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Experimental Investigation of Performanec of Single Cylinder 4s Diesel Engine Using Dual Vegetable Oil Blended

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ABSTRACT
Over the last two decades there has been a tremendous increase in the number of automobiles and a corresponding increase in the fuel price. In this regard, alternative fuels like vegetable oils play a major role. Use of pure vegetable oil in diesel engines causes some problems due to their high viscosity compared with diesel fuel. To solve the problems due to high viscosity various techniques are used. One such technique is fuel blending. This paper investigated the performance parameters of dual vegetable oil blends (mixture of Mustard oil and Palm oil) with diesel on a stationary single cylinder, four stroke direct injection compression ignition engine. The blends of BB 10 (combination of Diesel 90% by volume, Mustard oil 5% by volume and Palm oil 5% by volume) and blends of BB 20 (combination of Diesel 80% by volume, Mustard oil 10% by volume and Palm oil 10% by volume) gave better brake thermal efficiency, lower total fuel consumption and lower brake specific fuel consumption than other blends (BB 30, BB 40 and BB 50).
Key word: Diesel engine, Mustard oil, Palm oil, Performance parameters, Specific gravity, Flash point, Fire point.

I. INTRODUCTION

Vegetable oils have some advantages. They are renewable, easily available in the rural areas, have high cetane number, heat release rate is similar to diesel, it's emission rate is relatively low to be used in Compression Ignition engines with simple modifications and can be easily blended with diesel. Jatropha oil, sesame oil, coconut oil, sunflower oil, neem oil, mahua oil, peanut oil, palm oil, rubber seed oil, cotton seed oil and rape seed oil are some of the vegetable oils that have been tried as fuel in Internal combustion engines.

The use of vegetable oils as an alternative fuel for diesel engines dates back to around a century. Due to rapid decline of crude oil reserve and increase in price, the use of vegetable oils is again prompted in many countries. Depending upon soil condition and climate, different nations are looking for different vegetable oils for example, soybean oil in U.S.A., Mustard oil in Bangladesh, rapeseed and sunflower oil in Europe, palm oil in Malaysia and Indonesia, coconut oils in Philippines are being considered to substitute of diesel fuel.

II. OBJECTIVE

The aim of the present study is to evaluate the performance using different blends of palm oil and mustard oil with diesel in a CI engine. The following are the major objectives to fulfil the aim of present study.

1. Extraction of palm oil from palm seeds.
2. Determination of physical properties of palm oil, mustard oil and diesel.
3. Study of effect of dilution on properties of blending of palm oil and mustard oil with diesel.
4. Performance evaluation of Diesel engine using different blends of palm oil and mustard oil with diesel.

III. EXPERIMENTAL SETUP

ENGINE: The engine is water cooled single cylinder four stroke constant speed diesel engine 5 H.P Make Kirloskar.

Figure 1 : Setup of single cylinder four stroke diesel engine

Rope Brake Dynamometer: A rope brake dynamometer is supplied with the engine coupled with the flywheel of engine.

Load indicator: It indicates the load in kg range 0-20 kg Make Harrison.

M.S. Base Frame: The engine and the dynamometer are mounted on a solid M.S. Channel Base Frame.

Instrumentation for measuring various inputs/outputs: All instrumentation is incorporated on a control panel. The various factors to be measured are as follows:

- **Fuel measurement:** This is done by using burette which is mounted on the control panel. The fuel tank is mounted on panel. The fuel is supplied to engine using a fuel line to fuel injection system. The amount of fuel consumed is determined by the change in the readings shown on the burette. A three –way cock is used both to fill the burette and to allow the fuel to flow to the engine
- **Air flow measurement:** Air flow is measured using an air box Orifice is fixed in the inlet of air box suction pressure difference across the orifice is read on the U-tube manometer mounted on the panel. The outlet of the air suction box goes to the engine through the flexible hose for air suction.
- **Temperature measurement:** For heat balance analysis the PT-100 sensors are connected at exhaust gas calorimeter and engine cooling.

Table:1Engine Specification

Sr. no.	Items	Specifications
1	Model	KIRLOSKAR, AV1
2	Compression ratio	19:1
3	Method of starting	Hand starting
4	Type, no. of cylinders	Vertical–4stroke,1cylinder
5	Bore x stroke(mm)	87.5x110
6	Cubic capacity	624
7	Maximum power	5 Hp
8	Nominal speed	1500 rpm
9	Cooling system	Water-cooled
10	Fuel filter	Present
11	Lube oil filter	Present

IV. BLENDED OILS WITH DIFFERENT PERCENT'S OF DIESEL, MUSTARD OIL AND PALM OIL

FIG:1
(90% Diesel+5% Mustard oil+5% Palm oil)

FIG.:2
(80% Diesel+10% Mustard oil +10% Palm o

FIG:3
(70% Diesel+15% Mustard oil +15% Palm oil)

FIG:4
(60% Diesel+20% Mustard oil+20% Palm o

FIG:5
(50% Diesel+25% Mustard oil+25% Palm oil)

FIG:6
(All Sample)

V. EQUIPMENTS USED FOR THE EXPERIMENT

FIG.:1 (PENSKY MARTINS)

FIG.:2 (PRECISION BALANCE))

FIG.:3 (PYCNOMETER)

FIG.:4 (TECHOMETER)

FIG.:5 (PIPETTE)

FIG.:6 (STOPWATCH)

