Meeting Customer Expectations:
the Marketing Opportunity of Biolubricants

Wednesday 6\textsuperscript{th} July 2016
Kerry Larkin: Commercial Director, SIP
Biolubricants have been increasing in popularity and demand over the last decade, but there is still some confusion over their definition, features and benefits.

Today’s objective is to try and overcome this confusion through a review of the current market, existing and new technologies and then to present some of the opportunities biolubricants offer the consumer through examples from a new technology producer, Novvi LLC.
• Introduction to SIP and Novvi
• Biolubricants
  • Definition
  • Applications
  • Misconceptions
  • Statistics, regulation, market drivers and challenges
• Biolubricant feedstocks
• Market Opportunities and Applications
We reliably deliver individually specified product solutions backed by wide-ranging technical and industry expertise.
OUR VISION

TO BUILD UPON OUR STRONG EUROPEAN MARKET POSITION AND DEVELOP THE BUSINESS TO BECOME A RECOGNISED LEADING GLOBAL SUPPLIER OF SPECIALITY OILS & FLUIDS
SIP has a strong reputation as a supplier of high quality base fluids to the lubricants sector that meet customers evolving basestock needs.

• We value performance and quality and strive to identify suitable products from new technologies that will satisfy future feedstock requirements

• We see the value in renewable and sustainable base oils, which fit with our value proposition and product range

• This led to our European distribution agreement with Novvi LLC, and becoming a consortium member of the Horizon 2020 ‘First2Run’ project
Aims to demonstrate the techno, economical and environmental sustainability at industrial scale in a first-of-kind value chain where low input and underutilized oil crops grown in arid and/or marginal lands and not in competition with food or feed, are exploited for the extraction of vegetable oils to be further converted into bio-monomers (mainly pelargonic and azelaic acids) as building blocks for high added value bioproducts, biolubricants, cosmetics, bioplastics, additives through the integration of chemical and biotechnological processes.
SIPDRILL RS – designed for high performance drilling mud systems

NovaSpec™ Base Oils: classified as Group III+ but with PAO performance

Renewable esters based on C9 Pelargonic acid

Myralene™ M10: terpenoid solvent from sugar based feedstocks

Aria WTP 40 functionalised PAO and the Clean range of renewable solvents
About Novvi

• Novvi is a 50/50 Amyris & Cosan joint venture
• Formed in June 2011 to produce, distribute and market renewable synthetic base oils from patented Amyris technology
• Partner companies to provide a strategic advantage in market
  – Access to most competitive renewable feedstock
  – Access to Innovative Amyris technology
Synthetic Biology
Platform for Renewable Chemicals and Fuels

Amyris Modifies Microorganisms to Enable Production of 1,000s of Target Molecules
Novvi - Redefining Performance with No Compromise
Fifty Shades of Green
LUBRICANTS AND THE ENVIRONMENT

Water
- 1.5 million tonnes of used lubricating oil enters the oceans each year
- Oil tanker spill per week!!!
- 5 litres of used oil can contaminate 3 million litres of water.
- Massive impacts on fishing industry, tourism, biodiversity, water security

Land
- 5 Litres of lubricating oil can render 16000m² of agricultural land unsuitable for planting for up to 10 years.
- Impact on ground water from seepage into soil a further concern of contaminating natural aquifers.

Air
- Used oil burned in the US contributes to 36 Million Tonnes of GHG emissions.
- 38% of lubricants are “consumed in use” - creating GHG emissions
- Additive Chemistries used in EO – also result in other toxic gas and particulate emissions

SIP
INDEPENDENT MARKETER OF SPECIALITY OILS & FLUIDS
A biolubricant, or Environmentally Acceptable Lubricant (EAL) is defined as a lubricant which is produced primarily from bio-based, or renewable, feedstocks and is proven to be biodegradable and non-toxic.

It should perform equally as well as the lubricant it is replacing.
Typically used in applications such as agricultural equipment/off highway, chain saws, grease, commercial marine and motor boats where the lubricant could end up in the environment or contaminate ground water or soil.

