Primer on Tackifiers

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OUTLINE

• Definition

• Composition

• Uses

• Selection
• **Definition--**

An additive that imparts tack or stringiness to a lubricant. It may be used to provide adherence in way oils and chain lubricants, stringiness in greases, and anti-misting metalworking fluids.
• Makes an oil Viscoelastic

– What is Viscoelastic?
  • Viscous and Elastic
  • Stretch it -- It pulls back.

– Cohesive
  • Makes oil harder to remove
Tackiness vs Stringiness

• Tackiness $\leftrightarrow$ Adhesion
  – Difficult to demonstrate or measure

• Stringiness $\leftrightarrow$ Cohesion
  – Easier to demonstrate and measure
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Tackifier Selection Guide

ISO 9001:2000

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“Ductless Siphon”
Composition—

Consists of a high molecular weight polymer, usually polyisobutylene (PIB), dissolved in an appropriate diluent, usually mineral oil.
COMPOSITION

• Polymer types
  – Polyisobutylene (1MM to 4MM Mol. Wt.)
  – Ethylene Copolymers (< 1 MM Mol. Wt.)
  – Other Hydrocarbon Polymers
Polymer Comparison

- **PIB**
  - \([-\text{C(CH}_3\text{-CH}_2\text{)}_n\]
  
  Molecular Weight--
  
  1 MM to 4 MM

  More tack, less shear stable

Tack increases with increase in MW, shear stability decreases

- **OCP**
  
  polyethylene \([-\text{CH}_2\text{-CH}_2\text{)}_n\]
  
  Polypropylene \([-\text{CH(CH}_3\text{-CH}_2\text{)}_n\]

  Molecular Weight-- 800M

  More shear stable, less tacky
COMPOSITION

- DILUENTS
  - Petroleum Oils (Grp I, II, III & naphthenic)
  - White Oil
  - Vegetable Oil
FUNCTIONS

• Discourage Removal
  – Way Lubricants
• Discourage Dripping
  – Chain Lubricants
• Discourage Flinging
  – Chain Saw Oils
• Change Texture
  – Grease
PROPERTIES

• Viscoelastic Liquid
  
  – Can be very viscous, 3-10,000 cst @ 100 C

  – Cutbacks available for easier handling
OTHER VISCIOUS ADDITIVES

• Viscosity Index Improver
  – Lower molecular weight (~150,000)
  – Provide higher viscosity but not viscoelasticity
  – Typically olefin copolymer

• Antimisting Additives
  – Intermediate molecular weight (~700,000)
  – Discourage misting
  – Minimal contribution to tackiness
Applications

- **Chain Saw (Bar and Chain) Oil**
  - Keeps oil from flinging from chain
  - Mid to high molecular weight PIB

- **Way Lubricants**
  - Keeps ways wet with oil.
  - Minimizes washing off by coolant
  - Low to mid molecular weight PIB
APPLICATIONS

• GREASE
  – Shear stability
  – Texture
  – Water resistance
  – Olefin copolymers
Special Applications

• Food-processing machine lubricants (H-1)
  – Grease
    • Helps keep grease in bearings
    • OCP in food grade oil
  
  – Chain Oil
    • Minimizes dripping
    • PIB in food grade oil
Antimisting Additives

• Related to Tackifiers, but lower Mol. Wt.
  – For petroleum oil systems
  – For vegetable oil systems
  – For water-based systems

• Better shear stability than Tackifiers
• Less “drag out” than with Tackifiers
TACKIFIERS IN HIGH TEMPERATURE SYSTEMS
Problem

• A grease made from a Group 3 oil was showing poorer oxidation results than expected.

• The oxidative performance could be restored by omitting the tackifier additive.
‘CEILING TEMPERATURE’

- Polymers whose polymerization is a reversible reaction
  - 1,1-disubstituted olefins \((\text{CH}_2 = \text{CR}_2)\)
    - Polyisobutylene
    - Methacrylates

- Polymer equilibrates with monomer.
- Maximum temperature polymer can exist
POLYISOBUTYLENE CEILING TEMPERATURE

- PIB $\rightarrow$ isobutylene monomer
- PIB reported unstable over $\sim 90^\circ$C in oil
- Ceiling temperature 170 – 200$^\circ$C based on thermodynamic data
PIB in Group I oil at 100°C
GRP I vs GRP II

- 2 MM Mol Wt PIB in Group 1 with Antioxidant
- 2 MM Mol Wt PIB in Group 2 with Antioxidant
Oxidative vs. Thermal Loss

- Temperature $\ll$ ceiling temperature
- Rate is dependent on diluent
- Reaction inhibited by antioxidant
- Therefore
  - Polymer loss is oxidative rather than thermal
  - Viscosity loss due to polymer loss may be used to monitor the degree of oxidation
**EFFECT OF GRP I**

<table>
<thead>
<tr>
<th>Tackifier</th>
<th>2MM PIB in GRP III</th>
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<tbody>
<tr>
<td>Base Oil</td>
<td>GRP III</td>
</tr>
<tr>
<td>Treat Level</td>
<td>0.5%</td>
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<tr>
<td>Temperature</td>
<td>120 C</td>
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<table>
<thead>
<tr>
<th>Amt GRP I (%)</th>
<th>0 hr</th>
<th>24 hr</th>
<th>48hr</th>
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<tr>
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<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
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<td>0</td>
<td>26</td>
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<tr>
<td>10</td>
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</table>

% viscosity loss

# HI TEMP EFFECT ON VISCOSITY

<table>
<thead>
<tr>
<th>Polymer</th>
<th>2MM PIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diluent</td>
<td>GRP I</td>
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<tr>
<td>AO</td>
<td>0.1%</td>
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</table>

<table>
<thead>
<tr>
<th>Time (hrs)</th>
<th>Temp (C )</th>
<th>Vis Loss (%)</th>
<th>Vis Loss (%)</th>
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</thead>
<tbody>
<tr>
<td>96</td>
<td>100</td>
<td>37</td>
<td>0.0</td>
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<tr>
<td>96</td>
<td>120</td>
<td>33</td>
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</tr>
<tr>
<td>72</td>
<td>150</td>
<td>97</td>
<td>0.1</td>
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</table>

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# HIGH TEMP EFFECT ON TACKINESS

<table>
<thead>
<tr>
<th>Time (hrs)</th>
<th>Temp (C )</th>
<th>Tack Loss (%)</th>
<th>Tack Loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>100</td>
<td>31</td>
<td>0</td>
</tr>
<tr>
<td>96</td>
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<td>8</td>
</tr>
<tr>
<td>72</td>
<td>150</td>
<td>100</td>
<td>8</td>
</tr>
</tbody>
</table>

Polymer | 2 MM PIB
---|---
Diluent (tackifier) | GRP I | GRP III
Base Oil | GRP III | GRP III
Treat | 0.5% | 0.5%

**ISO 9001:2000**
CONCLUSIONS

• Polymer breakdown is an effective way to monitor lubricant oxidation.
• The breakdown of PIB in lubricants is oxidative rather than thermal.
• Polyisobutylene in lubricants is stable to much higher temperatures than previously reported, approaching its ceiling temperature of about 170-200°C, rather than merely about 100°C.
CONCLUSIONS

• Relatively small amounts of Group 1 oil, quantities that may be introduced as additive diluents, are sufficient to reduce the oxidative performance of Group 3 oils or PAO’s to the Group 1 level.

• Polymeric additives can be tailored for high-temperature performance by manufacture using a Group 3 diluent oil.