

# A Review of Waste Lubricating Grease Management

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**Abstract**—This paper reviews the handling, disposal, treatment of waste lubricating grease as well as its environmental impact. Lubricants require careful disposal as they contain pollutants. In response to economic considerations and environmental protection, there is a growing trend of regeneration and reuse of waste lubricants. Accordingly, this work provides an overview on various ways of handling, disposal, treatment of waste grease and its associated environmental impacts. In addition to the fact that petroleum and crude oil are not inexhaustible resources, waste products from these resources present a hazard to human health and the environment. As such, proper management of waste lubricants is necessary to prevent the adverse environmental impacts. Efficient recycling of waste lubricants could help reduce environmental pollution.

**Keywords** —Environmental impact, handling and disposal, pollution, waste lubricating grease, waste management

## I. INTRODUCTION

**L**UBRICATING grease is usually made from petroleum oils thickened with metal soaps, lithium soap is the most widely used thickening agent. In addition, lubricating greases usually contain some performance additives. Thus, the use of polymers is a common practice to modify the rheological properties of greases by reinforcing the role of the thickening agent [1]. The thickener is added to prevent loss of lubricant under operation conditions.

Generally, lubrication is achieved by oil. Oil viscosity decreases with increasing temperature hence the requirement for additives to support its duties at higher temperatures [2]. Lubricating grease is used in many applications to reduce the wear and friction between movable parts, usually metal joints. Due to its semisolid character, it can stay in place and act as a seal, thus preventing both solid and liquid contaminants from entering the system, without the need for a sump [3].

Due to the exhaustion of chemical additives and the

contamination from metallic materials, particulate dirt and grits, other asphaltic substances as well as the lubricant degradation and its deterioration will be the result after a certain period of operation. As a result, it becomes physically and chemically unsuitable for further service use and must be replaced [4, 5]. More than 90% of lubricating oils and greases are mineral oil based, they are non-biodegradable and hence they are not environmentally friendly. It is becoming a growing concern to dispose oils and greases more efficiently and safely. This has led industries and governments to find satisfactory solutions that will reduce the contribution of used lubricants to pollution and also recover these valuable hydrocarbon resources [6].

TABLE I  
CONSTITUENTS OF TYPICAL HIGH TEMPERATURE GREASE [7]

Grease Constituent	Percentage by Mass
Alkali metal high molecular weight fatty acid soap	20 – 50
Alkali metal salt of a short chain aliphatic acid	0.1 – 10
Alkali metal oil-soluble sulfonate (thickener)	1.0 – 20
Glycerine	0.0 – 2
Hydrocarbon Oil	Remainder

Used lubricants often pose serious pollution problems because of illegal dumping or improper disposal resulting in groundwater, surface water and soil contamination. Direct combustion of these used lubricants without any pre-treatment is subject to environmental restrictions as these waste oils may contain toxic and hazardous residues such as metal and metalloid particles, chlorinated compounds, polycyclic aromatic hydrocarbons and other residues which may be released into the atmosphere.

However, a proper collection system and treatment process for utilizing used lubricants would reduce its environmental impacts as well as preserve valuable resources [5]. 13–15% of the oil produced is used in open lubricating systems and hence it will unavoidably enter the environment as lost lubricants [8].

Today, industry is concerned with the impact process technologies and products exert on the environment. In addition, there is a general tendency to promote both the replacement of non-renewable raw materials by renewable resources as well as minimizing environmental impact caused by industrial waste materials. Consequently, a new market based on eco-friendly products is developing quite fast, where consumers are determined to use new products or even pay higher prices for alternative materials with reduced negative environmental effects. Many people have used waste lubricants for dust prevention [9]. This method of disposal is in many ways unsatisfactory as the lead-

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bearing dust and run-off, constitute air and water pollution.

## II. WASTE LUBRICANTS CHARACTERISTICS

The principal source of contamination during lubricant use is the chemical breakdown of additives and the subsequent interaction among the resultant components to produce corrosive acids and other undesired substances. Among the metals, lead is usually present in high concentrations due to combustion in engines using leaded gasoline. Chlorinated solvents may also be present in significant quantities as a result of the breakdown of additive packaging as well as the presence chlorine and bromine acting as lead scavengers in leaded gasoline. Polynuclear aromatic hydrocarbons (PAHs) are of particular concern due to their known carcinogenicity. Table 2 lists compounds of potential concern with their corresponding concentration ranges.

The amount of contaminants in waste oil depends on several factors such as the original detergents and diluents added to the virgin oil, storage location, and management practices. For example as leaded gasoline is gradually being phased out, lead concentrations in waste oil will decrease significantly, and consequently, the quantities of bromine and chlorine additives will also be lower, further reducing the presence of halogenated hydrocarbons in waste oil [10].

