

Environmentally aware hydraulic oils

Over the past twenty years or so, there has been an increasing awareness of the environmental impact of the large amount of lubricants entering the environment. This comes as the result of leakage, throw-off, emissions, spillage and careless disposal of mainly mineral oil based products. Some countries in Europe have even restricted the use of non-environmental friendly products and encouraged so-called biodegradable products in sensitive applications (e.g. near drinking water).

Although the term biodegradable has become widely used and accepted as a description of the property required for these ecologically friendly fluids, it is not sufficient criterion for complete environmental acceptability. Other important considerations include:

- Biodegradability or persistence in the environment
- Bio-accumulation potential
- Toxicity in the air, ground and water
- The nature of the emissions
- Whether or not the source is renewable.

Several countries have now adopted environmental acceptability labelling schemes (or Umweltzeichen in German) for various products.



The various schemes include:

- Blue Angel (Germany), above,
- White Swan (Scandinavia).

In addition to the environmental sign, the water-polluting classification in Germany (**Wassergefährdungsklasse** or **WGK**) has also become an important part of assessing the environmental impact of lubricants. The WGK stipulates what steps should be taken in case of an oil spill and the safety measures required for handling, manufacturing and storing products. The class is assigned to a substance depends on its WKZ water endangering number (WEN) which is obtained from toxicity measurements on mammalian, fish and bacterial activity. The higher the number the higher the toxicity. Three is the highest rating, zero is the lowest, even though WGK 0 has now been re-named to **NWG** (**n**on **w**ater **e**ndangering). The WGK has become vital for the marketability of environmentally acceptable products in Germany, Scandinavia and elsewhere in Europe and also in the rest of the world.

Biodegradable hydraulic oils

Overall, the biodegradable lubricants market remains very small compared to mineral oil based products. Within the biodegradable lubricant family, which includes mainly total loss lubrication (eg chain saw oils, mould release oils, wire rope lubricants, two-stroke engine oils, etc), hydraulic oils, which is not total loss, are the most popular and account for approximately 70% of the total market in Europe. Demand for biodegradable hydraulic oils is expected to increase in the next 10 years.

Ever increasing expectations are put on the performance of any modern hydraulic oil, whether synthetic, conventional mineral or biodegradable. More compact designs and the subsequent



reduction in the amount of circulating oil are leading to ever higher operating temperatures that put more emphasis on the fluid's thermal and oxidative stability. Longer drain intervals are required between oil changes and optimal performance is required over a wider range of operating temperatures.

In principle, biodegradable hydraulic oils should meet the same general performance characteristics, such as lubricity, viscosity, flow at hot and cold temperatures, thermal and oxidative stability, non-corrosivity and seal compatibility as mineral oil based products.

Of the different base fluids available for hydraulic oils, mineral oils and synthetic hydrocarbons are only poorly biodegradable whereas natural esters (such as triglyceride vegetable oils), synthetic esters

(poly- and di-esters) and glycols of polyethylene oxide are easily biodegraded.

Natural and synthetic esters and polyglycols all possess inherently good lubricity properties as their polar nature gives a greater affinity for metal surfaces than non polar mineral oils. Consequently the need for anti-wear additives is reduced, calling for lower concentrations of generally more toxic anti-wear agents. Pump tests have shown that rapeseed oil (triglyceride) and synthetic esters can perform better than standard anti-wear mineral oil based products. This is attributed to the naturally high VI of the base fluid but also due to the better filtrability, cleaner conditions through better solvency of residues and improved air release through the use of lower viscosities.

Categories of biodegradable hydraulic oils

According to the ISO 15380 standard (which originates from the VDMA 24568 specification in Germany), there are four categories of biodegradable hydraulic oil. The rate and degree of

Classification	Description	ExxonMobil Example
HETG	Hydraulic Oil Tri Glyceride	Mobil EAL 224H
HEES	Hydraulic Oil Synthetic Ester	Mobil EAL Syndraulic
		Mobil EAL Hydraulic Oil
HEPG	Hydraulic Oil Poly Glycol	-
HEPR	Hydraulic Oil Mixed	-
	Hydrocarbon/Ester	

biodegradability of Polyalkylene Glycol based products depends on the relative percentage of ethylene/propylene oxide in the polymer, the higher proportion of ethylene oxide being directionally more biodegradable. The major disadvantage of PAG based products is poor compatibility with seals, gaskets and linings and poor miscibility with standard mineral oils. Although used in certain niche applications, polyalkylene glycol based products are unlikely to increase their share.

The first generation biodegradable hydraulic oils were based on natural esters (triglyceride). They offer the advantages of being very biodegradable, good lubricity properties all at a relatively low cost. However as the technical requirements of modern hydraulic system increased, the performance of poorer quality natural ester based products has been found to be wanting, particularly concerning oxidation and hydrolytic stability, low temperature performance and service life.

Over the past few years, synthetic ester based products have increased their market share. High VI, excellent oxidation and thermal stability and low WGK ratings have all contributed to this trend. Raw material cost is higher but this

can be compensated by increased service life and improved reliability. Although water should be avoided where both natural and synthetic esters are used at high temperatures to minimise hydrolytic breakdown, modern good quality products are designed to have good demulsibility to minimise these effects.

Typical applications for biodegradable hydraulic oils

- Forestry
- Construction and cranes
- Commercial elevators
- Harbour dredging – hydraulically driven screens
- Off-shore drilling operations
- Snow removal equipment
- Heavy duty lawn care equipment
- Earth moving and excavators
- Off-shore wind turbines
- Reservoirs
- Parkland
- Canals and water-ways
- Rubbish collection
- Landfill operations
- Sewage plant
- Water treatment
- Rock-drill



ExxonMobil Biodegradable Hydraulic Oil Product Line

ExxonMobil has an extensive product line of biodegradable hydraulic fluids as viable alternatives to its conventional hydraulic oils in these highly niche environmentally-sensitive applications.

Mobil EAL 224 H was the first product to be introduced in the 1990s and has been a highly successful rapeseed oil product (HETG).

Mobil EAL Hydraulic Oil series, also based on high performance synthetic esters, will be the most recently introduced product with the lowest Water Hazard Classification rating (NWG).

Recommendations when switching product types

Normally mineral oil based products and natural and synthetic esters mix well together and serious operational problems should not be experienced. Any contamination of course negatively affects biodegradability and toxicity.

Conversion may be accomplished by draining the system completely and then flushing to reduce residual mineral oil to a minimum. Testing compatibility when changing products is recommended to check for foaming, water/air separation and additive compatibility.



In service monitoring

To maximise the life of a biodegradable hydraulic oil in service, the following characteristics should be monitored regularly, with warning limits:

- Viscosity : +10%
- Oxidation (TAN) : +2mg KOH/g
- Water content : >500ppm

If you would like to get further information on this or any other topic of this issue please contact lubes.industrial@exxonmobil.com.

