PERFORMANCE EVALUATION AND EMISSION ANALYSIS OF 4- S, I.C. ENGINE USING ETHANOL BIO-DIESEL BLENDED WITH DIESEL FUEL

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Abstract

Environment air pollution and global warming are alarming concern worldwide. Increasing air pollution, rapid growth of industrialization and the global trend of urbanization have totally disturbed the eco balance of resources on earth. The present study was done to visualize the potential of ethanol and biodiesel as an alternative fuel in C.I. engine. The salient features of the investigation include: (i) The study of basic fuel properties of ethanol, biodiesel and their blends with diesel for C.I. engine. (ii) To evaluate the potential of using biodiesel, ethanol and their blends with diesel for C.I, engine. (iii) Study of the engine performance and exhaust emission characteristics for various blends. Experiment set up was developed to carryout engine performance and emission characteristic studies on selected fuel blends at different load conditions. The present work has resulted in giving a good insight into the performance and emission characteristics of the C.I. engine using ethanol, biodiesel, diesel fuel blends. As fuel property point of view density and pour point of all the fuel blends are under the standard limits for diesel fuel. Heat of combustion of all blends is found to be lower than that of diesel fuel alone. D70B20E10 give lower CO and HC emission and slightly higher thermal efficiency than other blends

Keywords: *Heat exchanger, Flow induced vibration, TEMA, HTRI*

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1. INTRODUCTION:

Energy is very important for life quality and social development of people as well as economic growth Fossils fuels have been an important conventional energy source for years. Energy demand around the world is increasing at a faster rate as a result of ongoing trends in industrialization and modernization. Most of the developing countries import fossil fuels for satisfying their energy demand. Consequently, these countries have to spend their export income to buy petroleum products. The climate changes occurring due to increased carbon dioxide emissions and global warming, increasing air pollution and depletion of fossil fuels are the major problem in present century. The present researchers have been focus on bio-fuels as environment friendly energy source to overcome above two problems. Bio-ethanol, bio-diesel and to a lesser extent pure vegetable oils are recently considered as most promising bio-fuels. Ethanol is low cost oxygenated compound with high oxygen content (34.8%). Ethanol is an alcohol most often chosen because of ease of production, can be obtained from various kinds of biomass such as maize, sugarcane, sugar beet, corn, cassava, red seaweed etc., relatively low-cost toxicity Applications in transport sector are based on liquid fuels. The advantage of liquid fuels is that they are easy to store. Gaseous fuels are less utilized in transport sector. However, today transport fuels are classified into two basically different categories: fossil fuels which are mainly based on crude oils and natural gas, and bio-fuels made from renewable resources. Bio-fuels have some common characteristics although process for bio-fuels can be very different.

1.1 Ethanol as Blending Component for Diesel:

The use of alcohols in mixtures with diesel is limited to anhydrous ethanol, since methanol is practically insoluble in diesel. The use of ethanol/diesel mixtures increases the ignition's lag time due to the low cetane number of ethanol. There are a number of fuel properties that are essential to the proper operation of diesel engine. The blended fuel is expected to comply with such properties as per standards of diesel. The addition of ethanol to diesel fuel affects certain important properties like blend stability, viscosity, viscosity, flash point, lubricity energy content and cetane number. The blended fuel therefore requires cetane improvers to be added. In fuel injection pump system the fuel has an important role for lubrication. The addition of ethanol to diesel lower fuel viscosity and lubricity .Lubricity of the fuel is characterized by two ASTM tests, the Scuffing Load Ball –on Cylinder Lubricity Evaluator (SBCLE), ASTM D-6078-99 and High Frequency Reciprocating Rig (HERR), ASTM D-6078-99. Since ethanol addition reduces the lubricity of the resultant fuel, therefore, addition of lubricity additives are also incorporated in the emulsifying packages developed by various companies. However, in case of ethanol-diesel blends static discharge may not be as much of an issue because of the higher conductivity of ethanol.

