Lubrication Fluids and Regulations to Reduce Their Hazardous Effects on Environment

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Abstract

Lubricant is a substance that is used to reduce friction, especially in engine or other moving components. The majority of all liquid lubricants are oil based. Generally the oil based lubricants come from fossil oils or petroleum. Commercial vessels, cars, trucks, agriculture and forest equipment, and also manufacturing industry use all kind of oil based lubricants all over the world. Million liters of oil based lubricants from operational discharges and leaks are introduced into ocean and environment. The discharging or leaking of lubricant goes immediately in the ground. This is the main cause of pollution and contamination. It has hazardous effects on life on earth. Generally, petroleum based lubricants and oil do not have biodegradability property. Bio-degradable lubricants and fluids manifest chemical dissolution by bacteria or other biological means. To protect the environment and make it sustainable life, some countries apply environmental regulations and labels such as Eco mark (Japan), Blue angel (Germany), Eco Logo (Canada), The Thai Green Label Scheme (Thailand), Environmental Choice New Zealand (New Zealand), Ten circle mark (China), Green mark (Taiwan), Green label (Singapore). These labels focus on health, climate, water and resources. Labels and some governmental regulations encourage the use of eco-friendly or biodegradable lubricants, oils and fluids. This paper describes suitable regulations, laws and eco-labels to generate sustainable environment.

Key words: Lubricant, Bio-degradability, Eco-friendly lubricants, Environment labels, environmentally acceptable lubricant

1. Introduction

Lubrication fluids are used for lubrication of various engines or other moving components. The main function is to reduce wear on moving parts; it also cleans, inhibits corrosion, improves sealing, and cools the engine by carrying heat away from moving parts.

World lubricant demand was 40.55 million metric tons in 2012 with increase of 1.6-2.3 percent per year. In 2013 this demand was expected to reach 41.35 million metric tons. Demand for synthetic lubricants and functional fluids are forecast to climb 8.6 percent per year to $7.4 billion in 2015. Engine oil will remain the fastest growing product type. Group III base oils (automotive and industry) and polyalphaolefins (PAOs) will be the fastest growing materials. The vehicle and equipment market will remain by far the largest outlet. World bio based lubricant demand was 505.5 kilo tons in 2011 and is expected to reach 786.0 kilo tons in 2018, growing at a *compound annual growth rate* of approximate 6% from 2013 to 2018. While the fastest growth will be in manufacturing and other markets, it will still represent a slowdown from the 2002 to 2007 time period as the global economic slowdown of 2008 and 2009 restrains upward advances in lubricant demand through 2012[1]. During the 2011; 202.085 tons of vehicle lubricant, 158.460

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tons industrial lubricant and 50.814 ton marine lubricant and grease oil, at the 2012; 216.417 tons of vehicle lubricant, 148.579 tons industrial lubricant and 43.453 ton marine lubricant and grease oil used in the Turkey [2].

United States Environmental Protection Agency Office report define results indicate that commercial vessels make over 1.7 million port visits each year and leak 4.6 to 28.6 million liters of lubricating oil from stern tubes. In addition, 32.3million liters of oil are introduced to marine waters from other operational discharges and leaks [3].

Biodegradability is the most important aspect with regard to the environment of a substance. Biodegradation is the chemical breakdown of materials by living organisms (or their enzymes) in the environment. Organisms include bacteria, yeast, protozoans, and fungi, which break down molecules for sustenance, typically yielding carbon dioxide and water. Certain chemical structures are more susceptible to microbial breakdown than others; vegetable oils and synthetic esters, for example, will in general biodegrade more rapidly than mineral oils under the same conditions [4].

It must be tested e.g. for the EU dangerous preparation directive, the eco-labels and the German water hazard class classification (Willing, 1999). For this purpose standardized methods are being used, which ensure comparable and reproducible results in different laboratories. There are even a lot of standardized biodegradability test systems like OECD methods (OECD, 1992), ISO standard methods (ISO/TR 15462, 1997) and ASTM (D 5864, D 6731). The test systems details are explained in organizations or government rules [5,6].

There are many tests for measuring the extent of biodegradation. These tests are typically conducted in a controlled soil or aqueous (water) medium containing an inoculum of aerobic sewage sludge (as a source of organisms detailed previously) obtained from a local waste water treatment plant). Depending on the test design, it can measure primary biodegradability or ultimate biodegradability of the substance [4].

The term bio lubricant applies to all lubricants which are both rapidly biodegradable and nontoxic for humans and aquatic environments. A bio lubricant can be:

1. Vegetable oil-based (e.g. : rapeseed oils)
2. Based on synthetic esters manufactured from modified renewal oils from mineral oil-based products.

Vegetable oils are mostly known examples of green lubricants and are important due to their biodegradability, renewability, non-toxicity and environmentally acceptable properties as an alternative to the mineral oils[7].

