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Production of gasoline-like fuel obtained from waste lubrication oil and its physicochemical properties

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ABSTRACT

In this study, our main focus is on finding alternative fuel resources and utilizing them to eliminate their negative effects. Because of the limitations of petroleum products, the used engine oils can be used in engine as engine oil after purifying it. Production of gasoline like fuel from used engine oil is involving chemical filtrations and blending process. The GLF is produced from waste engine lubrication oil (WLO) using the pyrolitic distillation method. Firstly, the WLO collected in a tank was particulates removed by a refining process. The refined lubrication oil samples were taken into a reactor and blended with some catalysts, and purified from dust, heavy carbon soot, metal particles, gum-type materials and other impurities. A fuel production system mainly consisting of a seven main parts using are waste oil storage tank, filters, a reactor, oil pump, a product storage tank, thermostats and control panel. The characteristic such as density, viscosity, flash point, heating value, sulphur content and distillation of the GLF are deliberated. The gasoline like fuel can be used in gasoline engine without any problem and increases the engine performance.

Keywords: Waste oil; Gasoline fuel; Gasoline engine; properties; pyrolitic distillation method; Engine performance

Introduction

Lubricant oils are a common element in our daily lives, as they are needed to allow many engines and mechanisms to function. The EU consumed in 2006 roughly 5.8 million tones a year. However, through their use, they loose their properties, become contaminated and at some point they cease to be fit for the use they were originally intended. These used oils are then replaced by fresh lubricating oils and we are left with some waste oils. Some 50% of what is purchased will become waste oils (the rest is lost during use, or through leakages, etc.) That leaves us with approximately 3 million tones' of waste oil to manage every year in the EU.
Lubricating oil creates a separating film between surfaces of adjacent moving parts to minimize direct contact between them, decreasing heat caused by friction and reducing wear, thus protecting the engine. In use, motor oil transfers heat through convection as it flows through the engine by means of air flow over the surface of the oil pan, oil cooler and through the buildup of oil gases evacuated by the Positive Crankcase Ventilation (PCV) system.
In petrol (gasoline) engines, the top piston can expose the motor oil to temperatures of 160 °C (320 °F). In diesel engines the top ring can expose the oil to temperatures over 315 °C (600 °F). Motor oils with higher viscosity indices thin less at these higher temperatures.

Waste oils are hazardous waste as they display some hazardous properties. Waste oils that are found in rivers, lakes and streams threaten aquatic life. Indeed, a liter of waste oil can contaminate a million liters of water. Furthermore, severe soil contamination can result from waste oils being left on the ground.

Waste oils are governed by the Waste Framework Directive 2008/98/EC, especially by Article 21, which stipulates that Member States shall take the necessary measures to ensure that:
(a) Waste oils are collected separately, where this is technically feasible;
(b) Waste oils are treated in accordance with Articles 4 (waste hierarchy) and 13 (protection of the environment and human health);
(c) Where this is technically feasible and economically viable, waste oils of different characteristics are not mixed and waste oils are not mixed with other kinds of waste or substances, if such mixing impedes their treatment.

Thus, it is crucial to collect as much as possible this very valuable resource, in order to avoid the contamination of the environment and to be able to profit from the very high recovery potential of this waste stream. Industries, consumers, garages and do-it-yourselfers have to participate, by not dumping these precious liquids but by handing them to authorized collectors that will ensure their adequate recovery.

The aim of this experimental study was to investigate effects of the fuel obtained from waste lubricant engine oil and named as gasoline-like fuel (GLF) and its blend with different amounts of catalysts on performance of SI engine and its exhaust emission.

