



**ERGON**<sup>®</sup>  
UNITED BY SERVICE. DRIVEN BY SOLUTIONS.

High Performance  
Lubricity Additives  
for New Challenges

Selim Erhan, Ph.D.  
Process Oils, Inc.



# ERGON<sup>®</sup>

**UNITED BY SERVICE. DRIVEN BY SOLUTIONS.**

**4 segments. 60+ companies.  
Meeting a wide variety of market needs.**



### **Energy & Specialty Solutions**

We transform molecules that would otherwise be used as transportation fuels into noncombustible specialty naphthenic and paraffinic products for niche markets. We also manufacture resins, agents, additives and modifiers for specialty applications.

**Ergon Refining, Inc. | Ergon International, Inc. | Ergon - West Virginia, Inc. | Process Oils, Inc. | Resinall Corp**

### **Pavement & Coating Resources**

Our asphalt solutions extend the life of roadways around the world.

**Ergon Asphalt & Emulsions, Inc. | Ergon Asfaltos México HC, LLC | Ergon Asphalt Partners, LP  
Bryan & Bryan Asphalt, LLC | ErgonArmor | Paragon Technical Services, Inc. | Crafcro, Inc.**

### **Integrated Services & Logistics**

Our logistics companies are essential to North America's manufacturing supply chain and construction industry.

**Ergon Oil Purchasing, Inc. | Ergon Terminaling, Inc. | Ergon Trucking, Inc. | Magnolia Marine Transport Company  
Ergon Marine & Industrial Supply, Inc. | Lampton-Love, Inc. | Ergon Construction Group, Inc. | Ergon Properties, Inc.**

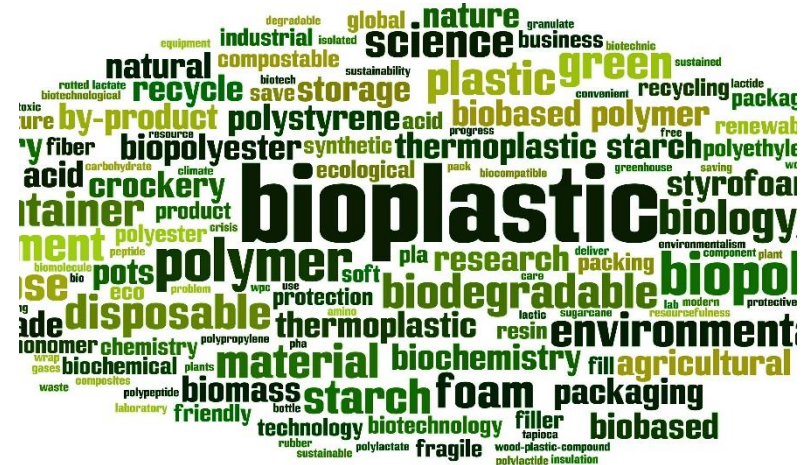
### **Exploration & Production**

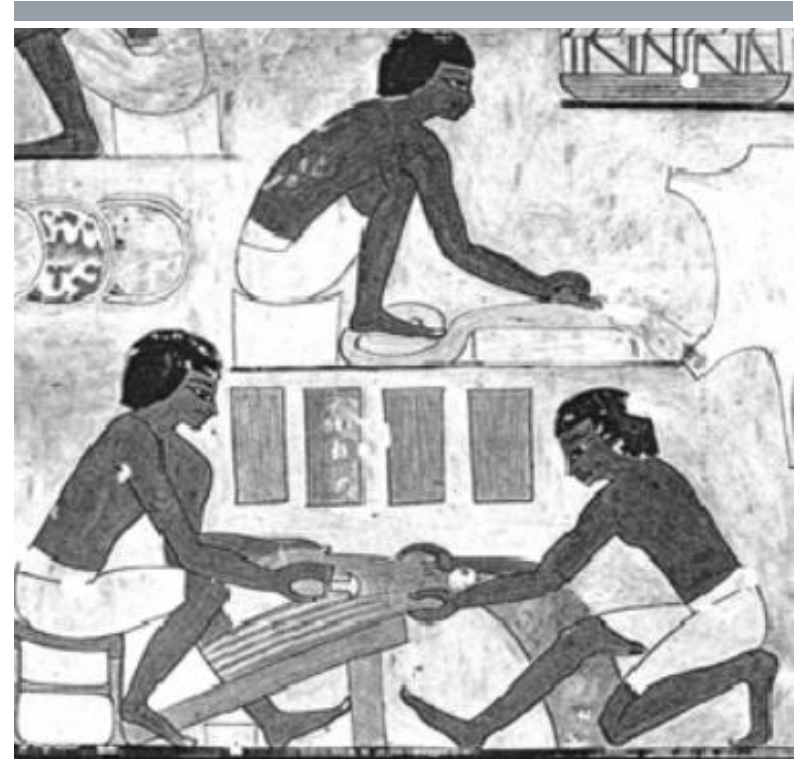
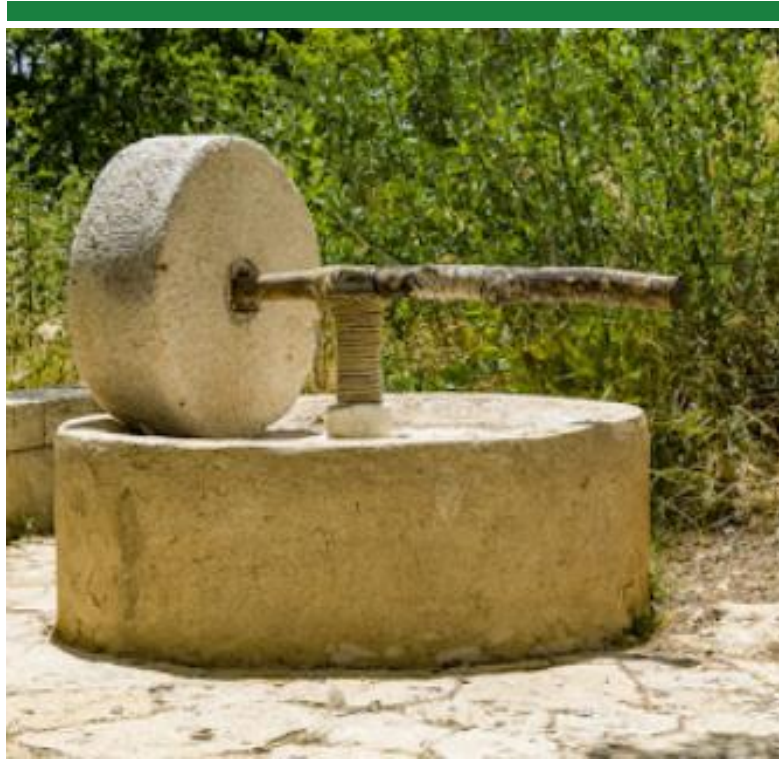
Ergon companies have been involved in oil and gas exploration and development since the 1970s.

**Ergon Exploration, Inc. | Ergon Energy Partners, LP**

## WHO IS PROCESS OILS INC.?

- POI has over 40 years experience in providing solutions for our customers in process oil, lubrication and niche applications.
- 2016 Ergon purchased POI due to strong partnerships with several mineral and vegetable oil producers which allows for unique chemistries and applications.
- POI's Team concentrates on non-traditional refinery products and applications.
- POI is dedicated to Business Development through a technical sales approach dedicated to solving a client's need for a solution.
- POI has most signed a marketing agreement with Cross Oil Refining to market their naphthenic oil product line





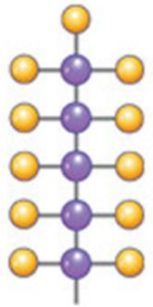
Plant-based oils have been used for lubricating needs since the beginning of civilization

