UCON Compressor Lubricants PE-320 and PE-320L

Product Description

UCON™ Compressor Lubricants PE-320 and PE-320L have been especially designed to provide the utmost in performance and reliability in the tough service experienced in hyper-compressors and intensifiers used in the high-pressure/low-density polyethylene (HP-LDPE) process. These high-performance synthetic lubricants are made from a specially selected polyalkylene glycol-base stock polymer to provide exceptional lubricity and other performance features. A dedicated production facility ensures consistent, high-purity product.

All the components of UCON Compressor Lubricants PE-320 and PE-320L are identified in FDA Regulation 21 CFR 178.3570, and the product is acceptable under this regulation for use as a lubricant for machinery for producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food.

UCON Compressor Lubricant PE-320L is identical in every specification to PE-320, but PE-320 has a higher content of antioxidant. In most cases, the products will perform equally well.
Special Features

UCON Compressor Lubricants PE-320 and PE-320L offer high-pressure/low-density polyethylene producers a set of unique features that offer several key advantages in the operation of hyper-compressors and intensifiers:

- Cleanliness: no sludge, varnish, lacquer, etc., formed.
- High viscosity index.
- No thickeners added to boost viscosity.
- Low pressure-viscosity coefficient.
- Excellent inherent lubricity without use of external lubricity additives.
- Oxidative and thermal stability.
- US FDA approved components (21 CFR 178.3570).

Performance Benefits

The special features associated with UCON Compressor Lubricants PE-320 and PE-320L lead to many benefits. Key among them are:

- Reduced maintenance and substantial maintenance dollar savings resulting from clean-running equipment.
- Increased equipment reliability, allowing scheduled maintenance at predictable intervals. Helps cut down lost production due to unscheduled, random maintenance shut-downs.
- Compressor packings run cooler and longer due to superior lubricity of UCON Compressor Lubricants PE-320 and PE-320L, an inherent property of the base polyalkylene glycol. There is no need for lubricity additives that are necessary with competitive white oil and polybutene products. Eliminates worries about potential negative effects of lubricity additives on the polyethylene product.
- UCON Compressor Lubricants PE-320 and PE-320L contain no polyisobutylene or other thickeners that could drop out and cause deposits on discharge valves. Valves run cleaner and require less maintenance.
- Cost-effective lubricant for high-pressure ethylene compressors.
- Low pressure-viscosity co-efficient reduces the lubricator pump pressure necessary to deliver lubricant to the cylinder.
Typical Physical Properties for PE-320 and PE-320L

Typical Physical Properties for PE-320 and PE-320L

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity†</td>
<td></td>
</tr>
<tr>
<td>cSt at 37.8°C (100°F)</td>
<td>303</td>
</tr>
<tr>
<td>cSt at 99°C (210°F)</td>
<td>42</td>
</tr>
<tr>
<td>Viscosity Index (ASTM D 2270)</td>
<td>207</td>
</tr>
<tr>
<td>Pour Point (ASTM D 97) °C (°F)</td>
<td>-7 (19)</td>
</tr>
<tr>
<td>Flash Point (ASTM D 92), Cleveland Open Cup, °C (°F)</td>
<td>207 (405)</td>
</tr>
<tr>
<td>Water Content, Maximum %</td>
<td>0.15</td>
</tr>
<tr>
<td>Ash Content, Maximum %</td>
<td>0.01</td>
</tr>
<tr>
<td>Specific Gravity, 20/20°C</td>
<td>1.079</td>
</tr>
<tr>
<td>Pounds Per Gallon, (kg/Liter)</td>
<td></td>
</tr>
<tr>
<td>At 15.56°C (60°F)</td>
<td>9.18(1.101)</td>
</tr>
<tr>
<td>At 20°C (68°F)</td>
<td>9.15(1.098)</td>
</tr>
</tbody>
</table>

† Other viscosity grades can be supplied on request.

Performance Characteristics

Viscosity Index
UCON Compressor Lubricants have inherently high viscosity indexes, in the range of 190-215, compared to viscosity indexes of 90-100 for mineral oils and polybutenes.

The benefits of high viscosity indexes are graphically illustrated in Figures 1, 2 and 3, which compare a typical mineral oil and UCON Compressor Lubricants PE-320 and PE-320L.

Performance Benefits of High Viscosity Index (VI):
UCON Compressor Lubricants PE-320 and PE-320L vs. Mineral Oil

Figure 1 • Lower Pour Point
Pour point is the temperature at which a fluid will not flow (where viscosity vs temperature curve intersects line A). The pour point of the high viscosity index UCON Compressor Lubricants PE-320 and PE-320L is lower than that of the same ISO viscosity grade mineral oil.