Lubricants include:

- Hydraulic oils
- Compressor oils
- Gear oils
- Two stroke oils
- Transformer oils
- Wire rope lubricants
- Stern tube lubricants
- Food grade lubricants
COMMON MISCONCEPTIONS OF BIOLUBRICANTS

- Poor performance
- Very expensive
- Spill and forget
- Feedstock complexity
- Non-toxic
- Meet OEM requirements
- Compatibility
Total lubricant demand in 2013/2014 was 38.2 mT per annum (Kline).

Biolubricant uptake is estimated at 400-600 kT of product or approximately 1% of the total market.

85% of the biolubricants demand is in Europe and the US.

Source: ‘Markets for Biolubricants’, Woodhead publishing 2013
Growth rates of biolubricants vary by region and penetration remains limited. WHY?

Five-year CAGR by country 2013 - 2018

Source: Kline 2014 forecast
MARKET SHARE

• Share of biolubricants in Europe is approximately 1% (Norby, 2011)
  • Higher in Germany approximately 4.3%
  • More than 8% of Statoil’s hydraulic volume in Scandinavia is biolubricants

• Blue Angel, Nordic Swan and the Swedish Standard have driven the uptake of biolubricants in Germany and Scandinavia: there is no equivalent here in UK

• FNR subsidy scheme helped to drive uptake in Germany

• Finished lubricant pricing tends to be higher in Europe so higher cost of biolubricants has been seen as a barrier to entry in the UK
There are a number of regulatory standards that define and drive the demand for biolubricants across the globe.

**USA**

- Vessel General Permit (VGP)
- USDA Biopreferred Programme

**Europe**

- EU Ecolabel
- Blue Angel
- Swedish Standard
- Nordic Swan (no longer certifying for lubricants, but was a regulatory driver in its time)
## REGULATION: SHADES OF GREEN FOR HYDRAULIC OILS

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>TEST METHOD</th>
<th>USDA Bio-Preferred</th>
<th>EPA VGP</th>
<th>Swedish Standard</th>
<th>Blue Angel</th>
<th>EU Ecolabel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renewability</td>
<td>D6866</td>
<td>X</td>
<td></td>
<td>Report</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Biodegradability</td>
<td>OECD 301,306, 31110, D5864</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Aquatic Toxicity</td>
<td>OECD 201,202,203, 210,211</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Non toxic metals</td>
<td>D5185 ICP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Bioaccumulation</td>
<td>OECD 123</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Performance</td>
<td>ISO 15380</td>
<td>X</td>
<td></td>
<td>SS15534</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

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**SHADES OF GREEN**
There are different test methods to measure biodegradability, namely:

- OECD 301B/D
- CEC-L-33-A93

Different methods can give different results on the same base stock.

The same species of inoculant from a different source can give different results (depends if been exposed to it in natural environment).

The handling of the inoculant can give different results.

- there are several different sample preparation techniques mentioned in OECD 301B
MARKET DRIVERS

• Environmental awareness / Corporate Social Responsibility
• Increase in availability of higher performance, green, bio-based feedstocks
• Regulation – Ecolabel and other technical standards
• OEM specifications
• Innovation: differentiation in a mature, commoditised market
MARKET CHALLENGES

• Lack of European legislation to drive the requirement for biolubricants despite Ecolabel which has the most stringent performance requirements globally

• Up to 80% of biolubricants are based on synthetic esters with little or no renewability and/or sustainability claims; vegetable oils (palm, rape, soya, castor) make up the rest of this sector but performance is inferior

• Majority of bio-based feedstocks require new formulations to counter the change in performance

• Premium performance bio-based feedstocks are currently more expensive, particularly those from new technologies which are not in full production
Is the consumer aware of the effect lubricants have on the environment?

Yes there is a need but when others don’t why should I?