# CHEMISTRY OF PLANT BASED OILS

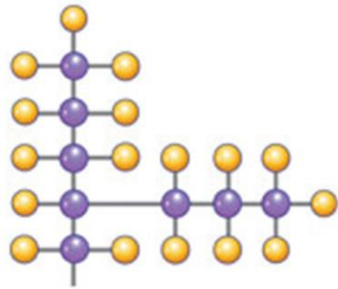


# Shifting Chemistry

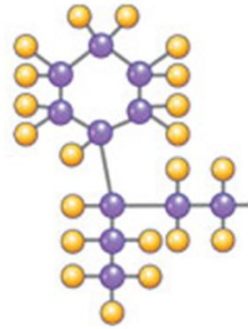
## Hydrocarbon



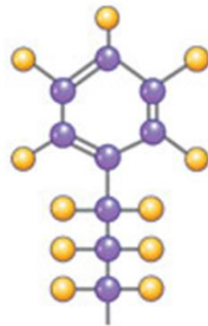
Paraffin



Branched  
Paraffin



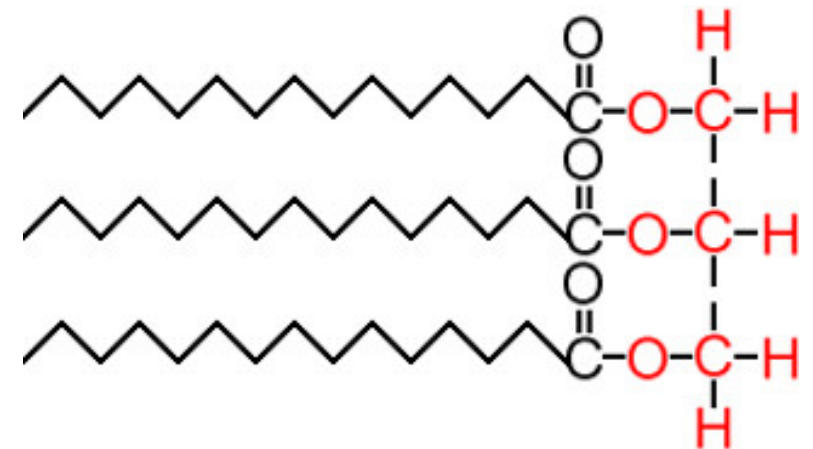
Naphthene



Aromatic



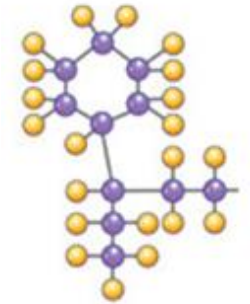
## Triglyceride



3 Fatty Acids + Glycerol

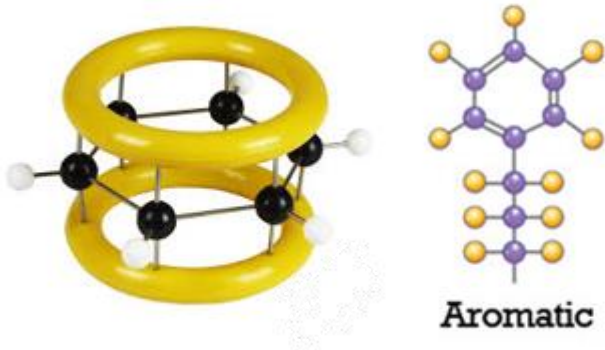
# Different Types of Solvency

**Naphthenic Oils** use *physical solvency* via Physical entanglements

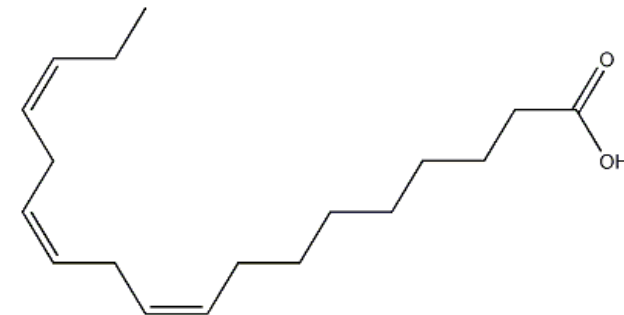


Naphthene

**Aromatic Oils** use *chemical solvency*, via loose electrons on the benzene rings



**Plant-based Oils** use both *chemical and physical solvency*

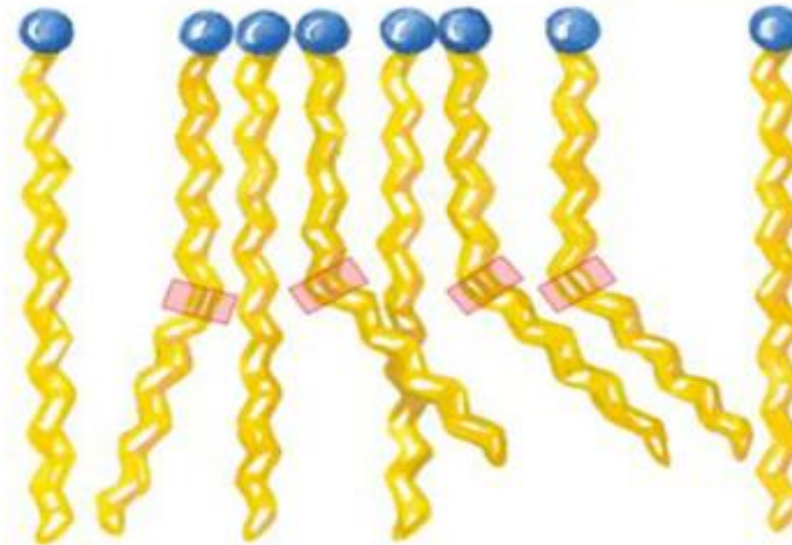


# Fatty Acid Arrangement & Physical Properties

Changing the geometries will:

- Determine physical characteristics
- Determine performance in final product

Stearic Acid takes a solid shape because of its saturation and arrangement of fatty acids

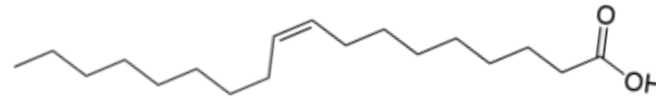
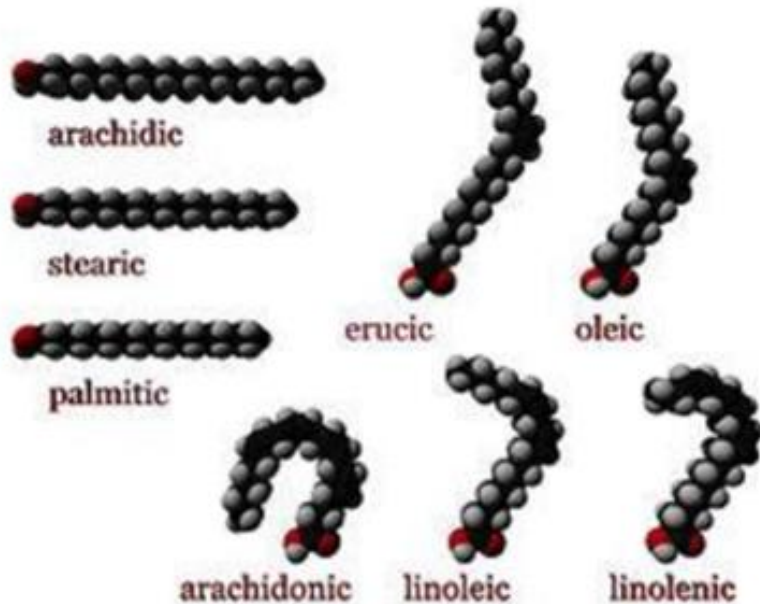


