SPENT ENGINE LUBRICATING OIL RECYCLING PLANT(S) IN NIGERIA: PROSPECTS AND CHALLENGES

Onuigbo Arinze Jude
Institute of Management and Technology (IMT), Enugu, Nigeria

Abstract
Nigeria has joined the league of countries seeking for alternatives to fossil fuels. Lubricating oil finds several applications in a technologically advanced economy; Lubricating mineral oil has a petroleum origin: therefore it is a precious product that can and must be ecologically recovered in order to save a non-renewable source of energy. Waste oil is almost totally re-usable, and presents different characteristics according to its origin: for example, the waste oil coming from the automotive sector generally can be used for the production of re-refined base oil, and also the one coming from industry, even if in lower percentages. This is suggested because developing countries are yet to enforce environmentally friendly automobile workshops and mechanic practice. If all automobile repair works in different cities are confined to mechanic villages, collection, preservation, recycling, and reuse of spent oil will become effective. The goal is to stop the habit of disposing spent automobile oil on the ground, which results in excessive trace metal pollution of topsoil and insecurity of food products in the affected areas. Beside environmental quality, business and employment opportunities will improve. Small-scale refining or reprocessing of used oil in mechanic villages is lucrative and recycling plants are affordable and available. My analysis indicates strong environmental benefits and economic value. Another benefit derivable from re-lubricant production include income generation for its owners, optimal utilization of oil resources, employment generation and the reduction in social vices like robbery, wandering, drug pushing and smuggling.

Keywords: Changed oil, reprocessing, re-refining, used oil regeneration

Introduction
Technology scenario is a prospect in any developing country. However, Nigeria suffers from an ironic contradiction. It is arguably the only crude oil producing country that imports petrochemicals. This fact often blinds foreign interests to the potential inherent in the Nigerian economy. In addition, the country suffers from a bad reputation for safety. Base oil is produced by means of refining crude oil. This means that the crude oil is heated in order that various distillates can be separated from one another. During the heating process, light and heavy hydrocarbons are separated – the light ones can be refined to make petrol and other fuels while the heavier ones are suitable for bitumen and base oils. As the world population increases, the energy consumption also increases. In any nation, energy is the most fundamental requirement for human existence and activities (Ribeiro et al., 2011). Unfortunately, the non-renewable energy sources that contribute over 86% of the global energy supply are depleting (Atadashi et al., 2011). Waste mineral oils are the result of the use of lubricating oils: most of them are consumed during their use while the remaining part represents waste oil. Lubricating oil finds several applications in a technologically advanced
According to the estimates of Europa lube, the Association in charge of harmonizing and publishing European lubricants statistics, 49% is used in the automotive sector, 37% is used by industry, while the remaining 14% is represented by base oils used like raw materials.

During its use, the lubricating oil undergoes chemical-physical transformations that make it no more suitable to perform the functions it was originally intended for and they require its replacement. Lubricating oil with greater amounts of such contaminants as organic oxidation products, aging materials, soot, wear debris and other dirt may not fully meet the demands and thus must be replaced. They are called used, spent or waste oils and should be collected and recycled in order to prevent the environment pollution and to preserve natural resources. In recent decades a number of innovative re-refining technologies have been developed that promise to solve technical, economic and environmental problems associated with used oil recycling. The current technology in re-refining is based on sophisticated unit operations, for example, special chemical pretreatment, specific vacuum distillation, extraction and hydrogenation. From an energy point of view, the re-refining of waste oil to manufacture a base oil conserves more energy than reprocessing the waste oil for use as a fuel. The energy required to manufacture re-refined oil from used oil is only one-third of the energy required to refine crude oil to produce virgin base oil. Therefore, re-refining is considered by many as a preferred option in terms of conserving resources, as well as minimizing waste and reducing damage to the environment.

