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Experimental Investigation of Performance and Emissions of VCR Diesel Engine Fueled with Soya-Seed Biodiesel

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ABSTRACT: In the current experimentation, which studied the performance characteristics of VCR diesel engine of single cylinder eddy current dynamometer with variable compression loads by using different bio diesels derived from the soya seed with the transesterification process. The bio diesels were composed of mixing with diesel of 10%, 20%, 30% named as BS10, BS20 and BS30. The investigation has carried out at constant speed and the parameters like brake thermal efficiency (BTE), indicated thermal efficiency (ITE), brake specific fuel consumption (BSFC) and exhaust emissions parameters were found at loads of no load, 89.51 N, 134.26 N and 179.03 N. Hence it was noted that the amount of reducing emissions like CO, HC, PM and subsequent increasing of NO_x were observed.

KEYWORDS: Soya methyl ester, Biodiesel, Specific Fuel Consumption, Brake Thermal Efficiency, Indicated Thermal Efficiency, Emissions.

I. INTRODUCTION

In Energy crisis has aggravated the world due to the rapid depletion of fossil fuels and environmental degradation [1]. Due to the reduction in the world's petroleum reserves and growing environmental concerns, there is an extensive demand for non-conventional sources of energy [2]. Augmented regulations on particulate matter and NO_x, and also issues raised on greenhouse gas emission like CO₂ are the reasons for demanding research work on bio-fuels all over the world [3-6]. Biodiesel derived from the trans-esterification of fats and oils [7-11] is a possible fuel for diesel engines. The properties of this fuel are comparable to that of diesel and can be used directly to run existing diesel engines or as a blend with crude oil diesel [12]. Biodiesel is renewable, biodegradable and non-toxic. With diesel, it increases fuel lubricity and operates in compression ignition engines with little or no modification [13]. Furthermore, biodiesel offers compensations regarding engine wear, cost and availability [14, 15]. Pollutants produced are less harmful comparatively. Biodiesel has low Sulphur content, low aromatic content and oxygen containing compounds due to which the emissions of SO₂, CO₂, HC and PM are reduced. Besides, it has good ignition ability in engine owing to its high cetane number compared to that of conventional diesel fuel [10]. The trans-esterification process is based on the chemical reaction between a triglyceride with an alcohol in the presence of a catalyst, potassium hydroxide, to produce biodiesel and glycerin. Castor, palm, sunflower, peanut and soybean oils can be used as biodiesel sources [24], but all of these are used for cooking purposes. Hence, instead of using edible oils for the production of biodiesel, non-edible oils can be used for the same. Low-cost renewable raw material is a very important requirement for economical production of biodiesel. Biodiesel produced from waste fish oil is a very good and low-cost alternative to petroleum diesel. The fish processing industry generates large quantities of tissue waste and byproducts which are either discarded or retailed at low values for fertilizer or animal feeds. A better way to utilize these byproducts is to convert them into biodiesels for use in diesel engines. India has one of the longest coastal areas in Asia and has excellent potential for fish and fish products including Fish meal and Fish oil [30]. Locally produced fish oil biodiesel blend fuels have the potential to create sustainable energy supply for use in remote regions, together with dramatic cost savings and reduced dependence on imported petroleum products. Easy-to manufacture, cleaner-burning fish oil biodiesel and its blends could potentially replace or reduce traditional diesel fuel requirements in India. This paper presents the experimental results of using 20% JOME and 20% FOME blend on the performance and emission characteristics of the engine. This work brings out the possibility to partially replace diesel to reduce dependence on petroleum-based diesel fuel. The use of animal fat to produce biodiesel has attracted public interest recently. The search for aquatic sources for energy



production makes economic sense as well as ecological sense. Also, the fish oil obtained has long carbon chain fatty acids which makes combustion to be efficient and reduces carbonaceous emissions greatly. In addition to the purified fish oil obtained from the wastes in the fishing industry, caustic soda is added. Eventually methanol is produced. One kg of fish oil waste can produce up to 1.13 lots of bio-diesel. Glycerin is a valuable byproduct obtained, which is used for pharmaceutical and cosmetic purposes. In Alaska, roughly 8 million gallons of fish oil is produced each year. Most of the oil is used as boiler fuel for drying the fish meal, while smaller quantities are blended with diesel and used for power production. In 2005, the Food and Agricultural Organization (FAO) estimated the world fish production at 142 million tons, of which 25% is destined for producing fish meal and oil. In 2008, the number of wastes was around 50% of the total fish production and the oil produced ranged from 40- 65%. Based on the above literature survey, the use of J20 and F20 blends with diesel was investigated in this work. The experimental results showed that the above blend can be used as a partial replacement for diesel to reduce dependence on petroleum-based diesel fuel.

