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# BIODEGRADABLE LUBRICANTS

With increasing emphasis on environmental issues, more and more attention is being paid to the overall environmental impact resulting from the manufacture, use and disposal of a whole number of products. The introduction and increasing recognition of the various European eco-labelling systems has increased public awareness of environmental issues and encouraged manufacturers to reconsider the design, constitution and potential for recycling of a whole range of products. Thus we now have low energy programmes on domestic dishwashers and washing machines, cars of which 90% of the components can be recycled, biodegradable detergents, etc., etc.

The biodegradability of a product, although now a widely-recognised term, is only one of the aspects which needs consideration when developing a product which is to have a low environmental impact. Biodegradability, ecotoxicity, bio-accumulation, potential for recycling, nature of emissions, renewability, etc., are other aspects which are also critical.

When considering biodegradability itself, this is the measure of the ability of the product to be degraded by naturally-occurring microorganisms such as bacteria, yeasts, moulds, fungi etc., into simpler derivatives. In order to satisfy the ecotoxicity requirements these derivatives must also be environmentally-acceptable.

The concept of biodegradable lubricants was originally developed following concerns of an accumulation of hydrocarbons in the sediment of the Bodensee in Switzerland. It was suspected that, since these hydrocarbons were characteristic of mineral oil, they emanated from two-stroke marine engines. Although subsequent analyses some years later disproved the theory, biodegradable two-stroke lubricants based on synthetic esters had by then been subsequently developed. Since then, further development of more generalised biodegradable lubricants has been rapid, especially those intended for application areas where there is a particular need, generally in situations such as forestry and mining where the lubricant is ultimately dispersed during use into the environment.

Biodegradability can be subdivided into ready, or primary, biodegradability and ultimate biodegradability. Primary biodegradability is the breakdown of the product into simpler products, which generally will have different chemical properties to the original. Ultimate biodegradability is the complete conversion of the original product into carbon dioxide, water, new microbial biomass and simple inorganic substances. Mineral oil, for example, is not readily biodegradable but is ultimately biodegradable. In order to meet the generally-accepted requirement for a biodegradable product, it is the readiness of biodegradability which is important.

Products based on mineral oil, with biodegradabilities of between 10 and 40%, as measured by the CEC L-33-A-93 test after 21 days, are not considered to be readily biodegradable.

In most cases, the biodegradability of the product is based upon the biodegradability of the lubricant base.

Those bases which are most commonly used, together with an approximate comparison of their main properties with those of mineral oil, include:

| PROPERTY | MINERAL OIL | VEGETABLE OIL | POLYGLYCOL (LINEAR) | SYNTHETIC ESTER |
|---|---|---|---|---|
| Viscosity Index | 100 | 200 | 200 | 200 |
| Shear stability | Good | Good | Good | Good |
| Aging stability: | | | | |
| Oxidative | Good | Good | Good | Good |
| Thermal | Good | Good | Good | Good |
| Hydrolytic | Good | Poor | Good | Good |
| Biodegradability | Good | Good | Good | Good |
| Water solubility | Poor | Poor | Good | Poor |
| Mineral oil miscibility | Good | Good | Poor | Good |
| Water Hazard Classification* | 2 | 0-1 | 0-1 | 0-1 |
| Price | Good | Poor | Poor | Poor |

(* The German Water Hazard Classification is based upon the aggregate of the mammalian, bacterial and fish toxicities. Low values indicate low toxicities.)

Although the development of biodegradable alternatives to conventional mineral oil-based lubricants has been rapid in recent years, the uptake in the market has been slower, presumably on account of increased costs and perceived performance limitations. The areas where biodegradable lubricants have found most outlets for use to date include cutter-bars in chainsaws, two-stroke engines, vehicle chassis lubrication, rail-track flange lubricants, rail-track points lubricants, open gears, wire ropes, air tools, mould release oils and corrosion preventative oils. Many applications also now being found for the use of biodegradable hydraulic oils.

It can be seen from the above that vegetable oils have many of the advantages of synthetic esters but are significantly cheaper. The main problem areas historically associated with the use of vegetable oils are the poor low temperature properties, and the poor thermal, oxidative and hydrolytic stabilities. These deficiencies can now be largely, if not completely, overcome by improved additive technology and careful selection of the appropriate oil. A further and particularly exciting development is the use of genetic engineering to produce modified plants which in turn will yield oils with the required characteristics.

The technology is therefore now in place to meet most of the foreseeable requirements.

The Environment Agency, now incorporating the former National Rivers Authority, is currently endeavouring to promote the use of 'Environmentally Aware' lubricants, including hydraulic fluids and chainsaw oils, not only throughout their own organisation, but also by contractors working on their behalf. The increase in the number of organisations now seeking accreditation to BS 7750, the Environmental Auditing System, will no doubt increase the amount of interest in the use of biodegradable lubricants. New Work Items added to the current work programme of the International Standards Organisation Technical Committee SC4 include the development of international specifications for environmentally acceptable lubricants.

To summarise, to date the development of environmentally acceptable lubricants has been in advance of the market requirements. However, recent trends are now indicating that general awareness of the need for such products is now increasing amongst potential customers, and it would be anticipated that the sales will significantly increase as a result.

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