Lubricating mineral oil has a petroleum origin: therefore it is a precious product that can and must be ecologically recovered in order to save a non-renewable source of energy. Waste oil is almost totally reusable, even if it presents different characteristics according to its origin: for example, the waste oil coming from the automotive sector generally can be used for the production of re-refined base oil, and also the one coming from industry, even if in lower percentages. Particularly, if it is used for re-refining, 1 kg and a half of used oil produces 1 kg of high quality base oil besides other oil products (gasoil, fuels, fluxed bitumen, etc.), small quantities of not polluting residues disposed of in the observance of the environmental regulations. The removal, transportation and aggregation of used oils for disposal or re-use is controlled by legislation in some countries with fiscal adjustments designed to ensure safe and effective handling and disposal. Most countries now legislate to ensure that used oil from all recognised points of generation (e.g. factories, vehicle workshops, etc.) is correctly handled and disposed of. Most European countries have different laws and regulations for the collection of used oils, normally based on the European Union Directives (EUD). All, however, maintain the basic principle that the generator of used oil is responsible for its safe collection and storage on site and for the eventual authorised removal. Segregating the different types of used oils (and perhaps other used fluids from vehicles) does enhance the inherent value of the waste for reprocessing and reduces the levels of contamination in the final product. Uncontrolled collection of many different types and qualities of used oils makes reprocessing significantly more difficult and expensive, and it increases the levels of contamination in the final products of recycling.

Throughout the EU, it is illegal for an individual to throw away used oil; it must be returned to a proper collection point. However, it is clear that used oil is still disposed of illegally in all European countries, although the situation varies considerably from country to country. Excluding government subsidies, the basic value of unsegregated used oils is broadly
related to the cost of industrial fuel because used oil is often used as a substitute fuel. That value establishes a firm economic platform from which any environmentally beneficial improvements can be costed and calculated. Improvements in the segregation of used oils improve the value. Even if it is estimated that less than 30% of European motorists currently change their own car engine oil, Do It Yourself (DIY) oil changes represent a great potential risk for the environment because the correct disposal of the used oil is dependent on the behaviour of individuals and the ready availability of appropriate facilities. Yet there is little enforcement of regulations covering the used oil produced as a result of a DIY oil change. There is a need to maximise the volume of used oil being returned to authorised disposal sites from individual DIY oil changes. Logically, improvement could be achieved by encouraging the establishment of many more local collection centers for used oil. However, it should be noted that DIY oil changes are not the whole problem. To put this sector into context, we estimate that the total DIY market for engine oils is in the order of 300 kt/year. Of this, about 200 kt is potentially recoverable and this represents only about 20% of the 1.1 million tons of used oil unaccounted for. Currently, only the lowest quality blending of used oils is collected at public facilities. The higher value, properly segregated collection of used oils is only possible at vehicle workshops, industrial businesses and other fully equipped facilities.

**Lubricating Oil Production**
The production of finished lubricating oils accounts for less than 1% of crude oil consumption, and only a small proportion of the crude oil fraction suitable as feedstock for lubricating oil production. In Europe, 5,300 kt of virgin lubricants were sold in 1993, mainly for automotive and industrial uses. Approximately half was consumed in use and half was potentially collectable after use. Of that 2,600 kt of potentially collectable used oils, only 1,500 kt was reported as being collected; meaning that about 1,100 kt (about 20% of the original volume of virgin lubricants) were “lost”.

**Legal Law Supporting Used Oil Recycling in Nigeria**
The legislative instruments developed by the Federal Ministry of Environment to halt environmental degradation arising from any pollution source including oil related activities are:

b) **Nigeria’s National Agenda 21 of 1999**,  
c) **The National Effluent Limitations Regulations 5.1.8 of 1991**,  
d) **Pollution abatement in industries and facilities generating waste regulation 5.1.9 of 1991**,  
e) **Waste management regulations 5.1.15 of 1991**,  
f) **Environmental impact assessment (EIA) Decree No of 1992**, and  
g) **National guidelines and standards for environmental pollution control in Nigeria 1991**.

**Quality of Used Oil**
Usually the term “used oil” is understood to include only those oils which arise from the use of lubricating oils. Slop oils recovered from drainage systems, refineries, fuel storage sites, etc., are not included, although they are generally mixed in used oil collection systems and decrease
the value of the material. The largest potential source of used oils is from vehicle use, particularly engine oils. In general, the additives (particularly metals) remain in the oil after use. In addition, used engine oil contains a range of other impurities which affect the final re-refined base oil quality and can cause problems to the re-refining activity. Metals from engine wear build up in the oil as does water formed from combustion of the fuel. A certain amount of unburned fuel (gasoline or diesel) also dissolves in the oil. Light hydrocarbons (HC) also arise from breakdown of the oil and heavier hydrocarbons, including Polynuclear aromatic hydrocarbon PAH, from polymerisation and from incomplete combustion of the fuel.

