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 wide range of products. The introduction and increasing recognition of the various European eco-labeling 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, biaccumulation, 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.

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>MINERAL OIL</th>
<th>VEGETABLE OIL</th>
<th>POLYGLYCOL (LINEAR)</th>
<th>SYNTHETIC ESTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity Index</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Shear stability</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Aging stability</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Oxidative</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Thermal</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Hydrolytic</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Biodegradability</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Water solubility</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Mineral oil miscibility</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Water Hazard Classification*</td>
<td>2</td>
<td>0-1</td>
<td>0-1</td>
<td>0-1</td>
</tr>
<tr>
<td>Price</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
</tbody>
</table>

(*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 SCA 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.

David Margaroni
TRIAZINE BIOCIDES & FORMALDEHYDE

GENERAL BACKGROUND

Aqueous metalworking fluids commonly contain biocides, some of which, including 'triazine' (full name: Hexahydro-1,3,5-tris(2-Hydroxyethyl)-5-Triazine), are made by reacting formaldehyde with various other substances, e.g. monoethanolamine in this case. Such condensation products are equilibrium systems in which small quantities of the constituent materials, in this case formaldehyde and monoethanolamine, are present in the free, i.e. unreacted form. Since formaldehyde is a suspected potential human carcinogen, many countries have now imposed limits on the maximum permissible concentrations for this substance in air, since inhalation is the most likely route of entry into the body. There is a general consensus within the lubricants industry that triazine is the most widely used formaldehyde-condensate biocide in metalworking operations.

U.S. SITUATION

In the USA, the Formaldehyde Standard requires manufacturers to assess whether a product may release formaldehyde under 'foreseeable conditions of use' which would result in an 8-hour TWA (Time Weighted Average) exposure exceeding 0.1 ppm concentration in air. Releases above that amount would require the product to be labelled as containing formaldehyde and would also require for additional information to be provided in the MSDS (Material Safety Data Sheet). Employers who purchase products that contain and can release formaldehyde in concentrations above 0.1 ppm must provide hazard communication training to their employees. Products that release formaldehyde above 0.5 ppm must also comply with additional and more stringent labelling requirements.

Since no data was available for the guidance of the manufacturers of metalworking fluids for their obligations under the US Formaldehyde Standard legislation, the five major manufacturers of triazine biocides formed a non-profit organisation, the Triazine Joint Venture. The purpose of this organisation was to conduct a comprehensive workplace exposure monitoring study (Joint Venture Study, JVS) to assess the potential of triazine-containing metalworking fluids to release formaldehyde under normal conditions of use. Their findings (A Study of Formaldehyde Exposures from Metalworking Fluid Operations Using Hexahydro-1,3,5-tris(2-Hydroxyethyl)-5-Triazine, Dr. H.J. Cohen, May 3 1994) were summarised by ILMA, the main points being:

1. The levels of formaldehyde found in the study followed a log-normal distribution. The majority of measurements obtained using personal samplers were below 0.1 ppm. Approximately 25% of the readings exceeded 0.1 ppm, although none of the readings were above 0.5 ppm. All of the area samples were below 0.3 ppm.

2. Not all formaldehyde exposure could be attributed to emanating from the use of triazine. Such is the ubiquity of formaldehyde in the workplace that background levels of 0.04-0.06 ppm were common in situations where no metalworking fluid was in use. Background levels exceeding 0.1 ppm were observed at two of the eight facilities.

3. Accurate measurement of formaldehyde levels at such low concentrations was difficult, the precision of the different sampling methods was calculated to be only 40-65% at the 95% confidence limit.

4. The JVS proposed a model of its data which suggested that exposure to formaldehyde at levels above 0.1 ppm could be expected whenever the triazine content of the fluid was in excess of 250 ppm. This is below the recommended use level for triazine. At the recommended level of 1,000 to 1,500 ppm, formaldehyde levels could be expected to be above the 0.1 ppm trigger about 30 to 50% of the time. Alternative analysis of the data may lead to other models with different conclusions.

The final conclusion was to the effect that the use of concentrated triazine, as specified in the study, would not result in detectable employee exposures, and that such exposure levels would be below the 0.1 ppm 8-hour TWA level stipulated.

A lengthy exchange of correspondence between ILMA and OSHA ensued following the findings of the JVS study, where assistance was sought by ILMA in the clarification of the obligations of their members under the requirements of the Formaldehyde Standard. Various aspects in the interpretation of the complexities of the technical data were examined in detail, and further supportive evidence was offered by Dr. Cohen.
Following resolution of the interpretation queries, OSHA accepted the evidence provided by the JVS together with the course of action proposed, namely, that Dr. Cohen would write to any interested parties who sought clarification of the findings of the JVS. Nevertheless, they indicated that OSHA compliance personnel would still, at their discretion, reserve the right to evaluate triazine-containing metalworking fluids for formaldehyde hazards at individual worksites during subsequent inspections.

