PREPARATION OF DIESEL FUEL FROM USED ENGINE OIL

Mani R[1], Ramachandran S[2], Shyam Sundar S[3], Srinivasan A[4], Vignesh C[5]

[1] *Associate Professor, Mechanical Engineering, Vidyaa Vikas College of Engineering and Technology, Tamil Nadu, India*

[2,3,4,5] *UG Scholar Mechanical Engineering, Vidyaa Vikas College of Engineering and Technology, Tamil Nadu, India*

ABSTRACT

Due to paucity of petroleum products, the worn engine oils can be used in engine as engine oil after purifying it. creation of diesel fuel from used engine oil is concerning chemical filtrations and unification progression. It could solve a few of the energy trouble with escalating the blending percentage of pre-treated used engine oil (UEO) or by using pre-treated worn engine oil as a diesel fuel. In the current study, samples of shipyard and light vehicles (bus and truck) pre-treated used engine oil and different proportion of blending of pre-treated used engine oil (including clay treatment, CT) into unsullied diesel have been measured. outcome show that pre-treated (including CT) used engine oil of shipyard (UEO) and 35% unification of pre-treated (including CT) used engine oil (UEO) into unsullied diesel are suitable to use as a diesel fuel in view of Caterpillar Specific Limit and comparing with the fresh diesel.

Keyword: - *Engine Oil, Specific Limit, and Filtration etc….*

1. INTRODUCTION

The production of waste automotive engine oil (WO) is estimated at 24 million tons each year throughout the world, posing a significant treatment and disposal problem for modern society. WO, containing a mixture of low and high molecular weight aliphatic and aromatic hydrocarbons, also represents a potential source of high-value fuel and chemical feedstock. The preferred disposal option in most countries is incineration and combustion for energy recovery, though vacuum distillation and hydro-treatment have been researched to recycle this waste. However, these disposal routes are becoming increasingly impracticable as concerns over environmental pollution, and additional cost, sludge and wastewater disposal are recognized due to the undesirable contaminants present in WO. . After a certain period of time these used engine oils are taken out. During lubrication about 20% of the lubricating oil are consumed and the rest 80% are remain as such with some impurities. Thus a huge quantity of used engine oil is left and wastage from different transport sectors everyday .Due to scarcity of petroleum products, these used engine oils can be used in engine as engine oil after purifying it. Production of diesel fuel from used engine oil is involving chemical, filtration and blending process. Very few numbers of studies have been carried out using used engine oil. They used up to 10% used engine oil into the heating oils and blended up to 5% used engine oil into the diesel fuel. From the test result of their blended fuel sample, they claimed that the blended fuel sample is cleaner and contains less harmful products than the clean low sulphur diesel. They also found that the blended fuel had good lubricity property and the acid number was below detectable limits. Thus, there is a great scope to utilize these waste used engine oil in better way which would help to decrease environmental liability, save waste oil disposal fees and reduce burden of fuel import.

1.1 WASTE ENGINE OIL

In recent years, recycling of the waste lubricant oils and utilizing of the products as fuels have become important topics for researchers. Most of the lubricant oils are generally obtained from petroleum resources. 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 pose an 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-like fuels to be used in engines without disposing is very important. Utilization of the diesel-like fuels produced from the waste lubricant oils, and blending of the produced fuels 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. Characteristics of any fuel are very important from the point of deciding whether the fuel can be used for desired application or not. Therefore, some characteristics of the produced diesel-like fuel. The table shows that some of the parameters of density, boiling point, viscosity, flash point and lower heating value are in the standard values of the diesel oil or reasonably close to the standard values. But, sulfur amount is considerably higher than that value. It should be decreased below the value of 50 ppm.

