

# Next Generation Bio-Based Lubricants

**Erik Willett – VP Tech at Functional Products Inc.**

2022 STLE Orlando  
4:30pm Tuesday May 19<sup>th</sup>  
Commercial Marketing Forum IV



# Introductions

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# Functional Products Inc.

- Founded in 1985
- Focus on customer driven solutions
- Full service technical support lab
- ISO 9001 with Design
  
- Expansion completed 2020
  - Facility doubled
  - 2x lab and technical staff
  - Expanded test capabilities
  
- **Let us do the search and you do the research**

2020



2021



x2

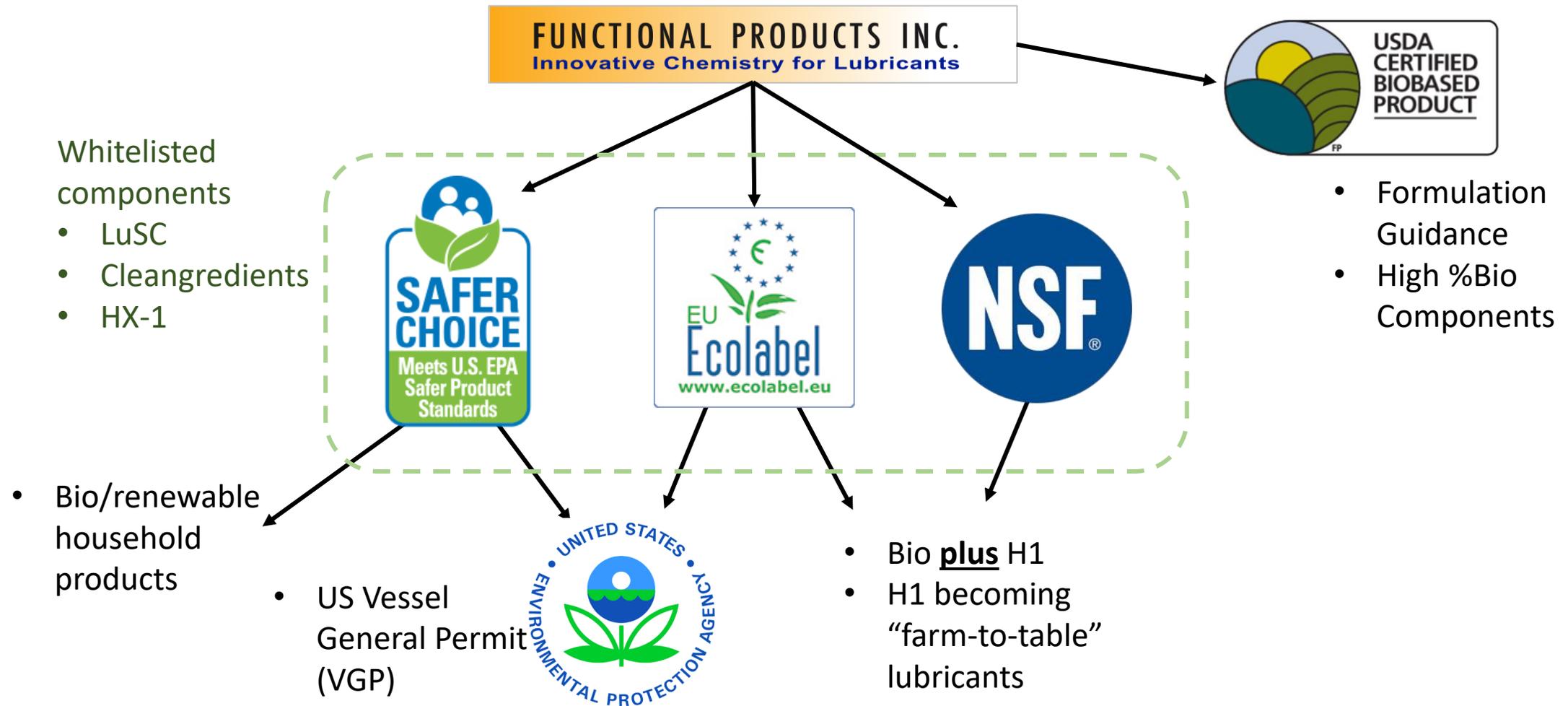


# Market Position

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- 🔥 Full Service Additive supplier and unique base stock supplier
  - 🔥 Market leader in lubricant tackifier technology
  - 🔥 Technical leader in polymer-based additives for industrial lubricant, grease, and specialty products
- 🔥 Ability to develop new performance packages for various base fluids
- 🔥 Unique portfolio for industrial and niche markets:
  - 🔥 Specialty viscosity modifiers for PAO, ester
  - 🔥 NSF HX-1 food machinery lube additives
  - 🔥 Biobased and EAL
  - 🔥 Grease polymers
  - 🔥 Custom polymethacrylates

