NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 2, ISSUE 7, JULY-2015

WASTE OIL AS AN ALTERNATIVE FUELS FOR FUTURE –A REVIEW

Sudershan B.Gadwal,
Dept of Mechanical Engineering,
A.G.Patil Institute of Technology and Science,
Opp SRP Camp, Bijapur road, Solapur, Maharashtra, India

M.A.Kamoji,
Mechanical Engineering,
KLE Society's College of Engineering and Technology,
Udyambag, Belgaum, Karnataka, India

Prasad Baburao Rampure
Department of Mechanical Engineering,
KLE Society's College of Engineering and Technology,
Chikodi, Karnataka, India

ABSTRACT

The financial growth of the country is measured by efficient use of natural resources especially fuel. Fossil fuels have played a dominant role in the rapid industrialization of the world and thereby increased and improved quality of life. However, due to the threat of supply crunch ever rising prices and the effect of green house gases caused by conventional fuels there is an urgent need to explore the possibility of using waste oils (tire process oil) as alternative fuels to reduce the pollution and to increase the energy self-reliance of the country. The study aims to review the alternative fuels for diesel engine for future. It was found that the properties of the TPO are almost same as that of pure diesel oil.

KEYWORDS: Alternative fuels, pyrolysis, tire oil.

INTRODUCTION

The financial growth of the country is measured by efficient use of natural resources especially fuel. Fossil fuels have played a dominant role in the rapid industrialization of the world and thereby increased and improved quality of life. Low fuel consumption and better efficiency are the facts that attracts towards the use of diesel engine. Increasing consumption rate of diesel fuel and environmental issues has renewed an interest of the researchers to explore the alternative fuels to diesel fuel. Presently petroleum fuel including diesel is depleting at an increased Consumption rate of 3%. Easy availability, renewable and greener to the environment are the three major advantages of the biodiesels to attract major researchers. In recent years systematic efforts have been made by several investigators to use biodiesels made from vegetable oils like sunflower, peanut, soybean, rapeseed, palm, cotton seed, corn, linseed, sesame, karanja, rubber seed oils etc as alternative fuel to Diesel oil. The vegetable oils used to produce biodiesels are made from renewable sources that are potentially inexhaustible, environmental friendly, biodegradable, non aromatic and practically have zero sulphur content in them. Many of the vegetable oils are edible in nature, but their use as fuel has limited applications due to higher domestic food requirement. Only few non edible and waste oil have been tried on a Diesel engine, leaving a lot of scope in this area..

PRODUCTION OF BIODIESELS.

Researchers are trying to find several ways to make biodiesel from different feed stocks like edible and non edible vegetable oils, waste cooking oil, animal tallow, plastic oil, Yeast cells, algae etc. Most of the researchers prepared biodiesel by transesterification process from the raw feed stocks using a base catalyst and some of them used acid catalyst also. Gimbun and ali [1] developed a oil from rubber seed oil (RSO) by the use of limestone based catalyst for transesterification of high free fatty acid (FFA). Pre calcinated limestone known as clinker was activated using methanol and transesterification was performed under reflux with constant stirring. The rubber seed oil was obtained using both microwave and soxhlet extraction using hexane as solvent. FFA content and fatty acid methyl ester content were determined using gas chromatography mass spectrometry (GC-MS). In this process, conversion of high FFA rubber seed oil to biodiesel as found to be up to 96.9%. The highest conversion of 96.9% was obtain from catalyst activated at 700°C, with catalyst loading of 5 wt. %; he ratio of methanol to oil is 5:1, reaction temperature is 65°C and reaction time of 4 hours.
OmotolaBabajide and Leslie Petrik [2]presents the results of transesterification reaction using sunflower oil as feedstock with methanol and class F fly ash catalyst derived from a coal fly ash dump in South Africa to produce methyl esters (biodiesel). The fly ash based catalyst was prepared using the wet impregnation procedure with different loadings of potassium. The fly ash based catalyst loaded with 5% wt KNO_3 at a reaction temperature of 160ºC exhibited maximum oil conversion (86.13%). The utilization of fly ash as a suitable feedstock for use as heterogeneous catalyst for the transesterification would allow beneficiation of fly ash in an environmentally friendly.