1.2 POLLUTION CONTENT IN USED ENGINE OIL

1.2.1 Water Content:

Water content (ASTM D95, D1744, D1533, and D96) is the amount of water present in the lubricant. It can be expressed as parts per million, percent by volume or percent by weight. It can be measured by centrifuging, distillation and voltametry. The most popular, although least accurate, method of water content assessment is the centrifuge test. In this method a 50% mixture of oil and solvent is centrifuged at a specified speed until the volumes of water and sediment observed are stable. Apart from water, solids and other solubles are also separated and the results obtained do not correlate well with those obtained by the other two methods. The distillation method is a little more accurate and involves distillation of oil mixed with xylene. Any water present in the sample condenses in a graduated receiver. Voltametry method is the most accurate. It employs electrometric titration, giving the water concentration in parts per million. Corrosion and oxidation behaviour of lubricants is critically related to water content. An oil mixed with water gives an emulsion. An emulsion has a much lower load carrying capacity than pure oil and lubricant failure followed by damage to the operating surfaces can result. In general, in applications such as turbine oil systems, the limit on water content is 0.2% and for hydraulic systems 0.1%. In dielectric systems excessive water content has a significant effect on dielectric breakdown. Usually the water content in such systems should be kept below 35 [ppm].

1.2.2 Sulphur Content:

Sulphur content (ASTM D1266, D129, and D1662) is the amount of sulphur present in an oil. It can have some beneficial, as well as some detrimental, effects on operating machinery. Sulphur is a very good boundary agent, which can effectively operate under extreme conditions of pressure and temperature. On the other hand, it is very corrosive. A commonly used technique for the determination of sulphur content is the bomb oxidation technique. It involves the ignition and combustion of a small oil sample under pressurised oxygen. The sulphur from the products of combustion is extracted and weighed.

1.2.3 Ash Content:

There is some quantity of noncombustible material present in a lubricant which can be determined by measuring the amount of ash remaining after combustion of the oil (ASTM D482, D874). The contaminants may be wear products, solid decomposition products from a fuel or lubricant, atmospheric dust entering through a filter, etc. Some of these contaminants are removed by an oil filter but some settle into the oil. To determine the amount of contami- nant, the oil sample is burned in a specially designed vessel. The residue that remains is then ashed in a high temperature muffle furnace and the result displayed as a percentage of the original sample. The ash content is used as a means of monitoring oils for undesirable impurities and sometimes additives. In used oils it can also indicate contaminants such as dirt, wear products, etc.

1.2.4 Chlorine Content:

The amount of chlorine in a lubricant should be at an optimum level. Excess chlorine causes corrosion whereas an insufficient amount of chlorine may cause wear and frictional losses to increase. Chlorine content (ASTM D808, D1317) can be determined either by a bomb test which provides the gravimetric evaluation or by a volumetric test which gives chlorine content, after reacting with sodium metal to produce sodium chloride, then titrating with silver nitride

2. CONVERSION PROCESS

The production process is broadly divided into two steps.

i) Pre-treatment of used engine oil
ii) Blending and filtrations

Pre-treatment of used engine oil basically depends upon the sequence of operation of acid treatment, neutralization treatment and clay treatment. Other types of chemical treatment, acid treatment is the most important one because total success of reclamation of used engine oil (UEO) depends upon it. The whole processes are presented in the flow sheet.

(i) Used engine oil
(ii) Fresh diesel.

(iii) Concentrated sulfuric acid (98% H2 S04). (iv)
(iv) Caustic soda.
(v) Activated clay (activated bleaching earth) .

2.1 Fuel properties determination:

2.2.1 Caloric Value:

It is determined by Oxygen Bomb Calorimeter.

Higher calorific value, HCV = $(tw-e)/m$

Where,

t= Temperature difference between final temp. and initial temp.

w = energy equivalent of the calorimeter =2426 cal/^{o}C

e = correction in calories for heat of combustion of fuse wire = 2.3×c when using nickel-chromium fuse wire

c= fuse wire consumed in firing, cm=LW_{bf}-LW_{af}

LW_{bf} = length of wire before firing= 10 cm

LW_{af} = length of wire after firing, cm m = weight of sample in gm.

2.2.2 API Gravity:

Specific gravity (S.G) at ^{o}C = (Density of substance / Density of water of same volume).