# Supporting a Network of Needs



Safer Choice formerly known as Design for the Environment (DftE)

# Agenda

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- Biobased introduction
- Polymers for viscosity
  - Industrial Viscosity Modifiers
  - Shear Stable Base Stocks

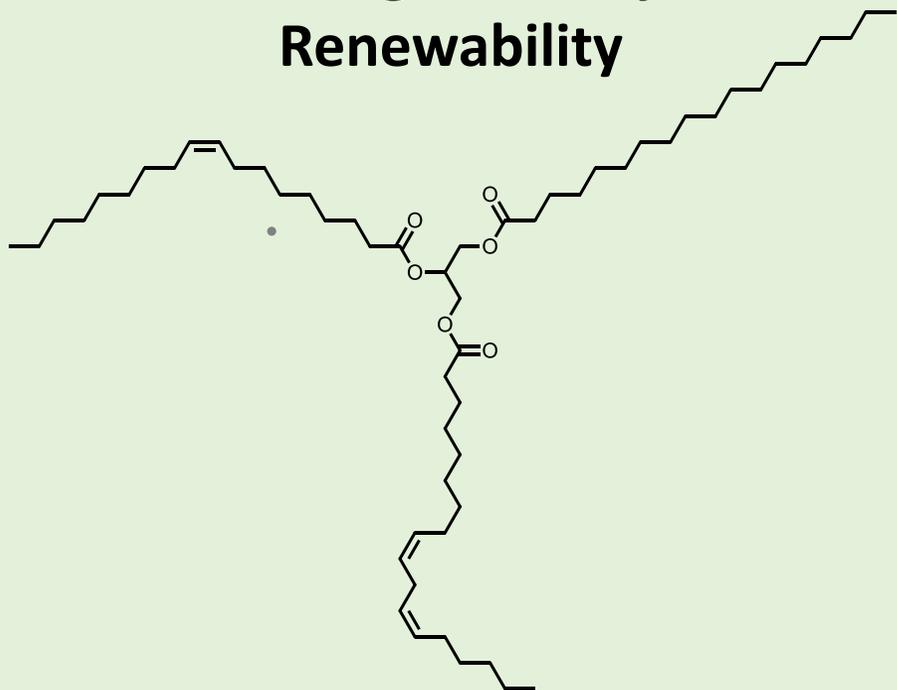
# Intro to Biobased

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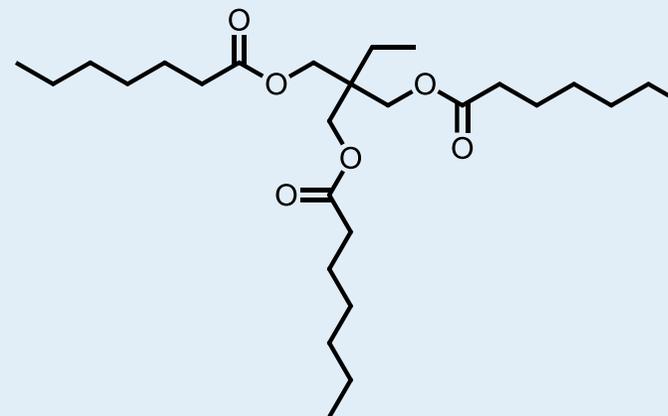
# Biobased Market Is Diverse

Performance Target:  
**Biodegradability,  
Renewability**



**Natural Esters**

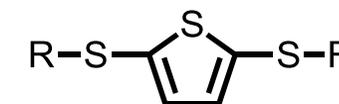
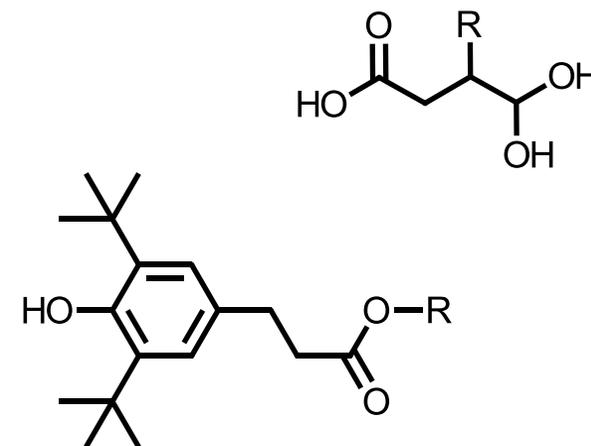
Performance Target:  
**Stability, Long Life,  
Volatility, Solvency**