TABLE II  
CONTAMINANTS OF POTENTIAL CONCERN IN WASTE OILS [11]

Organic contaminants	Probable source	Concentration ( $\mu\text{g/l}$ )
<i>Aromatic hydrocarbons</i>		
Polynuclear (PNA)	Petroleum base stock	
Benzo(a)pyrene		360-62 000
Benzo(a)anthracene		870-30 000
Pyrene		1670-33 000
Monoaromatic	Petroleum base stock	
Alkylbenzenes		900 000
Diaromatic	Petroleum base stock	
Naphthalenes		400 000
<i>Chlorinated hydrocarbons</i>		
Trichloroethanes	Chemical reactions	18-1800
Trichloroethylene	during use of waste	18-2600
Perchloroethylene	oil	3-1300
<i>Metals</i>		<b>mg/kg</b>
Barium	Additive package	60-690
Zinc		630-2500
Aluminium	Metal wear	4-40
Chromium		5-24
Lead	Leaded gasoline	3700-14 000

## III. ENVIRONMENTAL AND ECONOMIC CONSIDERATIONS

It is estimated that approximately 37 million tons of lubricants are used in the world each year. Approximately 10% of these lubricant products are used in systems where the waste lubricant is discarded directly into the environment. It is also estimated that 13 to 32 % of used lubricants are returned to the environment in a state where they are essentially unchanged [12]. Environmental protection and conservation of non-renewable resources require significant consideration.

Although most lubricants are made from mineral oils, some are made from synthetics lubricants, such as silicones. It is important to recover as much as possible of the

lubricating oil and recycle it in an environmentally friendly manner. Disposal through incineration contribute to environmental pollution through carcinogenic product emission [13].

Used lubricants can be used as a fuel source after removing water and impurities. In this regard, the waste-to-energy utilization route has been mostly used in developed countries compared to recycling applications such as chemical feed stocks and other petroleum products [14].

### A. Effect on Human Species

Exposure to hazardous compounds in waste may be either directly through skin contact or ingestion, or indirectly through the environmental pollution. Health hazards due to drinking waste-oil-contaminated water vary from mild symptoms of accumulation of toxic compounds in the liver to complete impairment of body functions and eventually death [15]. These relate to the hazardous properties of used lubricating oil and the risk of hazardous substances in it. Such impacts may include deleterious effects on the viability and sustainability of terrestrial and aquatic ecosystems.

Indiscriminate dumping of used lubricating oil to sewers may contaminate surface waters and interfere with biological treatment and filtration systems at sewage treatment plants. Over time, the layer of grease becomes thicker, and the flow of wastewater in the sewer pipes becomes restricted. This can lead to water and sanitation problems. During heavy rain, sewer overflows can occur and the wastewater in the pipes with plenty of bacteria, pathogens and viruses will result in backup or overflow through manholes into public places, such as streets and parks [16].

### B. Effect on Aquatic Life

Grease and oil in waterways rises to the top, forming a film that blocks sunlight, impairs photosynthesis, and prevents oxygen replenishment, which disrupts the oxygen cycle and enhances growth and reproduction of micro-organisms that use oil as a food source. This process leads to eutrophication, whereby available oxygen required for fish, shellfish, and other living organisms which comprise the aquatic food chain is depleted. Furthermore, larval stages of aquatic organisms are particularly vulnerable to toxic substances contained in waste oil or lubricants in general. Toxins can accumulate in plankton and other tiny organisms at the base of the food chain and ultimately reach human beings as contaminants move up the food chain [10].

### C. Economic Impact

When lubricants are disposed in the water system, the layer of grease becomes thicker, and the flow of wastewater in the sewer pipes becomes restricted. Blockages in the wastewater collection system are serious, causing sewage spills, manhole overflows, or sewage backups in homes and businesses. These overflows can result in costly clean-up and repairs as well as attracting severe fines from the regulatory agencies [16]. Countries spend billions of rands every year unplugging or replacing grease-blocked pipes, repairing pump stations, and cleaning up costly and illegal wastewater spills. These repairs cost money and may lead to higher local wastewater rates, thereby affecting the business

and citizens as well. These extra charges are brought to recover cost of the extra techniques employed to remove these hazardous material from the waste water stream prior to purification process. On the other hand, waste minimisation and recycling has resulted in a number of businesses and employment opportunities being created [16].

#### IV. WASTE LUBRICANTS MANAGEMENT

The principal objective of any waste management plan is to ensure safe, efficient and economical collection, transportation, treatment and disposal of waste and as well as satisfactory operation for current and foreseeable future scenarios [17]. The purpose of NEMA (National Environmental Management Act 107 of 1998), with regards to waste management, is to avoid waste generation, or to otherwise treat/store/recycle waste in the most sustainable way possible, in order to ensure a healthy environment with reduced impact on human health. The Act states as a principle that waste generation should be avoided, and whenever this is not possible, generation should be minimized. The efficient recycling of waste lubricants could help reduce environmental pollution.

##### A. Collection and Handling

Producers of used lubricants have responsibility to dispose their waste in containers which meet appropriate environmental standards. When used lubricant is to be disposed via a third party, the generator should check that the collector is licensed, or otherwise lawfully entitled, to collect and transport such substances. It is also important to specify and record that the collector disposes the waste at an appropriately licensed facility or a facility which is otherwise lawfully entitled to receive it [18].