2.2.3 Aniline Point:

Specified volumes of aniline and sample are pleased in a tube and mixed mechanically. The mixture is heated at a control rate until the two phases become miscible. The mixture is then cooled at a controlled rate and the temperature at which the two phases separate is recorded as the aniline point or mixed aniline point.

2.2.4 Diesel Index:

Diesel Index is determined by calculation from the API gravity and the aniline point of the sample using the following equation:

Diesel Index= GA/100

Where,

G is the API gravity;

A is the aniline point in ^{o}F.

2.2.5 Viscosity:

The viscosity is determined by the Oswald viscometer. Co-efficient of viscosity or dynamic viscosity, μ= Aρt Kinematic viscosity, ν= μ/ρ = At

Where

t = falling time of a liquid for a particular distance through the tube of Oswald viscometer.

ρ= density of liquid

A=calibration constant of Oswald viscometer, which is numerically equal for every liquid flowing past a particular distance through the tube of Oswald viscometer.

Hence

V_W= A×t_w ‘w’ refers the water. A

=V_w / T_w; The value of A can be easily.

2.2.6 Flash Point and Fire Point:

This method covers the determination of flash point & fire point by Pensky-Martens Closed Cup tester of fuel oils, lube oils, suspensions of solids, liquids that tend to form a surface film under test conditions and other liquids. The sample is heated at a slow, constant rate with continual stirring.A small flame is directed into the cup at regular intervals with simultaneous interruption of stirring. The flash point is the lowest temperature at which application of the test flame causes the vapor above the sample to ignite. Fire point is the temperature at which the flash will sustain itself as a steady flame for at least five seconds.

2.2.7 Cloud Point:

After preliminary heating, the sample is cooled at a specified rate and examined at intervals of 2^{O}F (1^{O}C) for flow characteristics. The lowest temperature at which a cloud or haze of wax crystal appears at the bottom of the test jar when the oil is cooled under prescribed condition.

2.2.8 Pour Point:

After preliminary heating, the sample is cooled at a specified rate and examined at intervals of 5^{O}F (3^{O}C) for flow characteristics. The lowest temperature at which the movement of the oil is observed is recorded as the pour point.

2.2.9 Lead (Pb) Concentration:

Lead concentration is determined with the Ultraviolet-Photo- Spectra-Meter while experiment is conducted at Bangladesh Council for Scientific & Industrial Research (BCSIR), Dhaka, Bangladesh.

3. RESULT AND DISCUSSION

3.1 Results obtained from waste engine

3.1.1 Effect on performances:

As we conducted an experimental study on diesel-like fuel (DLF) on engine performance and exhaust emission. It is observed from the test results that about 60 cc out of each 100 cc of the waste oil are converted into the DLF. It is observed that the produced DLF can be used in diesel engines without any problem in terms of engine performance. The DLF increases torque, brake mean effective pressure, brake thermal efficiency and decreases brake specific fuel consumption of the engine for full power of operation. We found that T, Bmep, thermal efficiency and Bsfc trends for the DLF and diesel fuel are similar in nature. It is known that T and Bmep are directly proportional but Bsfc is indirectly proportional with the engine brake power given. The T, Bmep, and thermal efficiency values obtained for the DLF are slightly higher than those obtained for diesel fuel, but Bsfc is lower in all revolutions. Average increases of the T and Bmep values are approximately 0.69% for the DLF. This was due to high distillation temperature of the DLF than diesel fuel. In internal combustion engines, the T increases to a maximum point with the increase of engine speed. After that critical point, generally the torque decreases step by step. The maximum T and Bmep values obtained from the measured data for the DLF and diesel fuel in 2000 rpm are 33.86 and 33.71 Nm, 1048.21 and 1043.38 kPa, respectively. The corresponding thermal efficiency and Bsfc for the same fuels and the engine speed are 40.68 and 37.88%, 213.23 and 224.52 g/kWh respectively. After the maximum and minimum values of these parameters they decrease and increase with the engine speed gradually.