Mixture of saturated and unsaturated fatty acids

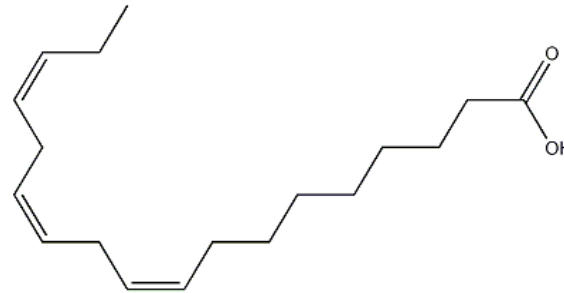
Saturated fatty acids



## Unsaturation and Solvency



**C18:1 Oleic Acid**



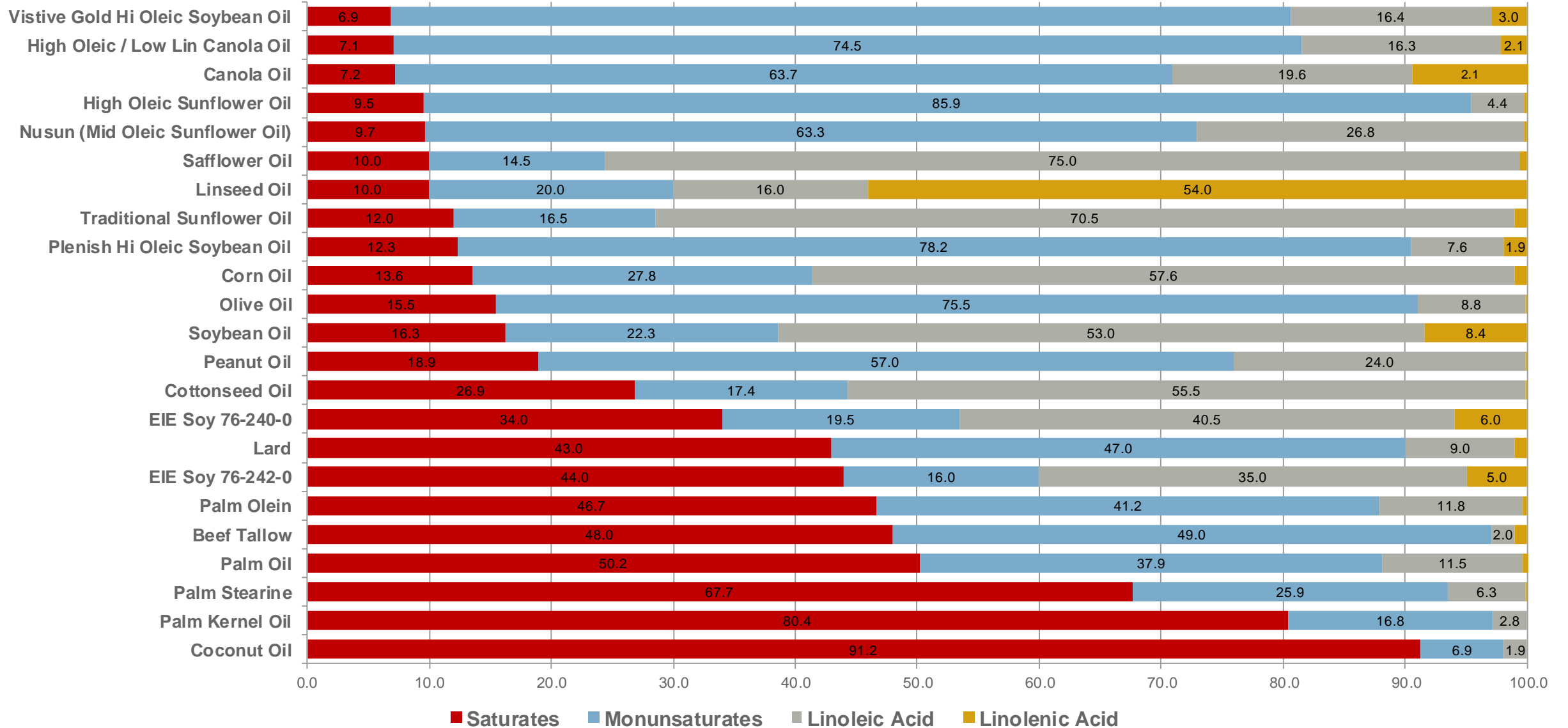
**C18:3 Linolenic Acid**

For Mineral and Plant-based, the Same Principles Apply

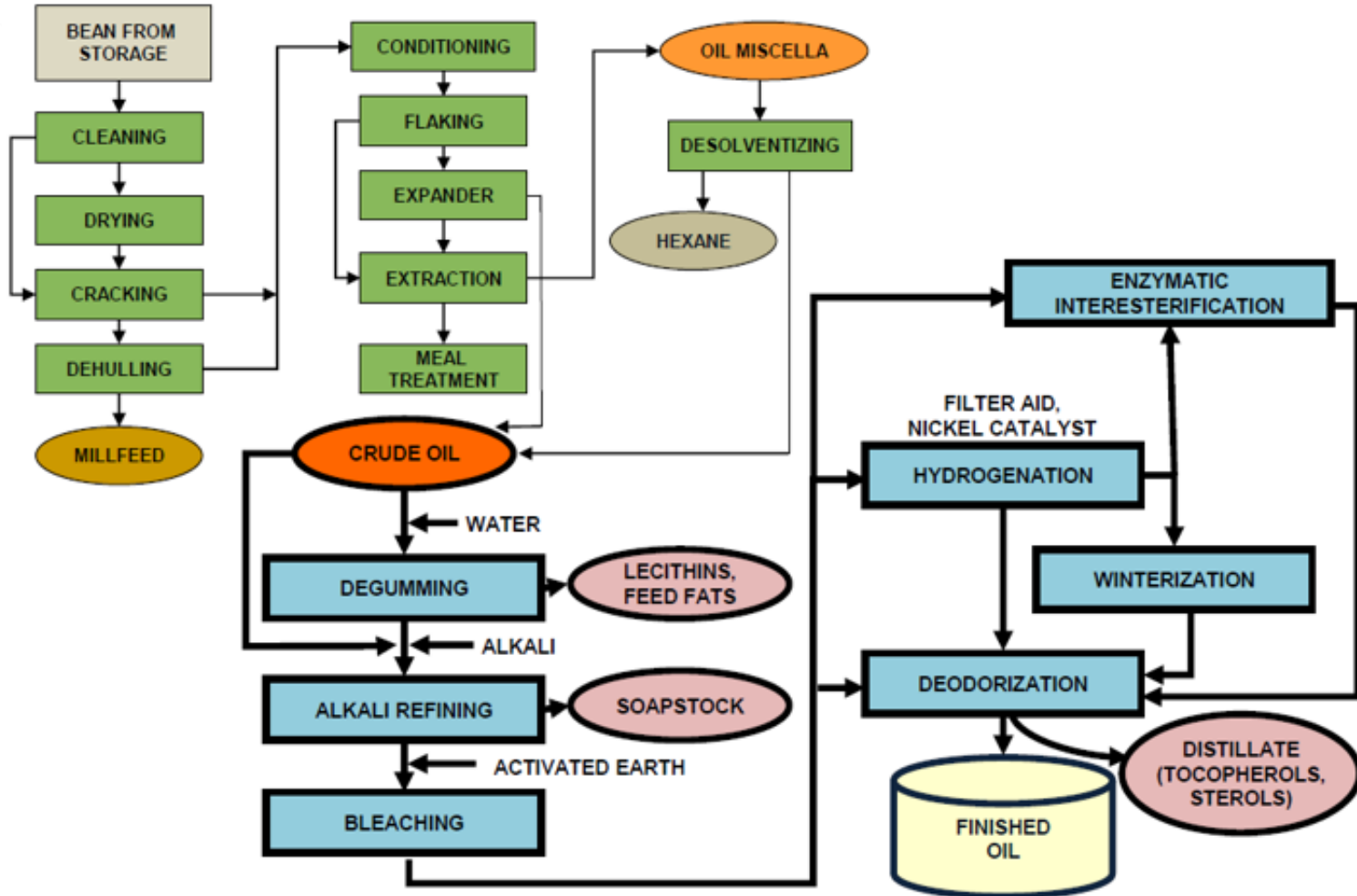
↑ Unsaturation    ↑ Solvency

↑ Unsaturation    ↓ Stability

# Fatty Acid Profile of Common Plant-based Oils



# Refine, Bleach, Deodorize



## Differences and Advantages v. Mineral Oil Refining

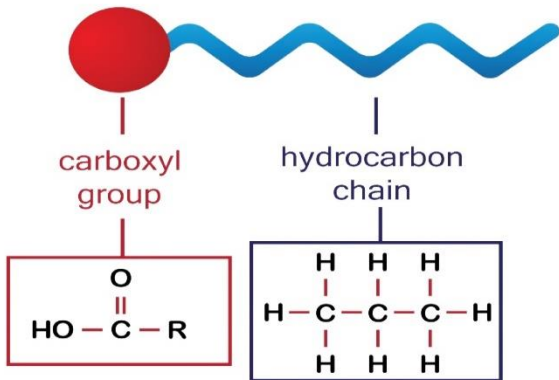
- Less Complex- Cleaning and Extracting
- Cleaning a product that is already synthesized
- The product can be pulled for the market throughout the process at different property stages

# ACID OIL: COMPOSITION OF FREE FATTY ACIDS

## Fatty Acid

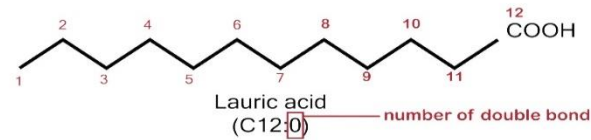
Fatty acid made up from carboxylic group and hydrocarbon chain

