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Defining Environmentally Acceptable Lubricants:

Addressing the confusion of EAL names and base oil technology.

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Contents

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Environmentally **Acceptable** Lubricants

Environmentally **Friendly** Lubricant

Environmentally **Considerate** Lubricants

HEPR (Polyalphaolefins PAO's) Synthetic

HETG (Triglycerides) Vegetable oil based

HEPG (Polglycols PG's or Polyalkylene PAG's)

HEES (Synthetic Esters) Saturated/**U**nsaturated

Not all EAL's are created equal

HEPR (Polyalphaolefins PAO's)

HETG (Triglycerides) Vegetable oil based

HEPG (Polglycols PG's or Polyalkylene PAG's)

HEES (Synthetic Esters) Ester based

Why customers get confused:

HEPR (synthetic)

HETG (natural ester)

HEPG (synthetic)

HEES (unsaturated synthetic esters)

HEES (saturated synthetic ester)

Synthetic = compounds formed through a chemical process. Ester = acid and alcohol

Not all EAL's are created equal

HEPR (Polyalphaolefins PAO's)

HETG (Triglycerides) Vegetable oil based

HEPG (Polglycols PG's or Polyalkylene PAG's)

HEES (Synthetic Esters) Ester based

Why customers get confused:

 Fluid Performance Characteristics

	<i>Petroleum Based</i>	<i>Synthetic Esters</i>	<i>Conventional Vegetable Oil</i>	<i>PolyAlkylene Glycols</i>		
Readily Biodegradable	No	Yes	Yes	Yes	Yes	Yes
Ecotoxicity	High	Low	Low	Low*	Low	Low
Bioaccumulation Potential	Yes	No	No	No	No	No
Sheen	Yes	No	No	No	No	No
Seal Compatibility	Good	Good	Good	Poor	Good	Good
Wear Performance	Good	Very Good	Very Good	Very Good	Very Good	Very Good
Oxidation Performance	Good	Good	Poor	Very Good	Good	Very Good
Low Temperature Performance	Good	Very Good	Poor	Very Good	Good	Very Good
Viscosity Index	Poor	Very Good	Very Good	Very Good	Very Good	Very Good

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Approvals / specs based on **current formulation!**



Rolls-Royce®



FINCANTIERI
MARINE GROUP



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KLIMA- OG
FORURENSNINGS-
DIREKTORATET



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Why do we use lubricant?

- 1.Prevent wear (save our equipment)
- 2.Reduce friction (save energy)
- 3.Remove heat
- 4.Prevent rust and corrosion
- 5.Remove contaminants



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Dredging lubricants
at work



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What is in lubricants?

Base oil (80 - 95%)
+
Additives (5 - 20%)
=
Finished Lubricant



Main EAL components (Saturated ester)