1.2 Biodiesel.

- Biodiesel is non toxic & environmental friendly as it produces substantially less carbon monoxide and 100% less sulfur dioxide emissions with no unburnt hydrocarbons and thus it is ideal fuel for heavily polluted cities. Biodiesel reduces serious air pollutants such as particulates and air toxicity.
- Due to its less polluting combustion, biodiesel provides a 90% reduction in Cancer risks and neonatal defects.
- Biodiesel has good potential for rural employment generation
- Just like petroleum diesel, bio-diesel operates in compression ignition engine; which essentially require very little or no engine modifications because bio-diesel has properties similar to petroleum diesel fuels.
- It can be stored just like the petroleum diesel fuel and hence does not require separate infrastructure.
- The use of bio-diesel in conventional diesel engines results in substantial reduction of un-burnt hydrocarbons, carbon monoxide and particulate matters.
- Bio-diesel is considered clean fuel since it has almost no sulphur, no aromatics and has about 10 % built- in oxygen, which helps it to burn fully.
- Its higher cetane number improves the ignition quality even when blended in the petroleum diesel.
- For new vehicles, a drastic reduction in sulphur content (< 350 ppm) and higher cetane number (>51) will be required in the petroleum diesel produced by Indian Refineries. Bio-diesel meets these two important specifications and would help in improving the lubricity of low sulphur diesel.
- The present specification of flash point for petroleum diesel is 35°C which is lower than all the countries in the world (>55°C). Bio-Diesel will help in raising the flash point, a requirement of safety.
- B20 (a blend of 20 percent by volume bio-diesel with 80 percent by volume petroleum diesel) has demonstrated significant environmental benefits with a minimum increase in cost for fleet operations and other consumers.
- Bio-diesel is registered as a fuel and fuel additive with the US Environmental Protection Agency and meets clean diesel standards established by the California Air Resources Board.

2. SPECIFICATIONS OF THE ENGINE:

TABLE 2.1 Specifications of the engine

2	Model	Single cylinder 4-stroke diesel engine ,water cooled engine
3	Brakepower	3.7 kW (5 H.P.)
4	Speed	1500 r.p.m.
5	S.F.C.	251 gm/kWhr
6	Lubricant oil	SAE 30/40
7	Type	VCR

3. ACTUAL EXPERIMENTAL SET-UP

INSTRUMENTATION:

A single cylinder 4-stroke water-cooled compression ignition engine manufactured by Rocket Engineering Corp. Ltd., Udhyamnagar, Kolhapur was used in the present experimental investigation as shown in Fig.

Fig.3.1 Single cylinder 4-stroke Diesel

Engine Following instruments were used to measure various parameters of performance and emission characteristics of the said engine.

4. EXPERIMENTAL PROCEDURE:

The engine was started with neat diesel as fuel at no load by pressing the inlet with decompression lever and it was released suddenly when the engine was hand cranked at sufficient speed and it was allowed to run about half an hour till the steady state conditions reached.

The engine was then loaded gradually from no load to full load (i.e. 0% to 100%) in the step of 20% keeping the speed within the permissible range and the observations of different parameters were recorded.

With the fuel measuring apparatus and stop watch the time elapsed for the fuel consumption for 25 cc of fuel was measured.

The other observations recorded were brake load reading, engine speed, exhaust gas temperature, cooling water inlet & outlet temperatures etc. Besides these parameters, CO (carbon monoxide), HC (hydro carbon) emissions were also measured.

This experiment was taken into account to prepare base line data for neat diesel. The various blends of jatropha oil methyl ester, ethanol with diesel that was tested on same engine in the same manner as described above are as follows:

(1) D80B15E5:
(2) D70B20E10:
(3) D70B25E5:

Sr. No.	Brake Load (W)	Speed (N)	Time For 100cc Fuel Consu.	Cooling Water		Exhaust Gas Temp.	Exhaust Emissions	
				Inlet Temp.	Outlet Temp.		CO	HC
Unit	kg	rpm	Second	℃	℃	℃	%	ppm
1	0	1560	750	30	34	70	0.008	10
2	3	1550	550	30	36	78	0.01	30
3	6	1520	360	30	37	90	0.028	30
4	9	1510	290	30	41	114	0.037	40
5	12	1500	270	30	43	125	0.05	43