Besides of that approximately 40% of the mineral based lubricant is lost in many industries. The ability to biodegradable vegetable oil reduces environmental impact, naturally. Vegetable oil is a biodegradable lubricant. So, it reduces environmental impact. Vegetable oils offer significant advantages in terms of resource renewability and biodegradability, as well as comparable

performance properties to petroleum-based products. Their amphiphilic character makes them an excellent candidate as lubricants and as specialty chemicals [8].
Lubricants are consisting of base fluids and performance enhancing additives. Mineral oils, rapeseed oils and synthetic or native esters and other organic compounds are used as base fluids. Esters are readily biodegradable in contrast to mineral oils[6]. Environmentally acceptable lubricants are commonly classified according to the type of base oil used in their formulation. In general, lubricants consist of approximately 75 to 90 percent base oil. As well as, the remaining fraction of a lubricant formulation consists of performance enhancing additives. A lubricant formulation can include hundreds of additives, which address performance issues specific to their application and performance shortcomings of the base oil. Additives are commonly used to address oxidative aging, corrosion, high pressure, low or high temperature conditions, phase transition, shear, foaming, and hydrolysis (particularly for vegetable and synthetic ester-based oils) [3]. In German's application, the concentrations of additives usually are below 10% w/w. For the eco-label ''blue angel'' it is tolerated, that the additives are only potentially degradable, if their concentration is below 7% w/w [6].

For some of the strict labeling programs, additives used in environment friendly lubricant must be both ashless (i.e., containing no metals other than Ca, Na, K, Mg) and non-toxic. European Commission announced the restricted substances for lubricant formulations, they must not include certain specific substances, including halogenated organic compounds, nitrite compounds, metals or metallic compounds (with the possible exception of sodium-, potassium-, magnesium-, lithium-, aluminum- calcium-based soaps) [3]. Some indication of the cost of environmentally acceptable lubricants relative to conventional lubricants was provided by a major lubricant vendor and is showed in Table 1.

Table 1. Cost of environmentally acceptable lubricants[3].

Lubricant base oil	Ratio of environmentally acceptable lubricants cost to conventional mineral oil lubricant cost
Mineral oil	1
Vegetable oils	1.2
Synthetic esters	2 to 3
Polyalkylene Glycols	2 to 3

The benefit of using environmentally preferable lubricants can be considerable in terms of reduced environmental impacts. Cost of the environmentally friendly lubricants should be reduced and support from managements.

This paper gives information about lubrication fluids such as bio lubricants, environmental friendly lubricants. Some countries use environmental labels and regulations which encourage the use of environmentally acceptable lubricants. This paper, gives some examples of labels that belong to countries which are using regulations to reduce lubricant's hazardous effects on environment.

2. Eco-friendly lubricants

An ecolabel is basically a label which identifies overall environmental preference of a product (lubricant) based on life-cycle considerations. This environmental preference is guaranteed by the ecolabel. Ecolabel is a tool that helps buyers conflict among a number of products, often accompanied by unverified claims about their supposed ecological advantages, and recognize those that actually offer a better environmental performance.

There are several eco-labels which are designed to differentiate these lubricants from existing conventional lubricants. European Eco-label, for which the symbol is a daisy, can only be used on products which satisfy strict criteria as regards their low environmental impact. It is one of those rare labels which provides a guarantee of performance and can be used to distinguish an ordinary biodegradable oil from a proper biolubricant.

Many lubricants are advertised as being environmentally preferable. However, currently there are no regulatory standards for environmentally acceptable lubricants, and no internationally accepted term by which they are defined. To distinguish lubricants which have been shown to be both biodegradable and non-toxic according to acceptable test methods from those lubricants that are simply marketed as being "environmental" (or similar terminology). Also, lubricant formulation can include hundreds of additives, which address performance issues specific to their application and performance shortcomings of the base oil. Additives are commonly used to address oxidative aging, corrosion, high pressure, low or high temperature conditions, phase transition, shear, foaming, and hydrolysis [3]. Many hydraulic equipment such as sawing machine, snow/ski machines, two-time yacht, boat motors used in the ports, lakes, forests and agricultural land areas. In these areas it is necessary to use environmentally friendly products as a lubrication fluid. The use of petroleum-based products has numerous negative effects on the environment. The most important of these negative effects is contaminating surface and groundwater, after than air and soil pollution. These petroleum-based product substances are harmful to human health which is passes food through the human body [9,10,11]. There are several advantages of eco-friendly lubricants [11-13];

- Biodegradability
- Low toxicity
- Respect for the environment
- Low oil evaporation losses
- Good lubricating properties
- High viscosity index
- High ignition temperature
- Increased equipment service life
- Possible longer intervals between changes

3. Environmental regulations and Ecolabels

The term biolubricants applies to all lubricants which are both rapidly biodegradable and nontoxic for humans and aquatic environments. A biolubricant can be:

1. Vegetable oil-based (e.g. : rape-seed oils)
2. Based on synthetic esters manufactured from modified renewal oils from mineral oil-based products.