COST versus incumbent technology: BATNEEC (Best Available Technology not Entailing Excessive Cost)
• Recognises the need for biolubricants but despite EU Ecolabel there is no mandatory use of biolubricants
• Environmental and sustainability concerns can and have been addressed through technically equal (or superior) feedstock solutions
• New generation bio-based feedstocks can overcome the performance challenges in more severe applications

Cost remains an issue but can be addressed by legislation and targeting value add applications and considering total cost
1. Vegetable Oil (triglyceride)
   - Biodegradable and renewable but not sustainable (food for fuel). Poor oxidative stability and inferior low temperature properties

2. Esters - can be vegetable or petrochemical derived
   - Vegetable derived esters have improved performance over vegetable oil – performance determined by degree of saturation
   - Petrochemical derived esters are biodegradable but not renewable. Possible seal swell issues

3. Synthetic hydrocarbon
   - Superior performance, low toxicity and inherently biodegradable
   - New feedstocks are biodegradable, renewable and sustainable, with outstanding performance
PERFORMANCE: SHADES OF GREEN

- PAO
- Petrochemical Ester
- Unsaturated Ester
- Saturated Ester
- Farnesene based Hydrocarbon
- Triglyceride
- Estolide

INDEPENDENT MARKETER OF SPECIALITY OILS & FLUIDS
The common misconception is that all biolubricants suffer from poor performance and/or high cost, leading to a trade off between price and performance.

- In reality there is a wide variety of feedstocks, which vary in both performance and ‘shade of green’
- Not all bio-based products are suitable for all ‘bio’ applications
- Formulators may require a range of feedstock options to meet their application performance criteria

No longer the case with the new generation of bio-based feedstocks which offer the formulator flexibility to reduce complexity.
## FEEDSTOCK FLEXIBILITY

<table>
<thead>
<tr>
<th>Obstacles</th>
<th>Technology that Overcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodegradable</td>
<td>Canola-based Diester, Elevance, BST, Novvi, Solazyme, some Synthetic esters (Croda, BASF, Nyco etc..)</td>
</tr>
<tr>
<td>Sustainable feed stocks – Land Use</td>
<td>Elevance, Novvi, BST, Solazyme, Croda</td>
</tr>
<tr>
<td>CO2/ GHG reductions</td>
<td>Novvi, Solazyme, BST</td>
</tr>
<tr>
<td>Oxidative stability</td>
<td>Novvi, BST, some synthetic esters</td>
</tr>
<tr>
<td>Hydrolytic stability</td>
<td>Novvi, BST</td>
</tr>
<tr>
<td>Drain intervals</td>
<td>Novvi, BST</td>
</tr>
<tr>
<td>Fuel Economy – can make 0WXX</td>
<td>Novvi</td>
</tr>
<tr>
<td>Drop into formulations</td>
<td>Novvi</td>
</tr>
<tr>
<td>Drop into rerefining infrastructure</td>
<td>Novvi</td>
</tr>
</tbody>
</table>
Consumer Applications for Biolubricants evidenced with Novvi base oils
Novvi - Redefining Performance with No Compromise

![Graph showing the comparison between Traditional High Performance Petroleum Base Oils and Environmental Friendly Base Oils, with NovaSpec positioned at the intersection where both performance and environmental friendliness are considered.](image-url)
• **Sustainability**: both through selective land use and sugar feedstock diversity

• **Renewability**: up to a 100% renewable product

• **Biodegradability**: up to 75% biodegradable in 28 days on OECD 301B

• **Toxicity**: no contaminants, pure hydrocarbon, base oil has food grade approvals

• **Recyclability**: drops into existing infrastructure
SUSTAINABILITY: FEEDSTOCK DIVERSITY

- Sweet Sorghum
- Sugar Beets
- Sugar Cane
- Molasses
- Corn
- Cellulosic Sugar

SUGAR

BioFene
1 Hectare

- Farnesene: 5680 L
- Cellulosic: 5680 L
- Coconut: 380 L
- Soy: 590 L
- Canola: 720 L
- Palm: 4200 L
- Farnesene Cane: 4180 L

1. Oil World 2007
Novvi uses biodegradability test standard OECD 301B Modified Sturm

- Test method covers the determination of the degree of aerobic aquatic biodegradation of lubricants on exposure to a bacterial inoculum under laboratory conditions