II. MATERIALS AND METHODS OF PREPARING BIODIESEL

Transesterification of Soya seed methyl ester (SME)

The soya seeds were taken for the experimentation from the near cultivation market and the raw soya seed oil extracted at oil mill. The methyl ester was made by amalgamation of soya seed by using of transesterification process. The raw oil has done filtration by removing impurities after that oil is heated up to the temperature of 65°C. Two jars of one liter capacity, magnetic stirrer, soyabean oil, 100ml of methanol and 3ml of Sulphuric acid (H_2SO_4) used as catalyst and small amount of phosphoric acid (H_3PO_4) was used. This is called acid treatment and it's poured into the decanter followed by 4-5hrs of time is required to settle and its separate the pulp from acid treated oil.



(a) VCR diesel engine Kirloskar



(b) Heating of raw soyabean



(c) After mix of acid and methanol



(d) NAOH pellets in methanol with stirrer



(e) Oil after base treatment



(f) Separation of glycerol from biodiesel

Fig. 1 (a-f) Shows different stages of preparing biodiesel

III. EXPERIMENTAL PROCEDURE

The experimentation was done on the VCR diesel engine on varying different loads like no load, 89.51 N (9.14kgf) load, 134.26N (13.6kgf) and 179.03 N (18.25kgf) to test its performance characteristics using diesel as main fuel with a speed of 1500rpm and the soya seed biodiesel blends such as BS10, BS20 and BS30 are used as alternatives in diesel engines. Kinematic viscosities of the blends were determined with respect to time (secs) using Redwood viscometer and for every load measuring the corresponding HC, CO, CO₂ and NO_x emissions are measured using with Exhaust gas digital analyzer. With respect to above the ITE, BTE and SFC were measured and the graphs has plotted for the better comparison of results.

Table.1 Properties of test samples

S.NO	TYPE OF FUEL	DENSITY (kg/m ³)	FLASHPOINT (°C)	FIRE POINT (°C)	CALORIFIC VALUE (kJ/kg)	KINEMATIC VISCOSITY (m ² /sec)
1	DIESEL	830	82	94	42000	0.01104279
2	SOYA SEED	890	110	85	39870	0.0000553
3	BS10	837	125	95	39380	9.2902e-7
4	BS20	839	135	120	39200	8.37e-8
5	BS30	845	190	180	39200	3.5392e-7



Table.2 Engine specifications

ITEM	SPECIFICATION
Engine	Single cylinder, four strokes diesel engine with eddy current dynamometer
Speed	1500 rpm
Stroke (l)	110mm
Bore(D)	80mm
Max power (P)	4.5HP

IV. RESULTS AND DISCUSSIONS

The experimental results compared with the diesel and biodiesel blends were with the normal diesel fuel which attributed the performance and percentage of releasing harmful gases were noted.

Performance Characteristics

The variation of brake thermal efficiency and indicated thermal efficiency of calculating with different loads at the compression ratio of 18:1 was compared with the mixed blends and the results indicate that the biodiesel blend SB20 with shows the low fuel consumption than diesel and other blends as shown in the below figure (1).