### Structure



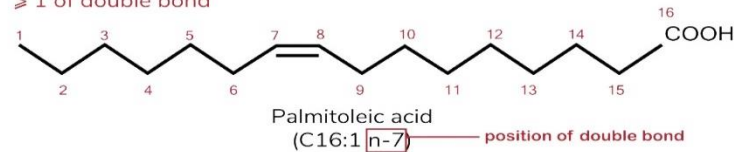
### Saturated fatty acid

No double bond in structure



### Unsaturated fatty acid

≥ 1 of double bond



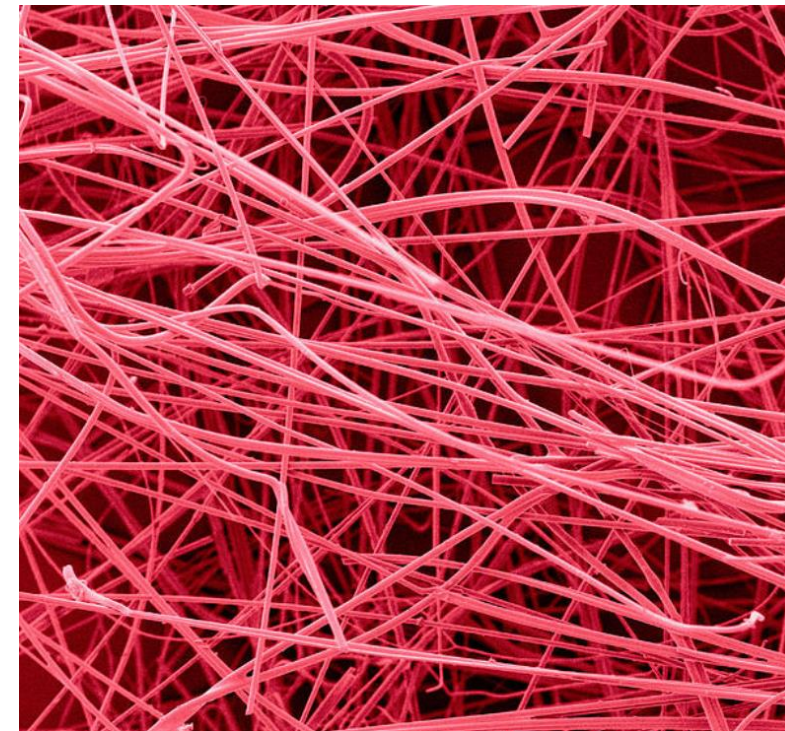
Applications : Extender for 1,2 hydroxysteric acid, TOFA replacement, fuel additive,

### Acidulated Oil Composition

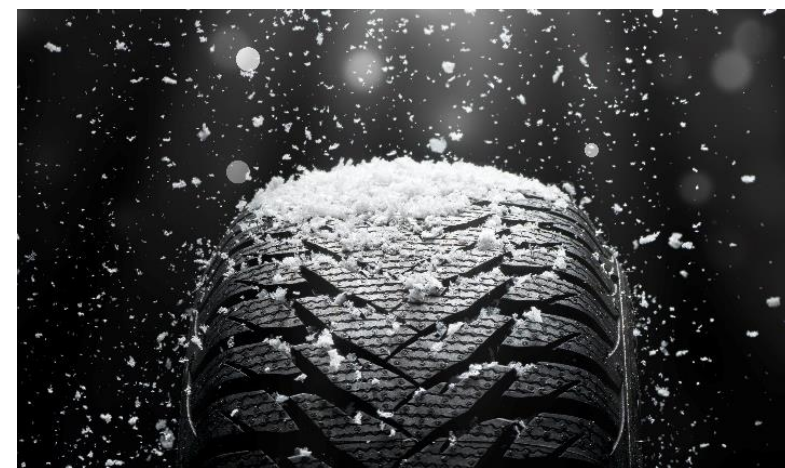
Item	Unit	Test Method	Decatur West
Appearance			
Color (AOCS RY, 1-inch)			Too dark to measure
Gardner color		by Automated tintometer	Too dark to measure
pH		AOCS G7-56	2.4
Specific gravity		Hydrometer, @50C	0.900
Free fatty acids by titration	%	AOCS Ca 5a-40	60.9
Acid value	mgKOH/g	AOCS Cd 3d-63	121.2
Moisture content	%	Karl Fischer	0.91
Moisture content	%	Halogen moisture analyzer	1.11
Total fatty acids		AOCS G3-53	86.1
Iodine value		AOCS Cd 1c-85	120
Pour point	°C	ASTM D5949	-16
Free sterols	%		1.93
Total sterols	%		3.04
Glyceride composition	%		
FFA			51.8
MG			1.5
DG			8.7
TG			28.2
FAME			0.05
Glycerol			0.04

# Plant-based Oil through the RBD Process





Why consider plant-based oils in industrial applications now?



# MEETING GLOBAL RAW MATERIAL TRENDS



**New sustainability  
and ESG goals**



**Bioaccumulation  
and Biodegradation**



**Attaining smaller  
carbon footprint**



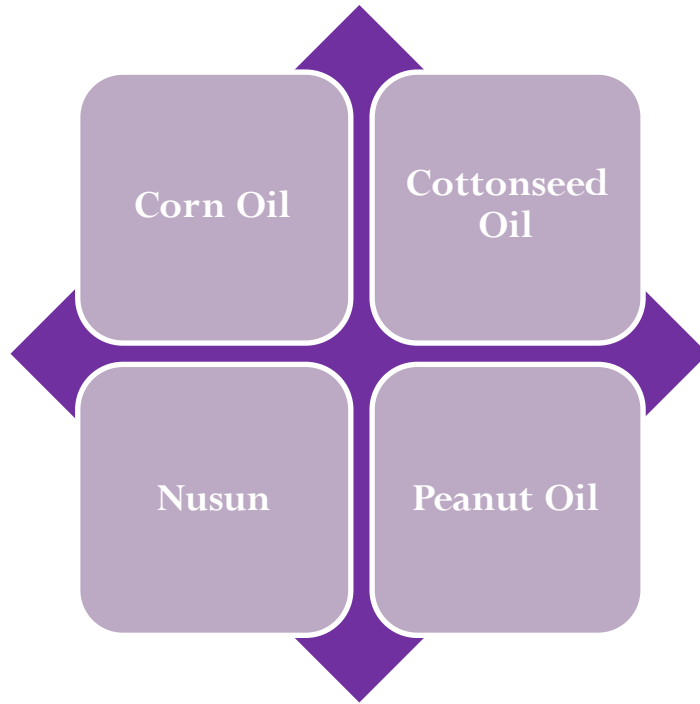
**Life Cycle  
Assessments:  
Cradle to Grave**



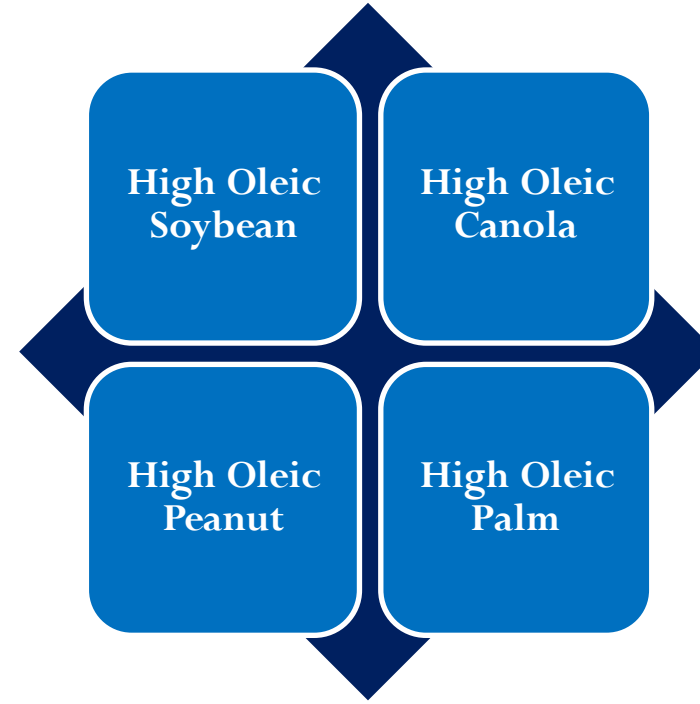
**Consumers  
Education in raw  
materials**

