INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING (IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

PRODUCTION OF POWER FROM WASTE LUBE OIL

G.Manoj Kumar[1], S.K.Narendranathan[2], M.Ragesh Sathiyan[3] Prahalad Rao[4]

[1,2]Assistant Professor, Department of Mechanical Engineering, Agni College of Technology
[3]IES College of Engineering, Thrissur, Kerala, India
[3]Student, Department of Mechanical Engineering, Agni College of Technology, Chennai.

Abstract- Diesel like fuel is produced from Waste Lube Oil (WLO) through the process of pyrolysis. The Pyrolysis involves the following setup. The Pyrolysis reactor, Induction Heater, 20 microns filter, Condenser. The Waste Lube Oil which we have obtained has to be passed through the 20 microns filter paper as to remove the impurities from it. Then the WLO is brought to the pyrolysis reactor and then it is been heated until it reaches 500^0 C which is the cracking temperature of Lube Oil. Once the WLO attains this temperature the vapour from the pyrolysis reactor is taken out and it is admitted in the condenser. The condenser will condense the vapour by removing the latent heat of the vapour and then the fuel will be obtained from it. With the fuel obtained it is been tested as to know the properties, characteristics, chemical compound in it. The obtained fuel is given for FTIR, GC/MS for to identify its chemical properties and the mass of the chemical compound present in it and it is also given for Emission test as to find the SO_X, NO_X and HC content in the exhaust gas from the engine. This paper introduces a new method for Waste management and also to go with the pollution free environment.

Keywords— Waste lube oil, Pyrolysis and Emission test

1. INTRODUCTION

1.1 Pyrolysis

Pyrolysis is a thermal decomposition of organic materials at elevated temperatures in an inert atmosphere such as a vacuum or nitrogen gas. It involves the change of chemical composition

INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING (IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

and is irreversible. The word is coined from the Greek – derived elements pyro "fire" and lysis "separating".

Pyrolysis is most commonly applied to the treatment of organic materials. It is one of the processes involved in charring wood , starting at $200^0 - 300^0$ C. In general, pyrolysis of organic substances produces volatile products and leaves a solid residue enriched in carbon, 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 Ethylene, many forms of carbon, and other chemicals from petroleum, coal and even wood, to produce coke from coal. Aspirational applications of pyrolysis would convert biomass into syngas and biochar, waste plastics into usable oil or waste into safely disposable substances.

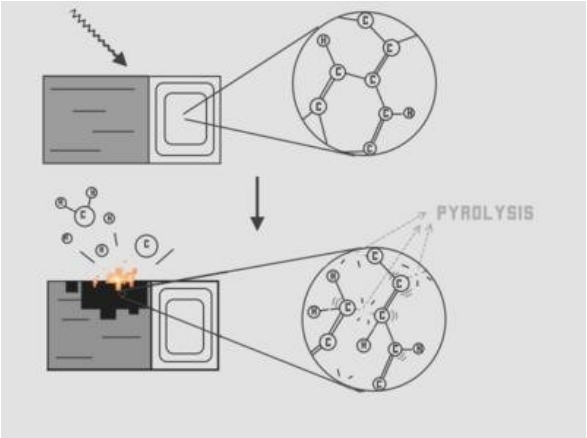

Fig. No. 1 Pyrolysis Depiction

1.2 Process Terminology and Mechanism

Certain uses of pyrolysis are called dry distillation, destructive distillation and cracking. The processes involve thermal depolymerization, i.e., the breaking of the chemical bonds in macromolecules to give smaller fragments. The phenomenon involves exceeding the ceiling temperature of the polymers.

Pyrolysis differ from other processes like combustion and hydrolysis in that it usually does not involve the addition of the other reagents such as oxygen (O_2 , in combustion) or water (in hydrolysis). In practice, it is often not practical to achieve a completely O_2 or water - free condition, especially as pyrolysis is often conducted on complex mixtures. The term has also been

ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

applied to the decomposition of organic material in the presence of superheated water or steam (hydrous pyrolysis), for example, in the steam cracking of oil.

Pyrolysis has been assumed to take place during catagenesis, the conversion of buried organic matter to fossil fuels. In vacuum pyrolysis, organic material in heated in vacuum to decrease its boiling point and avoid adverse chemical reactions called flash vacuum pyrolysis, this approach is used in organic synthesis.

