EXPERIMENTAL INVESTIGATION OF 4 STROKE COMPRESSION IGNITION ENGINE BY USING DIESEL AND PROCESSED WASTE COOKING OIL BLEND

Neelesh Soni[1], Om Prakash Chaurasia[2]
[1]Assistant Professor, Dept. of Mechanical Engg., Shri Ram College of Engineering & Management, Banmore, Gwalior (M.P)
[2]Professor & Head, Dept. of Mechanical Engg., NIT, Patna (Bihar)
Email:neeleshsoni7@gmail.com[1]

Abstract

Due to future energy demand in the world it became necessary to focus on the alternatives of conventional fuel. To overcome this energy crisis it is also necessary to examine every aspect of performance of these substitutes in well manner so that they can fulfill the requirement of energy in an economic way. In this regard an experimental investigation of compression ignition engine have been carried out by using diesel and blend of biodiesel derived from waste cooking oil (WCO).

In the proposed work, waste cooking oil derived from hotels and restaurants has chemically processed in the laboratory of Delhi University. Chemical treatment included transestification, phase separation and filtration of waste cooking oil. After preparation, the blends of waste cooking oil with diesel in different proportions such as B5, B10, B20, B40, B60, and B80 have investigated in CI engine in varying load conditions. On the basis of observations and calculated results, it has observed that engine was running successfully while using different blends of WCO biodiesel without any modification of engine and it has concluded that among all WCO biodiesel blends, the specific fuel consumption, brake specific fuel consumption and brake thermal efficiency of B20 is quite comparable to that of diesel for the power variation 0 watt to 3000 watt. The temperature of exhaust gas was minimum (110°C) for B20 blend.

Keywords: CI engine, Waste cooking oil, Transistification, blending

1. INTRODUCTION

Compression ignition engine a type of internal combustion engine which has been employed for power generation since several years. These engines are operated by using conventional fuels like diesel fuel and operated on diesel cycle which includes two isentropic process, one constant pressure process and one constant volume process.

Heat addition takes place at constant pressure process and rejection at constant volume process [1]. According to the current scenario of energy, sources of these conventional fuel are continuously depleting and need of energy is in extreme point so it become very necessary to investigate the alternatives of conventional fuel and examine them to determine the utility of these alternatives [2].

In the particular context waste cooking oil derived from hotels and restaurants has considered as an alternative fuel which has been processed by transestification and filtration to obtain the properties of fuel nearby diesel and made suitable for diesel engine [3]. After chemical treatment it has blended with diesel in different proportion such as B5, B10, B20, B40, B60 and B80. After preparation of blend they were investigated in single cylinder four stroke diesel engine by determining the parameters such as Specific fuel consumption, Brake specific fuel consumption, Brake thermal efficiency and exhaust gas temperature.

For successful proceeding of experiments, concerned literature has been reviewed. Balat et al. [4] presented economic factor to consider for input costs of biodiesel production is the feedstock, which about 80% of the total operating cost. Other important costs are labor, methanol and catalyst, which must be added to the feedstock. Using an estimated process cost, exclusive of feedstock cost, of US$0.158/l for bio-diesel production, and estimating a feedstock cost of US$0.539/l for refined soya oil, an overall cost of US$0.70/l for the production of soy-based bio-diesel was estimate. Milind & Patil [5] represented the test results for blends 5% to 20%.For all fuel sample tested it is observed that with the loading of the engine at 2.138 kW. BTE of pure diesel and blend of diesel and ethanol was almost same. That of kerosene BTE was low compare with diesel and ethanol blend. For 20 % mixture of ethanol blend with diesel has a very good efficiency compared with pure diesel and blend of kerosene. Stalin and Prabhu [6] presented a review of the alternative technological methods that could be used to produce this fuel. Biodiesel from karanja oil was produced by alkali catalyzed transesterification process and results indicated that the dual fuel combination of B40 can be used in the diesel engines without making any engine modifications. The cost of dual fuel (B40) can be considerably reduced than pure diesel. Nantha et al. [7] described the energy and exergy analysis of a diesel engine integrated with a PCM (phase change material) based energy storage system, and provides more realistic and meaningful assessment than the conventional energy analysis.. It is observed through the analysis that 6.13% of the total energy of the fuel is saved using the TES system. From the exergy analysis, it is identified that only 0.47% of the chemical availability of the fuel is saved. The energy efficiency of the integrated system is found to be varying between 3.19% and 34.15%.In contrast, the energy efficiency, which incorporates the second law of thermodynamics for the integrated system, ranges from 0.25% to 27.41%. Singh and Rath [8] investigated the performance, emission and combustion characteristics of a diesel engine using different blends of methyl ester of karanja with mineral diesel. Karanja methyl ester was blended with diesel in proportions of 5%, to 100% by mass and studied under various load conditions in a compression ignition (diesel) engine. The exhaust gas temperature is found to increase with concentration of karanja methyl ester in the fuel blend due to coarse fuel spray formation and delayed combustion.

