BASF PAG-Based Finished Lubricant Solutions for Compressor Applications

STLE Annual Meeting Commercial Marketing Forum
Minneapolis, MN
May 20-24, 2018
Fuel And Lubricant Solutions
Our Business Segments

Fuel and Lubricant Solutions
Your Leading Solution Provider

POLYISOBUTENES
Low, Medium and High Molecular Weight Polyisobutenes (PIB)

MINERAL OIL ADDITIVES
Fuel Additives
Aviation Fuel Additives
Refinery Additives

AUTOMOTIVE FLUIDS
Engine Coolants
Brake Fluids

LUBRICANT ADDITIVES
Antioxidants
Antiwear Additives
Extreme Pressure Additives
Metal Deactivators
Corrosion Inhibitors
Pour Point Depressants
Viscosity Modifiers

BASE STOCKS FOR LUBRICANTS & COMPONENTS FOR METALWORKING FLUIDS
Base Stocks
Thickeners
Emulsifiers
Solubilizers

COMPOUNDED LUBRICANTS
Transmission Fluids
Axe Lubricants
Industrial Gear Oils
Biodegradable Hydraulic Fluids
Industrial Compressor Lubricants
Refrigeration Compressor Lubes
BASF’s Offer to the Compressor Lubricant Market

Know-how + global supply and service capability to meet customer needs

**Fuel and Lubricant Solutions**
Your Leading Solution Provider

**Broad access to chemistry**
- BASF produces a wide array of chemicals serving many end markets, including base stocks and additives
- BASF brings together deep expertise in additive and base stock chemistry with formulating know-how to develop high-performance formulations

**Geographic reach**
- Regulatory support from country experts with understanding of local regulations and market drivers
- Global sales network
- Four global technical support labs
  - Tarrytown, NY
  - Ludwigshafen, DE
  - Shanghai, CN
  - Mumbai, IN
- Truly global supply network, with multiple production and warehousing locations, and flexible packaging capability

**Focus on lubricant markets**
- Global, dedicated teams focused on understanding markets and focusing resources where BASF can win
- Resources to follow trends, uncover OEM needs, and demonstrate the value of BASF’s products in meeting these
- Expertise in developing and conducting rig and field tests to showcase performance differentiation → end-user benefits
## BASF Market Segmentation
### The Market for Compressor Lubricants

<table>
<thead>
<tr>
<th>Segment</th>
<th>Industrial</th>
<th>Oil &amp; Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General Industrial</td>
<td>Exploration &amp; Production</td>
</tr>
<tr>
<td>Drivers</td>
<td>Longer fluid life</td>
<td>LDPE processing under tremendous cost pressure</td>
</tr>
<tr>
<td></td>
<td>OEMs try to protect their service fill business</td>
<td>Mainly hyper-compressors</td>
</tr>
<tr>
<td></td>
<td>Mainly rotary screw compressors, some reciprocating</td>
<td>H1 approval necessary</td>
</tr>
<tr>
<td>Leading OEMs</td>
<td>Ingersoll Rand</td>
<td>Burckhardt Compression</td>
</tr>
<tr>
<td>Sources</td>
<td>Ingersoll Rand, Burckhardt Compression, GE Oil &amp; Gas, Ariel Corp., NEA Group, Gas Compressor Association, US DoE, IHS SCUP 2015, Synthetic Lubricants</td>
<td>Howden</td>
</tr>
</tbody>
</table>

* Sources: Ingersoll Rand, Burckhardt Compression, GE Oil & Gas, Ariel Corp., NEA Group, Gas Compressor Association, US DoE, IHS SCUP 2015, Synthetic Lubricants
Market Drivers
Global natural gas consumption expected to continue to grow
# Types of Compressors

## Rotary Screw and Rotary Vane Compressors

<table>
<thead>
<tr>
<th>Rotary Screw</th>
<th>Rotary Vane</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation</strong></td>
<td><strong>Operation</strong></td>
</tr>
<tr>
<td>A pair of counter-rotating, intermeshing, conical screws with progressively reduced gas volume</td>
<td>Slotted rotor mounted eccentrically inside a housing where sliding vanes enclose gas while reducing its volume</td>
</tr>
</tbody>
</table>

## Lubrication Requirements

- Fluid is directly injected into the air stream to seal screws/vanes and cool components
- Fluid is cycled through the unit
- Good oxidation stability and demulsibility
- Lower viscosity for more effective heat transfer
- Typically ISO VG 32, 46, and 68
Types of Compressors
Reciprocating Compressors