**Synthetic Ester**

# “Biobased” Lubricant Additives

- May or may not be biobased themselves
- Required for proper operation of biobased *finished* product
  - A means to an end
- i.e. antioxidants, corrosion inhibitors, antiwear, EP...
- Toxicity and wt% limited by regulatory program



# Environmentally Acceptable Lubricants

- EAL and “biobased” market
  - Goals depend on which program
    - USDA – biobased
    - VGP / Ecolabel – biodegradability and toxicity
  - Programs can change over time

		<u>Biobased</u>	
		No	Yes
<u>Biodegradable</u>	Yes	PAO* PAG*	Vegetable Oil Synthetic Ester* Polymeric Esters*
	No	Petroleum Oil Hydrocarbon Polymers	Commodities from Industrial Fermentation (Ethanol to Ethylene)

# Covering Your Bases in Specialty Lubes

- ‘Feature complete’ slate of Ecolabel registered components

Role	Ecolabel LuSC Listed
Base Stock	V-5019, V-5048
Viscosity Modifier	V-515, V-521, V-508
Tackifier	V-584, V-188P2
Pour Point	PD-585, PD-590
Packages/Additives	HF-595, SGP-563
Demulsifier	DM-400
Defoamer	DF-400, DF-500
Grease Polymer	V-4051, V-508S



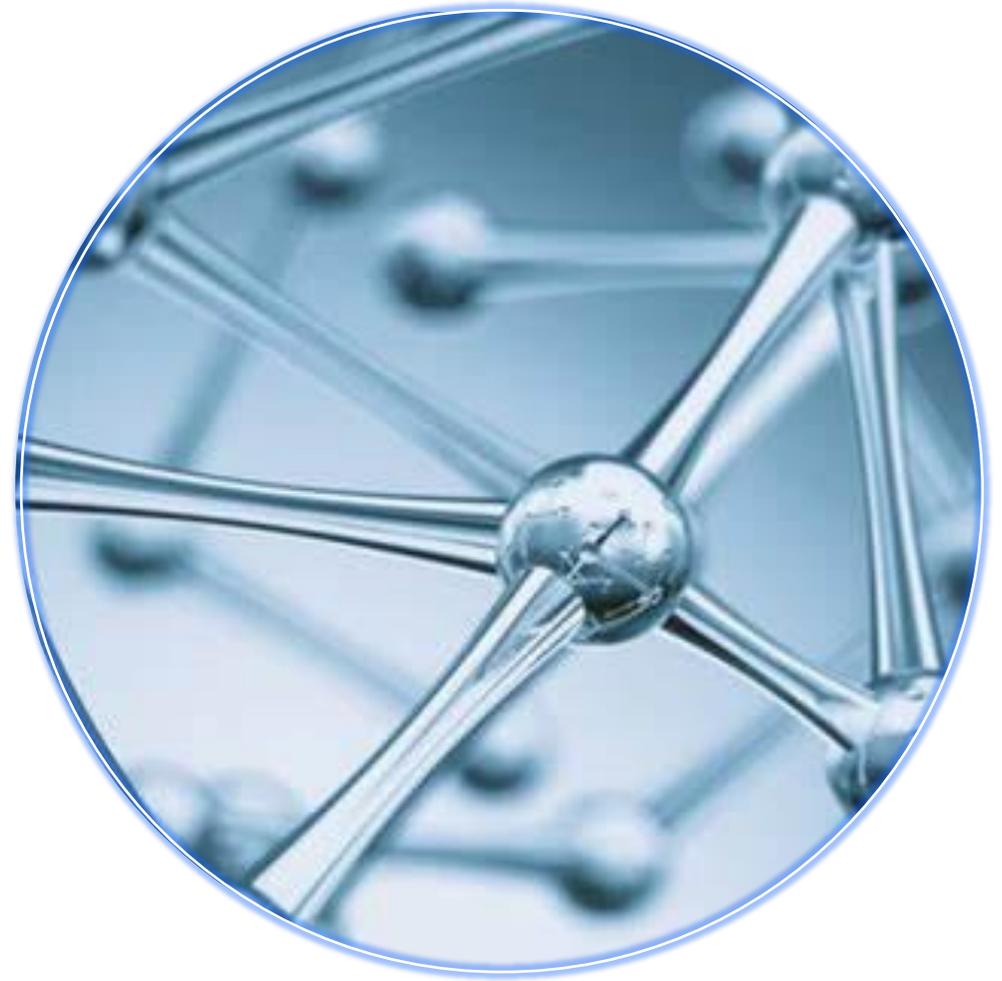
# Goals for Specialty Lubes

- Provide the same range of options to specialty formulators
  - Tackifier, VM, PPD, packages, additives, etc.
- Three levels of specialty products:
  1. **Okay** products that meets the regulations
  2. **Good** products that performs same as industrial
  3. **Great** products that outperform industrial lubes
    - Truly special