Jones et al. [9] indicated that vegetable oils can readily be used as a fuel source when the vegetable oils are used alone or are blended with diesel fuel. Long-term engine research shows that engine durability is questionable when fuel blends contain more than 20% vegetable oil by volume. More work is needed to determine if fuel blends containing less than 20% vegetable oil can be used successfully as diesel fuel extenders.

2. EXPERIMENTAL SETUP:

3. LISTS OF THE INGREDIENTS USED IN THE EXPERIMENT SETUP:

1. Foundation structure	2. Steel frame mountings
3. Internal combustion engine	4. AC alternator
5. Electrical Load panel	6.Temperature sensing device
7.Speedometer (Tachometer)	8. Air intake measurement system
9.Fuel intake measurement system	10.Diesel & WCO Biodiesel fuel

4. SPECIFICATION OF DIESEL ENGINE USED IN THE EXPERIMENT SETUP:

For conducting the experiments on CI engine a four stroke, single cylinder, vertical and water cooled diesel engine has employed made from Kirloskar oil engine India. Engine have the compression Ratio 17.5:1, Stroke and Bore are 110 mm and 87.5 mm, rated power output 7.5

HP/5.2 KVA and rated RPM is 1500. Engine is hand start and direct injection type.

5. PROPERTIES OF DIESEL AND WCO BIODIESEL BLEND PREPARED FOR THE EXPERIMENT:

Properties of diesel and WCO biodiesel blends have explained in the table at annexure 1. That includes the specification of diesel and blends of waste cooking oil such as B5, B10, B20, B40, B60, B80 and B100.

6. EXPERIMENTAL METHODOLY:

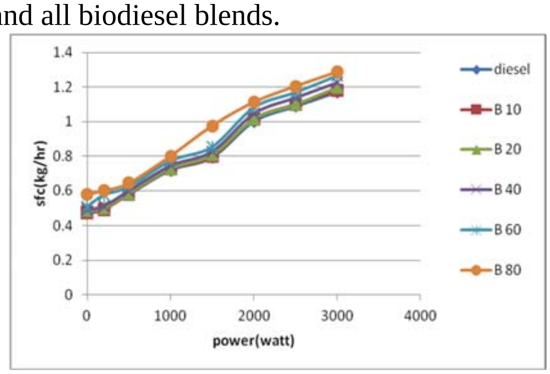
Conduction of the experiment on diesel engine by using diesel and WCO biodiesel blend included measurement of basic parameters like fuel consumption, RPM and temperature of exhaust gas while power varied from 0 watt to 3000 watt.

On the basis of this observation, parameters were calculated for diesel and different WCO biodiesel blend are specific fuel consumption, brake specific fuel consumption, brake thermal efficiency and exhaust gas temperature.

7. RESULTS AND DISCUSSION

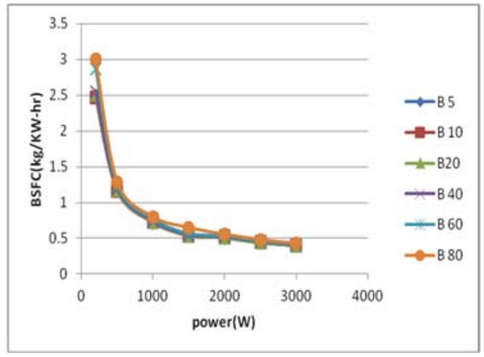
7.1 Variation specific fuel consumption with power for different blends:

It has been indicated by the graph that Specific fuel consumption was increasing when power increased on engine from 0 to 3000 kW for diesel and all biodiesel blends.



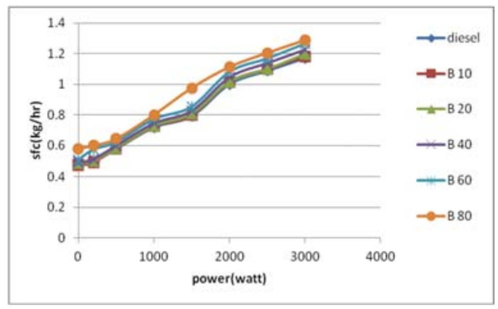
7.2 Variation of power with Brake specific fuel consumption (BSFC) for different biodiesel blends:

It has been indicated by the graph that brake specific fuel consumption was decreasing when power increased on engine from 0 to 3000 kW for diesel and all biodiesel blends.



