Environmentally Acceptable Lubricants (EALs): Choosing the right EAL type for your application

There is a wide range of performance levels among both readily biodegradable and petroleum based lubricants. Customers have a wide array of options from lower performance lubricants to high end, high performing “fully synthetic” products. While care must be taken in choosing the appropriate product for the specific application, Environmentally Acceptable Lubricants (EALs) also offer the full range of performance. It’s important to know that some EALs provide higher performance results than some petroleum based or readily biodegradable lubricants. Let’s take a look at the four types of EALs—their performance advantages and disadvantages—and clarify some misconceptions in the marketplace about EALs and recent legislation impacting marine vessel operators.

EAL Confusion in the Marketplace
There’s conflicting information in the marketing place about EALs. A lack of agreed upon definition is one contributing factor, as is lack of awareness of the four different types of EALs that are available. Inconsistent performance claims from manufacturers have also led to the confusion. Let’s clarify a few myths right from the start:

EALs Do
*Perform equal to or better than petroleum lubricants
*Improve productivity, which leads to profitability

EALs Don’t
*Mitigate the discharge’s environmental impact
*Eliminate spill occurrence
*Eliminate the need to report a spill or discharge
*Eliminate the need to clean up a spill or discharge

Legislative Background
In an effort to reduce pollution in the U.S. territorial waters, the US Environmental Protection Agency (EPA) has recently amended the type of lubricating oil commercial vessels are permitted to use. According to the EPA, up to 16 million gallons of lubricants are discharged into waterways annually—predominantly from stern tube leaks—equating to 1.5 times the size of the Exxon Valdez spill.[1] Other leak contributors include stabilizers, thrusters, rudders, propellers Azipods, hydraulic systems and towing notch interfaces.

Vessel General Permit (VGP and sVGP)

While leaks play a major role in water pollution, unplanned discharges are also a serious problem. Under the EPA's 2013 Vessel General Permit (or VGP), all ships larger than 79 feet must use Environmentally Acceptable Lubricants in oil-to-sea interfaces when in the three Nautical Mile limit and in the Great Lakes unless technically infeasible. These regulations include vessel discharges such as oil, waste, water and runoff. The permit also requires any above water line hull cleaning or deck wash downs resulting in discharge to be conducted with 'minimally toxic, phosphate-free and biodegradable' cleaners and detergents.

Similar EAL regulations are coming into effect for smaller vessels. The 2014 Small Vessel Permit (sVGP), which is currently pending, states that non-recreational and non-military vessels less than 79 feet in length that are operating in a capacity as a means of transportation will require compliance starting in December 2017.

EALs Defined

Environmentally Acceptable Lubricants are defined by the EPA as offering these three characteristics. First, they must be "biodegradable"—biodegrading into carbon dioxide and water by ≥ 60% or more within 28 days (according to OECD 301B or ASTM D7373 methods). Next, they must be "minimally toxic," causing only a light impact on the aquatic environment (LC50> 100mg/L for lubricants and LC50>1000mg/L). Lastly, they are "not bioaccumulative," and must have a low propensity to bioaccumulate in organisms.

Additionally, the Clean Water Act of 1972 mentions discharges of oils should not exhibit any visible 'sheen' on the water's surface otherwise it is considered a pollutant (according to CFR 40 Part 435 A).

Where to Use EALs

EALs should be used in place of traditional petroleum lubricants in all marine applications where there is any oil-to-water interface. These applications include stern tubes, controllable pitch propellers, stabilizers, rudders, thrusters, Azipods, towing, notch interfaces, wire rope and mechanical equipment subject to immersion such as dredges and grabs.

With land applications, EALs should be utilized in areas where potential ground water contamination is of concern. Examples include construction equipment, utility fleets, waste collection fleets, haulers, turf machinery, dams and locks.

The Four EAL Types

The EPA recognizes four types of EALs:

- Vegetable Oils (HETG)
- Synthetic Esters (HEES)
- Polyalkylene Glycols (HEPG)
- Polyalphaolefins (PAOs) and related hydrocarbon products (HEPR)

Below is an overview of each EAL type, the advantages and disadvantages of each, plus a side-by-side comparison chart to help you find the most suitable EAL for your application.

Triglycerides (HETG)
Also referred to as Natural Esters, these lubricants are made of vegetable, rapeseed (Canola), sunflower, coconut, palm or soybean oil.