# The Need for Stable Oils

## Naturally Stable



## Trait Enhanced





*Long/Medium*

# Fatty Acid Chain

*Short*

Soybean  
- Commodity  
- High Oleic  
Rapeseed  
- Commodity  
- High Oleic  
Corn  
Cottonseed  
Sunflower  
Peanut  
Linseed

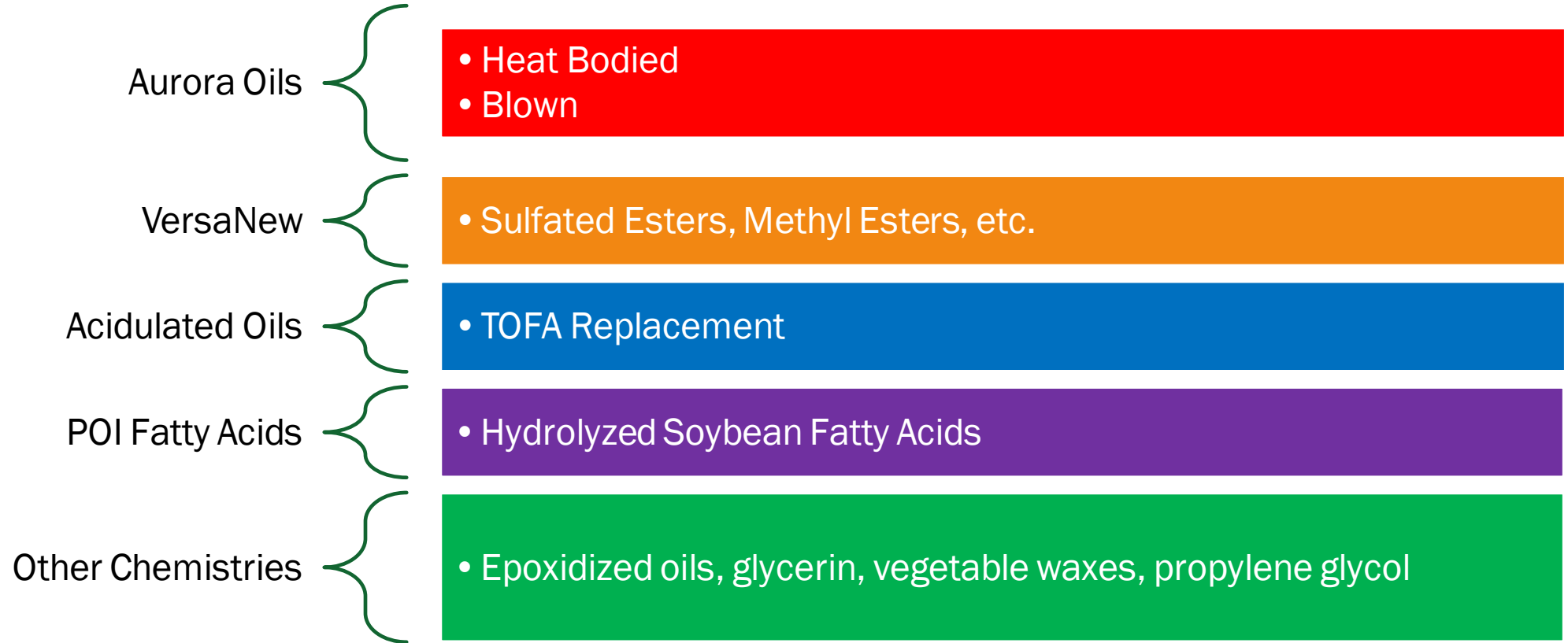
Palm Oil  
Palm Olein  
Palm Sterin

Coconut  
Palm Kernel

## Modification Options

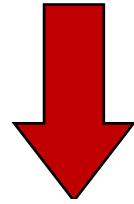
Blending  
Hydrogenation  
Enzymatic Interesterification  
Heat Bodied (LSO)  
Micro-Emulsions

## FUNCTIONALIZED NATURAL ESTERS AND SPECIALTY MINERAL OILS



## LUBRICITY MECHANISM

**Severe Pressure**



Hydrodynamic Lubrication

Boundary Lubrication

Cold

Hot

Metal

Metal

Oil

Metal

Metal

Oil

As oil gets hotter, it gets thinner decreasing the amount of film strength between the moving parts. The less film strength the higher the temperature. The higher the pressure and temperature, the higher the friction creating increased wear on components.

### Overcoming Friction

If pressure becomes more severe, lubricating liquid is pushed out of the contact zone. Traditional boundary lubricants adhere to surfaces with electrostatic interactions as their molecules are similar to fatty acids. However, electrostatic interactions are not very strong bonds and if the pressure is severe enough the adhered layer could be wiped away.

# TRADITIONAL EP ADDITIVES

## CHLOROPARAFFINS

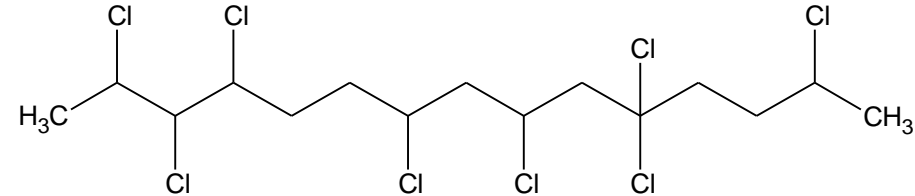
Pros

- Cost
- Broadly effective
- Non staining
- Bio resistance

Disposal

Cons

- Potentially corrosive
- Environmental



Chloroparaffin

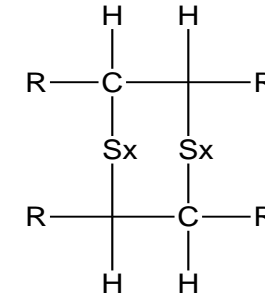
## SULFURIZED OIL/ESTER- INACTIVE

Pros

- Disposal
- Low staining

Cons

- Odor
- Biodegradable
- Stability in concentrate



Sulphurised oil/ester

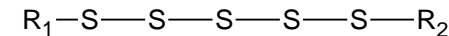
## SULFURIZED OIL/ESTER- ACTIVE

Pros

- Disposal
- High EP

Cons

- Non-ferrous staining
- Odor
- Biodegradable
- Stability in Concentrate



Polysulphide

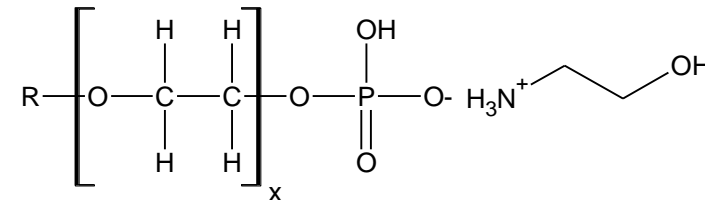
## PHOSPATE ESTER

Pros

- Low staining
- Corrosion inhibitor
- Synergy with S/Cl

Cons

- Low EP
- Fungus



Neutralised phosphate ester

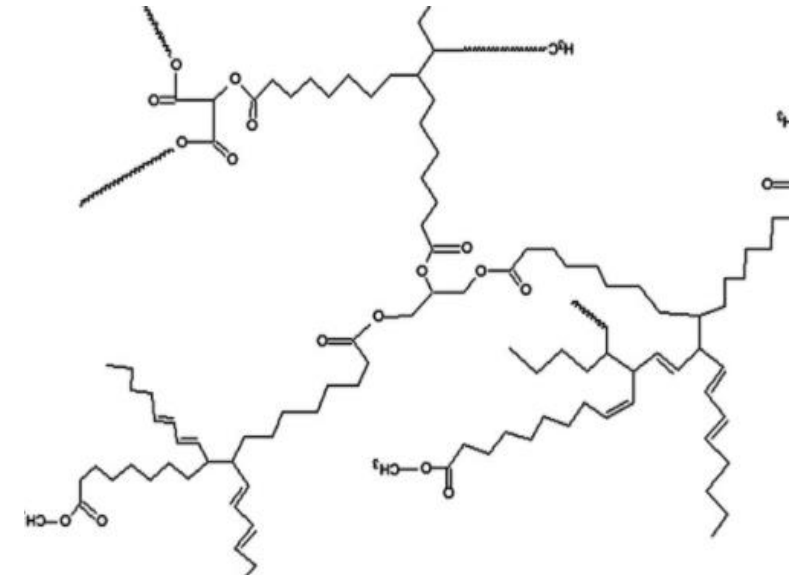
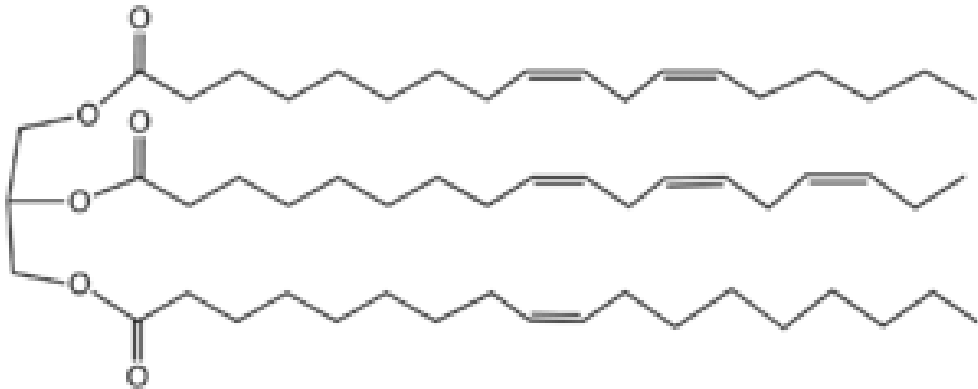
# Aurora Plant-based Oils