Goering et al [3] studied the characteristic properties of eleven vegetable oils to determine which oils would be best suited for use as an alternative fuel source. Of the eleven oils tested, corn, rapeseed, sesame, cottonseed, and soybean oils had the most favorable fuel properties.

Some of the researchers [4, 7] conducted the experiments on diesel engine using non-edible vegetable oils used as alternate fuels and found maximum Brake thermal efficiency, BSFC and emissions like CO,HC also increased without any engine modification. The uses of biodiesel [8] in conventional diesel engines result in substantial reduction in the emission of unburned hydrocarbons, carbon monoxide and particulate. Neat oil is converted into Methyl ester of oil (biodiesel) using trans-etherification process. Methyl and ethyl ester of Karanja oil [9] can also be used as fuel in compression ignition engine without any engine modification. Higher viscosity is responsible for various undesirable combustion properties of Neat vegetable oils. Four well known techniques are proposed to reduce the viscosity levels of vegetable oil namely dilution, Pyrolysis, Micro emulsion and Trans etherification.

The vegetable oils used to produce biodiesels are made from renewable sources that are potentially inexhaustible, environmental friendly, biodegradable, non aromatic and practically have zero sulphur content in them. Many of the vegetable oils are edible in nature, but their use as fuel has limited applications due to higher domestic food requirement. Only few non edible and waste oil have been tried on a Diesel engine, leaving a lot of scope in this area. Some of the alternative fuels are waste tire process oil and plastic process oil can be considered as biodiesel. The waste process oils are important from Indian perspective which are extracted from waste tire and plastics are considered as alternative fuels to diesels which are promising alternatives

Approximately 1.5 billion tires are produced each year which will eventually enter the waste stream representing a major potential waste and environmental problem. The disposal of waste tire has become a major environmental concern globally and this can be attributed to the increase in automobile usage, especially in areas of large population and highly industrialized nations. Waste tires have a high content of volatile matters as well as fixed carbon that makes them an interesting solid as a fuel for energy production or hydrogenation processes and in pyrolysis processes to obtain different fractions of solid, liquid and gaseous products. Also tire rubber has a lower ash content (≈3% vs. ≈7% for coal) and a lower carbon content (≈25% vs. ≈45% for coal) when compared to other activated carbon precursors for example coal and wood. The energy content or fixed carbon content of waste tires can be exploited by thermo chemical processes via pyrolysis into a more valuable fuel and useful chemical.

Pyrolysis is an endothermic process that induces the thermal decomposition of feed materials without the addition of any reactive gases, such as air or oxygen. The thermal efficiency of this process is approximately 70%, and can increase to 90% with the use of pyrolytic products as fuel.

This tire pyrolytic oil is obtained from the scrap tire. The scrap tire is one of the very common and important solid wastes all over the world. Scrap tire production shows increasing trend due to increasing number of vehicle in both developed and underdeveloped countries [2]. Nearly 1 billion of waste vehicle tires are accumulated each year [3]. By this accumulated tires pyrolytic oil is produced which carries 85.54% C, 11.28% H, 1.92% O, 0.84% S, and 0.42% N [4]. In our experiment fixed bed pyrolysis process is used to produce tire pyrolytic oil. In addition, chemical products such as benzene, toluene, xylene and limonene can be obtained from waste vehicle tire obtained pyrolysis liquid products [5-8].

METHODOLOGY

In the overall methodology there are different steps which are described in below

Production of crude TPO: The pyrolysis was done in a Fixed bed pyrolysis reactor in a temperature range 350-400˚C .The setup includes a condenser and fractionating column. Nitrogen gas was used to reach in an inert environment .In this pyrolysis, an automobile tire was cut into a number of pieces and the bead, steel wires and fabrics were removed. Thick rubber at the periphery of the tire was alone made into small chips. The tire chips (feed stock) were washed dried and were fed in a reactor unit.