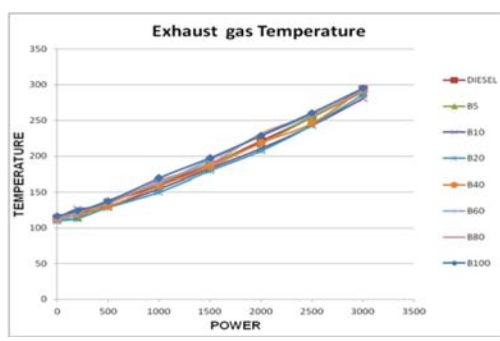
7.3 Variation of Power with Brake thermal efficiency (BTE) for different Biodiesel blends:

It has been indicated by the graph that Brake thermal efficiency was increasing when power increased on engine from 0 to 3000 kW for diesel and all biodiesel blends.



7.4 VARIATION OF TEMPERATURE EXHAUST GAS WITH POWER FOR DIESEL AND WCO BIODIESEL BLENDS

It has been indicated by the graph that exhaust gas temperature was increasing when power increased on engine from 0 to 3000 kW for diesel and all biodiesel blends.



8 CONCLUSIONS

After performing the successful experiment on CI engine by using diesel and various WCO blends, following major conclusions have been drawn from the results obtained.

- The specific fuel consumption has found optimum for the blend B20 and nearby diesel fuel for the power variation 0 watt to 3000 watt.
- Among all WCO biodiesel blends, the brake specific fuel consumption and brake thermal efficiency of B20 is quite comparable to that of diesel for the power variation 0 watt to 3000 watt.
- The temperature of exhaust is minimum (110°C) for B20 blend and maximum (295°C) for B100 for the power variation 0 watt to 3000 watt.
- Hence blend B20 may be used in the diesel engine without any engine modifications.

REFERENCES

[1] P. K. Nag, " Engineering Thermodynamics" Tata McGraw-Hill, Second edition, 2003,

[2] http//www.dieselpowermag.com, cited on 11/2013.

[3] Willard W. Pulkrabek, "Engineering fundamentals of the Internal Combustion Engine" PHI Learning New Delhi, second edition, 2010,

[4] Mustafa Balat, Havva Balat, 'A critical review of Biodiesel as a vehicular fuel' A Journal of energy conversion and management, 2008, VOL. 49.

[5] Milind, S., Patil, R., S., Jahagirdar, Eknath, R., Deore, "Performance Test of IC Engine Using Blends of Ethanol and Kerosene with Diesel" International Journal of Engineering Science and Technology, 2010, Vol. 2, 3503 – 3509.

[6] N. Stalin and H., J., Prabhu., "Performance test of IC engine using Karanja Biodiesel and blending with Diesel" A Journal of Engineering and Applied Sciences,October 2007, ISSN 1819-6608. Vol 2, Issue 5.

[7] K., Nantha, Rayapati Subbarao, V., Pandiyarajan and R. Velraj, 'Thermodynamic analysis of a Diesel Engine Integrated with a PCM based energy storage system' International journal of thermodynamics, March 2010, Vol.13 pp 15-21.

[8] R.,K., Singh and Saswat, Rath, "Performance analysis of blend of the Karanja methyl ester in a Compression Ignition engine" International Conference on Biomedical Engineering and Technology, 2011, vol.11.

[9] Sam Jones and Charles L. Peterson, "Using an Unmodified Vegetable Oils as a Diesel Fuel Extender" A Literature Review, University of Idaho, Moscow, Idaho.

[10] Amit pal and S.S. Kachhwaha. 'Waste cooking oil a promising feed stock for Biodiesel Production' American Journal of science and technology, 2014.

ANNEXURE

1. SPECIFICATION OF DIFFERENT BIODIESEL BLEND PREPARED FOR THE EXPERIMENT-

Sn.	Fuel type	Proportion of fuel in Volume (ml)	Density (kg/m^3)
1	Pure Diesel	100% Diesel	831
2	B 5	5% WCO Biodiesel + 95% Diesel	833.78
3	B 10	10% WCO Biodiesel + 90% Diesel	836.5
4	B 20	20% WCO Biodiesel + 80% Diesel	842
5	B 40	40% WCO Biodiesel + 60% Diesel	853
6	B 60	60% WCO Biodiesel + 40% Diesel	864
7	B 80	80% WCO Biodiesel + 20% Diesel	875
8	B 100	100% WCO Biodiesel	886

2. COMPARATIVE SPECIFICATIONS OF DIESEL AND BIO DIESEL FUEL

Property	Unit	Acceptable limit	Diesel ASTM D975	WCO Biodiesel
a- Density at 15°C	Kg/m^3	860-900	831	886
b- Kinematic viscosity at 40°C	m^2/s	$(3.5 - 5)\times10^{-6}$	$(2.5 - 6)\times10^{-6}$	4.3×10^{-6}
c- Flash point	°C	Min 100	51	>210
d- Sulphur contents	PPM	Max 350	500	<120
e- Water content	w/w%	0.02-0.05	0.005	>0.04
f- Calorific value	MJ/kg	….	42	36.34