3.1.2 Effect on emissions:

When the DLF sample is used, the exhaust temperature is higher than that of the diesel sample, and it increases with the engine speed. The measured exhaust temperature varied between 414 and 515°C for the DLF as compared to 397 and 477°C for diesel indicating remarkable variation in exhaust temperature. The higher values in temperatures for the DLF depend on the higher distillation temperatures, since any fuel distilled at higher temperature increases combustion temperature when it is combusted.As a result of the higher combustion temperature, exhaust gas temperature will increase. High temperatures in the exhaust are not desirable, for they cause higher energy transfer from the combustion chamber to the surrounding. High heat transfer decreases thermal efficiency of the engine at a finite value. Almost in all speeds of the engine the WEO100 gave the highest CO emission. At high speeds of the engine the lowest CO emissions were obtained from the diesel fuel. All the blend fuels of WEO and diesel fuel presented very similar CO emissions except for WEO100, WEO75 and WEO50.However, the increased engine speed caused to increase air movements in the engine cylinder which lead to more homogeneous air-fuel charge and thus resulted in an improved combustion and consequently lowered CO emissions. Therefore, when the engine speed increased CO emissions increased for all test fuels, especially WEO100 and WEO75 fuels. The highest HC emissions were measured for WEO100 and following were WEO75 and WEO50 fuels, respectively. The lowest HC emissions were observed for diesel fuel, WEO5, and WEO10 fuels. However, the HC emissions for WEO25 and WEO35 fuels were quite lower than that of the WEO100 fuel, and were in acceptable values. Generally, WEO–diesel blends that contained high concentrations of WEO lead to a considerably high amount of HC emissions in the exhaust gasses. The lowest NOx emissions were obtained for WEO100 fuel at the lower speeds of engine operation. However, at the higher speeds of engine operation WEO100 fuel resulted in higher NOx emissions in comparison to other test fuels. The reason of this increase is considered to be the slower combustion of the WEO100 fuel that results in a larger period of combustion. The amounts of SO 2 emissions found in the engine exhaust were almost linear with the WEO amount contained in the blend and considerably higher than that of diesel fuel since WEO contains a sulfur amount 4.5 times higher than that of diesel fuel. Therefore, it can be recommended that the sulfur amount of WEO fuel should be decreased.

4. CONCLUSIONS

From this preparation, it is evident that pre-treated (including clay treatment, CT) used engine oil (UEO) and 10%blending of pre-pretreated (including, CT) used engine oil of vehicle (UEO) into fresh diesel are suitable to use as a diesel fuel considering Caterpillar Specific Limit and comparing with the fresh diesel. Though the samples have a little bit higher value of viscosity (kinematics), flash point fire point but these value are in tolerable range. Produced diesel is technically suitable, economically viable and less responsible to pollute environment.

5. REFERENCES

[1.] "Annual Report" -Bangladesh oil and Gas Company, 1992

[2.] "Annual Report"-Bangladesh Petroleum Corporation, 1999.

[3.] "Test Results of Blending Diesel Fuel"- Global Energy Recovery Corporation, Feb.1997, ION Industries INC, August 1998, Echo Bay Minerals Company, June 1997.

[4.] Report on" Waste Oil to energy Converter" -Global Energy Recovery Corporation, 1997.

[5.] Chowdhury, M.A.and Hogue , Z."Diesel Fuel Production From Used Engine Oil", B.Sc. Engg. . Thesis, MEDept, BIT, Rajshahi Bangladesh, June 2000. Morse, F.T "Power Plant Engineering and Design" 3rd Edition, March 1, 1953. Mathur, M.L and Sharma, R.P "Internal Combustion Engines" 8th Edition, Dhanpat Rai Publication, 1996.

[6.] Dorado MP, Ballesteros E, Arnal JM, Gomez J, Lopez-Gimenez FJ (2003). Testing waste olive oil methyl ester as a fuel in a diesel engine. Energy Fuels 17:1560-1565.

[7.] Dorado MP, Ballesteros E, Mittelbach M, Lopez FJ (2004). Kinetic parameters affecting the alkali-catalyzed transesterification process of used olive oil. Energy Fuels 18:1457-1462.