**Degrees of Biodegradability determined by OECD 301B:**
- Readily or Ultimate: \( \geq 60\% \) Degradation within a 10 Day window after initial 10%
- Inherently: 20 - 60%
- Non-biodegradable: 0 - 20%

Molecular weight has a large effect on biodegradability

**Typical Industry Base Oil Biodegradability**

<table>
<thead>
<tr>
<th>Base Oil Type</th>
<th>Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral Oil</td>
<td>15 - 35%</td>
</tr>
<tr>
<td>White Oil</td>
<td>25 – 45%</td>
</tr>
<tr>
<td>Vegetable Oil</td>
<td>70 – 100%</td>
</tr>
<tr>
<td>PAO</td>
<td>5 – 40%</td>
</tr>
<tr>
<td>PIB</td>
<td>0 – 25%</td>
</tr>
<tr>
<td>Polyols – Diesters</td>
<td>55 -100%</td>
</tr>
</tbody>
</table>

**NovaSpec 450 Biodegradability – 74%**
NovaSpec base oils have very low levels of toxicity
  • Pure hydrocarbon
  • No contaminates

100% BioFene base oils have passed toxicity testing for use in human contact applications

Novvi has received NSF HX-1 Food Grade certification on NovaSpec base oils

NovaSpec base oils are suitable for use in food, pharmaceutical, and cosmetic applications
NovaSpec base oils are compatible with existing used oil collection services and re-refining infrastructure.

Used oil is the highest volume of hazardous waste generated in California with approximately 100 million gallons being recycled in-state each year.

Biodegradability is great for spills and total loss applications, but oil must be collected and recycled.

- Industry must continue to work and send this message.
- Motor oil causes over 40% of the pollution in America’s waterways.

**Oil Pollution in Rivers and Oceans**

<table>
<thead>
<tr>
<th>Type</th>
<th>Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Oil Spills - all types</td>
<td>37 million</td>
</tr>
<tr>
<td>Routine Maintenance on Ships</td>
<td>137 million</td>
</tr>
<tr>
<td>Dumped Down the Drain</td>
<td>363 million</td>
</tr>
</tbody>
</table>

# BENEFITS TO END USERS: FLEXIBILITY

<table>
<thead>
<tr>
<th>PRODUCT CATEGORIES</th>
<th>BENEFITS TO END USERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine oils</td>
<td>Group III+</td>
</tr>
<tr>
<td></td>
<td>0WXX Fuel economy</td>
</tr>
<tr>
<td></td>
<td>Renewable, Reduced C footprint</td>
</tr>
<tr>
<td>Hydraulic Fluids</td>
<td>Top-Tier Performance</td>
</tr>
<tr>
<td></td>
<td>Biodegradable, Renewable</td>
</tr>
<tr>
<td>Transformer Oils</td>
<td>Low-Temp Properties</td>
</tr>
<tr>
<td></td>
<td>Heat Transfer</td>
</tr>
<tr>
<td></td>
<td>Cost Performance</td>
</tr>
<tr>
<td>Compressor Oils</td>
<td>Oxidation Stability</td>
</tr>
<tr>
<td></td>
<td>Air/Oil Separation</td>
</tr>
</tbody>
</table>
ENGINE OILS
Allows formulators to produce a ‘green’ passenger car engine oil using 100% NovaSpec base oils

- API SN engine program run using Infineum P5711 and Infineum SV265 VM Technology
- Sequence VIII passed on the SAE 5W-30
- Sequence IIIG, IVA, and VG passed on the SAE 0W-30 for maximum read across
NovaSpec base oils are redefining 2-Stroke Engine Oil formulations by exceeding the highest levels of industry performance standards and environmental performance characteristics.