![Graph showing viscosity vs temperature with Mineral Oil and UCON Compressor Lubricants PE-320 & PE-320L compared]
**Figure 2 • Easier Low-Temperature Start-Up**

At a given start-up temperature (line B), the higher viscosity index of the UCON Compressor Lubricants PE-320 and PE-320L affords easier start-ups and handling because its viscosity is lower than that of the lower VI mineral oil.

**Figure 3 • Higher Viscosity at High Temperature**

If equipment runs hotter than expected (line C), the high viscosity index of the UCON Compressor Lubricants PE-320 and PE-320L provides higher viscosity for better lubrication of valuable equipment than the lower VI mineral oil.
Solubility

The solubility of ethylene in UCON Compressor Lubricants PE-320 or PE-320L is much lower than competitive white oil and polybutene products, as shown in Figures 4 and 5. This means that any reduction in lubricant viscosity due to gas dissolution in lubricant is minimal. Therefore, since UCON Compressor Lubricants PE-320 and PE-320L better maintain viscosity in contact with ethylene, they provide thicker lubricant films (film thickness being proportional to viscosity) and better lubrication than white oil and polybutene lubricants. The benefits to the user are efficient lubrication, reduced down times, longer run times between maintenance shutdowns, and increased equipment life. In short, UCON Compressor Lubricants PE-320 and PE-320L provide a low cost/performance ratio.

Figure 4 • Ethylene Solubility in UCON Lubricants PE-320 and PE-320L at 50°C vs White Oil
Pressure-Viscosity Relationship

The lubricant pumps and ethylene compressors used in HP-LDPE production operate at elevated pressures of up to 50,000 psi. The pressure-viscosity relationship of a lubricant becomes an important factor.

\[
\frac{V_2}{V_1} = e^{a(P_2 - P_1)}
\]

Or

\[
\ln V_2 = a(P_2 - P_1) + \ln V_1
\]

In the above relationships, \(V_1\) and \(V_2\) are viscosities at pressures \(P_1\) and \(P_2\), respectively, and \(a\) is the pressure-viscosity coefficient. Lower values of \(a\) are very desirable to keep the increase in lubricant viscosity within acceptable limits to provide efficient lubrication.

The pressure-viscosity relationships shown in Figure 6 clearly show that UCON Compressor Lubricants PE-320 and PE-320L have the most favorable pressure-viscosity response as compared to white oil and polybutene lubricants. The pressure-viscosity advantage of UCON Compressor Lubricants PE-320 and PE-320L is maintained at typical compressor operating temperatures as well.

Due to their favorable pressure-viscosity response, UCON Compressor Lubricants PE-320 and PE-320L provide important operating benefits. The viscosity of UCON Compressor Lubricants PE-320 and PE-320L are maintained at levels far below where a lubricant can become “solid-like”, thus providing efficient lubrication at the entire range of operating pressures. Additionally, as shown in Table 1, the internal pressures generated in lubricant pumps are far lower.
In order to achieve benefits similar to UCON Compressor Lubricants PE-320 and PE-320L, manufacturers of white oil and polybutene lubricants usually recommend an oil of far lower viscosity (at 40°C/104°F) to keep those lubricants from becoming solid-like at the higher operating pressures. This approach is, at best, a compromise and usually necessitates making up for the attendant penalty of lubricity loss by adding external lubricity additives. Despite the fact that a lower viscosity (700 SUS) white oil was used for the comparison of the pressure-viscosity relationship with UCON Compressor Lubricants PE-320 and PE-320L (1400 SUS) shown in Figure 6, it is clear that UCON Compressor Lubricants PE-320 and PE-320L have a more favorable pressure-viscosity response at typical operating pressures of 15-50,000 psia.

**Figure 6 • Pressure – Viscosity Relationship at 40°C**
Table 1 - Internal Manzel Pump Pressures\(^{(1)}\)

<table>
<thead>
<tr>
<th>Lubricant</th>
<th>Internal Pressure psi (Kg/Cm2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Oil</td>
<td>140,000 (9845)</td>
</tr>
<tr>
<td>UCON Compressor Lubricants PE-320 or PE-320L</td>
<td>85,000 (5977)</td>
</tr>
</tbody>
</table>

(1) To achieve 50,000 psi discharge pressure UCON Compressor Lubricants PE-320 and PE-320L are easily injected into hypers with Manzel Pumps. Internal pump pressures are much lower.

**Lubricity**

The lubricity of UCON Compressor Lubricant PE-320 was compared with that of a commonly used white oil using Falex Block on Ring Wear Test and Four Ball Wear Test. The UCON Compressor Lubricants PE-320 and PE-320L do not contain any lubricity additives, while the white oil used (a commercial sample) contained a high level of a lubricity additive. Despite this, UCON Compressor Lubricant PE-320 displayed superior lubricity, as summarized in the following tests.

