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TECHNICAL BULLETIN

Siltech® Wetting Agents

DESCRIPTION

Siltech® wetting agents are designed to lower the surface tension of and cause solutions in which they are contained at low use levels to wet out or spread upon a surface. The surfaces can be hard surfaces such as porcelain, ceramic, natural stones, rubber, plastics, coated surfaces, or many others; flexible surfaces such as fabric, paper or leather; or biological surfaces such as hair, skin, insect shells, or plant leaves.

Depending on the specific product the solutions can be aqueous, oil, or solvent based.

Super spreaders:

One class of these wetting agents lowers the surface tension of water to the 20-22 mN/m range at use levels around 0.01% (by weight.) This low surface tension causes the aqueous solution to spread on or wet nearly all known surfaces.

In addition, these materials exhibit the very unique property of superspreading. Believed to be driven by the forces set up when the surfactant molecules are slow to repopulate a surface that has been stretched, superspreading is when the solution covers a surface area much greater than that of normal surfactant solutions. Contact angles on most surfaces are 0° or nearly 0° and spreading is halted only by competition with evaporation of the water. Very few surfactants can do this; even fluorosurfactants which reduce surface tension to lower numbers do not super spread.

These low surface tension solutions also tend to flood through small openings which are normally protected from water penetration by high surface energy. For example, penetration of stomata on plant leaves; channels in textile fibres; biofilms; and pores on chitinous insect shells. Anything dissolved in the solution is carried through as well.

These highly thin films are subject to rapid evaporation often allowing claims of quick dry on fabrics and hard surfaces.

This product class is available in several products for water-based formulation; **Sil surf® A008-UP**, **Sil surf A008-AC-UP**, **Sil surf A008-MC-UP** and **Sil surf A004**(low foaming). Furthermore, these unique properties are available in reactive forms; **Silmer® ACR A0** (UV cured), **Silmer® OH A0** (condensation cured), and **Silmer® NH A0** (Condensation cure). The product backbone is also available with quaternary ammonium functional groups; **Silquat®A0** and **Silquat A0-1B**.

Data (Superwetters Aqueous):

Surfactant	0.1% ST (mN/m)	CMC (%)	5 min Foam Height of 1% (mL)	Draves Wetting (sec)	Spreading on Paraffin (mm ²)
None	74.6	NA	0	>300	2.0
LAE ¹	32.4	2x10 ⁻³	>500	37.4	4.0
SLS ²	30.9	4x10 ⁻² /6x10 ⁻² (3)	>500	>300	4.1
Sil surf A008-UP	21.1	1x10 ⁻²	348	14.2	75.5
Sil surf A008-AC-UP	21.5	6x10 ⁻³	91	22.2	55.5
Sil surf A008-MC-UP	20.8	8.1x10 ⁻³	427	13.0	80.0
Sil surf AG-64	20.4	3.1x10 ⁻³	307	21.7	76.0
Sil surf A010-D-UP	22.6	2.5x10 ⁻³	>500	11.5	35.9
Sil surf® A004	21.2	5x10 ⁻³	15	>300	39.4

¹LAE = Rhodasurf LA-9

²SLS = Jeelate SLS-30

³dual CMCs apparent in this experiment

One can see that compared to a strong performing organic nonionic control (LAE: nine mole ethoxylated linear alcohol) these superspreading silicone surfactants show much lower equilibrium surface tension, improved Draves wetting times, lower foam height, and extraordinary spreading on surfaces. They have similarly low critical micelle concentrations (CMC) which is often an indicator of minimum effective use levels.

When compared to a potent anionic surfactant, SLS, again one sees much lower equilibrium surface tension, dramatically improved Draves wetting times, lower foam height, and extraordinary spreading on surfaces. The CMCs are an order of magnitude lower as well. Even though silicone surfactants can cost more per pound than organic surfactants, the much lower use level can translate to less expensive costs and the unique properties can allow new and interesting claims.

Standard Wetting Agents:

Most **Silsurf**[®] surfactants are not designed to superspread but will still cause a solution to wet out and partially cover a substrate. In many applications; wicking in fibres, improved flow and levelling in coatings or other films, dispersing of pigments or other insoluble species, increased stability of emulsions, and other desirable properties are seen with very low use levels. Typical use levels are around 0.1% by weight of the total formula. In an ideal situation one can drive this use level down to the CMC.

These materials are excellent in applications where super spreading properties are not needed or undesirable. Products like **Silsurf A108**, **Silsurf A208** and **Silsurf B0.504** still give very low surface tension, spreading and Draves wetting and CMC values.

Products such as **Silsurf B608** and **Silsurf E608** give good surface tension and CMC performance with little foam or even defoaming.

