MOLYVAN® 3000
Friction Reducer

Branching Makes It Better

Friction Reducer     Antiwear Agent   Antioxidant
MOLYVAN® 3000
Friction Reducer
Molybdenum Dithiocarbamate Additive

Friction Reducer  Antiwear  Antioxidant

Typical Properties

<table>
<thead>
<tr>
<th>Physical State</th>
<th>Brown Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density at 25°C, Mg/m³</td>
<td>1.05</td>
</tr>
<tr>
<td>Viscosity at 100°C, mm²/s.</td>
<td>53.0</td>
</tr>
<tr>
<td>Color, 1% in hexane</td>
<td>L5.0</td>
</tr>
<tr>
<td>Sulfur Content, %</td>
<td>10.7</td>
</tr>
<tr>
<td>Molybdenum Content, %</td>
<td>10.1</td>
</tr>
</tbody>
</table>

MOLYVAN® 3000 is an exceptional oil soluble molybdenum dithiocarbamate (MoDTC) friction reducer with antiwear and antioxidant properties. Its unique alkyl group structure allows for improved solubility in today’s less polar base oils which makes it very useful in a wide range of automotive and industrial lubricants.

Table 1
Additive Solubility Performance

<table>
<thead>
<tr>
<th>Additive Solubility Performance</th>
<th>90 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ambient</td>
</tr>
<tr>
<td>MOLYVAN® 3000 Friction Reducer</td>
<td>Clear</td>
</tr>
<tr>
<td>Competitive MoDTC with 10% Mo</td>
<td>Clear</td>
</tr>
</tbody>
</table>

*Haze developed within 1 day

This solubility study was conducted in a prototype, fully-formulated 0W-20 GF-5 engine oil containing Group III base oil, 750 ppm phosphorus and 700 ppm molybdenum, based on observation of haze and precipitate formation at various temperatures. Low temperature solubility for MoDTC additives is critical in engine oil applications.

Disclaimer:
Before using, read, understand and comply with the information and precautions in the Material Safety Data Sheets, label and other product literature. The information presented herein, while not guaranteed, was prepared by technical personnel and, to the best of our knowledge and belief, is true and accurate as of the date hereof. No warranty, representation or guarantee, express or implied, is made regarding accuracy, performance, stability, reliability or use. This information is not intended to be all-inclusive, because the manner and conditions of use, handling, storage and other factors may involve other or additional safety or performance considerations. The user is responsible for determining the suitability of any material for a specific purpose and for adapting such safety precautions as may be required. Vanderbilt Chemicals, LLC does not warrant the results to be obtained in using any material, and disclaims all liability with respect to the use, handling or further processing of any such material. No suggestion for use is intended as, and nothing herein shall be construed as, a recommendation to infringe any existing patent, trademark or copyright or to violate any federal, state or local law or regulation.

Registered and pending trademarks appearing in these materials are those of R.T. Vanderbilt Holding Company, Inc. or its respective wholly owned subsidiaries. For complete listings, please visit this location for trademarks, www.rtvanderbiltholding.com

Vanderbilt Chemicals, LLC
30 WINFIELD STREET, P.O. BOX 5150, NORWALK, CONNECTICUT 06856-5150 • (203) 853-1400
Fax (203) 853-1452 • Internet Address: www.vanderbiltchemicals.com

2/9/2015
Figure 1
Low Temperature Solubility Performance

Photograph 1

Photograph 2

MOLYVAN® 3000 Friction Reducer demonstrates improved oil solubility versus the competitive product, a similar commercial molybdenum dithiocarbamate friction reducer that contains 10% molybdenum, when stored at -10°C for 90 days by virtue of the absence of haze and precipitate in the oil.
MOLYVAN® 3000 Friction Reducer demonstrates improved friction reduction and retention properties in a prototype SAE 5W-30 fully formulated GF-5 engine oil containing 750 ppm phosphorus and 320 ppm molybdenum using a Mini Traction Machine (MTM). The MTM bench test uses the ball-on-disc configuration with a slide-to-roll ratio of 50%, 35 N load at 120°C. Test oils are aged in a modified High Temperature Corrosion Bench Test for 48 hours at 165°C (provides similar FTIR oxidation level as Sequence VID aging after 100 hours or 6500 miles).
Figure 3
MTM ECR Film Formation Performance Comparison

MOLYVAN® 3000 Friction Reducer demonstrates improved film formation tendencies using the MTM as measured by Electrical Contact Resistance (ECR) in the boundary and mixed lubrication regimes versus the competitive MoDTC with 10% Mo. ECR measures the resistance to electrical current flow between ball and disc. High ECR values are an indication of thicker film formation whereas low ECR values are associated with thinner and incomplete film formation. Test oils and test conditions for oil aging and friction tests are the same as in Figure 2.