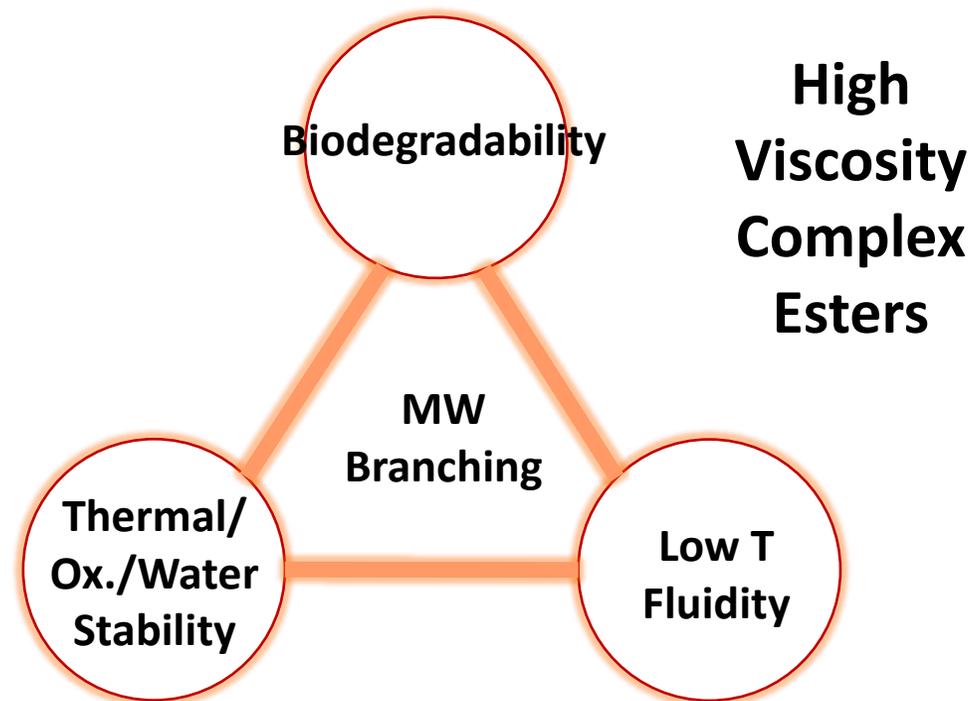
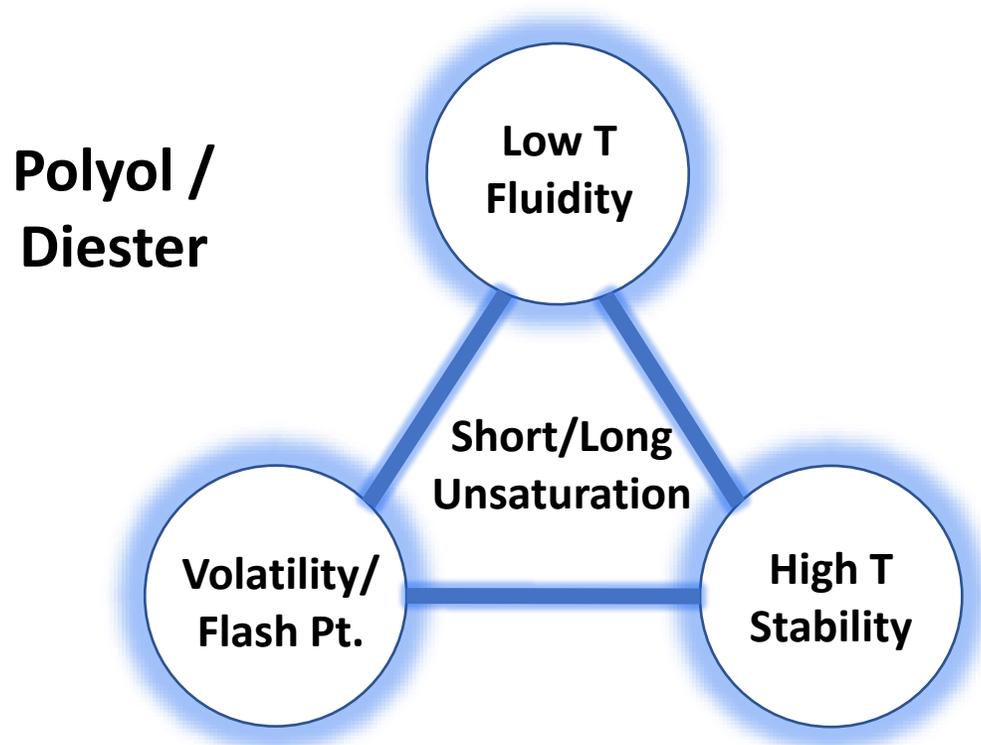
# Solving Problems with Polymers