Reciprocating

Operation
Uses reciprocating pistons within cylinders to compress gas and valves to control gas inlet and outlet

Lubrication Requirements
- Oxidatively stable lubricant with low volatility to keep components clean
- Relative high viscosity to counteract the high heat and high pressure application
- Hypercompressors are special reciprocating compressors with multi-stages for efficiency
- Typically ISO VG 100 or greater
**BASF Compressor Lubricants**

**Current Portfolio**

<table>
<thead>
<tr>
<th>Application</th>
<th>PAG</th>
<th>Ester</th>
<th>PAO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial Air Compression</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotary Screw</td>
<td>Plurasafer® CL 6000 ISO VG 32, 46, 68</td>
<td>Emgard® 2000 ISO VG 32, 46, 68</td>
<td>Emgard® CL 4000 ISO VG 32, 46, 68</td>
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<tr>
<td>Rotary Vane</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Reciprocating</td>
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<td></td>
</tr>
<tr>
<td><strong>Natural Gas &amp; Chemical Compression</strong></td>
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<tr>
<td>Rotary Screw</td>
<td>Plurasafer® CL Gas 9 ISO VG 100</td>
<td></td>
<td></td>
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<tr>
<td>Reciprocating</td>
<td></td>
<td></td>
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<tr>
<td><strong>Special Applications</strong></td>
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<tr>
<td>LDPE Hypercompressor</td>
<td>Plurasafer® CL HC 1400, 1400S, 1500</td>
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<tr>
<td>Refinery Platforming</td>
<td></td>
<td>Emgard® 2000 ISO VG 100, 150</td>
<td></td>
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</tbody>
</table>
Plurasafe® CL Gas 9 Series
Introduction
Plurasafe® CL Gas 9 Series

Technical Attributes

Description

- PAG-based high performance synthetic lubricant for gas and chemical compression

Performance at a Glance

- Reduced gas solubility for improved wear protection and extended life
- Multigas service for a wide range of gases including vinyl chloride and butadiene
- Does not promote the dimerization of butadiene or generate solid deposits

Plurasafe® CL Gas 9: Formulated to minimize viscosity loss in chemical and natural gas compression
Plurasafe® CL Gas 9
Water Handling

Plurasafe® CL Gas 9 provides lubricity at high water content
Plurasafe® CL Gas 9 Series
Cleanliness in a Reciprocating Compressor

Using Mineral Oil-based Lubricants Results in Deposit Formation

PAG-based Compressor Lubricants Offers Clean Operation
COMOTI Field Trial

- COMOTI produces and supplies compressors under Ingersoll Rand (GHH RAND) license
- Rotary screw compressors for natural gas
- Viscosity loss observed in previously used mineral oil-based and PAO-based compressor lubricants

Type of compressor: screw CF 180 GK
Pressure suction side: 0,7-2 bar
Temperature suction side: 3-25 °C
Pressure discharge side: 10-26 bar
Temperature discharge side: 70-90 °C
Gas volume: max 35.000 Nm³/day
Oil temperature: 60-85°C
Oil pressure: 6-23 bar
Oil flow: max 150 l/min
Oil volume: 370 L
Field trial results demonstrate Plurasafe® CL Gas 9 – 100 exhibited good performance for over 8,000 hours

Previous semi-synthetic products lasted < 4,000 hours in same compressor
**Plurasafe® CL Gas 9 Series**

**Summary**

**Description**
- PAG-based high performance synthetic lubricant for gas and chemical compression for use in rotary screw and reciprocating compressors
- Available in ISO VG 100, 150, and 185

**Performance at a Glance**
- Reduced gas solubility for improved wear protection and extended life
- Improved compressor efficiency and reduced foaming
- Multi-gas service for a wide range of gases including vinyl chloride and butadiene
- Does not promote the dimerization of butadiene or generate solid deposits

**Value Proposition**
- Less downtime and increased productivity
- Simplified lubricant inventory
- Lower operating cost and reduced oil carry-over
- Increased efficiency and savings from less compressor maintenance
Next steps

- Technical data sheets available on request
- Samples of all ISO VGs are available on request
- BASF has flexible packaging capability, and is open to rebranding/relabeling opportunities
- Commitment to truly global technical and regulatory support
- Additional field trial details available in handout

- **Talk to your BASF account representative about your needs**

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