Surface Tension Reduction of Motor Oil Utilizing Specialty Silicone Technology

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Siltech LLC
Surface Tension Reduction

Engine Oil Project
Surface Tension Definition

- A property of liquids arising from unbalanced molecular cohesive forces at or near the surface, as a result of which the surface tends to contract and has properties resembling those of a stretched elastic membrane.
Surface Tension Reduction

Structural Requirements

- The reduction of surface tension in oils is dependent upon the ability of an amphiphilic silicone to reach the liquid surface and orient itself properly.

- Surface Tension decreases with increasing temperature.
Surface Tension Reduction

Performance Requirements

- An effective silicone product must possess balanced solubility.
  - Sufficiently soluble to provide clarity
  - Sufficiently insoluble to migrate to the surface

- The most efficient molecules for reducing the surface tension are those that provide the lowest surface tension at the lowest concentration.
Surface Tension Reduction
Conventional Silicone Technology

- Lower surface tension can also be achieved by utilizing conventional silicones (dimethyl silicones).

- However, conventional silicones are poorly soluble in conventional and synthetic oils....principally used as antifoamants.
Siltech LLC has developed and filed patents on a series of silicone compounds that have the ability to lower surface tension of both conventional and synthetic engine oils.

The silicone compounds are active at treat rates of less than 1% active ingredient.

Branded as Silube® 5016 and Silube® 6016.
Silube® 5016 and Silube® 6016.

INCI: Cetyl dimethicone crosspolymer

The reduction of the surface tension of motor oil will increase miles per gallon and reduce the wear on the engine, resulting in increased engine life.
Surface Tension Reduction
Silube™ Structural and Mechanistic Features

• Selected alkyl groups on the silicone polymer improves the solubility of the Silube® Silicones in oils.

• Very limited crosslink density
  ▪ Lowest free energy of the oil occurs when the silicone polymer is pushed to the oil/metal interface where it surprisingly lowers surface tension.
Excellent Solubility in Engine Oils

10W-30 Synthetic Control (A)       (A) + 1% Silube® 5016
## Surface Tension Reduction

### Conventional Silicones

<table>
<thead>
<tr>
<th>Surface Tension:</th>
<th>1% in Lube A 10W-30</th>
<th>1% in Lube B 10W-30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Octyl dimethicone</td>
<td>29.3 mN/m</td>
<td>29.3 mN/m</td>
</tr>
<tr>
<td>Cetyl Dimethicone</td>
<td>29.9 mN/m</td>
<td>29.7 mN/m</td>
</tr>
<tr>
<td>Stearyl dimethicone</td>
<td>Solid</td>
<td>Solid</td>
</tr>
<tr>
<td>Lauryl Dimethicone</td>
<td>30.9 mN/m</td>
<td>30.6 mN/m</td>
</tr>
<tr>
<td>350 cSt Silicone Fluid</td>
<td>Insoluble</td>
<td>Insoluble</td>
</tr>
<tr>
<td>50 cSt silicone fluid</td>
<td>Insoluble</td>
<td>Insoluble</td>
</tr>
<tr>
<td>Control (Untreated lube)</td>
<td>31.0 mN/m</td>
<td>30.8 mN/m</td>
</tr>
</tbody>
</table>

ASTM D 7490
**Surface Tension Reduction**

*Silube® Silicones*

<table>
<thead>
<tr>
<th>Surface Tension:</th>
<th>1% in Lube A 10W-30 Mineral Oil</th>
<th>0.5% in Lube A 10W-30 Mineral Oil</th>
<th>1% in Lube B 10W-30 Synthetic</th>
<th>0.5% in Lube B 10W-30 Synthetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silube® 5016</td>
<td>22.5 mN/m</td>
<td>22.2 mN/m</td>
<td>22.0 mN/m</td>
<td>22.2 mN/m</td>
</tr>
<tr>
<td>Silube® 6016</td>
<td>23.5 mN/m</td>
<td>NA</td>
<td>23.1 mN/m</td>
<td>NA</td>
</tr>
<tr>
<td>Control (Untreated lube)</td>
<td>31.0 mN/m</td>
<td>31.0 mN/m</td>
<td>30.8 mN/m</td>
<td>30.8 mN/m</td>
</tr>
</tbody>
</table>

Surface Tension reductions of 24 – 29 % obtained with Silube® Silicones at 0.5 and 1 % treat rates

ASTM D 7490
Surface Tension Reduction
Conventional Engine Oil

Additive Treat Rate = 1.0 % in Lube A (* = 0.5 %)
Surface Tension Reduction
Synthetic Engine Oil

Additive Treat Rate = 1.0 % in Lube B (* = 0.5 %)
Implications to Lubrication

- Does reduced surface tension have the same effect as reduced viscosity?
  - Will a 10W-30 perform like a 5W-20 or an ISO VG 100 like an ISO VG 32?
- Does improved wettability/penetrability result in improved lube/lube additive performance?
- USP 5,320,761 (Pennzoil) cites Surface Tension reduction as way to improve fuel economy.
  - Employ detergents at ~ 3.0 % to maintain 20 mN/m during use.
Thank You

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Surface Tension Reduction
Silube® Silicones

Surface Tension reductions of 24 – 29 % obtained with Silube® Silicones at 1 % treat rate

ASTM D 7490
Surface Tension Reduction
Conventional Engine Oil

Additive Treat Rate = 1.0 % in Lube A
Surface Tension Reduction
Synthetic Engine Oil

Additive Treat Rate = 1.0 % in Lube B