## Types of Aurora Oils

- Polar
- Non-Polar

## Adjustable Polarity

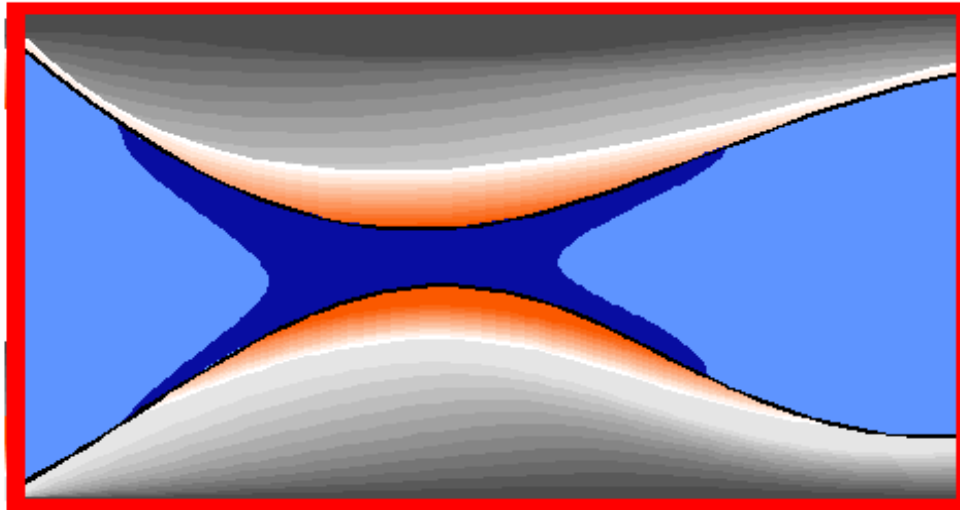
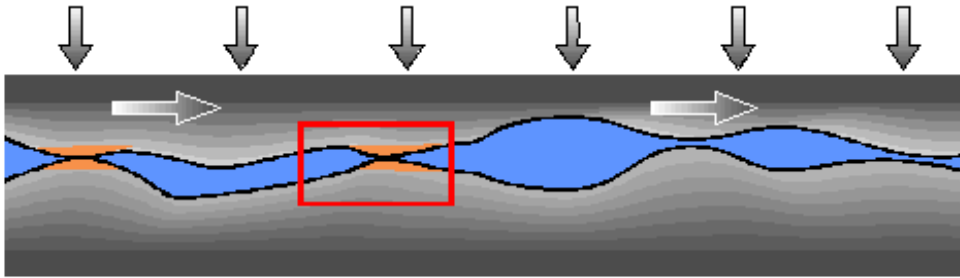
- Non-polar molecules with C-C links
- Polar Aurora have ether links that add a significant polarity to the matrix



## Benefits to Aurora Oils

- Higher Viscosities
- Less reactivity & oxidation
- Less solvency, close to mineral oil
- Higher molecular weight polymers that grow in 3 dimensions
- Molecular weight, size, and acid value can be adjusted in production
- Adjustable polarity

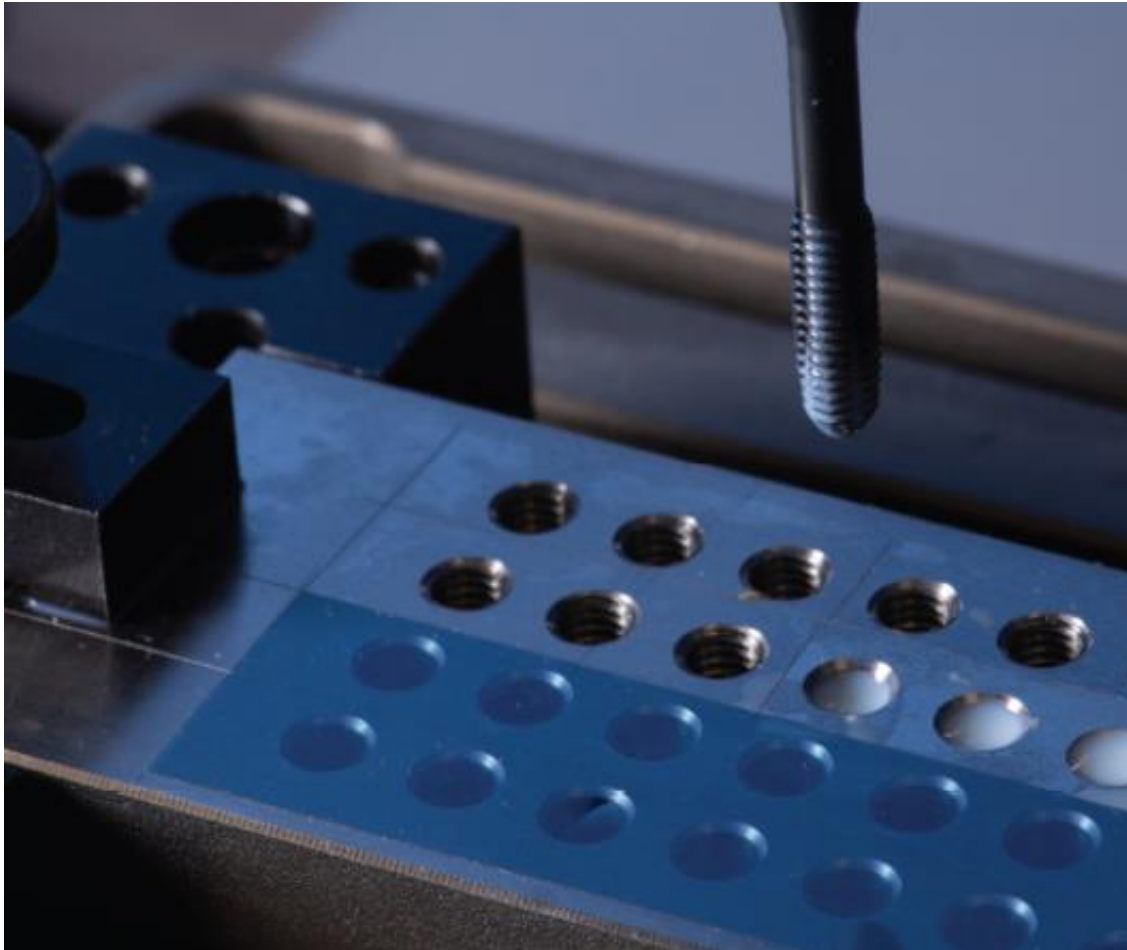
## AURORA OILS EP MECHANISM



- Polymer settles into valleys and on peaks of asperities
- Difficult to remove
- Shear stable
- Heat activation is not necessary
- Asperities do not break, less heat is generated, tools run cooler, wear is much reduced

- Lubricants and penetrating oils
- Corrosion inhibitor formulations
- Different Type of Metal Working Fluids

