Green Industrial Products for The Environment

Presentation to the Great Lakes Regional Pollution Prevention Roundtable Conference

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Cargill Industrial Oils and Lubricants

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Cargill Industrial Oils and Lubricants
Vision Statement

Cargill Industrial Oils and Lubricants is the leading global supplier of fats and oils and environmentally advantaged products to targeted industrial markets.
Drivers For Market Development

Cost  Environmentally Friendly  Performance

Cargill Industrial Oils and Lubricants is able to add an environmental dimension to the traditional cost/ performance trade off
Biodegradable Lubricant and Industrial Products

• Why Use Biodegradable, Renewable Products?
• Definition of Biodegradability
  – Types of Biodegradability
  – Means of Testing – Standards
• Types of Products
  – Biodegradable Content
  – Standards of Performance
  – Competitive Issues/Products
  – Uses
• How can the Great Lakes Regional Pollution Prevention Roundtable accelerate the use of bioproducts?
• Cargill Products
Why Use Biodegradable, Renewable Products?

- Reduced Environmental Impact in case of spills
  - Rapidly biodegradable
  - Less toxicity to living organisms

- Safer
  - Higher flash and fire points than most mineral based fluids
  - Less toxic to organisms and humans
    - Food grade in many cases

- Reduced dependence on foreign oil

- Enhance economy in Farm States using renewable resources
Biodegradable Product Concerns

• Traditional product performance concerns;
  • For example oxidation, low temperature, antiwear, antifoam, etc. in Lubricants
• Will the product biodegrade, to what extent and how fast?
• What is the toxicity of the product?
Biodegradable Lubricant and Industrial Products

- Passenger Car Motor Oils
- Two Cycle Engine Oils
- Hydraulic Fluids
  - Tractor Hydraulic Fluids
  - Food Grade Lubricants
  - Antiwear Hydraulic Fluids
  - Gear Oils
- Transformer Oils
- Solvents – FAME
# Vegetable Base Oils

## Advantages

- Excellent boundary lubrication
- Lower viscosity with low volatility
- Good Viscosity index
- Biodegradable, nontoxic and environmentally friendly

## Traditional Limitations

- Poor oxidative stability
- Poor low temperature properties
- Lack of viscosity range
- Limited additive technology
How is “Biodegradable” Defined?

Two general classifications (extent of)

Primary Biodegradation

Measures the loss of a product by alteration of the chemical structure resulting in loss or change of chemical nature of the product, but not the degree of degradation, i.e., partial or complete to \( \text{CO}_2 \) and water.

CEC L-33-A-93 is a test for primary biodegradation.

Ultimate Biodegradation (Mineralization)

Percentage of the substance that undergoes complete degradation to \( \text{CO}_2 \) and water, i.e., how long it takes to achieve a specific percentage of degradation.

ASTM D-5864 and EPA 560/6-82-003 are tests for ultimate biodegradation.
How is “Biodegradable” Defined?

Rate of biodegradation

**Readily Biodegradable**
Exhibits greater than a certain fixed percentage in a standard test. Most common are OECD301B-D, CEC L-33-A-93

**Inherently Biodegradable**
Degrade > 20% however have no defined test duration and are allowed to proceed as long as needed to achieve 20%.
Biodegradability Testing

Two Major Tests

• CEC L-33-A-93
  – Primary Biodegradation
  – IR method
    • Loss of -CH2- absorbance in IR of extracted material

• OECD 301 B (modified Sturm)
  – Ready Biodegradability
  – Measures the Ultimate Fate of a Lubricant
    • Lubricant breaks down to give CO2, H2O, and inorganic salts.
  – Test lasts 28 days
    • 10 day window when lubricant must biodegrade >60% (Readily Biodegradable)

• Specifications will usually call for a higher amount of biodegradation if the CEC test is used than if the OECD 301 B test is used
Comparison of Rapid Primary Biodegradeability

- Vegetable oil 95-100%
- Synthetic Esters
  - 2Ethylhexylcocoate 95%
  - TMPTriOleate 86%
- Mineral Oil 23-63%

CEC 33-L-93A

Willig, Chemosphere 43, 2001, 89.
Toxicity Testing

• Acute Aquatic Ecotoxicity is determined by testing on plant (algae), vertebrate (fish) and invertebrate (daphnia).
  • Many types of plants, fish and invertebrates
  • Dependent on nature (location) of material being tested
• Acute Soil Ecotoxicity is determined by testing on invertebrate (earthworms) and plant (lettuce).
• Many additive companies do not have aquatic toxicity data for additives
• Aquatic toxicity concerns rule out some additives
  • Some Food Grade Lubricant additives are too toxic for aquatic life yet are safe for humans!