**Test 1:** Falex Block on Ring Wear Tester  
ASTM D 2714 Modified  

**Conditions:**  
SAE 660 Bronze Blocks  
SAE 4620 (S-10 Steel Rings)  
Initial Temperature 65°C  
600 rpm During Test  
5 Minutes at 0 Load Break-In  
15 Minutes at Test Load

<table>
<thead>
<tr>
<th></th>
<th>20-Lb Load</th>
<th>50-Lb Load</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Results</strong></td>
<td><strong>Lubricant PE-320</strong></td>
<td><strong>White Oil</strong></td>
</tr>
<tr>
<td>Wear Scar (mm)</td>
<td>1.63</td>
<td>1.75</td>
</tr>
<tr>
<td>Weight Loss On Block (mg)</td>
<td>1.4</td>
<td>1.4</td>
</tr>
</tbody>
</table>
As is clear from these results, UCON Compressor Lubricants PE-320 and PE-320L showed much better lubricity and less wear than white oil under identical conditions. The wear scar as well as the weight loss produced by the wear on the test block were both much less for UCON Compressor Lubricants PE-320 and PE-320L at 50-lb. load than for white oil.

**Test 2:** Falex Block on Ring Wear Tester with Steel Blocks
ASTM D 2714 Modified

**Conditions:**
- Steel Blocks (H-30) SAE Oil
- SAE 4620 (S-b Steel Rings)
- 600 rpm During Test
- 5 Minutes at 0 Load Break-in
- 10 Minutes at 50-lb. Test Load
- 10 Minutes at 100-lb. Test Load

<table>
<thead>
<tr>
<th>Results</th>
<th>Lubricant PE-320</th>
<th>White Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wear Scar (mm)</td>
<td>2.75</td>
<td>4.25</td>
</tr>
</tbody>
</table>

This test was run to compare steel-on-steel wear vs. the bronze-on-steel wear comparison conducted in Test 1. Again, UCON Compressor Lubricant PE-320 demonstrated significantly better lubricity. This test was carried to 100-lb. test load because of steel-on-steel wear.

The extreme-pressure lubricity of UCON Compressor Lubricant PE-320 was determined using the Four Ball Wear Test. The results obtained in Tests 3 and 4 demonstrate that UCON Compressor Lubricant PE-320 performed significantly better than white oil. It is noteworthy that the final lubricant temperature for UCON PE-320 (55°C) was far less than that for white oil (170°C) in Test 3. Practically, this results in cooler running compressor packings and enhanced packing life with UCON Compressor Lubricant PE-320.

**Test 3:** Four Ball Step-Load Wear Test

**Conditions:**
- 2000 rpm
- Initial Temperature 20°-25°C
- 4 Minute Break-in at 10 Kg
- Increased by 20 Kg after 2 Minutes at Each Load

<table>
<thead>
<tr>
<th>Results</th>
<th>Lubricant PE-320</th>
<th>White Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Seizure at</td>
<td>100Kg</td>
<td>40Kg</td>
</tr>
<tr>
<td>Test Stopped at</td>
<td>140 kg</td>
<td>100 kg</td>
</tr>
<tr>
<td>Final Temperature</td>
<td>55°C</td>
<td>170°C</td>
</tr>
</tbody>
</table>
**Test 4:** Four Ball Wear Test  
ASTM D 4172 Modified

**Conditions:**  
1200 rpm  
75°C Initial Temperature  
No Break-in  
Time 60 Minutes at Test Load

<table>
<thead>
<tr>
<th>Test Load</th>
<th>Wear Scar Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lubricant PE-320</td>
</tr>
<tr>
<td>40 Kg</td>
<td>0.57</td>
</tr>
<tr>
<td>60 Kg</td>
<td>0.62</td>
</tr>
<tr>
<td>80 Kg</td>
<td>0.70</td>
</tr>
<tr>
<td>100 Kg</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Low Vapor Pressure**  
UCON Compressor Lubricants PE-320 and PE-320L have an inherently low vapor pressure. Lubricant losses into the process gas are minimal, resulting in low lubricant carryover to downstream processes.

**Elastomer and Coatings Compatibility**  
UCON Compressor Lubricants PE-320 and PE-320L are compatible with a variety of elastomers and coatings.