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# 'Iron Triangle' in Ester Synthesis

- To optimize one property, we lose performance in other properties
- "You can't have it all"

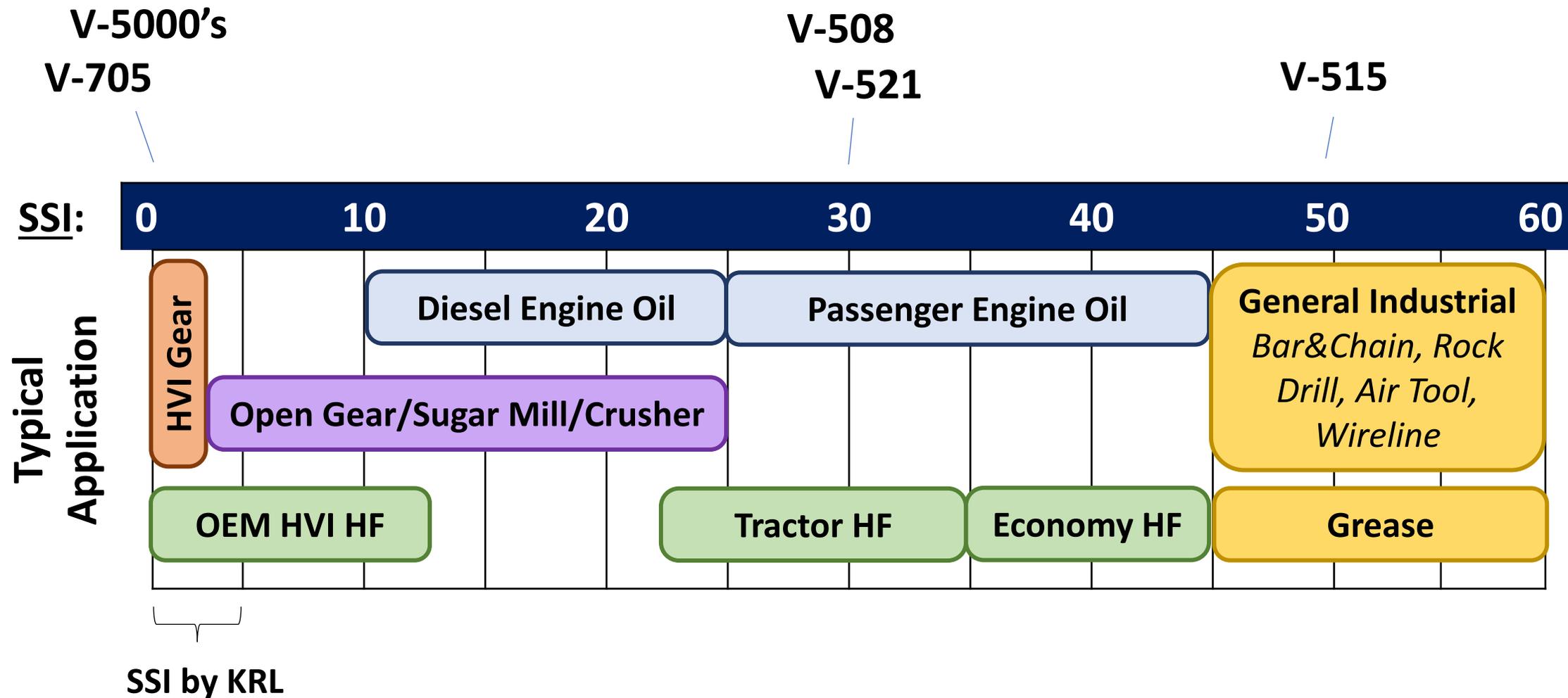


# Ester-Polymer Composite Approach

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- Use polymers (viscosity modifiers) to bend the Iron Triangle
  - Better exchange rate on trade-offs in performance (viscosity vs. fluidity)
  - Develop new fluids without new CAS# / reactors / supply chain
- Nothing for free:
  - Added complexity in formulating and 'know how'
  - Potential mechanical shear losses depending on SSI

# The Right Shear Stability by Need



# Viscosity Modifiers for Biobased

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# Industrial Fluids and Hydraulics

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- Three core product families for viscosity

**FUNCTIONAL V-515**



**FUNCTIONAL V-521**



**FUNCTIONAL V-508**



# FUNCTIONAL V-515



- **Role: Economical and slightly tacky (50 SSI)**
- Ideal for most low-shear industrial oils:
  - Rock drill & pneumatic oil
  - Rail grease, pellet mill
  - Total loss / single pass – saws, chains