##### B. Transportation and Storage

According to the Waste Act 2008 (Act No. 59 of 2008) and the Act on Transport of Dangerous Goods, hazardous materials must be transported as outlined in the act. In itself, this is not a problem, especially for waste management companies which transport such substances in daily operations but problems arise with the waste producers. Vehicles used for transporting used lubricating oil shall be appropriate for such use, structurally sound and safe. Spillages and contamination of used lubricating oil should be avoided [18]. After its use and application, fresh lubricant becomes waste and it is necessary to temporarily store it at source.

The 200 litre drum is the most common lubricant container used industry. The containers must be covered, or have a certificate that they can be kept outdoors. Care must be exercised when handling these drums. Storage tanks and bins in a warehouse or oil house should not be placed near heaters, steam lines or any other plant equipment that generates heat. The next steps in the management of waste lubricants is temporary storage at authorized collectors, waste treatment at processors and reporting of data to responsible authorities [19]. However, even though this seems to be a simple procedure, most companies experience lot of problems mainly due to lack of education and separation at source.

##### C. Disposal

Although companies must follow rules governing lubricant disposal, many people don't practice such strict guidelines when disposing lubricants. Thus, the majority of lubricants find their way into the environment. People or companies who pour used lubricants on the ground or into drains or improperly at landfills cause environmental damage.

Grease disposal is a challenge; landfilling is the conventional and most viable option to dispose waste grease. However, before land filling, water should be removed and the waste grease composition must be known. Some reports have reflected that a large portion of waste end up in landfills and water runoff through accidental leakage. However, this disposal method is a waste of a potential energy source. While attempts for better filtration are increasing, recycling is not a popular option for most companies.

##### D. Treatment

*Reprocessing* - The objective of re-processing is to produce a fuel oil with low basic sediment and water content that will not clog burners, foul boiler tubes, or cause sediment build-up in customer tanks. As such, the process requires filtration and removal of coarse solids that can cause environmental or operational problems. Treatment options include mainly physical processes like settling, centrifugation, filtration, or a combination of these operations. Unfortunately, these processes alone are not sufficient to remove all chemical contaminants in the oil, and inclusion of further treatment processes such as clay contacting and distillation would give fuel processors a competitive disadvantage [10].

*Re-refining* - Over the years, several re-refining technologies have been proposed for waste oil recycling. Re-finishing is the use of distilling or refining processes on used lubrication oil to produce high quality base stock for lubricants or other petroleum products. The use of this method has increased tremendously in developed countries, reaching up to 50% of some countries' need for lubricating oil [20]. It requires the conversion of waste oil to a product with similar characteristics to those of virgin oil.

The re-refining process is a solvent extraction followed by clay treatment or acid treatment. Basically the clay is used as an absorbent. Vacuum distillation followed by clay contacting produces less pollution and it's also an economic solution to the re-refining process, particularly for small-scale plants with a capacity range between 10000 and 30000 tons [10]. The resulting residual by-product is well compacted and baled in thick plastic sheets prior to disposal in landfills. Participation of a reputable recycling company can play an important role in enhancing the trust factor [21].

*Destruction* - This method is preferable in case the waste oil is highly contaminated, particularly with polychlorinated biphenyl (PCB) and polychlorinated terphenyls (PCT). In the absence of hazardous waste incinerators, controlled high-temperature incineration at cement factories is recommended. Temperatures at the flame end of rotating cement kilns ranges between 2000 and 2400°C. This high temperature is adequate to destroy organics and neutralize acid compounds. The heavy metals content is reduced

considerably compared to those found in the natural material used in the cement production process. Continuous monitoring of gas emissions at the cement factories would be required to ensure compliance with air quality standards [10].

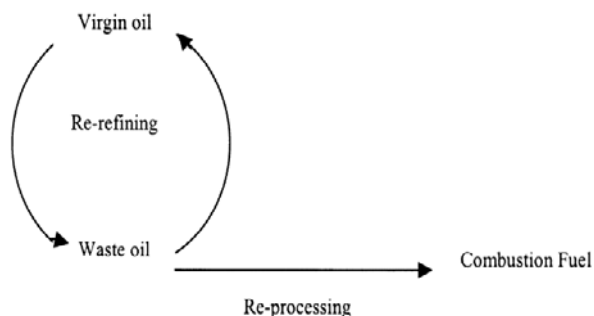


Fig. 1 Re-refining (continuous recycling) versus Re-processing (one-time recycling) [10].

## V. CONCLUSION

Proper waste management provides an opportunity to minimize adverse environmental and health impacts associated with the improper disposal of waste oil. Waste oil is a resource with potential to aid economic growth. Due to high levels of contamination from mineral oil, lubricants such as grease can be based on vegetable or synthetic base oils. Vegetable base oils are biodegradable, renewable and nontoxic.

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