For this purpose, three main tests, namely characteristics tests, performance tests exhaust emission tests were performed in this study. Alternative energy resources are becoming more imperative because there is an increasing demand for clean transport fuels. Many researchers are concentrating on developing alternative and renewable sources of liquid fuels, which are new energy resources to replace commercial petroleum products for the future. Large and increasing volumes of used lubricating oil are produced each year that, after use, are considered hazardous wastes. This is so because waste oils typically consist of a mixture of un degraded base oil and additives which high concentrations of metals, varnish, gums, and other asphaltic compounds coming from overlay on bearing surface sand degradation of the fresh lubricant component The used oil is disposed in many ways including incineration, land spreading, and dumping on the ground and into water. All used oil eventually creates environmental hazards.

Methodology

The GLF was obtained from waste lubrication oil (WLO) using the pyrolitic distillation method. Firstly, the WLO collected in a tank was particulates removed by a refining process. The refined lubrication oil samples were taken into a reactor and blended with some catalysts. The blended samples were heated in the reactor and then distilled to decrease sulphur and to produce fuel samples. Distillation tests and characteristics of the produced fuel such as density, flash point and lower heating value were examined.

Pyrolysis is a thermo chemical decomposition of organic material at elevated temperatures without the participation of oxygen. It involves the simultaneous change of chemical composition and physical phase, and is irreversible. The word is coined from the Greek-derived elements pyro "fire" and lysis "separating". Pyrolysis is a case of thermolysis, and is most commonly used for organic materials, being, therefore, one of the processes involved in charring. The pyrolysis of wood, which starts at 200–300 °C (390–570 °F), occurs for example in fires where solid fuels are burning or when vegetation comes into contact with lava in volcanic eruptions. In general, pyrolysis of organic substances produces gas and liquid products and leaves a solid residue richer in carbon content, char. Extreme pyrolysis, which leaves mostly carbon as the residue, is called carbonization. The process is used heavily in the chemical industry, for example, to produce charcoal, activated carbon, methanol, and other chemicals from wood, to convert ethylene dichloride into vinyl chloride to make PVC, to produce coke from coal, to convert biomass into syngas and bio char, to turn waste into safely disposable substances, and for transforming medium-weight hydrocarbons from oil into lighter ones like gasoline. These specialized uses of pyrolysis may be called various names, such as dry distillation, destructive distillation, or cracking. Pyrolysis also plays an important role in several cooking procedures, such as baking, frying, grilling, and caramelizing. In addition, it is a tool of chemical analysis, for example, in mass spectrometry and in carbon-14 dating. Indeed, many important chemical substances, such as phosphorus and sulfuric acid, were first obtained by this process. The most important advantage of this method Is that it does not pollute the environment when carried out in an Appropriate way, because pyrolysis products such as gases, liquidOils and carbonaceous residue can be used as fuels. However, the Pyrolized oil can be polymerized again since it consists of a lot of unsaturated hydrocarbon. By applying the thermal precipitation Method to the waste engine oils and plastics at a process temperature of 300e385 C, a type of fuel that can be used in ship engines has been obtained. Millions of tons of used oils are disposed through dumping onthe ground or in water, land filling, or non-energy-recovery .The used or waste oils can be refined and treated to produce fuels or lubricating oil base stock. On the other hand, the waste oils posean environmental hazard due to both their metal content and other contaminants. The high-volume waste oils can be turned into valuable fuel products by refining and treating processes. Converting of the waste oils into diesel and gasoline like fuels to be used in engines without disposing is very important. Utilization of the diesel and gasoline-like fuels produced from the waste lubricant oils, and blending of the produced fuels with gasoline or turpentine decrease consumption of petroleum based fuels, protecting environment from toxic and hazardous chemicals. It also saves of foreign exchange, reduces greenhouse gas emissions and enhances regional development especially in developing countries. Other advantages are:

