Small Vessel General Permit – sVGP

Presented by:

James Kovanda
Vice President
American Chemical Technologies, Inc.
A move towards alternative lubricants- WHY?

- The National Oceanic and Atmospheric Administration (NOAA) estimates that more than 700 million gallons of petroleum enter the environment each year, more than half of which is through irresponsible and illegal disposal.

- “Oil leakage from stern tubes, once considered a part of normal operational consumption of oil, has become an issue of concern and is now considered oil pollution”.

- Deepwater Horizon catastrophe – another wake-up!
The US EPA contracted an independent lab to review information on environmentally friendly fluid alternatives with the purpose of writing a White Paper - Draft.

The purpose of this document was to describe the range of environmentally preferable lubricants that may be used as a best management practice (BMP) by operators of vessels covered under the Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels.

The document – EPA 800-R11-002, November 2011 - defines what they are calling “Environmentally Acceptable Lubricants” – EAL’s

- Differentiating them from Environmentally Friendly Lubricants
Biodegradation
- Process of chemical breakdown of oil caused by organisms or their enzymes into carbon dioxide and water

Eco (Aquatic) Toxicity
- Concentration in ppm or milligrams per liter that kills a specified % of the species being tested

Bioaccumulation
- The build-up of chemicals within the tissues of an organism over time
“Readily” Biodegradable
- OECD 301 A-F
  - > 60 % biodegraded in 28 days

“Low (Aquatic) Toxicity”
- OECD 201 – 212
  - Food chain - Algae / Daphnia / Fish

“Non-Bioaccumulative”
- OECD 107 & 117
  - Partition Coefficients of Log Kow < 3.0 or > 7.0
Because the majority of a lubricant is composed of the base oil, (3) types that satisfied the requirements were identified:

- Vegetable Oil
- Synthetic Ester
- Polyalkylene Glycol (PAG)

Conclusions from the White Paper were used in the draft of the Vessel General Permit.
2013 VGP - Vessels 80’ and longer

- 2.2.9 Controllable Pitch Propeller and Thruster Hydraulic Fluid and Other Oil-to-Sea Interfaces Including Lubrication Discharges from Paddle Wheel Propulsion, Stern Tubes, Thruster Bearings, Stabilizers, Rudder Bearings, Azimuth Thrusters, Propulsion Pod Lubrication, and Wire Rope and Mechanical Equipment Subject to Immersion

- Page 43
2013 sVGP - Vessels 79’ and shorter

- **2.3 ENGINE AND OIL CONTROL**
- (h) Unless technically infeasible, you must use environmentally acceptable lubricants (as defined in Part 6 of this permit) in *all machinery and equipment*, including but not limited to stern tubes, wires, and two-stroke engines, where discharges of oil to surrounding waters are likely to occur.

- Page 4
“All Vessels constructed on or after December 19, 2013 must use an environmentally acceptable lubricant in all oil-to-sea interfaces”.

“For all vessels built before December 19, 2013, unless technically infeasible, owner/operators must use an EAL in all oil-to-sea interfaces”.

- “Technically Infeasible”
  - Equipment must be “retrofitted” to accept EAL
  - If EAL significantly degrades performance

  NOTE: If deemed Technically Infeasible, owner/operator must document why they cannot use EAL, and must note the use of a non-EAL in the vessel’s Annual Report.
“Lastly, any discharge of oil, including oily materials, from any of these oil-to-sea interfaces may not result in a discharge that may be harmful as defined by 40 CFR Part 110 or result in the production of a visible sheen”.

- Proposed 2013 VGP Fact Sheet, Page 136
  - Canada – If it floats, it is considered an oil

Note: Dispersants, detergents, emulsifiers, chemicals or other substances that remove the appearance of a visible sheen may not be added to the bilge.

- sVGP – Section 2.3 ENGINE OIL CONTROL, (j)
  - Workboat Show – emulsifier added to white oil
<table>
<thead>
<tr>
<th>Fluid Type</th>
<th>Typical Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral Oil</td>
<td>0.876</td>
</tr>
<tr>
<td>PAO (Bio-Sourced)</td>
<td>0.860</td>
</tr>
<tr>
<td>Vegetable Oil</td>
<td>0.923</td>
</tr>
<tr>
<td>Synthetic Ester</td>
<td>0.920</td>
</tr>
<tr>
<td>Water Insoluble PAG</td>
<td>0.990</td>
</tr>
<tr>
<td>Water</td>
<td>1.000</td>
</tr>
<tr>
<td>Water Soluble PAG</td>
<td>1.035</td>
</tr>
</tbody>
</table>
“Sheen” – Black Light Comparison

Water **Soluble**

Polyalkylene Glycol (PAG)

Water **Insoluble** Fluids

- Mineral Oil
- Synthetic Ester
- Polyalphaolefin (PAO)
- Vegetable Oil
### 40CFR435 – Static Sheen Results

<table>
<thead>
<tr>
<th></th>
<th>Water Soluble Polyalkylene Glycol (PAG)</th>
<th>Vegetable oil based hydraulic fluid</th>
<th>Synthetic ester based hydraulic fluid</th>
<th>White-oil based hydraulic fluid</th>
<th>Petroleum based hydraulic fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silvery or metallic sheen</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Increased reflectivity</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Visual Color</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Iridescence</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Oil Slick exceeding 10% of surface area</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Appendix 1 to Subpart A of 40CFR435 result</strong></td>
<td><strong>PASS</strong></td>
<td><strong>FAIL</strong></td>
<td><strong>FAIL</strong></td>
<td><strong>FAIL</strong></td>
<td><strong>FAIL</strong></td>
</tr>
</tbody>
</table>
Water Soluble PAG