- Chlorine in used lubricating oils is a potential problem as on combustion there is the possibility of dioxin formation. Chlorine in used oils arises from the following:
  - Contamination (either accidental or deliberate) with chlorinated solvents and Transformer oils, both of which are now becoming closely controlled
  - From lubricating oil additives
  - From the lead scavengers added to leaded gasoline

The concentration of chlorine in used oils is reducing as the use of chlorinated solvents for industrial cleaning applications is reduced and the use of leaded petrol declines. Used oil often becomes contaminated by all kinds of materials such as brake fluid and antifreeze at garages and paint, vegetable oils, etc. at public collection points. Such contamination can only be prevented by better segregation of oils on collection, through the provision of receptacles for other “oily” material and better policing. Such actions should be supported by monitoring of collected used oil for chlorine content.

Lead in used lubricating oil arises almost entirely as a consequence of the lead added to gasoline which peaked in the first half of the 1970s. The lead elimination initiatives already in place and still working through will reduce the lead content of used oils to low levels and there is the prospect of total elimination of gasoline lead thereafter. The lead pollution problem is, therefore, already on the road to being solved. Even without further contamination on collection, used oils thus often present a varied and poorly defined cocktail of compounds of which at best, 80% is lubricant base oil. This explains why re-refining is a complex task.

The key problems due to the contamination of used oil are:

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>SOURCE</th>
<th>EFFECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetable oils</td>
<td>Rape oils/sunflower oils/fried foods/Esters</td>
<td>Cracking/fouling/Off-gas</td>
</tr>
<tr>
<td>Solvents</td>
<td>Launderies/spent solvents disposal</td>
<td>Disposal costs/corrosion</td>
</tr>
<tr>
<td>Waters</td>
<td>Combustion/handling</td>
<td>Energy costs/waste waters</td>
</tr>
<tr>
<td>Metals</td>
<td>Mechanical wear/additives</td>
<td>Wear/by-products pollution</td>
</tr>
<tr>
<td>PCAs</td>
<td>Incomplete combustion and</td>
<td>Toxicity long drain interval</td>
</tr>
<tr>
<td>PCBs</td>
<td>Transformer oils</td>
<td>Toxicity</td>
</tr>
<tr>
<td>Silica</td>
<td>Antifreeze/industrial oils/brake fluids/textile industries....</td>
<td>Catalyst poisoning</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Solvents/chloro-paraffins</td>
<td>Corrosion</td>
</tr>
<tr>
<td>Waxes/paraffins</td>
<td>Fuel slops disposal</td>
<td>Lube opacity</td>
</tr>
<tr>
<td>Styrene</td>
<td>Styrene byproducts disposal</td>
<td>Toxicity/fouling</td>
</tr>
<tr>
<td>Sulphur</td>
<td>Additives/fuel engine leakage</td>
<td>Pollution/Costs/out of spec’s</td>
</tr>
</tbody>
</table>
PCAs: Printed circuit assembly
PCBs: Printed circuit boards

There isn't an international specification of used oil worldwide accepted; the quality varies country by country, according to the collection system adopted. In Italy, for instance, the Consortium in charge of the waste oil collection has defined different types of waste oil categories:

**Recycling Methods**

Many techniques are employed to treat waste oil. Some of these include acid/clay treatment, distillation processes, hydro treatment, solvent treatment, cracking, blending and compounding. To increase the purity of the treated oils, it is further refined using a combination of technologies such as decanting, settling and filtering. Recycling of waste oil is very important since in United States alone, it can yearly save the energy equivalent of 7 to 12 million barrels of crude oil, and provide employment.

**Acid-Clay Process**

Acid-clay process is one of the popular treatment methods for waste oil. In this process, the waste oil is treated with sulfuric acid. This acid reacts conversely with oxygen compounds and some sulfur- and nitrogen-based compounds to form sludge. Further refining is done in order to remove paraffinic and naphthenic hydrocarbons. Even after refining, there would be still some color and odor present in the oil which is later removed by treatment with activated clay. The problem with this method is that it produces a large volume of acid--sludge that is contaminated with petroleum. Due to these disadvantages, acid-clay process is now considered uneconomic since managing the residues incurs a huge cost. Nevertheless, Falah and Hussien (2011) demonstrated how this method could be used under different conditions and variables without bordering on the said disadvantages.