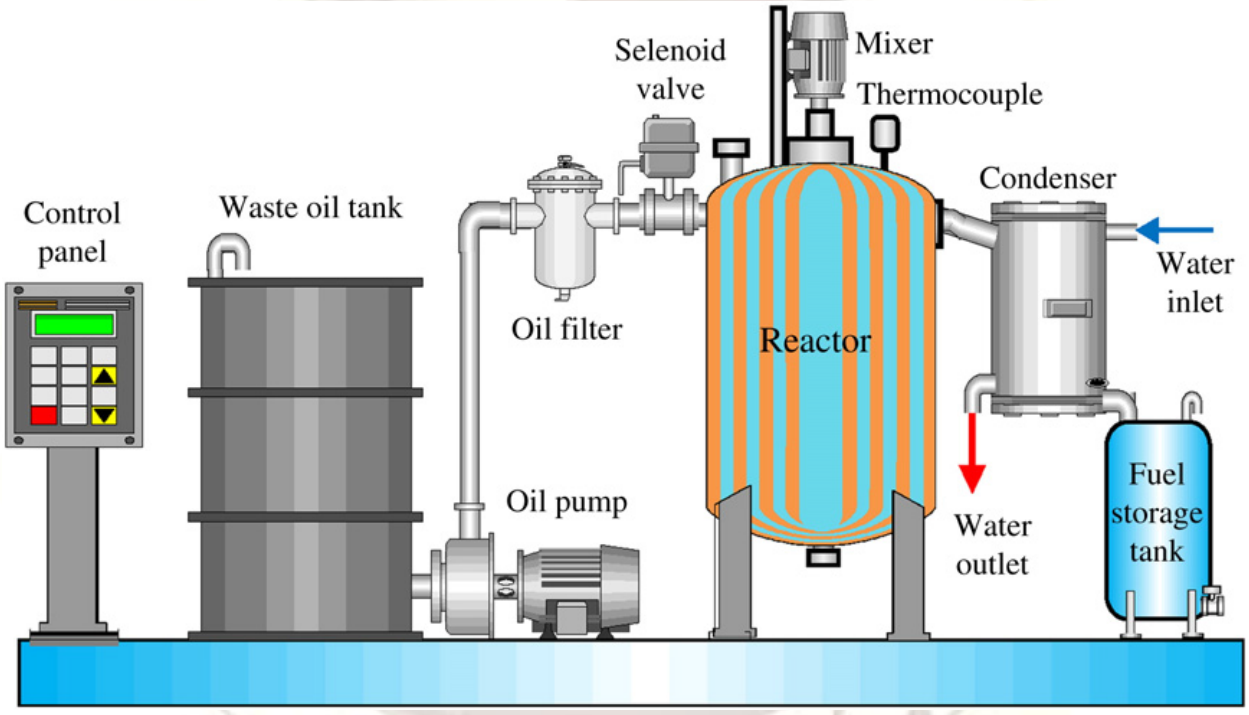
a) It is a renewable and environmentally friendly alternative liquid fuel;
b) Its heating value and viscosity are higher than those of gasoline;
c) It can be used in any spark ignition (SI) engines as an additive to the Gasoline or gasoline-like fuel (GLF);
d) Its self-ignition and boiling temperatures are higher than those of gasoline.

Experimental Setup

The purified and parolytic distillation system was designed and manufactured in industry to purify waste lubricant engine oil (WLO) from contaminants and to produce Gasoline-Like Fuel (GLF). A schematic diagram is shown in Fig. The system consists mainly of the parts are as waste oil

tank, pump and filters, reactor, mixer, condenser and control unit. Functions of all the system components are briefly explained in this section.

The waste oil tank was used to collect Waste Lubricants Oil having several hazardous materials within it. The Waste Lubricants Oil (WLO) was pumped from the tank to the reactor, and then it was flowed through the filters having 20 µm mesh size. While the Waste Lubricants Oil (WLO) was flowed through the filters, it was purified from the oil from small dust, carbon soot, small metal particles and some gum type and other materials. The most important part of the system is the reactor in which thermal treatment of the Waste Lubricants Oil (WLO) was carried out. It has a cylindrical shape with dimensions of 30 cm in diameter and 40 cm in height. It has a capacity that will be able to produce 20 lt of fuel. It is assumed that such a volume will suffice for all measurements and tests, since tests for thermal and physical characteristics, distillation of the produced fuel, and also several engine performance tests may be required for the same produced fuel. The reactor was isolated with glass wool having a thickness of 5 cm to minimize heat loss from the reactor. Electrical heaters with a total heating capacity of 5 kW were used to heat the oil and were placed around the reactor container. The electrical heaters have special resistance heaters which can heat the waste oil sample up to 600 °C. The heating rate can be controlled by the control unit adjusting voltage to keep temperature of the oil at desired levels. Temperature measurement was performed by means of thermocouple. It was placed in locations where temperature measurement was needed.



