawasaki 212-8554  
Japan  
Tel 81-44-542-1531  
Fax 81-44-542-1521

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

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