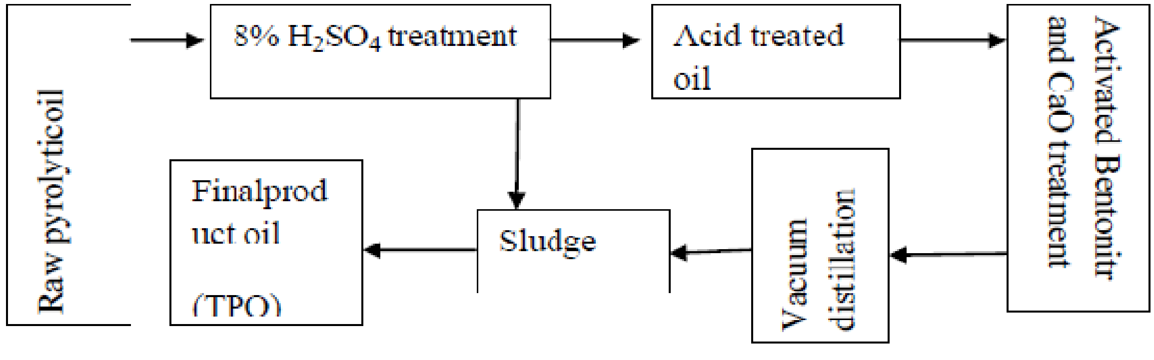
Modification of TPO: The modification of the crude TPO involves three stages, (i) removal of moisture (ii) Desulphurization (iii) Vacuum distillation.

Removal of moisture: Initially crude TPO was heated up to 100 oC, in a cylindrical vessel for a particular period of the removal of moisture, before subjecting it to any further chemical treatment.

Desulphurization: The moisture free crude TPO contains impurities, carbon particles and sulphur particle. A known volume of concentric hydrosulphuric acid (8%) was mixed with the crude TPO and stirred well. The mixture was kept for about 40 hours. After 40 hours, the mixture was found to be in two layers. The top layer was a thin mixture and lower one thick was sludge. The top layer was taken for vacuum distillation and the sludge was removed and disposed off.

Vacuum distillation: Vacuum distillation process was carried out to separate the lighter and heavier fraction of hydrocarbon oil. A known sample of chemically treated crude TPO was taken for vacuum distillation process. The sample was externally heated in a closed chamber. The vapour leaving the chamber was condensed in a water condenser and the TPO was collected separately. Non condensable volatile vapours were left to the atmosphere. The distillation was carried out between 70^{o}C and 90^{o}C. 80 % of TPO was distilled in the distillation whereas 5 % of TPO was left out as pyrogas and 15 % was found as sludge. The TPO has irritating odour like acid smell.

WORKING FLOW CHART:



First we took the raw pyrolytic oil in a beaker. Then the raw tire derived pyrolytic oil was subjected to 8%by weigh of hydro-sulfuric acid (H2SO4), stirred well by a electrical stirrer during 4 h and left to settle for 40 h. Temperature of the mixture was maintained at 50 ˚C during stirring process. The mixture was found in two layers 40 h later. The top layer was the clear viscous oil, and the bottom layer was the non-viscous acidic sludge. The clear viscous oil was taken for the activated bentonite–Calcium Oxide (CaO) treatment. Secondly, activated bentonite (100 g activated bentonite for every 1000 ml of acid treated pyrolytic oil) and CaO (50 g for every 1000 ml of acid treated pyrolytic oil) were added to the acid treated pyrolytic oil and mixed by an electrical stirrer for about 4 h. Temperature of the mixture was maintained at 70 ˚C during stirring process. The contents were kept for 24 h for the settling of the sludge. Whole contents were then filtered by filter-cloth to obtain healed pyrolytic oil for the vacuum distillation. Thirdly, the healed pyrolytic oil was distilled by vacuum distillation.

Percentage of oil obtained from TPO: Table 1 Percentage of oil obtained from TPO

Crude TPO	After removing sludge	Oil obtained %	After vacuum distillation	% of TPO Obtained finally
2150	1440	66.97	490	22.79

PROPERTIES OF TPO

After vacuum distillation the physical properties of TPO are measured and then these properties are compared with the conventional diesel. The engine performance greatly depends upon the chemical reaction between induced air and fuel in the combustion chamber, which permits the utilize of heat energy. For this reason a fuel should possess a number of properties for reliable engine performance .Bio-diesel also should have these properties for using it in diesel engine. These properties are **Absolute Viscosity:** This refers to a liquid resistance to flow. Viscosity of the TPO we are working is 1.51 centi poise (cp) at 30˚c.