Sr. No.	Brake Load (W)	Speed (N)	Time For 100cc Fuel	Cooling Water		Exhaust Gas Temp.	Exhaust Emissions	
				Inlet	Outlet		CO	HC
Uni	kg	rpm	Secon	℃	℃	℃	%	ppm
1	0	1560	770	30	35	72	0.01	12
2	3	1550	550	30	36	80	0.02	14
3	6	1520	340	32	38	95	0.03	15
4	9	1510	306	32	40	107	0.03	17
5	12	1500	290	30	42	118	0.03	19

Sr. No.	Brake Load (W)	Speed (N)	Brake Power	Fuel Consu.	Brake Spec. Fuel Consu.	Brake Spec. Energy Consu.	Brake Thermal Effi.	Exhaust Gas Temp	Exhaust Emissions	
									CO	HC
Unit	kg	rpm	kW	gm/hr	gm/kW hr	kJ/kWhr	%	℃	%	ppm
1	0	1560	0	420	0	0	0	70	0.00	10
2	3	1550	0.956	572.72	599.08	24338.51	14.79	78	0.01	30
3	6	1520	1.875	875	466.67	18958.8	18.98	90	0.02	30
4	9	1510	2.79	1086.20	389.32	15816.57	22.76	114	0.03	40
5	12	1500	3.71	1166.67	314.46	12775.47	28.17	125	0.05	43

Sr. No.	Brake Load (W)	Speed (N)	Brake Power	Fuel Consu.	Brake Spec. Fuel Consu.	Brake Spec. Energy Consu.	Brake Thermal Effi.	Exhaust Gas Temp.	Exhaust Emissions	
									CO	HC
Unit	kg	rpm	kW	gm/hr	gm/kWhr	kJ/kWhr	%	℃	%	ppm
1	0	1560	0	409	0	0	0	72	0.01	12
2	3	1550	0.956	572.72	599	24484.7	14.72	80	0.02	14
3	6	1520	1.875	926.47	494.11	20169.8	17.84	95	0.03	15
4	9	1510	2.79	1029.41	368.96	15061.1	31.78	107	0.03	17
5	12	1500	3.71	1086.20	292.77	11951.2	30.12	118	0.03	19

6: RESULTS AND DISCUSSION

6.1BRAKE SPECIFIC FUEL CONSUMPTION:

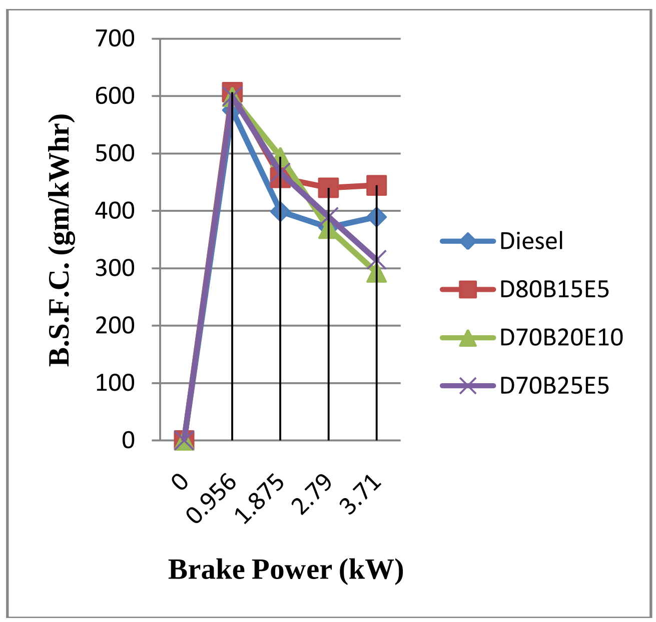


Fig 6.1 B.S.F.C.(gm/kW-hr) Vs B.P.(kW)

Brake Specific Fuel Consumption (B.S.F.C.) is the fuel consumed by the engine per unit of power output or produced. For fuel tested, decrease in B.S.F.C. was found with increase in brake power. It can be seen from this graph that as Brake Power increases, B.S.F.C. decreases to minimum at full load condition. By observing related results at full load engine condition, the value of B.S.F.C. for D70B20E10 blend is minimum. As compared to diesel, calorific value of biodiesel is less, so slight rise in Brake Specific Fuel Consumption was found in the blends D80B15E5, D70B20E10, D70B25E5 than Diesel fuel.

