# Management and Disposal of Used Oil - A Case Study of Menengai Geothermal Field

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***Abstract*- For a long time, used oil has been reused or disposed in methods that contaminated the environment or not recycled to maintain its resource value. In Kenya, it is estimated that 200 million gallons annually are poorly disposed by pouring on the ground, taken to dumpsites or discharged down sewers and storm drains. One gallon of used oil can contaminate up to one million gallons of clean water. Used oil also end up in lakes, rivers and streams where they threaten the aquatic life.**

**This is a case study undertaken at Menengai Geothermal Field to explore the handling, management and disposal of used oil. The study sought to identify the current uses and disposal methods of used oils and make recommendation that could help other entities to effectively manage used oil. Data was obtained from well costing/completion reports and company disposal records.**

**Findings reveal that proper management of used oil not only prevents environmental degradation, but can also results in significant economic benefits. In Menengai case, used oil is transported to cement factories where it is used for heating. Used oil can be processed into fuel oil, re-refined into lubricants or used as raw materials for refining and petrochemical industries.**

***Keywords*: Geothermal, used oil, disposal**

## I. INTRODUCTION

The United States Environment Protection Agency (EPA) defines the term *"used oil"* as "any petroleum or synthetic oil that has been used, and as a result of such use is contaminated by physical or chemical properties" (EPA, 2017). The EPA uses three-pronged criteria to define used oil: (1) origin, (2) use, and (3) contaminants.

The *Origin* criterion posits that for any substance to qualify as use oil, it must have originated from crude oil or synthetic materials (Ogbeide, 2010). Thus, vegetable and animal oil do meet the definition of used oil as they originate from different sources.

The *Use* criterion suggests that for any substance to fit the definition of used oil, it must have been put to some use such as lubricants, buoyant, heat transfer fluids, hydraulic fluids, and other purposes. Thus virgin oil recovered from spills does not qualify as used oil because this oil has never been "used."

The *Contaminants* criterion demands that for a substance to qualify as used oil, it must be contaminated by either chemical or physical impurities due to usage (Zitte, Waadu, & Okorodike, 2016). Examples of contaminants include dirt, sawdust, metal shavings, salfwater, halogens, solvents, and residues.

### *B. Sources of Used Oil*

The main generators of used oil are small generators (do-it-yourself (DIY) for motor vehicle, farm machinery and other equipments), vehicle repairs and servicing, industrial activities and shipping operations (Zitte et al., 2016). The quantity of used oil generated from these sources is difficult to quantify.

#### *1. Small generators*

Oil change in machines is a regular activity which is carried out in facilities equipped for the job (formal garages), open air garages or on-site (Ogbeide, 2010). Onsite oil changes are carried out by do-it-yourself (DIY) in service and repair of motor vehicles and farm machineries. These sources of used oil are regarded as small used oil generators and basically produce less than 10 litres of used oil at any one time. There is no proper used oil collection and disposal system.

#### *2. Vehicle repairs and servicing*

The amounts of oil changed at petrol service stations are quite low compared with those changed in open air garages where multiple services are offered at the same time hence the preference by some motorists (Abro et al., 2013). The latter practice poses a great environmental risk since the grounds are pervious and there is no proper prevention of spillages. The branded service stations have established a Safe Waste Oil Disposal (SWOD) initiative whereby a common truck collects the used oils and transports it to a treatment plant. In open air garages, the used oil is collected in drums or other small containers and there is no clear chain of custody of the oil after collection. Hence the oil may be used in other applications rather than being re-refined as recommended.

#### *3. Industrial activities*

Used oil is also generated from petroleum refineries, other industrial sources such as metal working industries, industrial machines, transport industry (railway, ships, aviation) petroleum tank cleaning, bulk petroleum storage tanks and heat transfer e.g. electrical transformers (Abro et al., 2013). One of the key sources of oily wastes is the sludge discharged from petrol storage tanks. The sludge that is often formed by high pressure water jet cleaning of storage tanks comprise of iron oxide, corrosion products, and sediments containing organic and inorganic compounds mixed with fuel

(EPA, 2017). The used oil from industrial sources is reprocessed at recycling facilities while that which is generated from petroleum tank cleaning operations is used for energy recovery or disposed off through weathering sites.

*4. Ship operations*

A major source of used oil/sludge in Kenya is the servicing of ships which dock at the port of Mombasa (Muia, 2004). The used oil will come as bilge water, or sludge from ship engine and other auxiliary machinery. Used oil from the ships is collected by either licensed storage or recycling facility operators while some directly get into the environment due to improper handling. The oil collected by the recyclers is basically decanted and used as fuel for boilers and furnaces among other uses.