**PRO’s**
- Proven – Since 2005
- Non-Sheening
  - Heavier than water /Soluble
- Inert to Water
  - Limit – 7,500 ppm salt water
- Superior Lubricity
  - Low Coefficient of Friction
- High Viscosity Index
  - High/Low Temp Properties
- Excellent Oxidation Stability
  - Extended drain intervals
- Factory Mutual Approved

**CON’s**
- Paint Compatibility
- Seal Compatibility
- 3-4 times price of conventional petroleum-based lubricants
PAG – Designed not Refined

Ethylene oxide (EO)  Propylene oxide (PO)

\[
\begin{align*}
\text{H}_2\text{C} & \quad \text{O} \\
\text{CH}_2 & \\
\end{align*}
\quad
\begin{align*}
\text{H}_2\text{C} & \quad \text{O} \\
\text{CH} & \quad \text{CH}_3
\end{align*}
\]

CLASSICAL POLYMER STRUCTURES BASED ON EO & PO

**Block Polymerization**
- Initiator
- PO block
- EO block

**Random Polymerization**
- Initiator
- 1 EO
- 1 PO

**Inverse block Polymerization**
- Initiator
- EO block
- PO block

Initiators are typically monols, diols or triols (for example butanol, propylene glycol, glycerol).

- Reaction of alcohol & oxide, Properties on choice of alcohol, oxide mixture, moles of oxide
- Polymers can be designed having a wide range of viscosities (10-20,000 cSt at 40°C)
- Extremely versatile and can be tailored designed to have many specific functionalities
## Water Insolube PAG

<table>
<thead>
<tr>
<th><strong>PRO’s</strong></th>
<th><strong>CON’s</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Proven – Since 1990</td>
<td>Paint Compatibility</td>
</tr>
<tr>
<td>Inert to Water</td>
<td>Seal Compatibility</td>
</tr>
<tr>
<td>Superior Lubricity</td>
<td>Approximately 2-3 times price of conventional petroleum-based lubricants</td>
</tr>
<tr>
<td>Limit – 7,500 ppm salt water</td>
<td></td>
</tr>
<tr>
<td>Low Coefficient of Friction</td>
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</tr>
<tr>
<td>High Viscosity Index</td>
<td></td>
</tr>
<tr>
<td>Excellent Oxidation Stability</td>
<td></td>
</tr>
<tr>
<td>Extended drain intervals</td>
<td></td>
</tr>
<tr>
<td>Least expensive EAL that is reliable and performs</td>
<td></td>
</tr>
</tbody>
</table>
“Sheen” – Black Light Comparison

- **Water Soluble**
  - Polyalkylene Glycol (PAG)

- **Water Insoluble**
  - Polyalkylene Glycol (PAG)

- **Water Insoluble Fluids**
  - Synthetic Ester
  - Polyaalphaolefin (PAO)
  - Vegetable Oil
## Hydrolytic Stability – ASTM D-2619

<table>
<thead>
<tr>
<th>EAL PRODUCT</th>
<th>Change in Acid Number - mg KOH/g</th>
<th>Total Acidity of the Water Layer - mg KOH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyalkylene Glycol</td>
<td>-0.01</td>
<td>Water Solubilized</td>
</tr>
<tr>
<td>Polyalphaolefin</td>
<td>-0.08</td>
<td>6.90</td>
</tr>
<tr>
<td>Synthetic Ester</td>
<td>+0.83</td>
<td>19.37</td>
</tr>
</tbody>
</table>
Comparative Wear Characteristics

MTM Coefficient of Friction

Slide Roll Ratio %

Coeficient of Friction

Water Insoluble PAG
Synthetic Ester
Water Soluble PAG
Vegetable Ester
PAO
Comparative Wear Characteristics

MTM Traction Coefficient

- Water Insoluble PAG
- Synthetic Ester
- Water Soluble PAG
- Vegetable Ester
- PAO
- Standard AW Petroleum
Industry standard is *change in volume and change in hardness at 1000 hours of less than +/- 12% when exposed to fluids that are \( \leq \) ISO viscosity grade 46 and +/- 10% when exposed to fluids that are ISO viscosity grade \( > 46 \).*

<table>
<thead>
<tr>
<th>1000 hrs.</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Durometer, points change</td>
<td>-0</td>
<td></td>
</tr>
<tr>
<td>Volume Change %</td>
<td>+3%</td>
<td></td>
</tr>
<tr>
<td>Weight Change %</td>
<td>+6%</td>
<td></td>
</tr>
</tbody>
</table>

**DUROMETER ASTM D 2240-05(10):**
- Shore A Durometer Point 86
- Confidence (+/-) 1

**FLUID IMMERSION PROPERTIES, ASTM D 471-10**
- Elastomers immersed @ 65ºC in UCON™ Trident™ AW-68 lot 31095.
Conversions

Compatibility: Trident AW-68 / Citgo 68

OBJECTIVE:
Check compatibility between Trident AW-68 and Citgo 68.

TESTING/RESULTS:
Trident AW-68 was mixed with Citgo 68 at the following ratios 50:50. (See Figure 1)

Figure 1: Trident AW-68 : Citgo 68

06/18/2008
Polyalkylene Glycol – *The True Solution*

** PLEASE COME VISIT US AT OUR BOOTH FOR FURTHER INFORMATION OR DISCUSSION**