Table 2. Properties of diesel, crude TPO, TPO

Property	Conventional Diesel	Crude TPO	TPO
Density(Kg /m3)	872.3	898.7	845.6
Viscosity(centi poise) (at 30˚c)	4	2.8	1.51
Calorific value (MJ/ kg)	45.85	41.5	42.37
Flash point (˚c)	46	40	34
Pour point (˚c)	-30 to -40	-2	-6

Table 3: Comparing the properties of our TPO with a reference thesis paper [11]

Property	Conventional Diesel	Crude TPO	TPO
Density(Kg /m^3)	830	935	871
Viscosity(centi poise) (at 40˚c)	2	3.2	1.7
Calorific value (MJ/ kg)	46.5	42.85	45.78
Flash point (˚c)	50	43	36

CONCLUSION

From the result it is found that the properties of TPO oil are almost near to that of Pure Diesel. Scope of work further is to carry the performance test on diesel engine using waste process oil as a biodiesel.

ACKNOWLEDGEMENT

It is a great pleasure and privilege for the authors to present this report on "Waste Oil as an Alternative fuels for future –A review" The authors wish to express their deepest sense of gratitude to their supervisor Professor Dr. P.B.Rampure Department of Mechanical Engineering, KLE college of Engineering and Technology for his incentive guidance and valuable suggestions regarding this work. His help in inspiration was undoubtedly a matter of pride.
The author expresses their cordial thanks to Professor Dr.M.A.Kamoji, Dean, faculty of Mechanical Engineering, KLE'S DR.MSSCET, Belgaum and Mr .Pavankumar Kulkarni, Senior GM, Gulbarga Power Plant, Gulbarga Dist. for their constructive advice to make success this work.

REFERENCE

[1] JoliusGimbun and Shahid Ali-Biodiesel *production from rubber seed oil using a limestone based catalyst , 2012, 2, 138 141 doi:10.4236/ampc.2012.24B036 Published Online December 2012.*

[2] OmotolaBabajide, Leslie Petrik-*Use of coal fly ash as a catalyst in the production of biodiesel, vol. 52 (4) 261-272, 2010 issn 1337-7027*

[3] C.E. Goering, A.W. Schwab et al., "*Fuel Properties of Eleven Vegetable Oils", Trans. ASAE, 25 (4-6), 1982, PP:1472-1477.*

[4]O.D. Hebbal, K. Vijaya Kumar Reddy and K. Rajagopal, April (2006). *"Performance characteristics of a diesel engine with Deccan Hemp oil", Fuel.*

[5] Srinivas, R.P., and Gopalakrishnan, K.V., "*Vegetable Oils and their Methyl esters as Fuels for Diesel Engines", Indian Journal of Technology, (29)PP: 292-297, 1991*

[6] Scholl, K.W and S.C. Sorenson., *"Combustion of Soybean Oil Methyl Ester in a Direct Injection Diesel Engine", SAE Paper No.930934, Warrendale, PA., 1993*

[7] S. Choudhury,P. K Bose, 2007, Karanja or Jatropha – *A better option for an alternative fuel in CI engine, International Conference On IC Engines(ICONICE), Hyderabad.*

[8] Avinash Kumar Agarwal, 2007, *Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engines, Progress in Energy and Combustion Science, (33)PP: 233–271*

[9] B. Baiju, M.K. Naik, L.M. Das , (2009) , *A comparative evaluation of compression ignition engine characteristics using methyl and ethyl esters of Karanja oil , Renewable Energy,(34)PP: 1616–1621.*

[10] Ramdas AS, Jayaraj S, Muraleedhran C, 2004, "*use of vegetable oils on IC Engines fuels – A review" . Renewable .Energy, (29) PP: 727 -742.*

[11] O. Arpa, R. Yumrutas and Z. Argunhan, "*Experimental Investigation of the Effects of Diesel-like Fuel Obtained from Waste Lubrication Oil on Engine Performance and Exhaust Emission," Fuel Process Technology, Vol. 91, 2010, pp.1241-1249.*