Purified and distillation system

Physicochemical properties

Petrol or gasoline is used as fuel in spark ignition (SI) engines. Gasoline is a hydrocarbon with different chemical compositions. Here are the properties that a gasoline should possess to qualify for being used as fuel in SI engines. Petrol or gasoline is usually used as fuel for spark ignition (SI) engines. Gasoline is a mixture of a number of low boiling point paraffins, naphthenes, and aromatics of varying proportions. There are certain properties that a particular gasoline should have to qualify as SI engine fuel. These properties havebeendiscussedbelow:

Viscosity:-Viscosity is technically defined as the fluid friction of an oil to put it more simply, it is the resistance an oil offers to flowing Heavy-bodied oil is high in viscosity and pours or flows slowly.

flash point:- The flash point is the lowest temperature at which the lubricating oil will flash when small flame is passed across its surface .when the oil is heated ,it reaches a temperature which ,if a small flame is brought near it ,a flash spreads across the oil .it happens due to the volatilization of the light particles of the oil the flash point of the oil should be sufficiently high so as to avoid flashing of oil vapours at the temperature occurring in common use.

Fire point: - If the oil is heated further after the fire

point has been reached, the lowest temperature at which the oil burn continuously is a called the fire point .the fire point also must be high in a lubrication oil, so that the oil does not burn in service.

Cloud point: - The oil change from liquid state to a plastic or solid state when subjected to low temperature. In some cases the oil start solidifying which makes it to appear cloudy. The temperature at which this takes place is called the cloud point.

Pour Point :-The pour point of an oil is the temperature at which the oil will just flow without disturbance when chilled.

Oiliness: - it is the characteristics properties of oil. An oil is said to be oil when it is has oiliness .this property is highly desirable in helping the lubricants to adhere to the cylinder walls.

Colour: - Colour of a oil is not of so much important for its properties its property as a test for checking the uniformly of any given grads or brand of oil.

Physical stability: - oil must be stable physical at the lower and highest temperatures between which the oil is to be used. At lowest temperature there should not be any separation of solid, and at the highest temperature it should not vaporize beyond a certain limit.

Chemical stability :- A lubrication oil should also be stable chemically .There should not be any faulty for oxide formation ,the oxidation product being sticky ,clog the working part case the faulty piston rings and valve action the oil should also decompose at high temperature to form carbon ,which makes spark plugs and valve to function.

Sulphur content :- If the sulphur is presents in considerable amount in the lubrication oil .It promotes corrosion .the carrion test shows the amount of sulphur contents .

Specific gravity: - Specific gravity is a measure of the density of oil. It is determined by hydrometers which float in the oil. And the gravity is read on the scale of the hydrometer at surface of the oil.

Cleanliness : - oil must be clean. It should not contain dust and dirt particles these impurities may be either be filtered out or removed with the change of oil at periodic interval, further the oil must contain agent called detergents which remove the impurities from the engine parts during oil circulation.

Volatility:- The gasoline should be volatile; a certain part of it should vaporize at room temperature to allow easy starting of the engine. Better vaporization of the fuel facilitates its even distribution inside the cylinders, which in turn leads to better acceleration of the vehicle.

Antiknock qualities of the fuel: Abnormal burning or detonation of the fuel inside the engine leads to the effect known as engine knock. During detonation large amounts of heat is released inside the engine which excessively increases the temperature and pressure inside the engine, drastically reducing its thermal efficiency. The fuel should have the tendency to avoid creating the situation of detonation; this quality of the fuel is the antiknock property of the fuel.