Traditional EAL



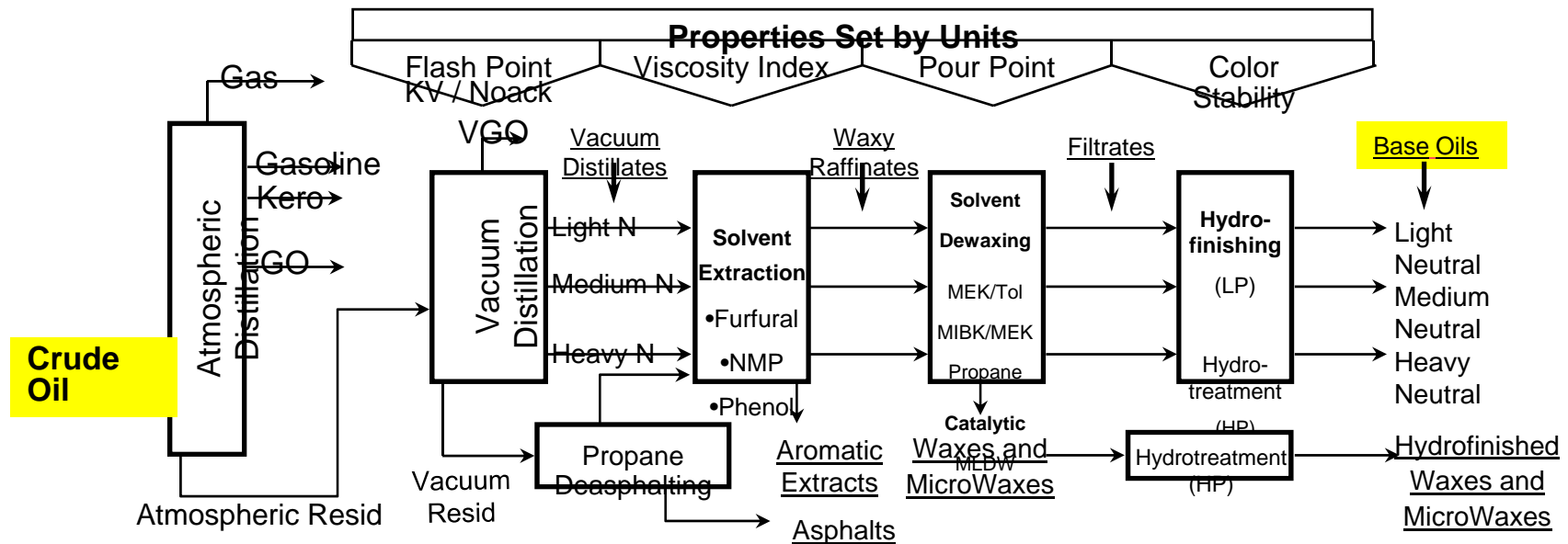
Renewable EAL



What is a base oil?

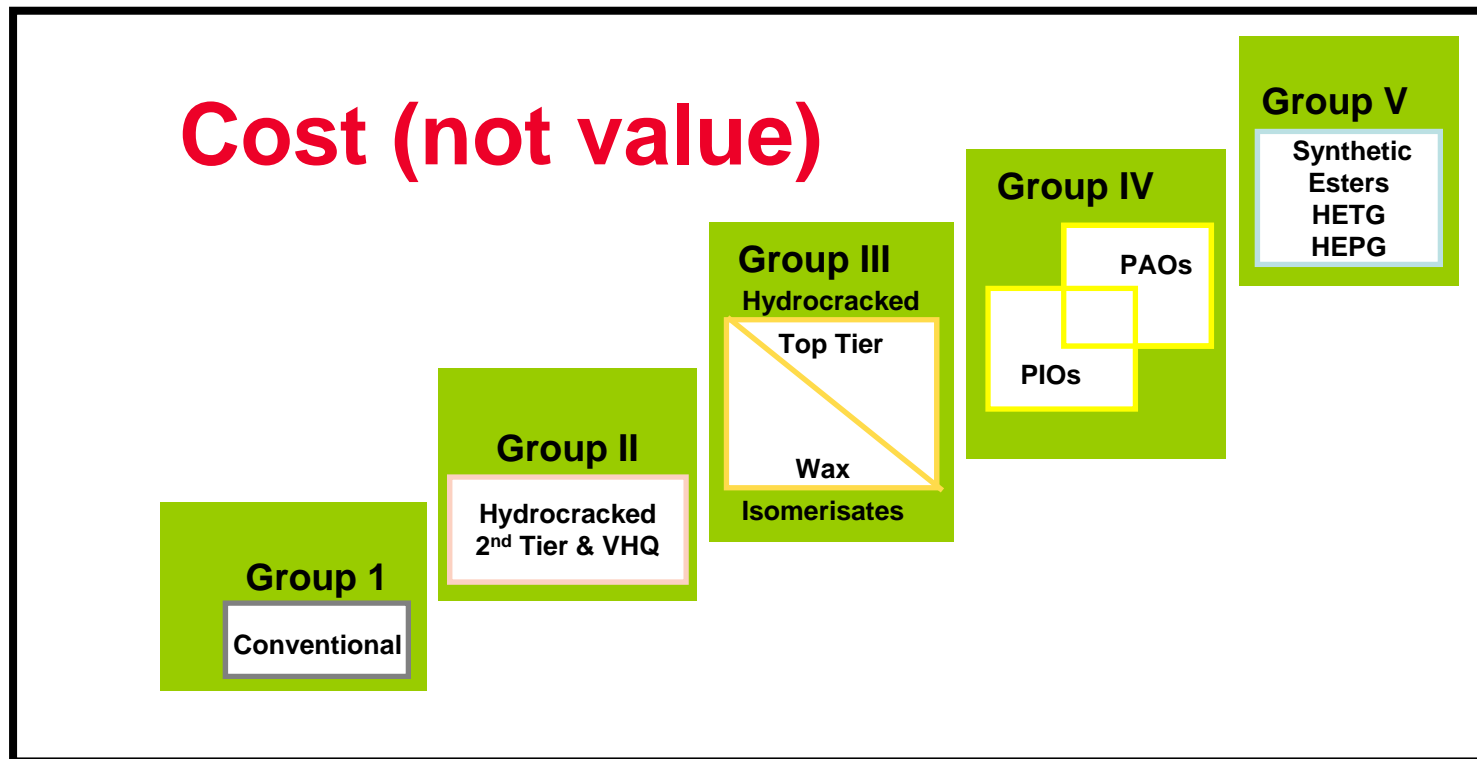
A base oil is a synthesized oil or processed from crude oil, used to blend finished lubricating oils and greases.