Pyrolysis can be analyzed by pyrolysis Gas Chromatography Mass Spectrometry (Py-GC-MS). In that technique, the volatile products from pyrolysis are separated by gas chromatography, and identified by MS. The technique is applied to many aspects of pyrolysis technology. Pyrolysis is also used in Carbon- 14 Dating.

2.EXISTING SYSTEM

The use of DLF from WLO as substitutes for diesel fuel requires measures that can solve the problems of long-term operation. In the present work, the adaptation of the fuel to the engines has been tried and a review of the previous work is presented here.

In [1], Demirbas A., Baluabaid M.A., Et.al have produced Diesel like Fuel from Waste Lube Oil by Pyrolytic Distillation method by using an catalyst called the Sodium Carbonate. They have investigated and reported that the addition of the catalyst in the pyrolysis reaction increases the distillation temperature which further increases the Combustion efficiency. They have also stated that by adding the catalyst sodium carbonate the distillation temperature of the WLO is mostly near to that of the diesel fuel and also its boiling is closer to that of diesel fuel. Also they state that the distillation temperature of the lube oil also changes with the amount of catalyst added to the waste lube oil. The distillation temperature increases with increase in the catalyst added to the WLO. The amount of catalyst added to the waste lube oil is about 2%, 6%, 10% and the distillation temperature and combustion efficiency increases respectively with respect to it.

In [2], Orphan Arpa, Recep Yumrutas, have investigated the GLF dfrom the waste lube oil and they have also gone through the emission and the performance characteristics with. They have reported that the addition of the catalyst Calcium Oxide plays a vital role in the production of GLF from the WLO. They have stated that the sulphur content from the emission will be reduced with the minimal amount of the catalyst used. According to them, 2% of calcium oxide is wt. is the best

INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING (IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

amount required for the WLO to have a lesser amount of sulphur dioxide in the emission of the GLF. They have reported that the amount of carbondioxide emission is more that of gasoline fuel when the engine speed increases while the hydrocarbon content in the emission increases initially but it gets reduced when the engine speed increases.

In [3], Xiangli Wang, Peiyong Ni have investigated the combustion and the emission characteristics of the of DLF from the WLO. In this paper he has stated that as the cetane number was low and the viscosity was higher in DLF, it has a ignition lag when compared to the diesel fuel. Then the compression temperature and pressure at the time of ignition was high than that of diesel fuel. They have also stated that the compression temperature and the pressure will be high when the distilled temperature of the DLF is high.

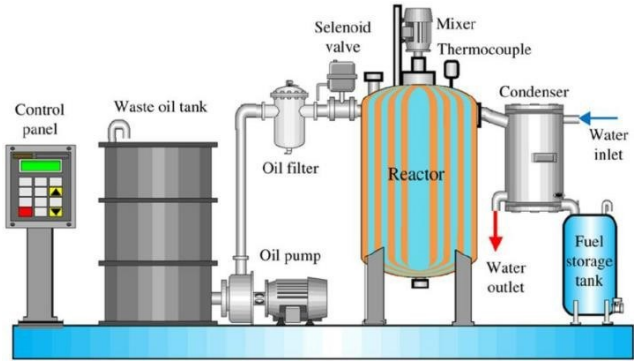

Fig. No. 2 Pyrolysis Process

The WLO which is used in this project is SAE 220 which is used for the lubricating purpose in the industry and the properties of that oil is taken and the same is given as follows. From the table we could able to infer that the properties are much higher than the required level for the fuel. So as to reduce it we are cracking the WLO and converting it to the Diesel like fuel (DLF). The process which is used to crack the WLO to DLF is called as pyrolysis and the basic setup of that process is depicted as follows. In this is given picture we can able to see that process flow from the used lube oil to diesel like fuel.

In the above given figure we can able to see that the waste lube oil is taken into the pyrolysis reactor through the pump and oil filter is place between it. The filter is used to remove the waste particles in the used lube oil. Then the WLO is heated in the reactor at high temperature in the

INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING (IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

absence of oxygen. Then the vapor produced from it made to pass through the condenser at different fractionates and then the collected oil is collected in a storage tank for the future purposes.

Properties	**Value**
Density	899 kg/m^3
Flash Point	200^0C
Auto-Ignition temperature	320^0C
Pour Point	-18^0C
Kinematic Viscosity at 40^0C	220 mm^2/s

Table No. 1 Properties of Used Lube Oil

It is also known to us that the fossil fuel is been used at the rapid rate which will cause our future generation to suffer without having the petroleum products. As to depict the usage of fossil fuels, a graph is depicted below.