6.2 BRAKE SPECIFIC ENERGY CONSUMPTION:

Brake Specific Energy Consumption (B.S.E.C.) is the energy used by the engine to produce unit power. For fuel tested, decrease in B.S.E.C. was found with increase in brake power. It can be seen from this graph that as Brake Power increases, B.S.E.C decreases to minimum at full load condition by observing related results at full load engine condition, the value of B.S.E.C. for D70B20E10 blend is minimum. As compared to diesel

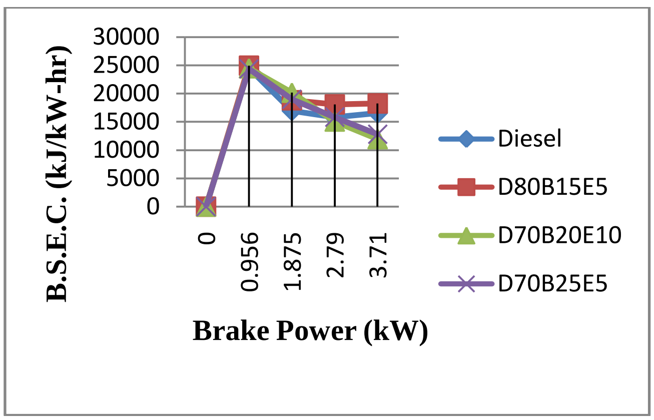


Fig 6.2 B.S.E.C.(kJ/kW-hr) Vs B.P.(kW)

Calorific value of biodiesel is less, so slight rise in Brake Specific Energy Consumption was found in the blends D80B15E5, D70B20E10, D70B25E5 than Diesel fuel.

6.3 BRAKE THERMAL EFFICIENCY:

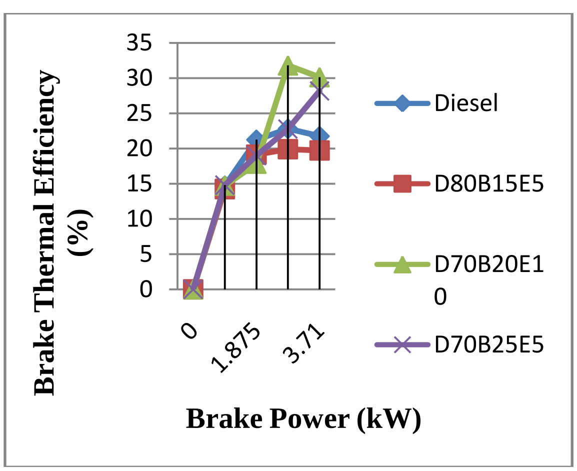


Fig6.3 BRAKE THERMAL EFFI (%) Vs B.P. (kW)

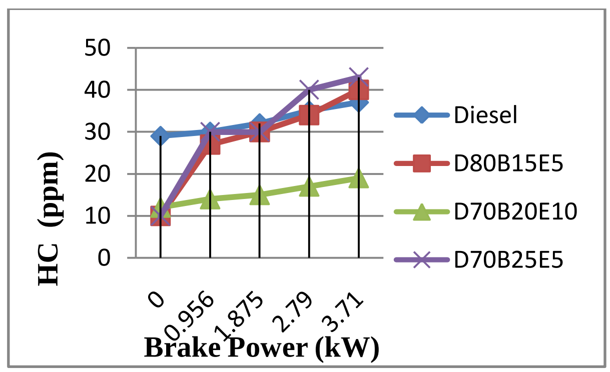
Brake Thermal Efficiency is the ratio of the power output of the engine to the rate of heat liberated by the fuel during the combustion. For the fuel tested, increase in Brake Thermal Efficiency was found with increase in brake power. It can be seen from this graph that at medium load the Brake Thermal Efficiency of diesel fuel is slightly higher than D80B15E5, D70B20E10, D70B25E5 blends. But at higher load the Brake Thermal Efficiency of D70B20E10 is than others.