The **quality** of each base oil varies by its crude source and/or processing.



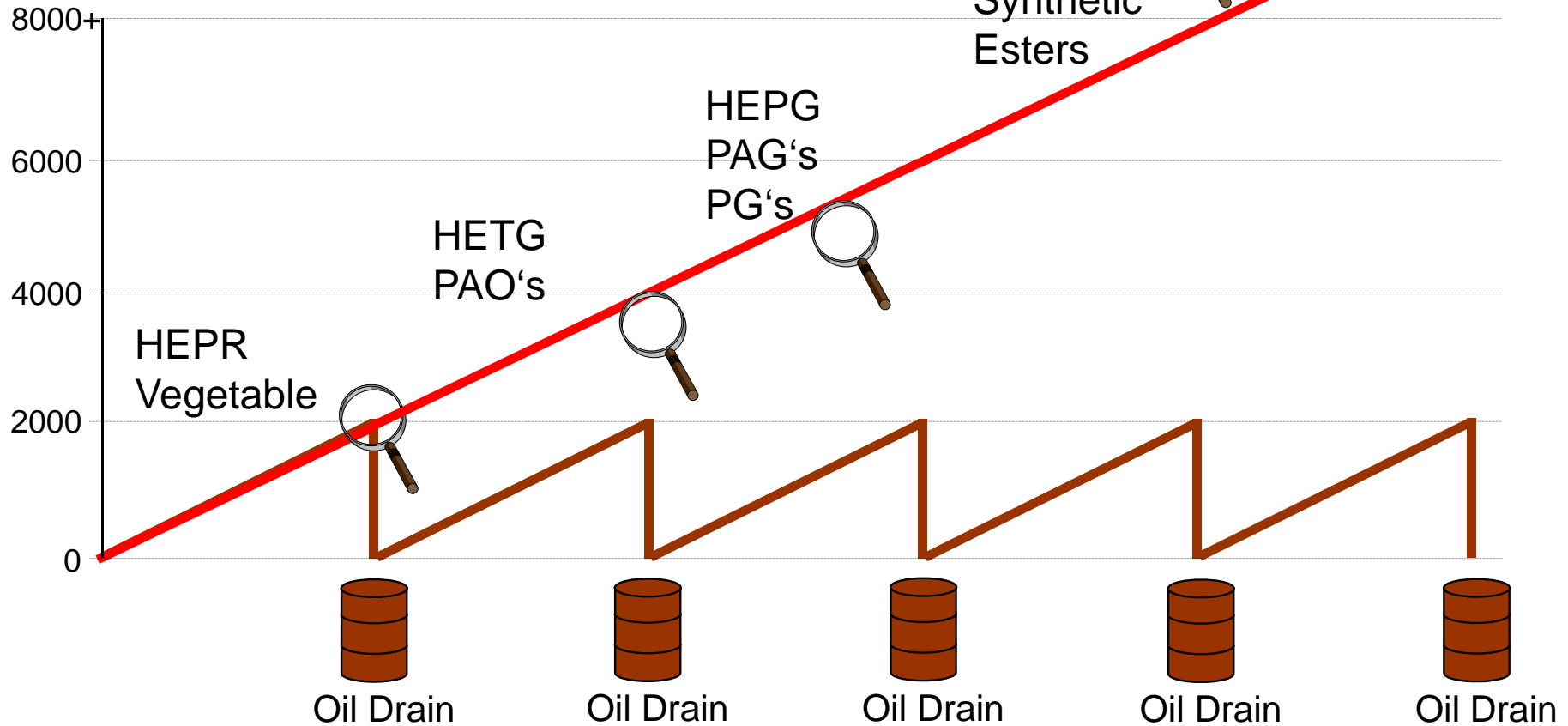
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As we move up in **groups**, the number of impurities are reduced. As the complexity for removing impurities rises so will the cost of the base oil.