Bio-lubricants must be used in priority for all applications where there is an environmental risk. This applies to:

- Total waste oils (chainsaw chain oils, 2-stroke engine oils and formwork release agents)
- Possible accidental leaks (hydraulic oils and greases).

Some environments for which environmental protection is a permanent preoccupation are particularly concerned by the use of bio-lubricants. This is the case for aquatic, mountain, agricultural and forest environments in particular.

Several countries are awarding environmental seals for the environmental acceptability eco-labelling schemes. The first seal was awarded by Germany by the name as "Blue Angel". Similarly "White Swan", "Green Cross" and "Ecomark" are the environmental seals of Scandinavia, and Japan and India, respectively. These eco labelling USA, schemes include ecological test requirements, prohibitions and manufacture's declarations which often differ and are being continually updated [13]. There are several labels which are designed to differentiate these products from existing conventional lubricants. Choosing to base your procurement on an ecolabel - that covers several product and service categories, offers a complete impact assessment over the life cycle and guarantees the impartiality of the scheme – is an assurance of the quality and reliability of the criteria. Very well-known ecolabels are the European Ecolabel (the Flower), the Nordic Swan and the Blue Angel. Beside of that Australia, China, India, Thailand, Philippines, Croatia, Ukraine, Taiwan, Indonesia, Canada, Korea, Japan, United States, Russia have their own labels in Figure 1.


European Flower Nordic Swan Blue Angel




Good Environmental Choise: Australia | Environmental Labelling China | Ecomark India | Green Label Thailand | Green Choice Philippines | Environmental Label Croatia | The Ecological Marking Ukraine

Green Mark Taiwan | Ekolabel Indonesia | EcoLogo Canada | Korean Ecolabel | Eco Mark Japan | Green Seal United States | Ecolabel Vitality Leaf, Russia

Figure 1. Environmental labels

Ecolabels are useful because: They allow consumers to make an environmentally friendlier choice without being environmental experts. They favor the encounter of demand and supply of green products and services. They offer a good marketing opportunity to products that stand out from the others because of their green performance. They support innovation, encouraging the diffusion of green products on the market.

From the perspective of UN procurement practitioners; they facilitate the inclusion of green criteria in public tenders and they offer a guarantee of impartiality, reliability and scientific accuracy to initiate and boost the use of biodegradable products, government incentives and mandatory regulations are needed to put pressure on the industries that release lubricants into the environment. There are some applications and regulation examples belong to the European Union, Germany and Japan about Eco label.

3.1. The European Union Ecolabel (EU)

The EU Ecolabel helps the identify products and services that have a reduced environmental impact throughout their life cycle, from the extraction of raw material through to production, use and disposal. Recognized throughout Europe, EU Ecolabel is a voluntary label promoting environmental excellence which can be trusted. In the European market due to environmental concerns and threats of bio-based oil consumption growth of 16.3% demonstrates the demand for current consumption [15].

3.2. Blue Angel (Germany)

Germany has some of the best known guidelines for environmentally acceptable lubricants with an oriented interest in the lubricants market. The first label, the Blue Angel, was created in 1978 by the German Federal Ministry for Interiors. Although labels popularity has been on the rise in recent years in connection with growing concerns for environmental deterioration and climate change. Within the Blue Angel label, substances are discriminated according to their water endangering potential.

3.3. Eco Mark (Japan)

Biodegradable lubricating oil that gives consideration to the environment in terms of manufacturing, distribution, and consumption in Japan. For get an Eco Mark certification in

Japan biodegradability of products measured by one of the following methods shall be 60% or more within 28 days.

Eco Mark OECD (Organization for Economic Cooperation and Development) Chemical Product Test Guidelines
OECD 301B (CO_2 evolution)
OECD 301C (Modified ministry of international trade and industry, Japan MITI(I))
OECD 301F (Manometric respirometry)

Eco Mark ASTM (American Society for Testing and Materials) Product Test Guidelines
ASTM D 5864 (Standard test method determining aerobic biodegradability of lubricating oil and lubricating oil components)
ASTM D 6731 (Standard test method determining aerobic biodegradability of lubricating oil or lubricating oil components sealed in the respirometer in water.)

4. Discussion and Conclusion

Biodegradability is depending mainly on the characteristics of the base fluids. Ecolabel is a key for choose and use the environmentally friendly lubricant by users. Ecolabel makes an easy to understand which is accepted as an environmentally friendly lubricant or product.
Manufacturers, importers, services providers, traders and retailers, may submit applications for the Ecolabel. Traders and retailers may submit applications in respect of products placed on the trade market under their own brand names.
Ecolabels should give from managements and encourage using those products for sustainable environment.

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