6.4 ENGINE EMISSION GRAPHS &DISCUSSIONS

6.4.1 HYDRO CARBON (HC):

Fig. 5.4 HC (ppm) Vs B.P. (kW)At different load conditions, Hydrocarbons (HC) were recorded by "Gas Analyzer" for various blends of diesel, biodiesel and ethanol i.e. D80B15E5, D70B20E10 and D70B25E5. The partially decomposed and oxidized fuels in exhaust, which are unburnt species, are collectively known as unburnt hydrocarbon emissions.Fig:5.4.shows graph for variation of HC emission with respect to brake power for various blends of diesel, bio-diesel and ethanol. HC emission for diesel fuel is slightly higher at low load than other three blends.

6.4.2 CARBON MONOXIDE (CO):



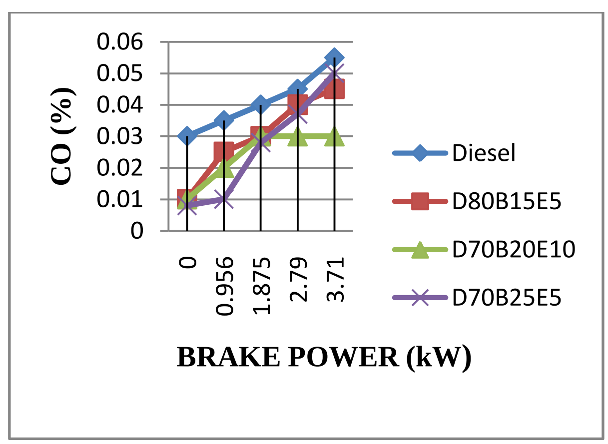


Fig. 5.5 CO (%) Vs B.P (kW)

At different load conditions, Carbon Monoxide (CO) was recorded by Gas-Analyzer for various blends of diesel, biodiesel & ethanol i.e. D80B15E5, D70B20E10, D70B25E5. Fig. 5.5 shows graph for variation of CO emission with respect to brake power for various blends of diesel, biodiesel and ethanol. It can be seen from graph that the CO emissions are low for various blends than diesel fuel because the biodiesel has higher cetane number than diesel fuel.

CONCLUSIONS:

- Following are the conclusions based on the experimental results obtained while operating on single cylinder diesel engine fuelled with biodiesel, ethanol, & its diesel blends.
- Engine can be run with biodiesel, ethanol and its diesel blends, i.e. D80B15E5, D70B20E10, & D70B25E5 without any abnormality and engine modification.
- As fuel properties point of view density and pour point of all the fuel blends under the standard limits for diesel fuel
- Due to higher density, lower calorific value of biodiesel and lower density, lower calorific value of ethanol , brake thermal efficiency of these fuel blends in sequence of D80B15E5, D70B20E10, & D70B25E5 are observed slightly lower compared to diesel & B.S.F.C. and B.S.E.C. are slightly higher for these blends in same sequence.
- As biodiesel has higher cetane no. & more oxygen compared to diesel & ethanol both, which acts as combustion promoter inside cylinder, resulting in to better combustion of fuel so, HC emission for D70B20E10 fuel blend are observed lower than the all fuel/fuel blends & higher in case of D80B15E5 fuel blend.
- Concerning CO emissions, they differ with the engine loads. At medium load, CO emission for D70B20E10 fuel blend is observed lower than the other fuel blends.
- Compared to diesel & ethanol, biodiesel has higher viscosity so for better combustion nozzle opening pressure should be kept on higher side compared to that in case of diesel when D70B20E10 fuel blend is used.
- On the basis of above conclusions, it is recommended that D70B20E10 fuel blend can be efficiently used in diesel engines.

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