Zonyl® Fluorosurfactants

Zonyl® fluorosurfactants, are a unique and useful formulation tool for paints, adhesives, inks, and other coatings. The multi-functional properties provided by Zonyl® fluorosurfactants include anti-cratering, improved leveling, reduced foaming, decreased blocking, open-time extension, oil repellency, and dirt pickup resistance.

Their ability to reduce surface tension gives the formulator a tool to create coatings that can effectively wet substrates with surface energies as low as 16 dynes/cm (see Table 1). They improve the coating’s ability to overcome surface contamination and wet low surface energy substrates (see Figure 1). Zonyl® fluorosurfactants enable the formulator to produce thinner defect-free coatings in spray applied, high-speed coatings techniques and traditional application methods, and they do so at very low use levels (see Figure 2).

Zonyl® fluorosurfactants dramatically reduce surface tension in coatings, below levels possible using hydrocarbon or silicone surfactants alone. When used in coatings, Zonyl® fluorosurfactants improve flow and wetting. They also reduce surface defects, such as craters, pinholes, orange peel, cratering, picture framing, and edge crawling.

Zonyl® fluorosurfactants are effective in aqueous or solvent-based systems, high and low pH systems, and powder and energy cured coatings.

Table 1

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Typical surface energies (dynes/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy</td>
<td>47</td>
</tr>
<tr>
<td>Polyamide</td>
<td>46</td>
</tr>
<tr>
<td>Polyester</td>
<td>43</td>
</tr>
<tr>
<td>PVC</td>
<td>39</td>
</tr>
<tr>
<td>Polymetric</td>
<td>35</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>33</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>30</td>
</tr>
<tr>
<td>Silicone</td>
<td>24</td>
</tr>
<tr>
<td>Teflon®</td>
<td>18</td>
</tr>
</tbody>
</table>
Synergies in Formulation with Zonyl® Fluorosurfactants

Mixed fluorosurfactant/hydrocarbon surfactant systems can give impressive gains in the areas of reducing foam, improving dynamic surface tension reduction, and enhancing fluorine efficiency. Improved performance (cost and function) from these mixed systems improve both cost and performance. Best synergy and cost-effectiveness are achieved when formulators remove or replace a portion of traditional surfactants with Zonyl® fluorosurfactants. In many applications overall costs can be reduced when removing a hydrocarbon surfactant and replacing with a fractional amount Zonyl® fluorosurfactant.

Fluorosurfactant Recommendations

Water-Based

Zonyl® FS-610, FSO, and 9361 are used extensively in coating applications and should be considered when evaluating fluorosurfactants in anionic water-based coating formulations. Other grades may be appropriate for specific applications. Typical use levels in water-based systems are 0.01–0.1% Zonyl® fluorosurfactant by weight of wet paint formulation. Fluorosurfactants are typically not defoamers, but Zonyl® FS-610, FSE, and 9361 used at recommended level in water based systems provide defoaming properties.

Solvent-Based

Zonyl® FSO-100 and FSG are recommended for solvent-based systems as wetting, leveling agents to reduce surface defects. Their typical use rate is at 0.01–0.1% by weight of wet formulation. In solvent systems that can tolerate low levels of water (<0.5%), it is possible to use the aqueous Zonyl® products for easy handling, because the final water concentration will be low enough to not cause interfere with system performance.

Cost-Effectiveness in Formulation

In most formulations, Zonyl® fluorosurfactants are used in combination with conventional surfactants. This can lower the total cost of the surfactant package and provide better performance as well. Typical formulations using Zonyl® are able to reduce the loading of the conventional (silicone or hydrocarbon) surfactants, while creating an even lower surface tension in the formulated product.

Figure 3 below shows mixed Zonyl® and hydrocarbon surfactants achieve lower surface tension than the same cost level of hydrocarbon surfactant alone. For example, when using Triton® X-100, a hydrocarbon surfactant, at an addition rate of 2¢ per formulated pound of product the surface tension is 32 dynes/cm. When 1¢ of the Triton® was removed and 1¢ of Zonyl® FSO was substituted in the mixture, the surface tension was reduced to 27 dynes/cm. For the same formulated cost, a surface tension reduction of 5 dynes/cm was achieved using Zonyl® FSO in the mixture with the hydrocarbon surfactant!
Figure 4 shows a comparison of a latex exterior paint with and without Zonyl® 9361 after nine months outdoor exposure. Zonyl® 9361 was used to provide anti-blocking, and oil repellency with additional wetting and leveling. It also allowed the reduction of oil attracting additives. The liquids in the picture are water (upper) and hexadecane (lower).