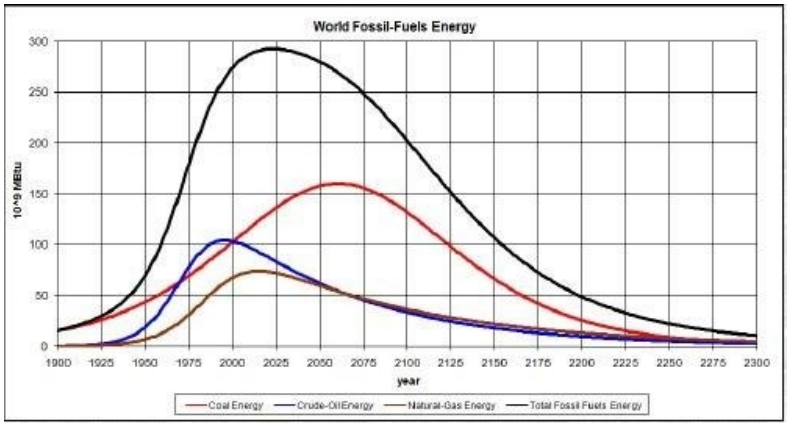

Fig. No. 3 Fossil Fuels Consumption Chart

From the above graph we can able to infer that the fossil fuels will get depleted if the usage of it continues as it is now and as to reduce the usage of it the kind of alternative fuels are into attack and they play a vital role in the replacement of fossil fuels. Once the alternative solution is

INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING (IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

found the next thing to take into account is that he one which we have found is correct or not. In this case the alternative fuel which is to be used must be checked with the emission norms as to be confident enough that obtained alternative solution does not cause any harmful reaction or it wouldn't contaminate the environment.

3.PROPOSED SYSTEM

3.1 Condenser

In systems involving heat transfer, a condenser is a device or unit used to condense a substance from its gaseous to its liquid state, by cooling it. In so doing, the latent heat is given up by the substance and transferred to the surrounding environment. Condensers can be made according to numerous designs, and come in many sizes ranging from rather small (hand-held) to very large (industrial-scale units used in plant processes).

In this project the condenser is used to condense the cracked lube oil vapor to the liquid form i.e., the cracked oil. Thus once the vapor is condensed the oil is taken for the tests and the performance. First the oil was collected with some concentration of water. Then we removed the oil alone by using the Diethly ether. As both oil and ether are organic it will be separated from water. As Diethly ether is highly volatile it evaporates easily in normal ambient temperature itself and thus would be getting the pure DLF.

Fig. No. 4 Condenser

3.2 Assembly

INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING (IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

The entire assembly is made with all the components attached to it. The entire assembly is shown below. In the below picture we can see that the pyrolytic reactor is heated in the induction heater at the thermal cracking temperature of lube oil and the vapor which comes out of the pyrolytic rector is made to pass through a tube and it is sent inside the condenser setup which is kept at the side of the pyrolytic reactor. The condenser is used to condense the hot cracked vapor to the fuel form which would be a DLF. The obtained fuel is given for the test and the results will be compared with the standard fuels. Then the obtained results is used to find the performance characteristics and emission characteristics with obtained DLF.

Fig. No. 5 Pyrolysis Setup

3.3 Fourier Transform Infrared Spectroscopy (FTIR)

Fourier-transform infrared spectroscopy is a technique used to obtain an infrared spectrum of absorption or emission of a solid, liquid or gas. An FTIR spectrometer simultaneously collects high-spectral-resolution data over a wide spectral range. This confers a significant advantage over a dispersive spectrometer, which measures intensity over a narrow range of wavelengths at a time.

The term Fourier-transform infrared spectroscopy originates from the fact that a Fourier transform (a mathematical process) is required to convert the raw data into the actual spectrum. For other uses of this kind of technique, see Fourier- transform spectroscopy. The goal of any absorption spectroscopy (FTIR, ultraviolet-visible ("UV-Vis") spectroscopy, etc.) is to measure how well a sample absorbs light at each wavelength. The most straightforward way to do this, the

ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

"dispersive spectroscopy" technique, is to shine a monochromatic light beam at a sample, measure how much of the light is absorbed, and repeat for each different wavelength. (This is how some UV– is spectrometers work, for example.)