**Dehydration Method**

Dehydration method is a process by which the impurities are removed through low temperature distillation. The oil thus refined is used as "cutter stock" for combining with heavy bunker oils. This process significantly reduces impurities in waste oil such as antifreeze, water and other solvents. The disadvantage is that this process does not reduce ash and such other residues, and this limits its use in other markets.

**Hydro-Treatment and Cracking**

Hydro treatment, cracking and high temperature distillation are some of the other methods employed to refine waste oil. This method is generally uneconomic, unsafe and is inconceivable to be used in a small scale. In hydro-treatment process, the waste oil undergoes a process that includes distillation and condensation. The resultant oil is hydro-treated for colour and odour correction. The oil is treated with nascent hydrogen in the presence of a catalyst.
Solvent Treatment Method
Solvent treatment method significantly reduces the impurities present in waste oil. The resultant refined oil is used as higher quality oil. In this process, the impurities are removed by a solvent-mixing process that does not include sulfuric acid. This solvent consists of butanol, methyl ethyl ketone and 2-propanol. The process produces a waste sludge which is removed as non-hazardous waste.

Recycling Options for used engine oil
In this paper, we have defined two types of used oil recycling processes that may be suitable in waste oil recycling plants:

1) Re-processing into fuel oil, and
2) Re-refining into lube oil.

Re-Processing Into Fuel Oil
A liter of used oil re-processed as fuel contains about 8,000 KJ of energy, which is enough energy to light a 100 W bulb for one day or to operate a 1000W electric heater for 2 h. Whereas 67l of crude oil is needed to obtain a liter of motor oil, only 1.6 l of used oil are required to produce the same amount of motor oil (EPA, 1996). The unit processes involved in re-processing into fuel oil and re-refining into lube oil. Waste oil used as a direct source of energy must undergo basic treatment to remove water and particulates before it is fit for use as fuel. This is to ensure that it does 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 pose environmental hazard 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 place fuel processors at a competitive disadvantage. Utilizing unprocessed waste oil as fuel for power generation, firing of boilers to generate process steam are associated with atmospheric pollution and increased hazards to human health. This is because of the relatively low temperature combustion of contaminants such as heavy metals and chlorides. However,
higher levels of pre-treatment can remove water, sediments, heavy hydrocarbons, metals and additives (Bamiro and Osibanjo, 2004).

Re-Refining into Lube Oil
The re-refining of used oils, first introduced in the 1930s, saw a significant increase during World War II, and thereafter up to the end of the 1970s. The second oil crisis engendered fierce competition between burning and re-refining. Used oil provided a low-price fuel oil substitute, but the environmental impacts were not always considered. At the same time used oils offered an alternative raw material for the production of base lubricating oils.

Subsequently, the increased environmental consciousness in the 1980s has had a number of consequences:

- The shutdown of many acid/clay re-refining plants, mainly in the US, for both economic and environmental reasons.
- The use of improved equipment and devices to reduce the potential pollution from burning used oil.
- The development of improved re-refining technologies for both environmental and product quality reasons.

Presently in the world there are around 400 re-refining facilities, with an overall capacity of 1800 kt/y. Although most of these plants are located in East Asia (India, China and Pakistan), their individual capacity is mainly low, 2 kt/y each, on average. The share of re-refined oils accounts for less than 10% of the overall base oil demand in Europe.

Recycling falls into two categories: regeneration and laundering. These basically differ only in the degree, and possibly the type of processing or cleaning required to recover reusable material from the waste product. Usually laundering applies to less heavily contaminated materials, which can be returned to original use with production of relatively little by-product. Regeneration applies to more heavily contaminated, or complex lubricating products which, when processed, produce a base stock and, usually, a greater proportion of by-products. The process typically involves, but is not limited to, pre-treatment by heat or filtration, followed by either vacuum distillation with hydrogen finishing or clay, or solvent extraction with clay and chemical treatment with hydro-heating. The vacuum distillation option followed by clay contacting offers a less polluting and more economic solution to the re-refining process, particularly for small scale plants with a capacity range between 10,000 and 30,000 tones (El-Fadel and Khoury, 2001). A variety of proprietary technologies has been tried for regeneration with mixed success and various yields of base oil and by-products. They all seek to recover the base blending fluid, predominantly mineral hydrocarbon with growing amounts of synthetic petrochemical material, by separating it from additive chemicals and any breakdown products that arise during use. Invariably, there is a tradeoff between the quality of the recovered base oil and the sophistication of the technology.