**Applications include**
- Snowmobiles
- Motorcycles
- Mopeds and Scooter
- Utility vehicles
- Chainsaws
- Generators
- Trimmers
- Blowers
- Lawnmowers
- Snow blowers
# 2 Stroke Oil: Features and Benefits

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Smoke Operation</td>
<td>Reduces smoke and odour associated with two-stroke engines</td>
</tr>
<tr>
<td>Superior Lubricity</td>
<td>Controls cylinder, piston, bearing wear and reduces ring sticking</td>
</tr>
<tr>
<td>Low Pour Point</td>
<td>High performance in very cold environments</td>
</tr>
<tr>
<td>Optimized Viscosity</td>
<td>Improved system performance over a wide temperature range</td>
</tr>
<tr>
<td>Excellent anti-wear protection</td>
<td>Prevents corrosion and carbon deposits</td>
</tr>
<tr>
<td>High purity renewably-sourced synthetic base oils</td>
<td>Reduces dependence on petroleum</td>
</tr>
<tr>
<td>Low toxicity</td>
<td>Reduces environmental impact in case of leaks or spills</td>
</tr>
</tbody>
</table>
2 STROKE OIL: FIELD TEST DATA

- Over 500 hours runtime in toughest conditions
- Noticeable power increase with Novvi oil
- Significant reduction in fouled spark plugs in comparison with premium manufacturer recommended oil
- Cleaner engine parts when taken apart and compared side by side with regular high performance oil

“After running Novvi 2-Cycle Oil in our fleet of 20 Sprint Karts for over a year, I can safely say that Novvi 2-Cycle Oil is a premium product able to provide the performance and reliability that Simraceway Performance Karting Center expects day in and day out.”

KC Morrison, Simraceway Performance Karting Center Manager
HYDRAULIC OILS
NovaSpec base oil makes a revolutionary No Compromise® product for the hydraulic oil market

- Best in class oxidation stability for long drain and consistent performance
- Low temperature fluidity for multigrade and extreme temperature environments
- Good VI for maximum efficiency in use
- Meets stringent renewability requirements for US and European standards
- Biodegradability properties to meet green specifications
- Demonstrates excellent technical performance hydraulic bench testing
## COMMERCIAL ISO 46 HYDRAULIC FLUID COMPARISON

<table>
<thead>
<tr>
<th>Feature</th>
<th>Commercial N</th>
<th>Commercial A</th>
<th>Commercial B</th>
<th>Commercial C</th>
<th>Commercial D</th>
<th>Commercial E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basestock</td>
<td>Renewable hydrocarbon</td>
<td>Mineral</td>
<td>PAO</td>
<td>PAO</td>
<td>Syn Ester</td>
<td>Veg Oil</td>
</tr>
<tr>
<td>Ashless</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>KV 40 cSt</td>
<td>48</td>
<td>46</td>
<td>46</td>
<td>48</td>
<td>45.9</td>
<td>36.8</td>
</tr>
<tr>
<td>VI</td>
<td>160</td>
<td>97</td>
<td>154</td>
<td>192</td>
<td>200</td>
<td>212</td>
</tr>
<tr>
<td>Pour Point °C</td>
<td>-40</td>
<td>-33</td>
<td>-54</td>
<td>-47</td>
<td>-33</td>
<td>-34</td>
</tr>
<tr>
<td>Renewable Content &gt; 50%</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OECD 301B Biodegradability &gt;60%</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Copper Strip</td>
<td>1B</td>
<td>1A</td>
<td>1B</td>
<td>1A</td>
<td>1A</td>
<td>--</td>
</tr>
<tr>
<td>Foam</td>
<td>20/0</td>
<td>20/0</td>
<td>50/0</td>
<td>0/0/0</td>
<td>0/10/0</td>
<td>--</td>
</tr>
<tr>
<td>FZG stage</td>
<td>10</td>
<td>12</td>
<td>11</td>
<td>--</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>RPVOT minutes</td>
<td>900+</td>
<td>152</td>
<td>209</td>
<td>376</td>
<td>258</td>
<td>44</td>
</tr>
</tbody>
</table>

**Least Desirable**

**Most Desirable**
TRANSFORMER OILS
Novvi XFo uniquely combines performance and environmental benefit into one package.

Unmatched oxidative stability provides fill-for-life capability, which in turn reduces amount of used transformer fluid waste, and reduce overall operations cost.

Heat transfer capabilities provide the highest levels of cooling performance.

Cold flow characteristics make Novvi XFo the first renewable transformer oil that can to be used anywhere in the world.