Fourier-transform spectroscopy is a less intuitive way to obtain the same information. Rather than shining a monochromatic beam of light at the sample, this technique shines a beam containing many frequencies of light at once and measures how much of that beam is absorbed by the sample. Next, the beam is modified to contain a different combination of frequencies, giving a second data point. This process is repeated many times. Afterward, a computer takes all this data and works backward to infer what the absorption is at each wavelength.

The beam described above is generated by starting with a broadband light source—one containing the full spectrum of wavelengths to be measured. The light shines into a Michelson interferometer—a certain configuration of mirrors, one of which is moved by a motor. As this mirror moves, each wavelength of light in the beam is periodically blocked, transmitted, blocked, transmitted, by the interferometer, due to wave interference. Different wavelengths are modulated at different rates, so that at each moment the beam coming out of the interferometer has a different spectrum.

As mentioned, computer processing is required to turn the raw data (light absorption for each mirror position) into the desired result (light absorption for each wavelength). The processing required turns out to be a common algorithm called the Fourier transform (hence the name "Fourier-transform spectroscopy"). The raw data is sometimes called an "Interferogram". The FTIR test is done in this project as to find the functional groups Contained in the obtained

INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING (IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

condensed oil from the pyrolysis process. The IR chart and the FTIR graph of the obtained DLF is shown.

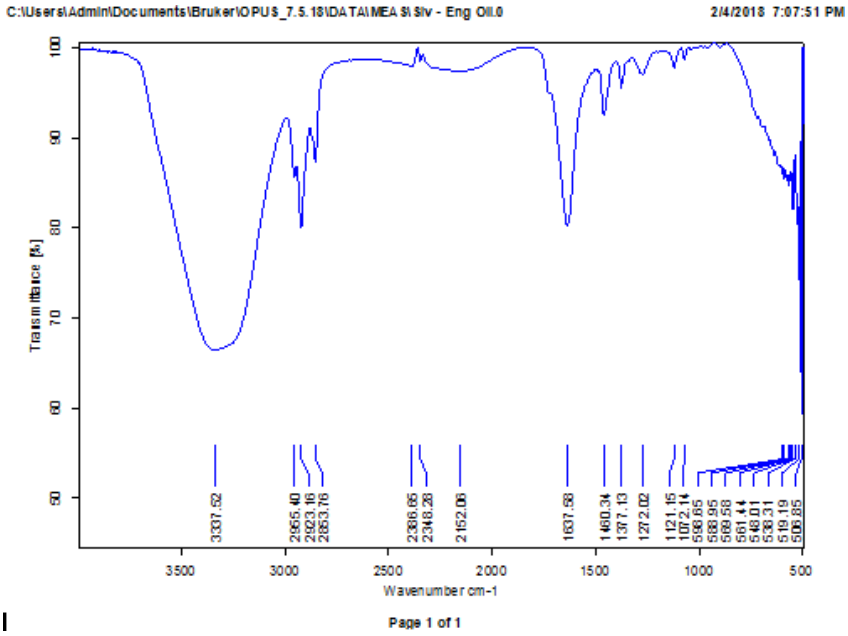

Fig. No. 6 FTIR Graph

4 RESULTS AND DISCUSSION

4.1 Emission Test

Emission test is the study of the Exhaust gas and the particulates contained in it. The particulates are CO, NO_X, HC, Sulphur oxide, Soot particulates etc. Once the obtained oil is found to be DLF, the fuel is checked for the emission test as it must be within the pollution limits which is there in the emission norms ie., the BS IV norms. The graphs shown explain the comparison of the obtained results of DLF with the Diesel fuel. The emission particulate comparison graphs are given as follows.

4.2 Carbon Monoxide

Carbon monoxide is a colorless, odorless, and tasteless gas that is slightly less dense than air. It is toxic to hemoglobic animals (both invertebrate and vertebrate, including humans) when encountered in concentrations above about 35 ppm

INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING (IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