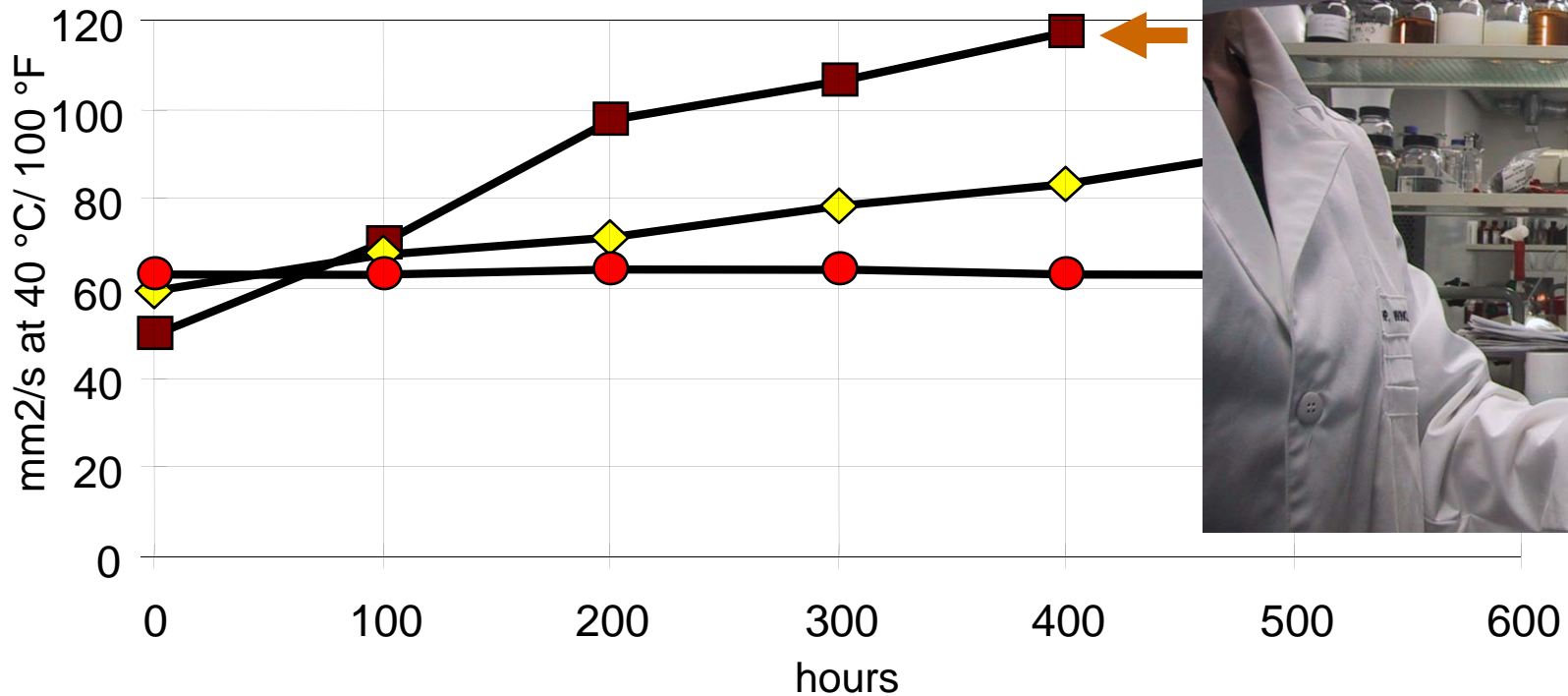
Base oil EAL Value Chart

Working hours



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Viscosity increase due to oxidation (at 72°C/160 °F)