The antiknock property of the fuel depends greatly on the self-ignition properties of the fuel, the fuel's chemical composition, and its chemical structure. The fuel most suitable for the SI engines is the one that has highest antiknock property, enabling the engine to work with high compression ratios of fuel, which in turn leads to higher fuel efficiency and higher power production.

Gum deposits formed from the fuel: When gasoline is stored for longer periods of time, it has the tendency to oxidize and form gummy, solid substances. When used with an engine, such gasoline will cause sticky valves and piston rings, carbon deposits in the engine, gum deposits in the manifold, clogging of carburetor jets, and enlarging of cylinders and pistons. The gasoline used in the engine should have a tendency to form lower gum content and have a lower tendency to form gum during storage.

Low sulfur content: Hydrocarbon fuels may contain sulfur in various forms like hydrogen sulfide and other compounds. Sulfur is corrosive in nature and it can cause fuel line corrosion, carburetor parts, injection pumps, etc. Sulfur also promotes knocking of engine; hence its content in the gasoline fuel should be kept to a minimum.

Calorific value: It can be defined as the amount of heat liberated in KJ or Kcal by the complete combustion of 1 Kg of fuel. There are two types of calorific values Higher calorific value (HCV) = It is the total heat liberated in KJ or Kcal by the complete combustion of 1 Kg of fuel. Lower calorific value (LCV) = It is the difference of Higher calorific value and heat absorbed by water vapors.LCV = (HCV – x.588.76) Kcal/Kg; Where 'x' is the fraction of water vapours.

Octane rating: When a mixture of gasoline (petrol) and air is compressed inside an engine cylinder it heats up. If the compression of the engine is high enough, and if the fuel is able to ignite easily enough, the air-fuel mixture may spontaneously ignite before the spark plug is fired at the optimum ignition moment. This is called 'premature detonation', better known as 'knocking'.

Gasoline fuel can be modified in manufacture, or through the addition of additives, so that it is less prone to spontaneously ignite. This ignition characteristic is known as its 'Octane Rating'. The less easily the fuel ignites, the higher the octane rating. Higher compression engines are more susceptible to engine knock, so they use fuels with a higher octane rating, that is, fuels that ignite less readily.

There are two different methods used to measure the octane rating of a fuel, which result in the Research Octane Number (RON), and the Motor Octane

Number (MON). The MON number is usually about 10 points lower than the RON number. Both are measurements of a fuel's resistance to knock, or premature detonation, but the MON is a better measure of how the fuel behaves when under load.

In most countries, including the whole of Europe and much of the rest of the world, the RON rating is the one that is usually displayed on the pump at filling stations. In the USA and Canada, and some other countries, the displayed fuel rating is an average of the RON and the MON rating. Consequently, whatever the rating may be called at the pump, the rating number for identical fuels will on average be about 5 points higher in Europe than they will appear to be in the USA.

There is a popular belief that higher octane rated fuels will give improved performance in cars that are designed to run on lower octane rated fuels. Although some premium fuels also have higher energy ratings, this is largely a myth. Higher powered engines usually have a higher compression ratio, so require the generally more expensive higher octane fuels to prevent premature detonation. Higher octane does not in itself mean higher energy output, so a fuel designed for a high compression engine will not necessarily deliver any more power in a lower compression engine. Engines perform best when used with the fuel that has the engine manufacturer's recommended octane rating.

Conclusion

In this work, the method of production of gasoline like fuel (GLF) produced from waste engine oil and ite various properties has been studied. In order to carry out the investigation, a fuel named as GLF was produced by using pyrolitic distillation method. Its characteristics such as density, viscosity, flash points, heating value, water and sulfur amount, and distillation tests of the GLF are discussed. This study is useful to information of the various properties of fuel which can be produced from waste engine oil. Hence , an alternative fuel may be produced for the engine.

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