The capital outlay for re-refining process is becoming exorbitant due to the fact that lubricant requirements are becoming more severe, particularly in automotive applications as vehicles are subject to longer service intervals, smaller sumps and higher operating temperatures. The proportion of additives and synthetic components in lubricating oil is increasing, thus setting higher standards for recycled base oil. Re-refining creates by-product streams that, in the case of the lighter components, may be used as fuel. The heavier residual
stream containing additives and carbonaceous species may be used as a blending component in the bitumen industry for incorporation into construction work such as road surfacing. Thus, re-refining requires modern processes which are expensive to operate when all safety and environmental considerations are included into the overall operating system.

CASE EXAMPLE

Refining process of used engine oil in Cairo
A practical example of small scale clay-process that can be visited is in Cairo. The installed equipment allows refining 3,000 liters of used oil in one batch (Vent, 2000). Only used engine oil is accepted for refining. The oil is collected from garages in the town or is delivered by individuals or intermediate waste oil collectors. It is stored at the recycling plant in old 200 l oil drums. To start the process the drums are emptied into a supply tank from where the oil is pumped into a heating vessel made of steel. The closed vessel is directly heated by a waste oil burner at the bottom. The oil is heated up to 170°C with an intermediate holding at 100°C to let the water content evaporate. Above 100°C other volatile matter are removed such as petrol or organic solvents which might have been mixed into the oil waste. Having reached the temperature of 170°C the oil is pumped into the first steel agitator. This open vessel is double walled to allow water to be pumped through as cooling agent. The oil is cooled down to approximately 30 to 40 °C. At that temperature, concentrated sulphuric acid is added at a quantity of 10% of the amount of oil. The mixture is stirred steadily for 3 to 4 h to let the acid react with the impurities forming sulphates.

The oil-acid mixture was afterwards pumped into cylindrical steel vessels with a conical shape at the lower end. It was kept there for one day to allow the insoluble sediments to settle in the bottom cone. Later the acid sludge was removed and filled into old oil drums for disposal. The remaining clear oil-acid mixture was subsequently pumped into a second open steel agitator. This agitator is double-walled as well, for heating purposes. The heating takes place indirectly using steam from a separate boiler. After filling the agitator with the oil-acid mixture (content 3000 litres), approximately 100 kg CaO or soda ash is added. Everything is heated up to 170°C while stirring. The whole process lasts for 2 to 4 h. The lime will react with the acid neutralizing the oil to pH 7 and forming gypsum. At the end of the lime treatment, the content of the agitator is passed through a filter press separating the solids (gypsum) from the oil. The clear oil is now pumped into storage vessels ready for distribution in small or big containers. The oil can be used for minor quality lubrication or cooling purposes, for example, for slowly moving parts, gearboxes or machines, during the machining of metals. One part of the refined oil is processed further on to grease. For that purpose the oil is mixed with Na- or Ca-stearate in a heated agitator and subsequently filled hot into containers for selling and distribution.

Past efforts to install used oil recycling plants in Nigeria
In 1996, Lube Oils Limited with the assistance of UNIDO assessed the techno-economic importance of refining used lubricating oil in Nigeria. Triple E Associates carried out a feasibility study that supported establishment of used oil recycling plant. Since after the study, no used oil recycling plant is installed in any part of the country.

173
Importance of Used Oil Regeneration

Re-refining offers significant energy savings and fewer environmental impacts than other reuse options that generate such products as fuel, distillate oils, or gasoline. Capital cost is the major hurdle to re-refining waste oil. This could be overcome if waste oil re-refining was integrated into existing lubricating oil refineries. Capital costs for hydrotreatment, product storage, sour gas processing, and pollution prevention would be minimized if existing refinery equipment could be employed for these services. A leading lubricating oil company endorsing re-refined oil by putting its brand name to it would have a significant positive impact on customer perceptions of product quality.