# FUNCTIONAL V-521



- **Role: General purpose and low temperature (30 SSI)**
- Best option for low pour esters (polyol, diester)
  - Excellent complement to TMPTO
  - HETG / HEES hydraulic fluids (ISO 15380)
  - Municipal (plow/bucket/garbage trucks)



# FUNCTIONAL V-508



- **Role: Versatile and high temperature (29 SSI)**
- Best oxidative, thermal stability; NSF HX-1
  - High temp chain oil, bakeries/ovens
- Most versatile in ester, WI/OS PAG
  - Metal forming – neat or emulsified



# Relative Comparison

V-515



V-521



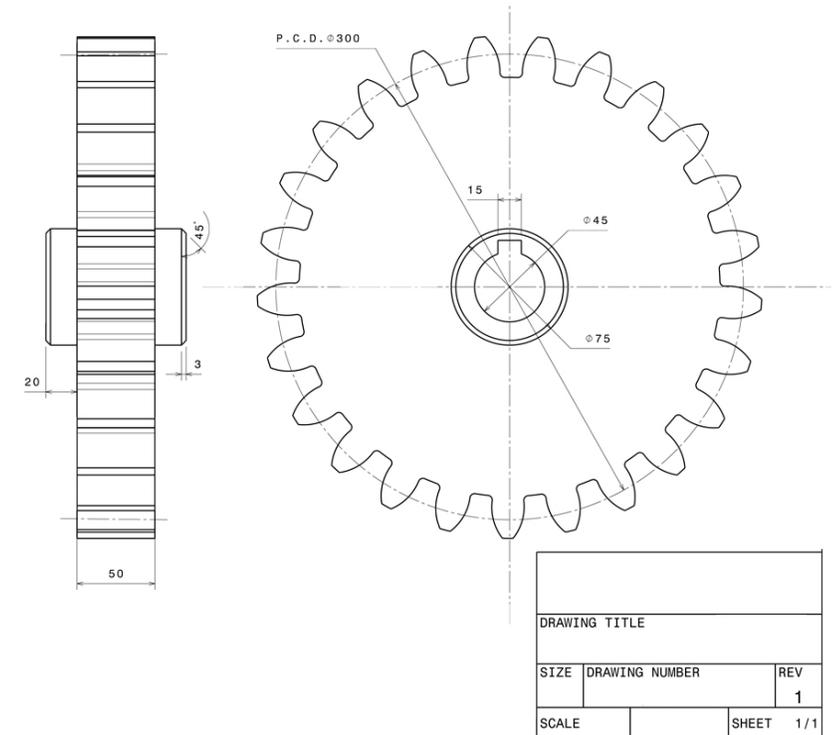
V-508



Programs:	Ecolabel	Ecolabel	Ecolabel, HX-1
Thickening:	★★★	★★	★★★
Shear:	★	★★	★★
Tackiness:	★★	--	★
High Temp:	★	★★	★★★
Low Temp:	★★	★★★	★
Grease:	★	★★	★★★
Compatibility:	Ester, PAO, AN	Ester, AN	Ester, PAG, AN