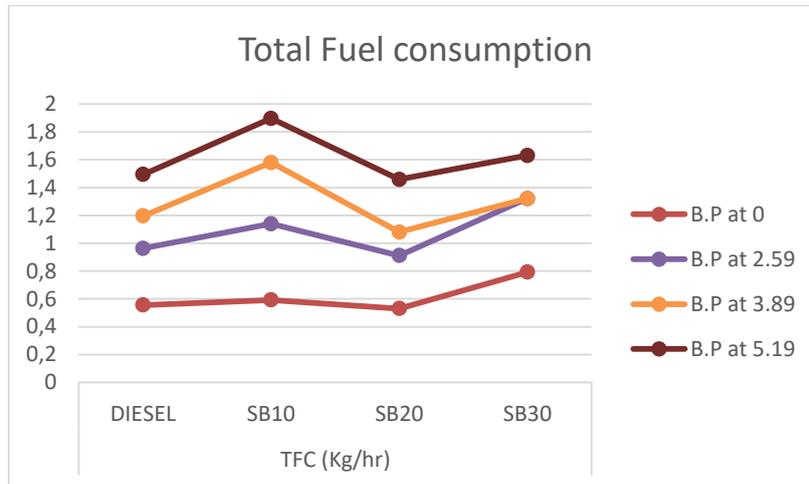


Fig.2 Shows the graph of Total fuel consumption at different brake power

The brake thermal efficiency and brake power variations for different fuels considered for the present analysis is presented in fig.2 the brake thermal efficiency of B20 is very close to brake thermal efficiency of diesel SB20 can be suggested as best blend for preparation biodiesel with mix of soyabean oil. In all cases BTE brake thermal efficiency has the tendency to increase with increase in applied load which is due to the reduction in heat loss and also increase in power developed with increase in loads.

The variation of η_{bth} with brake power for different percentages of adding methyl compounds with the gasoline makes the mixture gets higher BTH which improves the combustion efficiency. BTH (η_{bth}) is based on brake power and on calorific value of the particular fuels. From the results and graph has plotted it was noted that brake thermal efficiency is lower at low values of brake power (B.P) and is increasing with an increase of B.P for all biofuels.

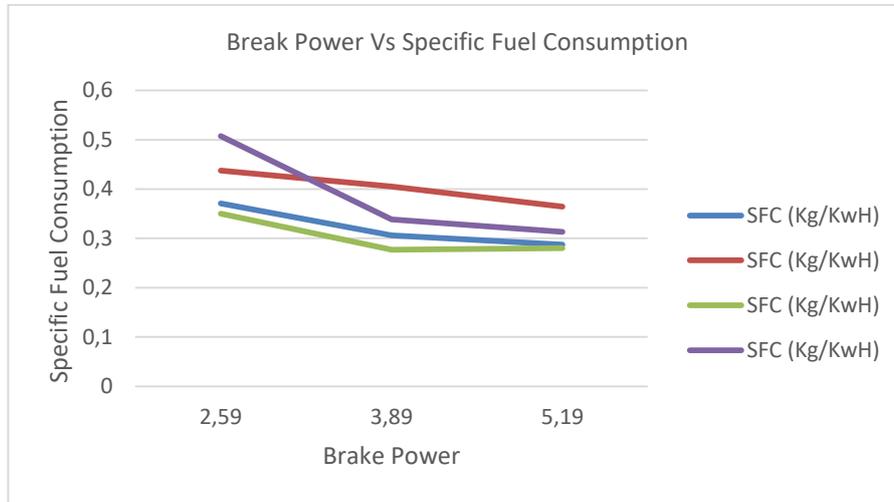


Fig.3 Shows the graph of BP Vs SFC

Emission Characteristics

The emission characteristics at maximum and minimum loads have been found out by using exhaust gas analyzer were identified as compare the values of amount of CO, HC, CO₂ and PM are decreasing with addition of soya seed methyl ester oil to the diesel and also getting better Nox has raised at two loads 89 N and 179 N which has given in the below tables.

Table.3 Emissions of fuels used in diesel engine at 89N load

S.NO	FUEL	LOAD	BP	gm/bp-hr				
				CO	HC	Nox	CO ₂	PM
1	DIESEL	89.51	2.59	1.51	0.72	4.23	654	0.197
2	SB10	89.51	2.59	1.43	0.63	4.38	657	0.186
3	SB20	89.51	2.59	1.32	0.56	4.46	667	0.175
4	SB30	89.51	2.59	1.14	0.51	4.52	673	0.173