Re-refining within a lubricating oil refinery is not commercially practiced. Research is needed in the following areas to commercialize this option:

1. To develop and demonstrate pre-treatment technology required to integrate re-refining into a virgin lubricating oil refinery; and
2. To identify used oil contaminants that deactivate hydrogenation catalysts, and if needed, develop technology for their removal and/or develop catalysts that are immune to deactivation by the contaminants. To ensure commercial viability of this technology, research and development work should be conducted in partnership with a lubricating oil manufacturer. Recycling, re-refining and reuse of contaminated resources are obviously much more preferable to their improper disposal or destruction. By doing so, we can help preserving our natural resources, and also address the problem of environmental pollution in a positive, meaningful way.

The United States Department of Energy of the University of Chicago has developed the hierarchy of waste oil reuse options, as shown here below considering both environmental and economical aspects.
Because of the energy savings associated with multiple uses, re-refining is ranked higher than other consumptive reuses. Re-refining in a lubricating oil refinery is ranked above re-refining in a dedicated grass-root standalone unit because of the opportunities for capital cost reductions, existing facilities and utilities utilization, recovery of higher-value by-products, and more efficient pollution control. Also for these reasons, reprocessing in a primary refinery is ranked above reprocessing in dedicated equipments. Reprocessing in dedicated equipment and burning in space heaters sometimes are ranked equally because they didn’t find clear basis to rate the trade-offs. Burning in space heaters, when heat is needed, avoids the energy consumption and environmental impacts associated with transporting and reprocessing oil. However, the uncontrolled emissions from space heaters, particularly in populated areas, may be more harmful than burning reprocessed oil at an industrial site that may be equipped with pollution control equipment.

Finally, used oil disposal or dumping is the least desirable alternative because the energy value of the oil is lost and the oil can potentially contaminate soil, groundwater and surface waters. Used oil disposed of in landfills or discharged to the ground or into sewers can contaminate soil, groundwater or surface waters. Like many petroleum products, used oil contains organic toxic compounds (e.g., benzene, toluene, naphthalene, phenols, and PNA's such as benzo[α]pyrene) at levels higher than health-based standards. Although the environmental impacts of used oil disposal have not been definitively determined, recovering this oil can be defended on the basis of energy savings alone, so extensive studies on environmental impacts are not required to justify promoting waste oil recovery and recycle.

Waste oil represents an important energy resource that, if properly managed and reused, would reduce dependence on imported fuels.

**Conclusion**

The problem is more severe in Nigeria where private sector investors have neglected the used oil recycling business because of the availability of oil and oil products in the country. Investors are one directional on the issue of used oil recycling. They are after the financial benefits and the establishment of a large-scale venture. As a result there is not yet a single used automobile oil recycling plant in the country. This paper informs that small-scale used oil recycling is lucrative, and can be economically housed in mechanic villages. The paper on the other hand encourages the establishment of local mechanic villages near urban areas where all mechanics concerned with automobile works and oil change may operate. This will facilitate private small-scale used oil collection and recycling in the cities. Waiting indefinitely for multi-million dollar recycling plants to be established by government is not good enough for industrialization and sustainable development. Beside the substantial economic benefits, small-scale used oil recycling in mechanic villages will provide employment, help in poverty alleviation, and improve environmental quality. Other business sharing benefits such as: availability of operational space, used oil, cheap labour, bank financing and cheap overhead cost exists.
Recommendations

The Nigerian government should regulate or may compel changed oil from electric generators in homes, offices and in business premises to supply such oil for recycling free or a fee per gallon. An important requirement is to enact a new legislation regulating the establishment of automobile mechanic villages across the country. A section of the mechanic village may be reserved for maintenance and services of electric generators. A primary goal of this project is to concentrate all activities involving oil change to mechanic villages. In absence of used oil recycling facility in a mechanic village, the new legislation will empower extended producer responsibility (EPR) for routine collection of used engine oils by the nation’s major oil marketers. By EPR requirements, major oil marketers or their gas stations representing the producers shall be mandated by law to collect changed oil from mechanic villages on routine bases for recycling or proper disposal. Government owners of mechanic villages shall provide adequate storage facilities for changed oil in mechanic villages. The law to stop disposing changed oil on the ground and to comply with the order of storage on the other hand shall be enforced with appropriate penalty. Re-processing of used oil to fuel oil will be a most attractive management option in view of the high cost of energy. Today, private electric generating plants can be found in almost every household, office, and even the smallest business places and in Nigeria. This development produces large amount of used oil to add to the quantity in mechanic villages. Recycling operators in mechanic villages will make extra efforts to reach understanding with used oil producers outside mechanic villages to increase supply in line with their demands.
References