<table>
<thead>
<tr>
<th></th>
<th>Recommended</th>
<th>Not Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elastomers</strong></td>
<td>Viton A</td>
<td>Buna S</td>
</tr>
<tr>
<td></td>
<td>Kalrez</td>
<td>Hycar</td>
</tr>
<tr>
<td></td>
<td>Butyl K 53</td>
<td>Natural Black Rubber</td>
</tr>
<tr>
<td></td>
<td>Buna N</td>
<td>Hypalon</td>
</tr>
<tr>
<td></td>
<td>Natural Gum Rubber</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neoprene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethylene Propylene Rubber</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chloro Sulfonated Polyethylene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thiokol 3060 Polysulfide</td>
<td></td>
</tr>
<tr>
<td><strong>Coatings</strong></td>
<td>Catalyzed Epoxy-Phenolic</td>
<td>Alkyd</td>
</tr>
<tr>
<td></td>
<td>Modified Phenolic</td>
<td>Vinyl</td>
</tr>
</tbody>
</table>
Clean Operation
UCON Compressor Lubricants PE-320 and PE-320L are made from a polyalkylene glycol (PAG) basestock. They do not decompose under typical compressor operating conditions. Should some degradation occur, the products of decomposition are also polar, much like the parent PAG molecule. Decomposition products are therefore soluble in UCON Compressor Lubricants PE-320 and PE-320L and do not tend to separate in the form of sludge or contribute to generating varnish or lacquer. Consequently, equipment runs very clean for long periods. Furthermore, this UCON PAG is an excellent solvent and is very effective in removing residue from compressor parts. The exceptional cleanliness that results from using UCON Compressor Lubricants PE-320 and PE-320L translates into longer equipment life and longer run times between maintenance shutdowns. The net result is economical, trouble-free compressor operation.

Operating Experience
UCON Compressor Lubricants PE-320 and PE-320L have been used by many world-class HP-LDPE producers who have had good operating experience in equipment made by most compressor manufacturers. Some of the locations where UCON Compressor Lubricants PE-320 and PE-320L have been used include:
• Australia
• Argentina
• Brazil
• Europe
• Japan
• Mexico
• USA
UCON Compressor Lubricants PE-320 and PE-320L have been used successfully both in hyper-compressors and intensifiers. A summary of historical evaluation results is included in this literature. It is notable that several users have reported substantial improvements in hyper-compressor operation and polyethylene film quality while using UCON Compressor Lubricants PE-320 and PE-320L.

EVALUATION STATUS SUMMARY
Hyper-Compressors
• Mechanical Packing Life
  Exceeded all goals for first- and second-stage packing sets.
  Survives numerous cold starts with no apparent packing damage.
• Manzel Lubricant Pumps
  Internal pump pressures reduced by half over white oil at 50,000 psi discharge.
  No difficulties with lubricant feed. High pressures produce little change in viscosity.
• Lubricant Content in Resin
  Less than 25 ppm lubricant can typically be detected in LDPE resin.
  Low solubility of lubricant in ethylene.
• Lubricant Compatibility
  At levels ten times greater than actually observed in resin, this lubricant has no detectable effect on any physical or film property.
  With several years of LDPE resin production, there have been no quality problems which could be attributed to this lubricant.
Intensifiers

- **Lubrication at High Pressure**
  Allows 40% reduction in lubrication rate to all ends.
  Wear rates reduced 80 to 90%.
  Reduced plunger-rod temperatures averaging 10 to 15°C at all ends within 45 minutes of lubricant application.
  Hot seals/rods (under lubrication) eliminated.
  Lubricant tolerates greater than 3,500 ppm water with no loss of lubricity benefits.

- **Reduced Ethylene Solubility**
  Underlubricated conditions due to ethylene solubility in lubricant films eliminated.
  Plunger rod and barrel scoring several orders of magnitude lower than with white oil.
  Less than 25 ppm lubricant can be detected in LDPE resin.

- **Lubricant Stability**
  No structural or property changes can be detected in vented lubricant.
  Lubricant can be reclaimed to meet all original specifications.
  All deposits and long-term corrosion effects eliminated.

- **Leakage**
  Observed 60 percent reductions in ethylene leakage within one hour of lubricant application.

- **Resin Properties**
  At levels ten times greater than actually measured in resin, this lubricant produces no detectable effect on any physical or film property. No resin quality problems which could be attributed to this lubricant have been observed.

**Changeover Procedure**

Anytime a lubricant change is made, care should be taken to assure that the system is properly prepared according to good operating standards. At a minimum, we recommend that old lubricant be drained from the lubricator pumps, the system cleaned, any seals and elastomers inspected, and filters replaced or screens cleaned before the UCON Compressor Lubricant is installed. System cleaning may be necessitated by the build-up of sludge and/or varnish in old systems. Physical wiping or flushing with UCON Compressor Lubricant may be required if residual contamination is expected. New units require the removal of preservative or coating fluids in similar fashion.

After installing the UCON Compressor Lubricant, adjust lubricators to deliver the manufacturer’s recommended rate of lubricant. Check filters or screens frequently during the early stages of operation since UCON Compressor Lubricants will likely loosen residual sludge, varnish, and paint.
Product Stewardship

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