# Mircotap Test Results & Review



## ASTM D5619 Tapping Torque

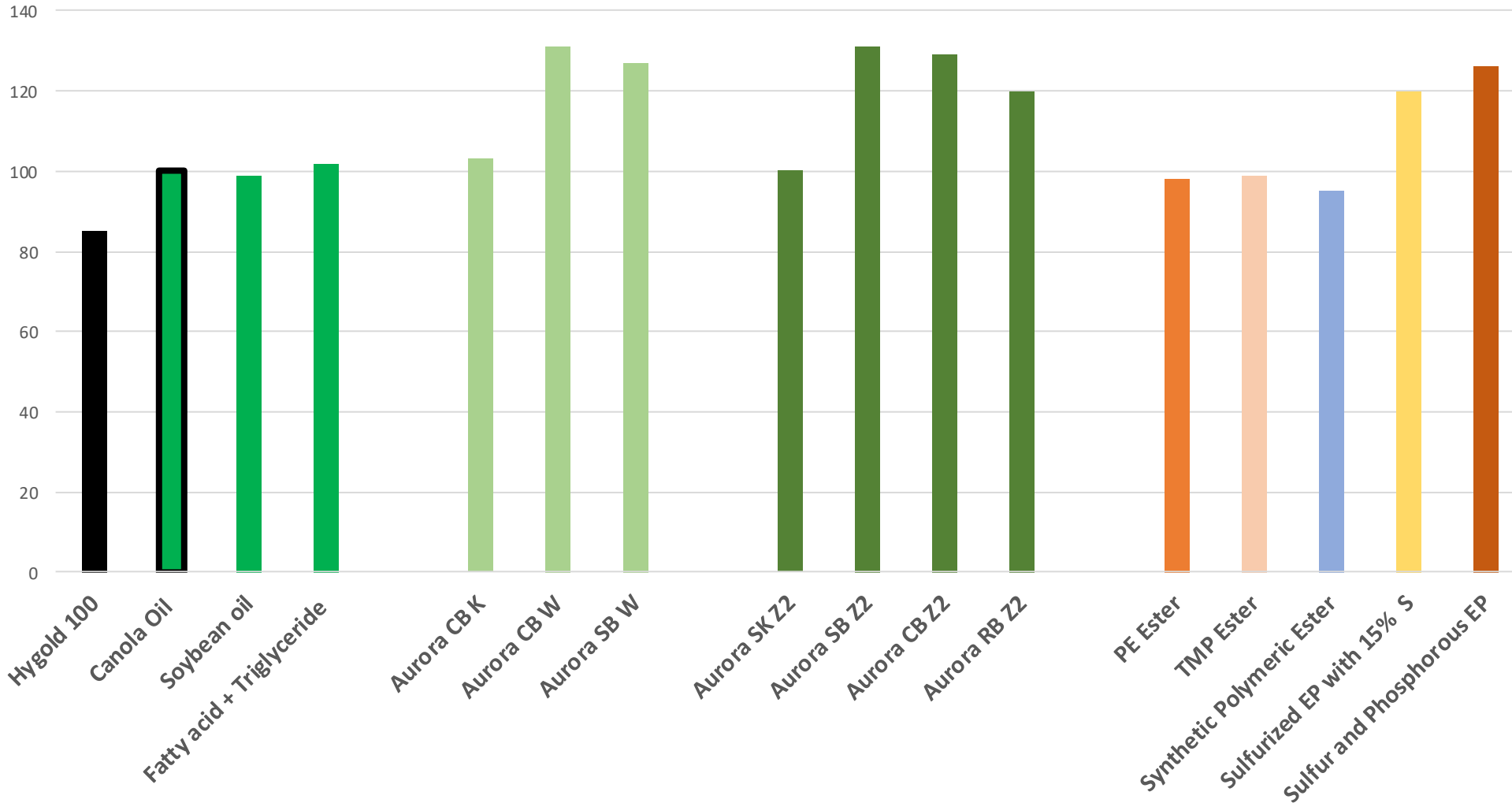
Canola Oil used as standard and assigned  
100% efficiency

All fluids tested contained the following  
formulation:

- 90 Parts- 100 SUS Naphthenic Oil
- 10 Parts- Various additives
  - RBD Plant-based Oil
  - Aurora Non-Polar Oils
  - Aurora Polar Oils
  - Natural Esters
  - Synthetic Esters

# MODIFIED AURORA OIL ON STEEL

% Efficiency on 1018 Steel with Forming Tap

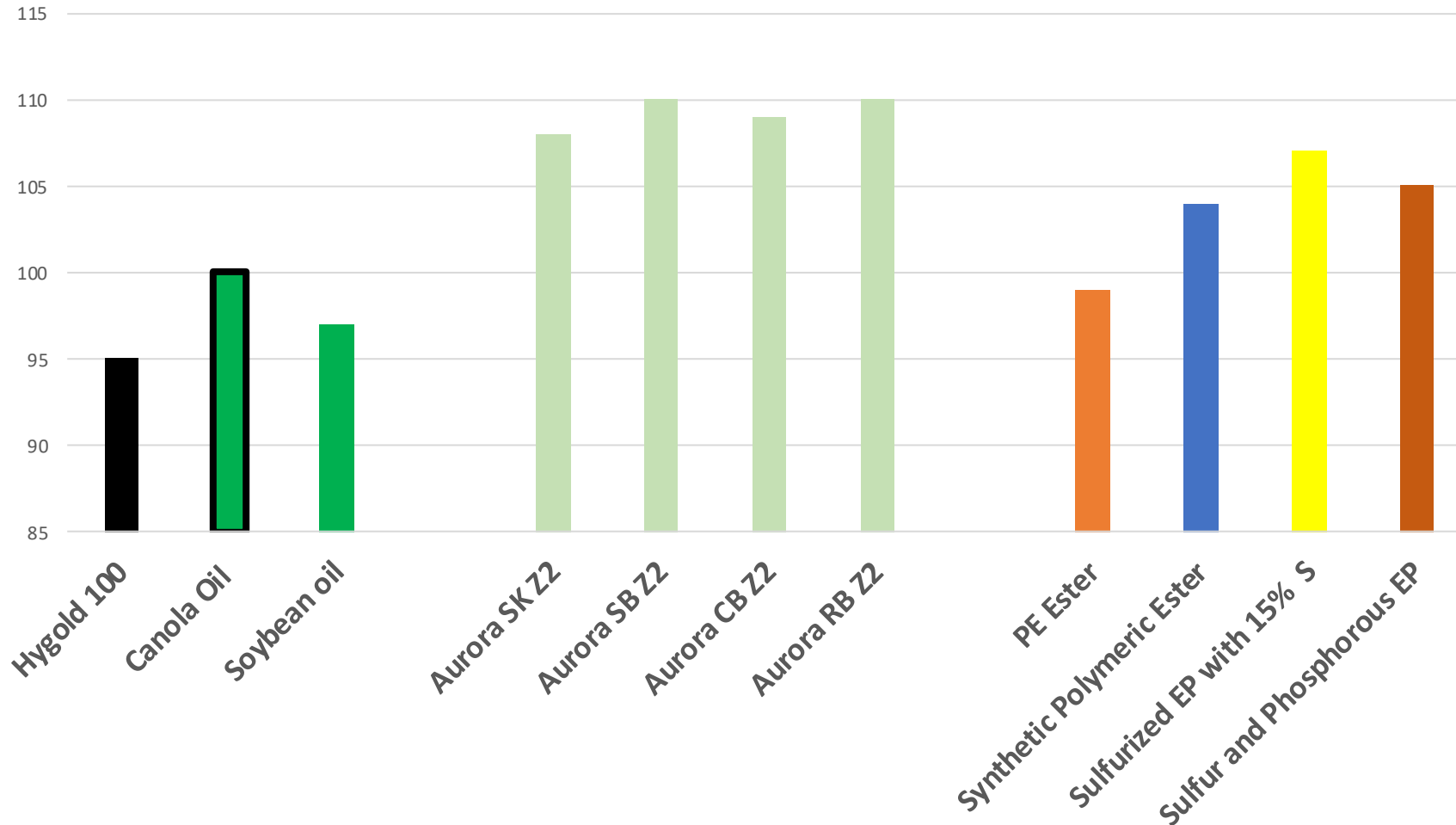


Both Soy & Canola oils modified to W & Z viscosities met or exceeded the performance of complex esters.



# MODIFIED AURORA OIL ON ALUMINUM

% Efficiency on 6061 Aluminum with Forming Tap.