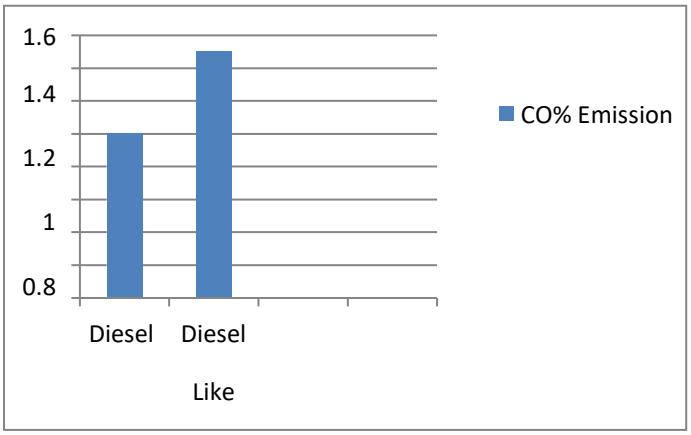

Fig. No. 7 CO % Emission Graph

4.3 Hydrocarbon

Hydrocarbon is also a organic compound which comes out of the engine with the exhaust gas due the reason of incomplete combustion. The below graph will explain the HC emission from the CI Engines.

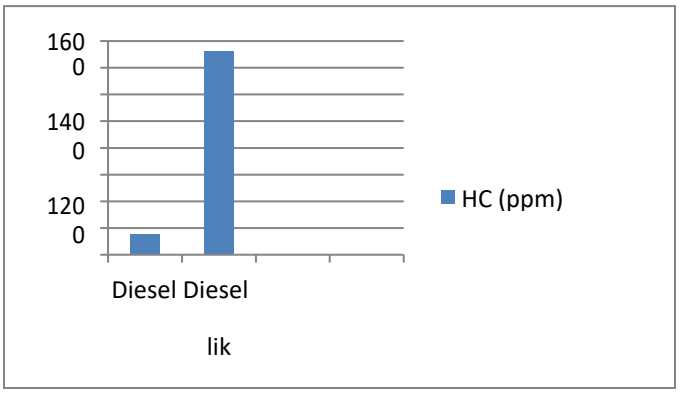

Fig. No. 8 HC Emission Graph

5 CONCLUSION & FUTURE WORK

The work produces power from alternative fuel which led to produce from the WLO. The project also involved the Waste Management process as to refine the Waste Lube Oil (WLO) to the useful Diesel like Fuel (DLF). With this project we have produced DLF by the cracking of lube oil through the process called pyrolysis and we have calculated the performance characteristics and emission characteristic of the obtained fuel.

ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 2 – www.ijrmmae.in – Pages 127-137

By using this fuel the power obtained will be higher than that of the normal diesel fuel and the efficiency is also higher than that of diesel. We have also gone through the emission characteristics of DLF and compared with diesel and we have got slight higher concentration in CO, HC etc than that of diesel. But the obtained results are within the safety limit. Though it is within the limit it can be further reduced by using a concerned catalytic converter and also by using proper fuel ratio. The perfect development of the project would reduce the emission particulates, so that it would be perfect alternate fuel for the CI engines and also a good waste management process which does not affect the Pollution Control Board.

6 REFERENCES

1. "Diesel Fuel from Waste Lubricating Oil by Pyrolitic Distillation" - A. Demirbasa, M. A. Baluabaida, M. Kablia and W. Ahmada a King Abdulaziz University, College of Engineering, Department of Industrial Engineering, Jeddah, Saudi Arabia.
2. "Experimental Verification of Gasoline Like Fuel Obtained from Waste Lube Oil" - Orhan Arpa, Recep Yumrutas, University of Gaziantep , Department of Mechanical, Turkey.
3. "Combustion and Emission Characteristics of Diesel Like Fuel from Waste Lubrication Oil" - Xiangli Wang, Peiyong Ni, School of Mechanical Engineering, Nantong, China.
4. "Gasoline and Diesel Synthesis from Waste Lubrication Oil" – N.B. Selukar, S.M Wagh, Department of Chemical Technology, Lakshminarayanan Institute of Technology, Nagpur.
5. "Measurement of Diesel Engine Emissions." - Herbert C. Mckee , John M. Clark & Ralph J. Wheeler.
6. "A Review: Waste Lubricating Oil as an alternative fuel blended with diesel." – Venkata Ramesh Mamilla, St. Peters University & Lakshmi Narayana Rao G. QIS Institute of Technology.
7. "Waste Lubricating Oil reuse as a fuel." – Steven Chansky, James carroll, James Sahagian, Norman Surprenant, Bejamin Kincannon. Washington Environment Research Centre and Environment Protection Agency.
8. "Waste oils as alternative fuel for diesel engine: A review." – K. Naima, A. Liazid. Research Laboratory LTE-ENSET, Algeria.