Compatibility with mineral oil provides easy handling from refill applications to used oil disposal processes and re-refining.

Biodegradability and Renewability ensure the highest levels of environmental performance.
## Transformer Oil: Features and Benefits

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meets ASTM D3487 &amp; IEC 60296</td>
<td>Rigorous assurance of physical, electrical, and chemical properties and performance</td>
</tr>
<tr>
<td>Excellent heat transfer characteristics</td>
<td>Heat easily removed from core and windings</td>
</tr>
<tr>
<td>Outstanding oxidation stability</td>
<td>Extends transformer life and reduces maintenance</td>
</tr>
<tr>
<td>Low pour point</td>
<td>Can be used in very cold environments</td>
</tr>
<tr>
<td>Exceptional dielectric strength</td>
<td>Withstands high electric stress without breakdown</td>
</tr>
<tr>
<td>High purity synthetic hydrocarbon base oil</td>
<td>High performance and drop-in compatibility for mineral oil replacement</td>
</tr>
<tr>
<td>Low toxicity</td>
<td>Reduces environmental impact in case of leaks or spills</td>
</tr>
<tr>
<td>Biodegradable</td>
<td>Safer for use in areas where an unintended release would contact local environment</td>
</tr>
</tbody>
</table>
• Pure hydrocarbon, unlike vegetable oil and other ester-based fluids
• Compatible with mineral oil transformer design and seals
• Direct replacement for mineral oil with no flushing or system modification requirements
• Miscible with mineral oils and vegetable oils and will not lift any mineral oil deposits left in the equipment, allowing it to be used for fluid changes
• Can be recycled and reused like a mineral oil
• Rerefining utilising existing mineral oil infrastructure
# XFo TRANSFORMER OIL

<table>
<thead>
<tr>
<th>Feature</th>
<th>NOVVI XFo</th>
<th>MINERAL OIL</th>
<th>VEGETABLE OIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meets ASTM D3487 Standard</td>
<td>![Green Circle]</td>
<td>![Brown Circle]</td>
<td>![Red X]</td>
</tr>
<tr>
<td>Meets IEC 60296 Standard</td>
<td>![Green Circle]</td>
<td>![Brown Circle]</td>
<td>![Red X]</td>
</tr>
<tr>
<td>Low Temperature Operation</td>
<td>![Green Circle]</td>
<td>![Brown Circle]</td>
<td>![Red X]</td>
</tr>
<tr>
<td>Compatible with Mineral Oil for Refilling &amp; Disposal</td>
<td>![Green Circle]</td>
<td>![Brown Circle]</td>
<td>![Red X]</td>
</tr>
<tr>
<td>Environmental Performance</td>
<td>![Green Circle]</td>
<td>![Red X]</td>
<td>![Brown Circle]</td>
</tr>
<tr>
<td>Heat Transfer Performance</td>
<td>![Green Circle]</td>
<td>![Red X]</td>
<td>![Brown Circle]</td>
</tr>
<tr>
<td>Oxidative Stability</td>
<td>![Green Circle]</td>
<td>![Brown Circle]</td>
<td>![Red X]</td>
</tr>
</tbody>
</table>
COMPRESSOR OILS
Renewable hydrocarbon based compressor oil is the only oil that can meet any operating environment and environmental conditions

- Best in class oxidation stability for long drain internal and consistent performance
- Best in class air and water separation
- Low temperature fluidity for extreme temperatures
- Meets stringent renewability requirements for US and European standards
- Biodegradability properties to meet green specifications
- Demonstrated excellent technical performance in compressor bench testing
Air/Oil Separation Speed Comparison

Samples were shaken at 60°C for 3min, picture is taken after 20min.

renewable hydrocarbon compressor oil provides fast release of air.

* All compared samples are compressor oils. Label refers to base oil chemistry/API-category of each compressor oil.
Thank you for listening!

I would also like to thank my SIP colleagues Simon Lawford and Mike Peters and Novvi colleagues Bill Downey and Jeff Brown for their assistance in preparing this presentation.

Any questions?