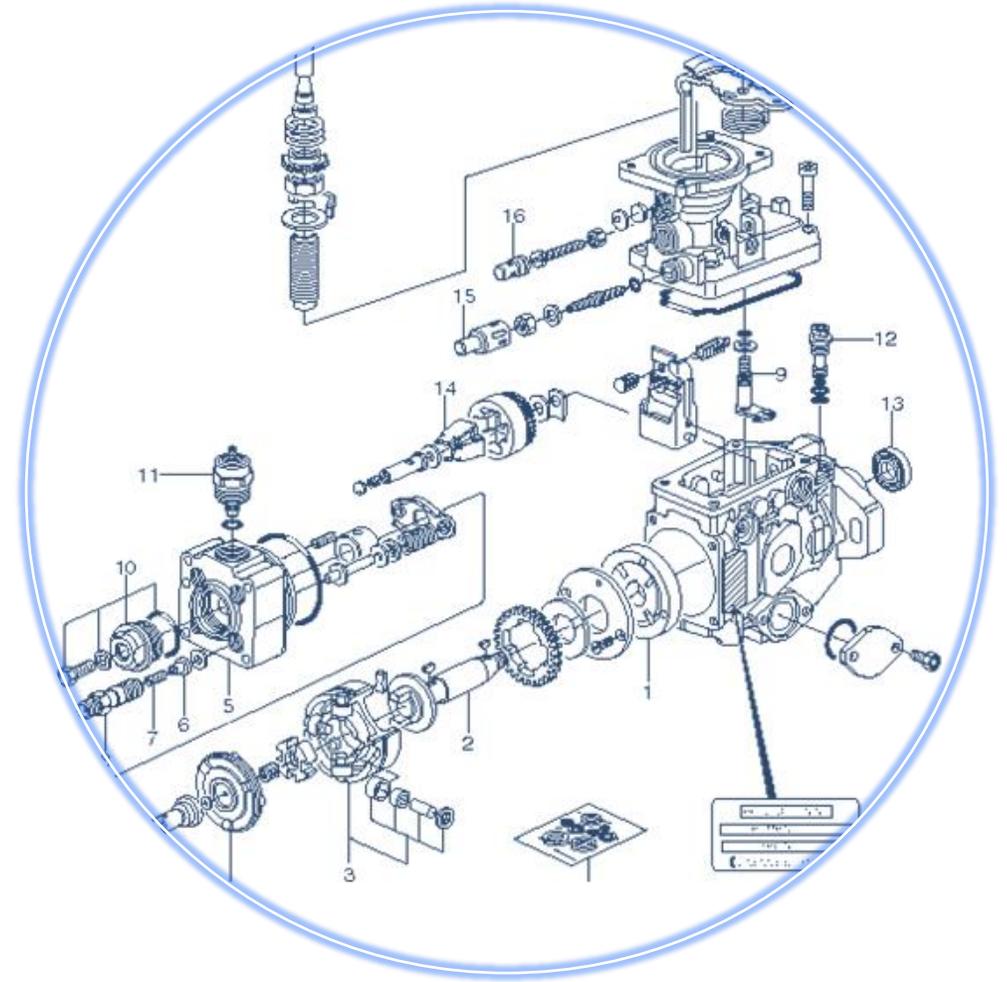
# Customization

- Default carrier oil is natural triglyceride
- Typically 2000 – 8000 cSt @ 100°C
- We aim to provide your custom solution
  - High oleic veg oil
  - Synthetic ester
  - PAG
  - PAO
  - *Or something different?*



# High Performance Base Stocks

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# Synthetic Base Stocks

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- Industrial gear oils and HVI hydraulics require KRL shear stability
- FUNCTIONAL V-705
  - High performance low temperature stock
- FUNCTIONAL V-5000 Series
  - Heavy EAL base stock

# FUNCTIONAL V-705

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- Low temperature base stock / VM hybrid for VHVI HF and ind. Gear
  - Popular for elevating Group I/II/III to high viscosity, low pour fluids
    - Comparable to full PAO on shear and fluidity
- Lesser known fact, compatible in many esters and some PAG

# V-705 in Ester

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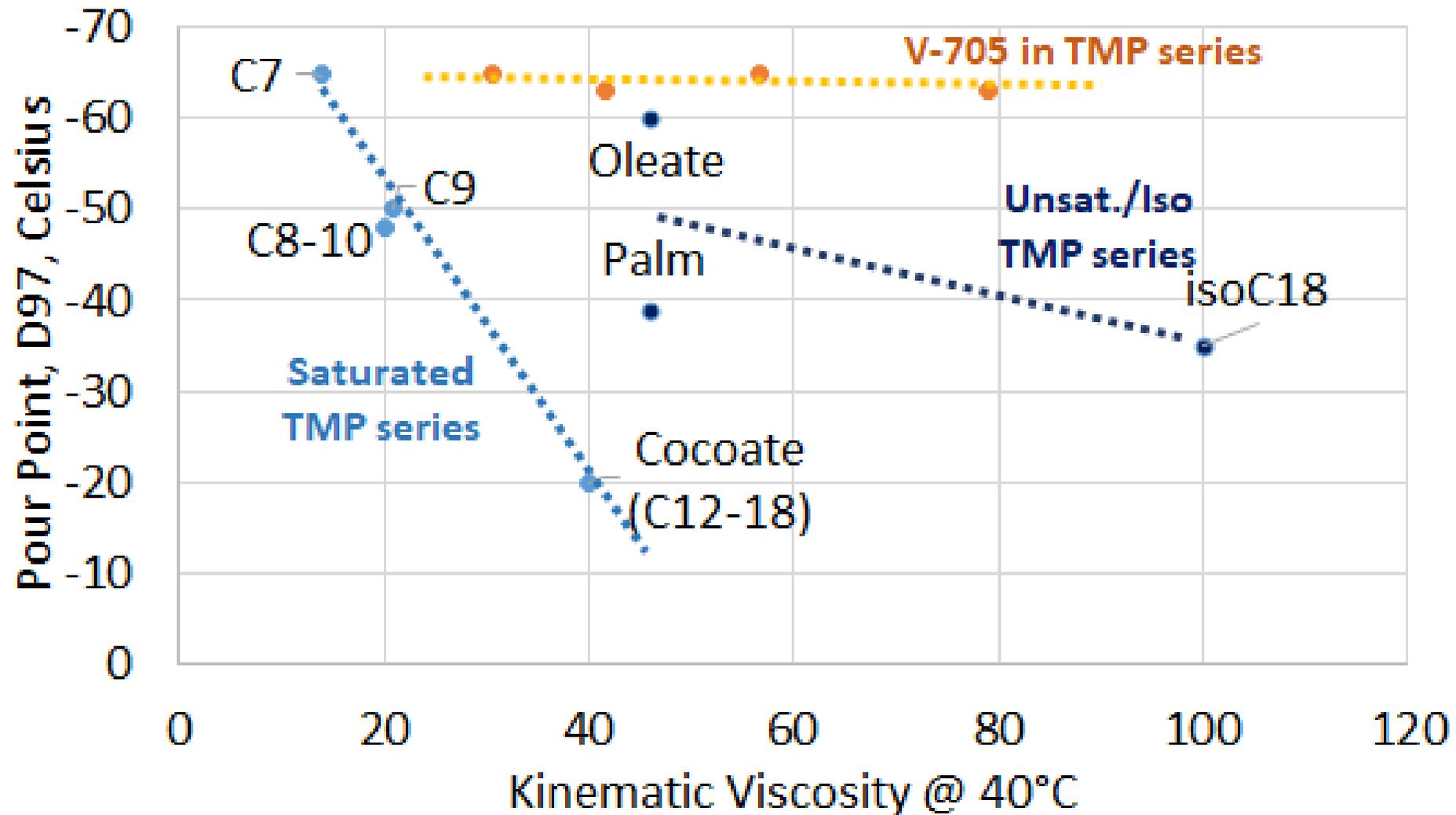
- 10wt% can 5x viscosity without affecting pour point