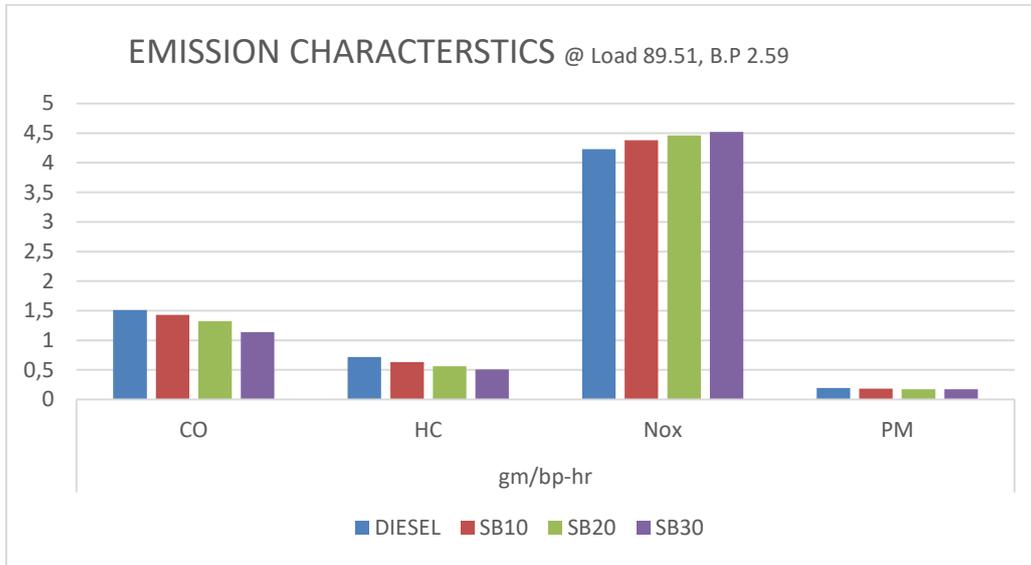


Fig.4 Shows the graph of Emission characteristics at Load 89.51 and B.P 2.59

Table.4 Emissions of fuels used in diesel engine at 179N load

S.NO	FUEL	LOAD	BP	gm/bp-hr				
				CO	HC	Nox	CO2	PM
1	DIESEL	179.51	5.2	1.79	0.72	4.42	686	0.199
2	SB10	179.51	5.2	1.67	0.42	4.41	667	0.276
3	SB20	179.51	5.2	1.52	0.42	4.46	664	0.261
4	SB30	179.51	5.2	1.61	0.38	4.46	676	0.216

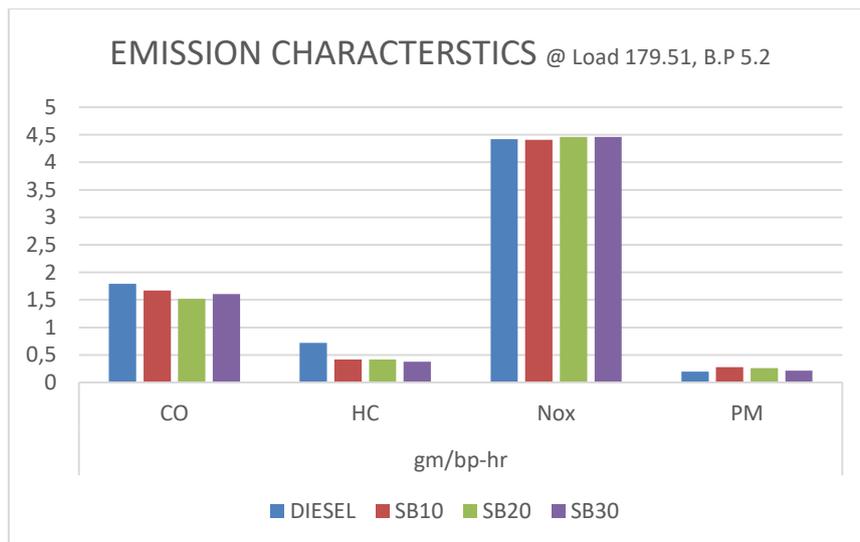


Fig.5 Shows the graph of Emission characteristics at Load 179.51 and B.P 5.2

V. CONCLUSION

In this experimental study was concluded that the maximum indicated thermal efficiency (49.61%) and brake thermal efficiency (23.62%) regenerated by the SB20 soya methyl ester blend was getting best results than the that of



diesel fuel operations, So the SB20 is very close to diesel characteristics suited as alternate fuel in general to this the flashpoint and fire point were calculated with the changes of kinematic viscosities of different blends at different densities and temperatures. The rate of heat releases in the premixed combustion phase of diesel higher than that of biodiesel blends. Both the rate and maximum value of heat release decreased with the higher percentage of Soya seed ester in the blends. In particular the reducing of exhaust emissions were identified and increasing of NO_x gives engine timing while subsequently maintain the emissions reductions with fuelling of 20/80 soya-methylester have no negative obstruction on engine performance.

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