• Difficult, costly testing
  • Reproducibility
  • Standardization
  • Statistical evaluation important
ASTM D-6046 Hydraulic fluids:

Toxicity results are used to classify the fluid

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<th>Ecotoxicity in Water Designation</th>
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Hydraulic Fluids

- Hydraulic Fluids Exist Based on Biodegradable/Renewable Base Oils
  - Different “levels” of Performance
  - Veg Oil
  - Polyol Esters
- Biodegradable Content is high – up to 90+% 
- Additive Packages and technology are limited
- Approval warranted by completing pump testing by existing Standards
  - Vickers (35VQ) and Denison HF0 are two major tests
  - Very few biodegradable fluids have obtained approvals

- Used in environmentally sensitive areas
  - Wetlands
  - Forestry
  - Waterways

- Compete against
  - Conventional Mineral Oil Hydraulic Fluids
  - PAO based Hydraulic Fluids
  - White Oil Based Hydraulic Fluids

- Issues – Cost and performance vs mineral oil based hydraulic fluids
Bio-renewable Passenger Car Motor Oils (PCMO)

• Very challenging application for renewable based materials
• Renewable content of 20-30% possible
• Additive technology important
  – Overcome oxidative instability
• API/ILSAC certifications allow marketing as any other motor oil
  – Labeled with “star” on container
  – No veg based oil has yet achieved this certification
  – Product containing AP-560 has passed all tests
• Competes vs. conventional motor oils
• Reduces dependence on foreign oils

• More expensive than conventional motor oils

• How do we sell this to GLRPPR state vehicle fleets?
  – Cars and light trucks
Two Stroke Motor Oils

- Significant reductions in emissions of outboard motors being required.
- Engine modifications being implemented
  - Direct Fuel Injection 2 cycle
  - 4 Stroke
- Approvals
  - National Marine Manufacturing Association
  - JASO
- DFI engines require improved lubricity and deposit control over conventional 2 cycle oils.
- New renewable based containing formulas being tested
- Improved detergency relative to test formulations
- Potentially important for motors on waterways

- Issues
  - Hotter engines due to less air cooling of design
  - Deposit control important
  - Cost relative to conventional 2 cycle oils
Transformer Oils

- Conventional Mineral Oils in Transformer Oils can pose threat to environment if spilled
- Vegetable Oils with additives make excellent replacement (98% veg oil)
- Completely PCB, Dioxin, Furan free
- High flash and fire point relative to conventional mineral oil transformer fluids
  - Safer in applications near buildings and schools
- Dielectric properties are sufficient
- Improved lifetime over mineral oils shown in studies
  - To be proven in real life
- Emerging Technology
  - ASTM Specifications being defined
  - Fire Resistance verified by Factory Mutual and Underwriters Laboratory Approvals

- Main Issues
  - Relatively high cost of fluid
  - Potential longer life, retrofill, smaller transformers may accelerate adoption
  - Technology needs to be demonstrated in commercial applications

- How can the GLRPPR accelerate use of biodegradable transformer oils?
Solvents – Fatty Acid Methyl Esters

- Methyl Esters of vegetable oil
- Solvent properties for clean-up of grease, oil
- Low volatility
- Relatively high flash point compared to mineral oils
- Good solvency for oils and greases
- Low odor

- No standardized performance specification – try and see if applicable to each proposed use.

- Issues – cost relative to mineral spirits and other solvents

- Where are areas of interest for solvents in State of Illinois governments?
How Can “Biobased” Acceptance be Accelerated?

Farm Bill
The Farm Security & Rural Investment Act of 2002 ("Farm Bill") establishes a new program for the purchase of biobased products by federal agencies.
Federal Agencies must give preference in purchasing to biobased materials if they:

1) Meets performance requirements
2) Not excessively expensive (provide value)
3) Available

- 12 Categories of Biobased Products
  - Adsorbent - Landscaping materials
  - Adhesives - Lubricants and functional fluids
  - Alternative Fuels - Paints and Coatings
  - Bioplastics/polymers - Personal Consumer Items
  - Solvents and Cleaners - Inks
  - Construction materials, composites, plastic lumber
  - Inks - Tree free paper and alternative fibers

Definition of biobased and listing of products being developed at Iowa State University.
- Biobased content and Lifecycle impact analysis to be required.
- Industry to determine performance standards
How Can “Biobased” Acceptance be Accelerated?

- Many Regulations dictate/decide/influence permissibility or desirability of use
  - Dependent on applications and definitions
- Regulations covering disposal of used oils
  - Used Oil disposal covered under RCRA (Title 40 CFR Part 279)
    - Veg oil is “not” used oil
- Spills –
  - Classified as Hazardous or non-hazardous
  - Land or Waterbased Spill
    - EPA or Coast Guard Authority
  - All spills are treated equally
    - Regulations to date do not differentiate small vs. large spill
    - Can small spills be considered less hazardous with their own cleanup protocol?
    - Individual state regulations?

- Studies show reduced persistence and impact of veg oils on soils and crops in subsequent years relative to mineral oil.

- Recognition of this fact by EPA in regulation of spills
  - Relative economic benefit – cost effective to require $30,000 for spill of 20 gallons of transformer oil??
Three main lubricant product lines

Formulated Hydraulic Fluids

Water Dispersable Lubricants
Cargill Industrial Oils
Oleochemical Products
- For the Lubrication Industry

- Synthetic Esters
  - Interester Chemistry
  - Polyol Vegates
- TMP-TO Ester replacements
- Polyol Esters
- Fatty Acid Methyl Ester
- Free Fatty Acid
  - Tallow
  - Stearic
  - Soybean
  - Coconut
- Vegetable Base Oils
- Fats & Greases
Biodegradable, Renewable Industrial Products

• Low Environmental Impact
  – Reduced Persistence in the environment
  – Rapidly Biodegradable
• Increased usage of renewable components – crop based
• Performance Meeting Industry Needs
  – Technology reducing price and performance gaps
• Low Toxicity
• Government Use Necessary to Drive Initial Demand
• Total Cost of Use Needs Increased Awareness
  – Government Promote Use
  – Implementing Environmental Policies