■ Vegetable

◇ PAG's, synthetics

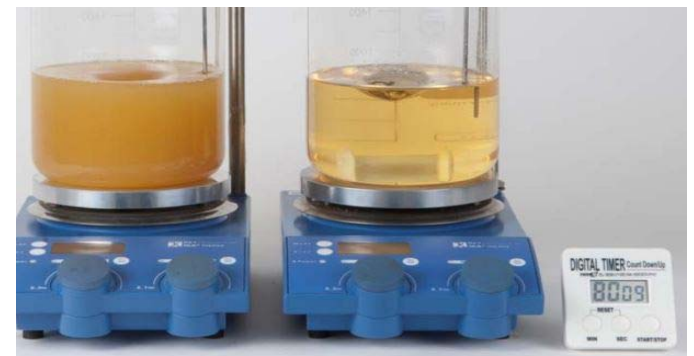
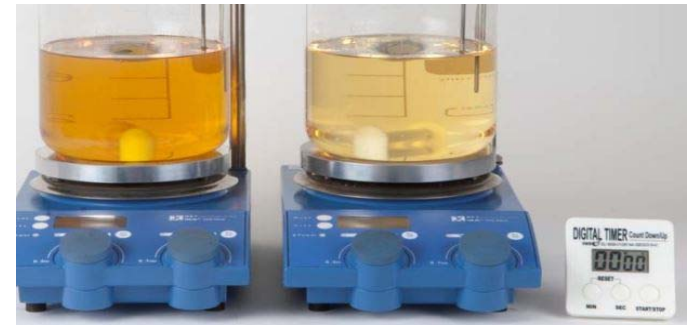
● Saturated ester

Water / Moisture and oils:

All lubricant manufacturers agree that **water in lubricating oil is not ideal.**

So the question is how to handle this issue.

- Soluble / emulsifying oil
- Separating / non emulsifying oil
- Tolerance while working with moisture in the system.



Additives must be carefully selected to be compatible with the oil and each other, so they will produce no unwelcome side effects.

Additives can be grouped into three main types (although a number of additives perform more than one function):

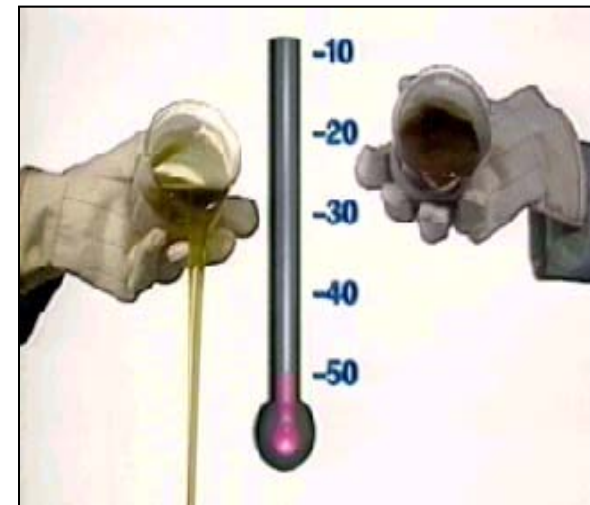
- 1. Modifiers**
- 2. Oil protectors**
- 3. Surface protectors**



Improving the Natural Performance of Base Oils

Modifiers are used in lubricants to improve the natural performance of a base oil. Modifiers can be grouped into three main types:

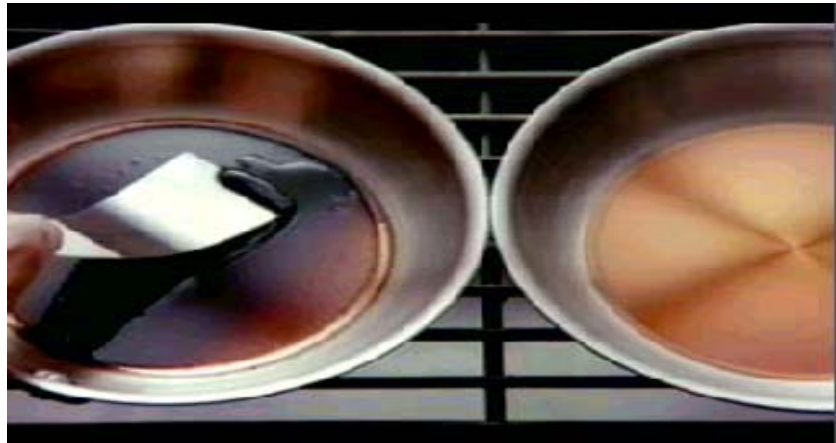
1. **Viscosity Index Improvers (VII)**
2. **Pour Point Depressants (PPD)**
3. **Seal-swell Controllers**



Oil protectors are used in lubricants to inhibit undesirable changes in lubricants.