*C. Uses of Used Oil*

For many decades, motor oil has been salvaged or discharged in ways that neither conserved the environment nor sustained its resource value. In Kenya alone, an estimated 36.55 Million Litres of used motor oil were generated in the year 2003 (Muia, 2004). Most of this volume is inappropriately disposed of by being discarded on the ground, thrown in the trash (ending up in landfills), and dispensed down storm sewers and drains. The rest is used for timber treatment, upgrading of dusty roads, and mosquito control in ponds, irrigation areas and swampy areas. Some insignificant amount is recycled for burning in cement kilns.

Applying the cradle-to-grave concept, manufacturers of products must follow them up from production, to their use, until their final disposal. Lubricant manufacturers should be the first ones to be concerned with measures to be taken in order to capture the cradle to grave concept in use "of lubricants. Currently in Kenya we have three major oil blending plants all located in Mombasa where the major oil marketers, that is the big 5, namely Shell BP, Mobil, Caltex, Total and Kenol/Kobil, blend their lubricants (Mutegi, 2016). There are also small recycling plants that recycle used oil into lubricants and market them cheaply to Jua kali garages and hardware shops mainly at Kirinyaga road. A few exports are coming in from Dubai and the Middle East but they only account for less than 10% of lubricants market. 90% of lubricants are blended within the country (oil industry lubricant sales figures).

In Kenya most of the used oil generated is disposed in ways that pose serious threats to the environment and this can partly be attributed to the slack legislation regarding its disposal and ignorance of persons about the health risks it poses during handling of used oil (Muia, 2004). This therefore poses major challenge to not only the government but also the oil manufacturers that supply other users, as well as on consumers who actually generate used oil from their equipment to come up with disposal methods that are environmentally suitable.

Now with the enactment of EMCA (Environment Management and Coordination Act, 1999) it has become more urgent to define the cradle to grave management process, in order to not only comply with legislation but also to ultimately protect our environment. It is clearly known that used oil, besides loosing it's physical properties, is normally contaminated with other chemical compounds having poisonous effects on both man and other living organisms and hence must be properly disposed off to minimize environmental pollution.

Disposal of used oil through drainage system, storm water drains or simply dumping on the ground is common all over the country especially at the so called Jua Kali garages yet this goes against EMCA legislation and municipal council legislation touching on effluent discharge from service stations (Muia, 2004).

Major oil marketers who market their lubricants alongside petrol fuel have a way of collecting used oil through used oil underground tanks in their service stations but still face difficulties on disposal. The tanks are connected to the pit stop bays where vehicles are serviced (Kamau, 2016). The oil is then drained into used oil underground tanks or drums where underground tanks are not installed. The stations are designed with oil water interceptors/separators connected to the drainage system within the station that drains into storm water drains. The interceptor is a system of chambers that filter out the oil and allows only clear water to drain off into storm water drains. The oil left in the interceptor is schemed or scooped off into the used oil storage.

However most independent garages especially the Jua kali (down at Kirinyaga road, in estates and market centres) do not have this interceptor system and hence used oil is dumped on the ground and continues to flow and to be washed off by rain into storm water (Kamau, 2016). In addition, it has been established that even oil markers that have the interceptor system do not have laid down procedure of handling the oil once the tanks are full. This has led to disposing it through un environmentally friendly ways including selling to third parties who use it in various ways including dust suppression, swampy areas treatment, timber treatment, to mention but a few. All this methods of oil disposal pose serious threats to the environment, more adversely to water.

## II. MENENGAI GEOTHERMAL FIELD CASE

*A. Background*

Kenya Vision 2030 aspires for the realization of about 23,000MW of electricity by the year 2030 (Republic of Kenya, 2007). To achieve this target, the Government formed the Geothermal Development Company (GDC) with the mandate of accelerating geothermal development in the Country. It is a 100% state owned corporation that was established as a special purpose vehicle to accelerate development of green energy from geothermal resources as envisage in the government of Kenya vision 2030.

GDC's current development plan envisages the development of 465MW at Menengai, 300MW at Baringo-Silali and 300MW at Suswa Field. The company operates 7 drilling rigs each with a capacity of 2000hp at the Menegai Geothermal Field (MGF). Each rig is made of a number of equipment which includes five high capacity generators, four compressors and various heavy lifting machines.

The Equipment Maintenance department is tasked with the maintenance of rig equipment & auxiliary equipment which includes minor, major, break down and predictive maintenance. The company operates a total of One hundred and thirteen (113) caterpillar engines at the rig sites for power generations, cementing, air drilling and circulation systems Each of them consumes a lot of oil during their regular maintenance. The handling of this used oil has been a constant challenge to the company

Company records indicate that MGF had used over 1.3 million liters of oil between 2011 and 2016. The engines at the MGF are the greatest consumers of oil followed by coolants. Other areas in which oil is consumer in large quantities include the running and maintenance of compressors, hydraulics, and gears. Table 1 presents a tabular representation of the total amount of various oils issued for the period of 2011 to 2016.