V-705 in DTDA	0wt%	5wt%	10wt%
KV40	22	50.9	98.9
Visc Index	150	191	222

V-705 in TMP C9	0wt%	5wt%	10wt%
KV40	21	41.6	79.1
Visc Index	140	209	235

V-705 in TMP C7	0wt%	5wt%	10wt%
KV40	14	30.5	56.8
Visc Index	120	218	250

# V-705 in TMP vs. Straight TMPs



Pour points based on manufacturer averages from public datasheets/literature.

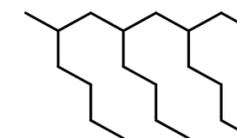
# FUNCTIONAL V-5000's

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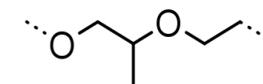
- Difficult to make readily biodegradable, shear stable fluids at ISO 1000+
- **FUNCTIONAL V-5019** – ISO 1900
- **FUNCTIONAL V-5048** – ISO 4800
  - 70% biodegradable by OECD 301B
  - Compatible in: polyols; diesters; complex esters; WI and OS PAG
  - Heavy duty polymeric ester
    - Oil/gas, mining, couplings, dragline, worm, silica grease, etc.

# High Viscosity EAL Base Stocks on Ecolabel

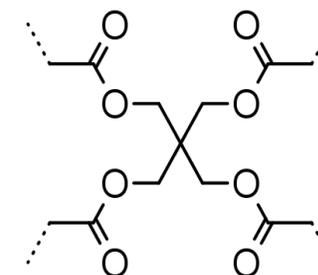
Material	Type	KV40	% Biodeg.	Pour	Ecolabel?	LuSC Limit
	PAO	81	>30%	-27°C	Yes	5-25%
	PAG	335	<20%	-32°C	Yes	5-20%
	Ester	680	76%	-18°C	Yes	None
	Ester	1000	63%	-24°C	Yes	None
	PAG	1000	<20%	-26°C	Yes	5-20%
	Ester	1000	60%	-23°C	Yes	None
	Ester	1700	<60%	-20°C	Yes	7-39%
<b>V-5019</b>	<b>Ester</b>	<b>1900</b>	<b>70%</b>	<b>-24°C</b>	<b>Yes</b>	<b>None</b>
	Ester	3000	20-60%	-15°C	Yes	5-20%
<b>V-5048</b>	<b>Ester</b>	<b>4800</b>	<b>70%</b>	<b>-15°C</b>	<b>Yes</b>	<b>None</b>
	EPO	37500	<20%	-5°C	Yes	5-20%
	Ester	47000	<20%	N/A	Yes	5-21%



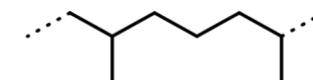
PAO



PAG



Ester



EPO

# Closing Remarks

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# Summary

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- FPI is a full service supplier and developer in the biobased/EAL market
- The perfect ester at the right price likely can't be synthesized
  - Polymers bend the limitations on properties vs. performance
    - Viscosity modifiers for industrial fluids, general purpose
    - Synthetic base stocks for shear stable fluids

**Thank you for attending  
today's session!**

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