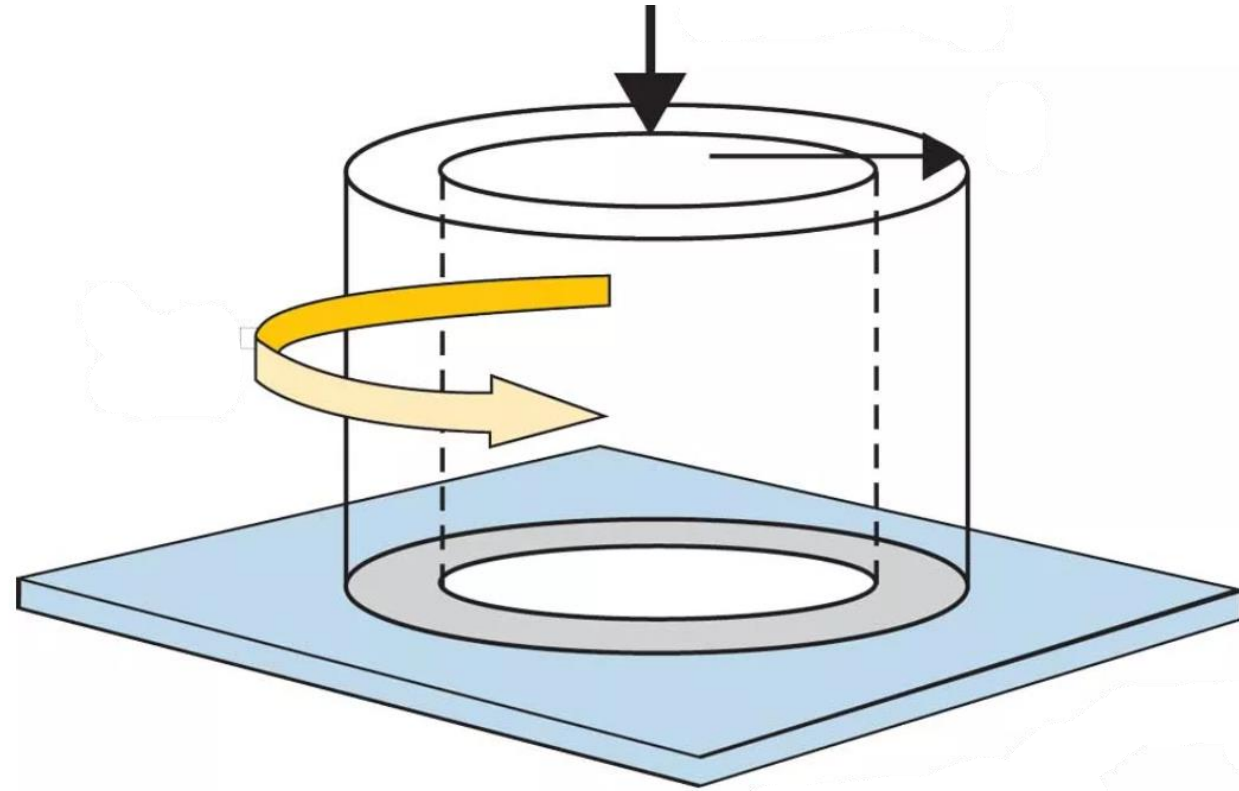
Same high efficiency of modified on aluminum.

Complex ester's lack of sacrificial layers formed with sulfur and phosphorous on aluminum make differences more pronounced

# Twist Compression Test Results & Review

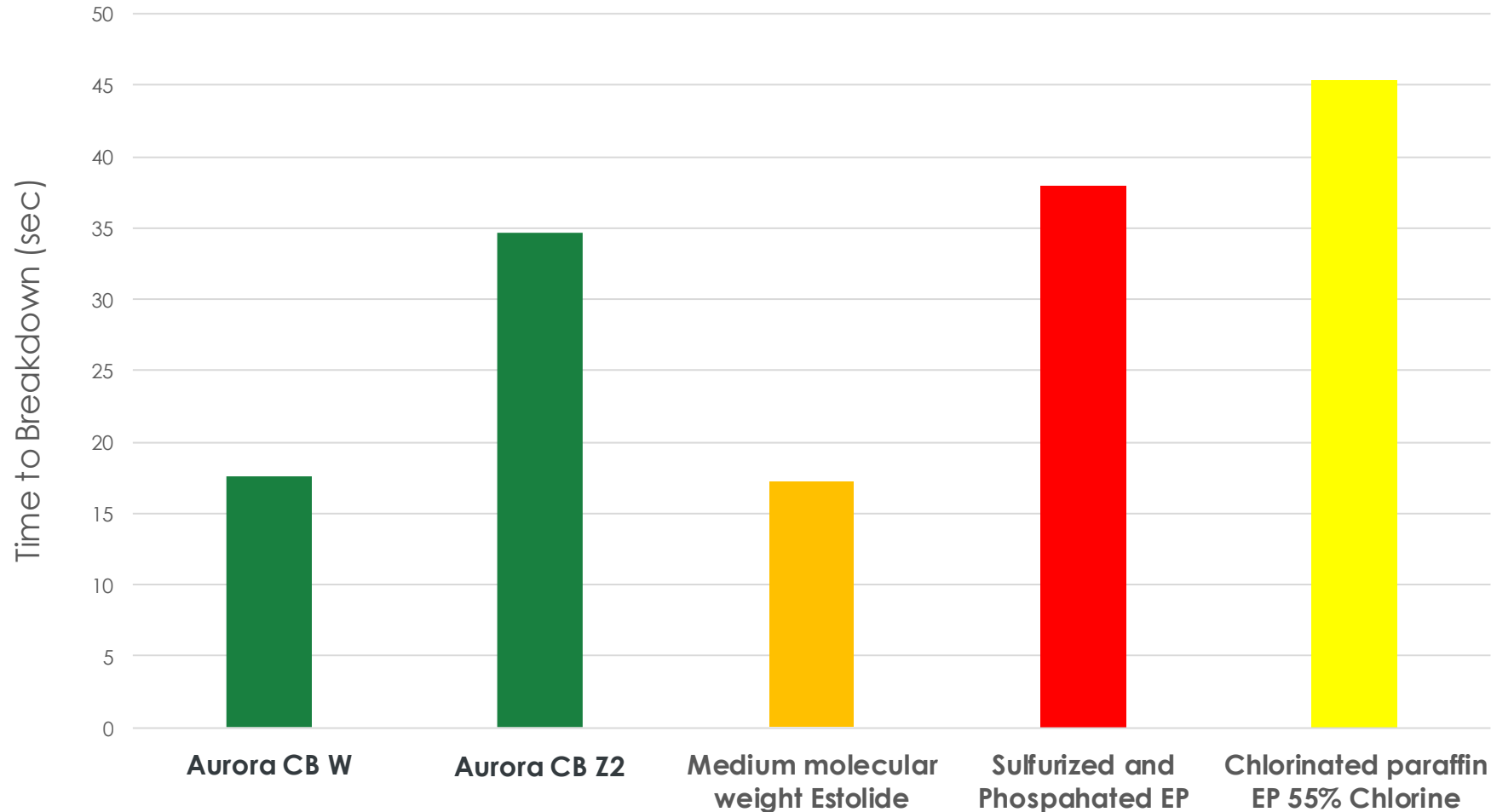
All fluids tested contained the following formulation:

- 85 Parts- 100 SUS Naphthenic Oil
- 15 Parts- Various additives
  - Aurora Polar and Non-Polar Oil
  - Synthetic Esters



# Ergon's Aurora Polymerized Oil Twist Compression Results

Performance in 85/15% Naphthenic/Additive blend



**Aurora Oils  
can replace  
CP's with  
limited  
performance  
loss**

## ANSWERS TO INDUSTRY CHALLENGES FOR MWF FORMULATORS

### Changing Metallurgy

- Fuel efficiency requirements = lighter, stronger metals
- Spherical esters can provide more effective lubrication

### Formulation Difficulty with Polymers

- Medium chain chlorinated paraffins phased out, difficulty with long chain chlorinated paraffin's
- Aurora oils provide alternative

### New EP Solutions

- Non-ferrous alloys do not form sacrificial layers with traditional EP additives
- Aurora oils perform across multiple metal, no heat activation required

### Foaming

- Foaming blocks CNC optical eyes
- Aurora Oils' large molecule size reduces foaming



# **ERGON**<sup>®</sup>

**UNITED BY SERVICE. DRIVEN BY SOLUTIONS.**

# THANK YOU!

---

Dr. Selim Erhan  
Director of Technical BD  
+1 (217) 413-6961  
[serhan@processoilsinc.com](mailto:serhan@processoilsinc.com)