Applications Data (Standard Aqueous):

Surfactant	0.1% ST (mN/m)	CMC ⁽¹⁾ (%)	5 min Foam Height of 1% (mL)	Inverse Cloud Point (°C)	Draves Wetting (sec)	Spreading on Paraffin (mm ²)
Silsurf B608	36.2	4x10 ⁻² /5x10 ⁻²	25	<25	>300	2.8
Silsurf E608	37.0	7x10 ⁻² /1x10 ⁻²	38	<25	>300	3.9
Silsurf B0.504	21.9	3x10 ⁻³ /7 x10 ⁻³	186	33 ⁽²⁾	63.8	14.8
Silsurf C208	28.0	2x10 ⁻³ /7 x10 ⁻³	293	61	>300	5.4
Silsurf A208	22.1	4x10 ⁻³	347	60	40.7	23.6
Silsurf A108	21.8	2x10 ⁻³ /8 x10 ⁻³	405	65	47.0	12.0

¹dual CMCs apparent in these experiments

²not completely clear at 25°C, but a definite transition at 33°C

Surface Tension Reduction of Non-Aqueous Systems:

Despite the low surface tension of solvents, one can reduce that even further with the proper silicone wetting agent. This can enhance the solvent properties and perhaps allow less of these materials to be used. The data below is a screening at 0.5% use level, in most cases one can reduce that considerably.

	ST of Pure Solvent (mN/m)	ST w/ 0.5% additive (mN/m)	Additive
Toluene	28.9	25.0	Silwax [®] D026
2-butoxyethanol	29.1	22.0	Silwax C18
Isopropanol	21.7	20.5	Silsurf A008-UP
Motor oil	31.0	22.6	Silwax CR 5016

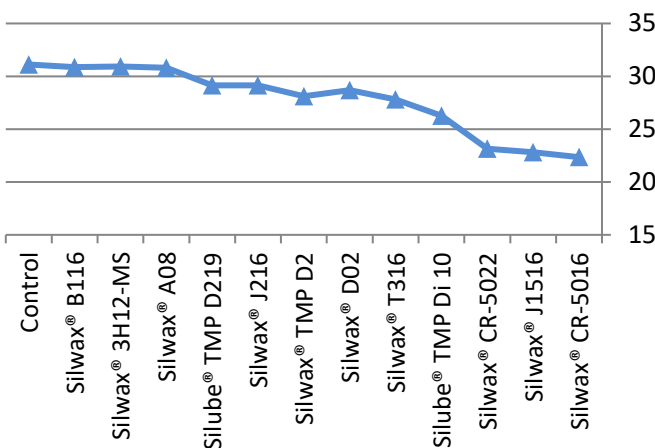
Oil Based Wetting Agents:

Oil soluble silicones **Siltech® CR-5016** and **Silwax® D02** have been shown to be particularly efficacious at lowering the surface tension of petroleum or natural polar oils respectively at very low use levels. Use levels can be as low as 0.05% by weight. This causes those oils to feel like silicone oil in many cases. It can also lead to those oil solutions spreading on surfaces much more than the pure oils.

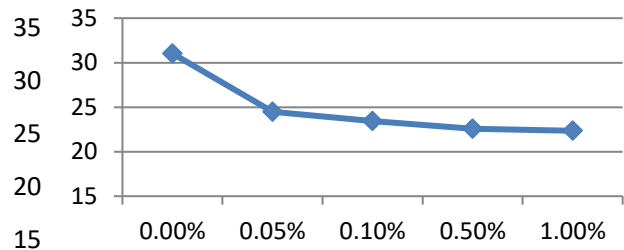
These have been shown to spread oil on water more extensively than oil alone and have been used in personal care skin care formulations as a desirable oil phase.

Applications Data

**Surface Tension of Motor Oil with
1% of Various Silicones Added**



Silwax CR 5016 in Motor Oil



USES AND APPLICATION

Silicone based aqueous wetting agents can be used to provide, wetting, coverage, penetration or flooding of micro orifices in a variety of applications such as coatings, hard surface cleaners, polishes, biofilms, fabric care, or pigments.

Oil based wetting agents can be used in a variety of applications where reducing the surface tension of oils is desirable such as spreading oil across water or hard surfaces, lubricating as in oil or gas pipelines, improving coverage such as waxes or polishes.

Use levels are 0.5% and lower. The materials are typically dissolved into the solution with minimal stirring.

SAFETY

Before handling, read the Material Safety Data Sheet and container label of the individual products for safe use, physical and health hazard information.

LEGAL DISCLAIMER

Siltech Corporation believes that the information in this technical data sheet is an accurate description of the typical uses of the product. Siltech Corporation, however, disclaims any liability for incidental or consequential damages, which may result from the use of the product that are beyond its control. Therefore, it is the user's responsibility to thoroughly test the product in their particular application to determine its performance, efficacy and safety. Nothing contained herein is to be considered as permission or a recommendation to infringe any patent or any other intellectual property right.

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