Oil protectors can be grouped into three main types:

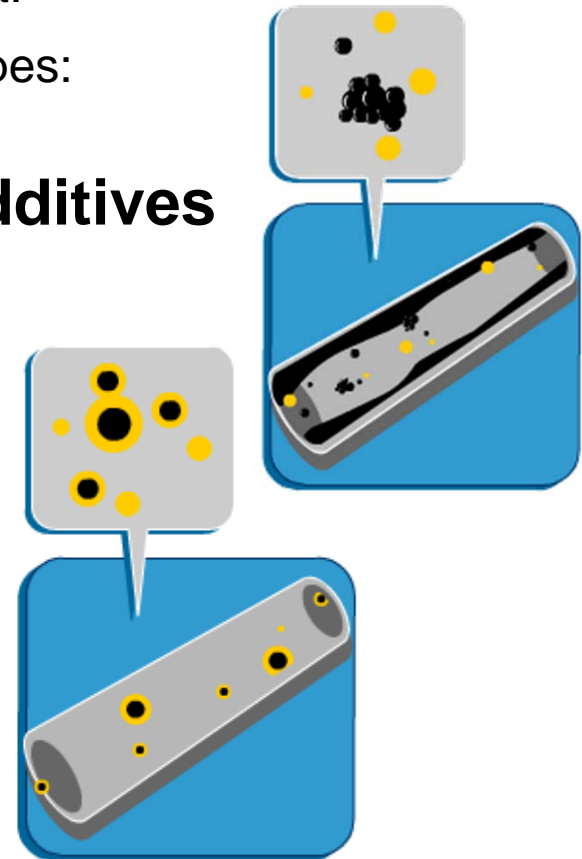
1. **Anti-oxidants**
2. **Metal de-activators**
3. **Anti-foam agents**



Surface protectors are used in lubricants to add new performance characteristics to the lubricant.

Surface protectors can be grouped into five main types:

- 1. Anti-wear and extreme pressure additives**
- 2. Corrosion inhibitors**
- 3. Detergents**
- 4. Dispersants**
- 5. Friction modifiers**



EPA, Vessel General Permit (VGP and sVGP)

- VGP publish date March 2013, effective date Dec. 19th 2013
- 2.2.9 All commercial vessels in US waters **must use** “environmentally acceptable lubricants”
- Appendix A clarifies: “**biodegradable**”, “**minimally-toxic**” and not “**bioaccumulative**”
- What vessels apply: all new builds after (Dec. 2013), older vessels “unless technically infeasible”, exempt vessels are military defense
- Blue Angel, European Ecolabel, Nordic Swan, Swedish Standard SS 155434 & 155470, OSPAR, EPA DfE, Self Certification

EPA VGP EAL Standards 2013

Biodegradable or readily Biodegradable

Minimally Toxic

Non Bioaccumulative or no Bioaccumulation



Saturated ester – References



Machinery Application	Working Hours without oil drain	PANOLIN Quality Volume
Liebherr P 995	> 26'000 working hours	PANOLIN HLP SYNTH 46 11'000 litres (2'905 gallons)
Dredger		



Saturated Ester - Reference

Machinery Application	Working hours without oil drain	PANOLIN Quality Volume
London Eye Ferris Wheel	>100'000 working hours	PANOLIN HLP SYNTH 46 4'000 litres (1'056 gallons)

Interesting trends regarding base oils:

The worlds 1st, 2nd, 5th and 7th largest lubricant manufacturers have or are all trying to produce saturated ester products **NOT** Vegetable, PG's, PAG's or PAO's. Statistics show saturated esters are superior performers and that is clearly their focus.

Base oils are a key factor but **additives** and **experience** make the product effective. Why subject your equipment to an unproven or an inferior product!

PANOLIN GREENMARINE = SUSTAINABILITY

Our credo:

Only a concept which is

- economically viable
 - technically mature
 - environmentally considerate
- can be truly sustainable.

Thank you.