ILMA then provided each of their member companies with a copy of a memorandum prepared by their legal advisers. The memorandum did not allow for a collective decision by ILMA members regarding the need for compliance with the Formaldehyde Standard because of the potential anti-competitive effects which could trigger anti-trust actions. It was therefore necessary that each member company should reach its own decision from the evidence and would be based solely on internal communications. They were not able to compare notes with competitors or customers. Then followed a draft letter which could be used by manufacturers to notify their customers that the situation had been investigated in detail, the results indicating that the supplier was exonerated from any hazard communication obligation under the standard.

**U.K. SITUATION**

In the UK, exposure of workers to substances hazardous to health is covered by the COSHH regulations. These regulations refer to the HSE EH 40 series of texts which define exposure limits for the majority of substances which have been assessed as being hazardous to health; these limits being updated annually. The limits are set according to the recommendations of the Advisory Committee on Toxic Substances (ACTS) following assessment by the Working Group on the Assessment of Toxic Chemicals (WATCH) of the toxicological, epidemiological and other data.

There is no separate legislation which covers the particular case of formaldehyde as such, as in the US. However, in view of the equivocal nature of the human epidemiology data and concerns for carcinogenicity raised by the animal data, it has been considered prudent to regard formaldehyde as a potential human carcinogen. For this reason a Maximum Exposure Limit (MEL) has been assigned in the EH 40, at 2 ppm for both the 8-hour Time Weighted Average and for the 15 minute Short Term Exposure Limit. Although this limit is higher and therefore less stringent than in the US, under the COSHH regulations employers who use triazine-containing metalworking fluids must ensure that the workplace exposure to formaldehyde is as low as is reasonably practicable and in any case below the MEL.

**BLF VIEWPOINT**

According to Regulation 6 of the COSHH Regulations, a programme of monitoring need not be undertaken if the assessment process has shown that the level of exposure would never exceed the 2 ppm 15 minute Short Term Exposure Limit. The results of the American JVS may well be used as a reference document in cases where users of formaldehyde-containing fluids are obliged to carry out workplace COSHH assessments, since the information contained in the study could be incorporated into the workplace assessment process. The JVS findings indicate that workplace levels would not exceed the 2 ppm level and therefore a monitoring programme is unlikely to be required. However, users must be reminded of the requirement that exposure to formaldehyde must in any case be as low as is reasonably practicable and that high standards of housekeeping, hygiene and fluid management must be maintained in addition to workplace control methods such as local exhaust ventilation etc.

*D J Margaroni*

Photograph provided courtesy of Fuchs Lubricants plc.

Photograph provided courtesy of Careless Refining and Marketing Ltd.
ECOLABELLING

WHAT IS ECOLABELLING?

'ECOLABELLING' is an EU-wide scheme (arising from EEC regulation No. 880/92) which was launched in July 1993, the purpose of which was to encourage manufacturers of consumer products to provide items which were less damaging to the environment and also to assist consumers in making informed choices. Products qualifying for an 'ECO­ Label' are identified by the incorporation of appropriate logo, and governments are entitled to a licensing fee of 0.15% of the sales value. The basic concept had already been adopted some years previously by a number of other countries where local ecolabelling schemes have since become well established. These include Germany (Blue Angel), Canada (Environment Choice Programme), Japan (Ecomark) and the Nordic countries (White Swan).

WHY ECOLABELLING?

Increasing awareness and concern for environmental matters has been very evident during recent years. Many manufacturers had identified that a commercial advantage could be achieved by making 'environmentally-friendly' claims for their products. However, in the absence of proper guidelines and criteria, it was suspected that many such claims would not withstand proper scientific challenge and further measures were needed in order to protect the interests of the consumer.

WHAT ARE THE CRITERIA FOR ECOLABELLING?

In order to assess the overall environmental impact of a product, it is necessary to first perform a 'cradle-to-grave' Life Cycle Analysis (LCA) as follows:

1. The consumer market for retail gasoline lubricants is diminishing as a result of:
   1.1 Smaller sump volumes
   1.2 Longer oil drain intervals
   1.3 Increasing penetration of diesel engines

2. There is a danger of misleading customers into believing that the used oil can be disposed of directly to the environment.

The BLF agreed that an EcoLabel for lubricants is not appropriate. In addition to the points raised by ATIEL, there are a number of additional reasons to support this viewpoint, i.e.:

1. An in-depth LCA would be extremely costly to perform. Because of the variety of chemistries and base fluids used, it would be difficult to balance the relative overall environmental impacts of the various pre-production routes. Also, it is difficult to identify those relevant lubricant features which can be accurately measured and which have a clear, proven impact on the environment.

2. Legislation, technology and customer demands are already improving the environmental performance of lubricants e.g. in the US the ILSAC GF-1 and GF-2 and in Europe the recently introduced ACEA categories A1.96 and B1.96 all place emphasis on reduced fuel consumption, reduced emissions and various limitations on additive contents and compositions.