100% Solids, Powder, and Radiation-Cured Coatings

The same principles of wetting and leveling on low surface tension substrates apply to these types of coatings. To achieve good film properties, the surface tension of the coating must be below the substrate surface energy. Recommendations for 100% solids coatings are Zonyl® FTS, 8857A, and FSO-100. For powder coatings, Zonyl® FTS and FSG are recommended. In radiation-cured coatings, Zonyl® 8857A or FSO-100 are recommended as inert additives. Zonyl® TM, a fluorinated methacrylic monomer, is recommended as reactive additive. Addition rates are typically 0.05–0.10% weight for a typical 25 µm thickness of coating. On thicker coatings, less may be needed; thinner coatings may require more Zonyl® agents.

Note: In the case of powder coatings, it is possible to mix the fluorosurfactant in the extrusion or solvent stage or to directly mix the surfactant with the powder.

Zonyl® Surface modification agents

Anti-blocking, easy clean, and dirt pickup resistance agents modify coating surfaces to improve cleanability and soil repellency and to reduce or prevent blocking. These Zonyl® grades migrate to the paint surface, and provide effective protection where it is needed most. (Zonyl® products used in these applications do not affect recoat adhesion).

Antiblocking for low VOC paints—Zonyl® 9361, FS-610 and FSE are effective antiblock additives for low VOC aqueous coatings such as gloss and semigloss latex paints. Typical use levels are 0.04 to 0.08% for Zonyl® 9361, 0.08 to 0.1% for FS-610, or 0.08 to 0.1% for FSE by weight on wet coating formulation. In this application, we recommend to reduce defoamer, and other wetting, leveling agents to gain the full benefit of the multifunctional properties of the Zonyl® agent.

Easy clean for interior flat paints—Zonyl® 8867L provides oil repellency and oily stain resistance in interior latex paints (especially flat paints), making soils like greasy fingerprints easier to clean. Zonyl® 8867L can also be used in other aqueous coatings, such as floor finishes and acrylic sealers. Typical use level is 0.3 to 0.75% by weight on wet coating formulation. Also effective in these applications with the proper formulation is Zonyl® 9361, FS-610, and FSE.
Dirt pickup resistance for exterior paints—Zonyl® FS-610, 9361, and FSE can be added to latex exterior formulations to provide oil repellency while serving as wetting, leveling, anti-foam, and anti-blocking agents. Since Zonyl® agents provide multiple functions in the coating formulation, the reduction of other additives that are oil attracting additives is an important element of reducing exterior dirt pickup. Recommended use levels are 0.08 to 0.12% for Zonyl® FS-610, 0.05 to 0.1% for 9361, and 0.1 to 0.2% for FSE by weight on wet coating formulation.

Solvent-based coatings—Zonyl® 8857A provides oil and water repellency and anti-block performance in alkyd paints and stains, as well as other solvent-based coatings. This product migrates to the coating surface. In alkyd systems, Zonyl® 8857A crosslinks with the base resin to lock in the film protecting the surface. Typical use levels are 0.01 to 0.1% Zonyl® 8857A by weight on wet formulation. Zonyl® FSG and FSO-100 may also be used to increase oil repellency in solvent-based systems.

Using Zonyl® Products

• Lower use rates for Zonyl® are needed compared with hydrocarbons. With Zonyl® typical use rates are 0.1% or less.
• Create stock solutions for more accurate and easier addition of Zonyl® samples: take your preferred solvent or solvent blend and mix Zonyl® agent in to make this stock solution; a typical solution is 10%, or 9 parts of solvent and 1 part Zonyl®. Creating this stock solution makes addition of the Zonyl® to the system easier. Instead of adding 1 lb of material to a 1,000 lb batch, add 10 lb of the stock solution.
• Zonyl® products should be agitated prior to use to ensure performance consistency.
• Some Zonyl® fluorosurfactants form sediment when stored at less than 10°C (50°F). The sediment is concentrated active ingredient. We strongly recommend that you mix the material prior to use; redispersing is made easier when heated to 40°C (100°F), but good mixing alone prior to addition is sufficient to achieve equal dispersion of the fluorosurfactant.