Advantages
- High viscosity index
- Very good wear properties
- Compatible with most seals and hoses

Disadvantages
- More susceptible to oxidation under high temperatures and pressures
- More prone to hydrolysis in the presence of water
- Shorter lifespan than other EAL types

Suitable Applications
- Typically recommended for use in a wide range of land based applications with scheduled change out intervals

Synthetic Esters (HEES)
Esters are synthesized by the reaction of an alcohol with an acid to form an ester. This reaction process allows for the flexibility to customize the type of ester used for a particular application.

Advantages
- Delivers high performance
- Good thermal and oxidation stability
- Readily separates from water
- Offers good corrosion prevention and hose compatibility
- Extended fluid life

Disadvantages
- Can be prone to hydrolysis in the presence of water

Suitable Applications
- Typically recommended for use in a wide range of both land and marine applications with scheduled change out intervals; for marine applications, saturated hinder esters are used to provide the best oxidation and hydrolytic stability

Polyalkylene Glycols (HEPG)
Made of synthetic, petroleum based oil, HEPGs are created by the polymerization of ethylene or propylene oxide.

Advantages

- Designed to be water soluble; however, solubility may increase the toxicity
- Excellent high and low temperature viscosity performance
- Fire resistant properties

Disadvantages

- Compatibility challenges with seals, hoses, paints and varnishes
- Incompatible with mineral oils and other EALs
- Typically not derived from a renewable resource

Suitable Applications

- Typically recommended for use in a wide range of both land and marine applications with scheduled change out intervals

Polyalphaolefins PAOs and related hydrocarbon products (HEPR)

Often referred to as classic mineral oil based lubricants, HEPRs are synthesized hydrocarbons derived from crude oil meant to provide a low viscosity base oil that is readily biodegradable. However, more recently, HEPR type base stocks from renewable sources have been developed and are being offered by some manufacturers.

Advantages

- Highly durable and offer extended wear protection
- Extended fluid life
- Broad temperature range performance
- Excellent thermal and hydrolytic stability
- Excellent seal compatibility
- Excellent water separation characteristics
- Good corrosion protection and oxidation stability

Disadvantage

- Typically not derived from a renewable resource

Suitable Applications

- Typically recommended for use in a wide range of both land and marine applications with scheduled change out intervals

EALs Side-By-Side

Choosing the most suitable EAL depends on the end-user application. See the chart below for a quick side-by-side glance comparing features for all four EAL types and standard petroleum based lubricant.

	HETG	HEES	HEPG	HEPR	Standard Petroleum
Readily Biodegradable	Yes	Yes	Yes	Yes	No
Ecotoxicity	Low	Low	Low*	Low	High
Bioaccumulation Potential	No	No	No	No	Yes
Sheen	No	No	No	No	Yes
Seal Compatibility	Good	Good	Poor	Good	Good
Wear Performance	Very Good	Very Good	Very Good	Very Good	Very Good
Oxidation Performance	Poor	Good	Very Good	Very Good	Very Good
Low Temperature Performance	Poor	Very Good	Very Good	Very Good	Poor
Viscosity Index	Very Good	Very Good	Very Good	Very Good	Poor

*Solubility may increase the toxicity of some PAGs

See Glossary at end of paper for definitions of product features used in above table.

Conclusion

Environmentally Acceptable Lubricants are not only mandated by the EPA, they perform equivalent or better than petroleum lubricants. EALs prevent wear and tear on parts, reduce friction (for improved performance), reduce heat and prevent corrosion. EALs are safer for employees to handle and have less impact on the environment. Many factors should be considered when evaluating which EAL best fits your needs including operating temperature and pressure, seals/elastomers, water ingress, fluid life, preventative maintenance cycles and spill/discharge potential.

1- Source: EPA EAL 800-R-11-002 November 2011

Glossary

Definitions of features used as a basis for comparison for EAL technologies and standard petroleum based lubricant:

Readily biodegradable – the ability of a product to biodegrade quickly and completely (≥ 60% by OECD 301/ASTM D7373 testing)

Ecotoxicity – the potential for biological, chemical or compounds to affect ecosystems

Bioaccumulation potential – the propensity of an organism absorbing a toxic substance at a rate greater than that at which the substance degrades

Sheen – “rainbow effect” of fluid in water

Seal compatibility – reaction by fluid on seal material that that can weaken or damage seal

Wear performance – lubricity of fluid to protect to protect moving parts in pump

Oxidation performance – reaction of oxygen with fluid to chemically alter fluid affecting performance

Low temperature performance – viscosity at low temperatures

Viscosity index – relationship of viscosity to temperature of a fluid