As a best practice, the maintenance team ensures that all used oil is stored in containers and tanks that are clearly labeled "used oil". The containers and tanks are regularly maintained and kept in good condition to avoid rust and deterioration that could lead to leakage. Structural defects on the containers and tanks are fixed immediately.

Table 1: Amount of Oil Used in Various Areas

| **Material Description** | **Total Issue Quantities (Ltrs)** |
|---|---|
| ENGINE OIL 15W-40 | 532649 |
| HYDRAULIC OIL DT 13 | 24765 |
| GEAR OIL 620,627,632,634 | 26160 |
| COMPRESSOR OIL SULLAIR AWF | 119393 |
| HYDRAULIC TRANSMISSION OIL AUTOMOTIVE | 4766 |
| GEAR OIL ISO VG 320 | 50595 |
| GEAR OIL SAE 80W90 | 48304 |
| GEAR OIL ISO VG 150 | 92109 |
| GEAR OIL ISO VG 220 | 49372 |
| COMPRESSOR OIL S40 MONO GRADE | 28141 |
| HYDARULIC OIL ISO VG 46 | 54728 |
| AUTOMATIC TRANSMISSION FLUID | 3328 |
| TRANSFORMER OIL ISO 3675 | 539 |
| COOLANT | 226083 |
| MDTOTCO INSTRUMENTATION OIL | 425 |
| PAROIL COMPRESSOR OIL | 5357 |
| OIL CAN PARO -BOOSTER | 5016 |
| DEGREASER | 2160 |
| Brake Fluid | 100 |
| Hydraulic Oil ISO VG 32 | 77633 |
| PAROIL COMPRESSOR OIL S | 7860 |
| PAROIL COMPRESSOR OIL E | 20 |
| Doosan XHP605 | 7152 |
| **Total** | **1,366,655** |

*B. Method of Managing Used Oil at MGF*

To manage the vast amount of used oil generated at the MGF, Geothermal Development Company has made arrangement with its oil suppliers that require suppliers to carry away the used oil when they deliver new oil. The used oil is sold to cement manufacturing companies in Nairobi where it is used in clinker firing; an essential step in the cement production process. In this way, the company is able to make extra money while at the same time reduce environment degradation by ensuring that its used oil is properly managed. It also promotes sustainable use of fossil fuel resources that are dwindling by the day. The use of used oil to clinker firing has also helped the cement factories to manage cost and increase their competitiveness. Energy is a major cost element in cement manufacturing accounting for between 30-40% of total production cost (Chatziaras, Psomopoulos, & Themelis, 2015). Reduction in production cost of cement is not a benefit for the cement manufacturers only but also to the entire society as cement is critical in ensuring access to affordable housing and other critical infrastructure such as roads and bridges. The approach of managing waste has also helped the Geothermal Development Company to strengthen its relationship with the cement manufacturers being itself a major consumer of cement often used to case geothermal wells after during drilling. This used oil management approach has largely been enabled by the development of an elaborate reverse logistics strategy that involves using the oil suppliers to transport the used oil to the cement factories. Previously, GDC oil suppliers used to deliver oil to the field and return with their tanks empty. Todays these suppliers have been contracted to transport the used oil to the cement factors thus ensuring efficient utilization of their trucks as well as presenting them with an opportunity to earn additional income.

## III. CONCLUSION

The recovery of used oils for use by processing and manufacturing industries presents a sustainable way of managing used oil. From the study, it was found that an initiative for the collection and disposal of used lubricating oil can be undertaken sustainably to ensure safe disposal of the used oil generated from various sources. The thriving cement industry provides a ready market for most of the used oil

generated in Kenya. Channelling the used oil to this industry will not only help to conserve the environment but also increase the competitiveness of the industry by lowering their production costs. This strategy can only be successful if the government together with oil marketers are able to develop an effective reverse logistics strategy that facilitates the movement of used oil from event the small times users. Burning of used oil should however be restricted to industrial operators who have resources to design heaters and furnaces that can contain harmful emissions. This is because combustion of used oil has the potential of realising harmful substances into the atmosphere such as arsenic, cadmium, and lead hence combustion should be regulated and controlled. The government should also consider setting up oil recycling industry to accommodate all the oil waste and consequently reduce the price of oil. Re-refining used oil requires about 33 percent of the energy for refining crude oil to lubricant quality. One gallon of used oil has the potential of generating 2 quarts of high-quality lubricating oil as compared to 42 gallons of crude oil required to make the same amount of lubricating oil. Thus recycling of used oil presents greater economic value.

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