FIG.:7 (PLASTIC JAR)

FIG.:8 (NOB)

Table: 2Properties of Diesel, Palm oil, Mustard oil and its blends

Fuel	Density(Kg/m^3)	Calorific value(KJ /Kg)	Flash Point(^0C)	Fire Point(^0C)
Diesel	825.9	44000.0	72	210
Mustard oil	925.24	32390.0	297	343
Palm oil	918	40000.0	267	296
BB 10	818	43219.5	85	95
BB 20	864	42439.0	92	110
BB 30	909	41658.5	105	126
BB 40	936	40878.0	123	148
BB 50	955	40097.5	145	172

VI. EXPERIMENTAL PROCEDURE

- Fill the fuel tank with the fuel.
- Start the cooling water supply to the engine and the calorimeter.
- Fill the burette with the fuel.
- Switch on the control panel.
- Start the engine with cranking handle provided.
- Note down the readings in the observation table.
- Load the engine gradually by providing weights on the loading hanger.
- Note down the reading, for various load.

VII. CALCULATIONS

The basic performance parameters that were determined for performance evaluation of engine are:

- Brake Power
- Brake thermal efficiency

Brake specific fuel consumption
Total fuel consumption

Various formulae that were used for performance evaluation are listed below:
The brake power is calculated by measuring load on dynamometer and engine speed and then putting these values in,

$$BP = \frac{(W - s) \times \pi(D + d)N}{60 \times 1000} KW$$

Where,
W is the weight applied on spring balance
N is the engine speed in RPM
D = Dia. of Drum (340mm)
d = Dia. of Rope (20mm)

The fuel consumption rate is noted for each loading and then brake specific fuel consumption is calculated as,

$$BSFC = \frac{TFC}{BP} \times 3600 \quad \text{kg/kw-hr}$$

The brake thermal efficiency of the engine is calculated as,

$$BTE = \frac{BP}{TFC \times CV} 100$$

Total fuel consumption,

$$TFC = \frac{\mathbf{cc(ml)}}{\mathbf{time}} \times \frac{\mathbf{(specificgravity)}}{\mathbf{1000}}\ kg/_{sec}$$

VIII. RESULTS

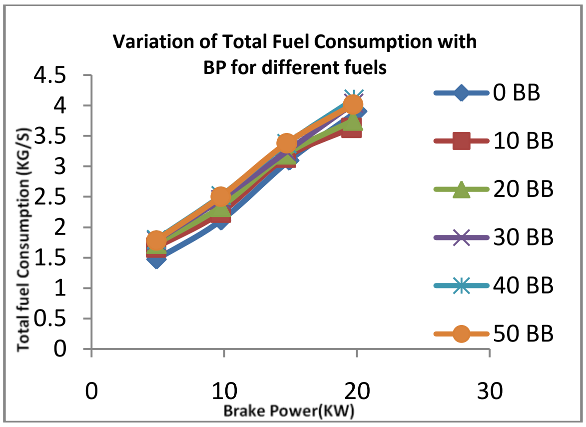

Figure 2: Variation of Total Fuel Consumption with BP for different fuels

FIGURE:2, Depicts about variation in total fuel consumption with bp for different fuels. From the curve it is observed that the value of the total fuel consumption is increased from BB10 to BB40, after that the blending ratio are increases, decreases in the total fuel consumption. We get better total fuel consumption at BB10 and BB20.

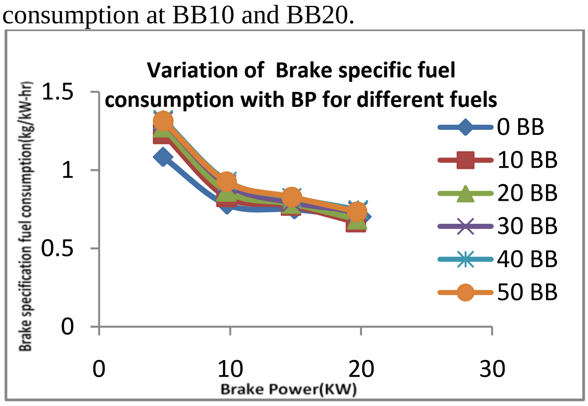

Figure 3: Variation of Brake specific fuel consumption with BP for different fuels

FIGURE:3, Depicts about variation in Brake specific fuel consumption with bp for different fuels. From the curve it is observed that the value of the total fuel consumption is increased from BB10 to BB40, after that the blending ratio are increases, decreases in the

Brake specific fuel consumption. We get better Brake specific fuel consumption at BB10 and BB20.

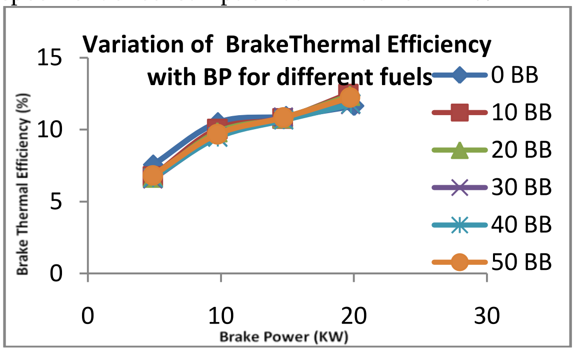

Figure 4: Variation of Brake Thermal Efficiency with BP for different fuels

FIGURE:4, Depicts about variation in Brake thermal efficiency with bp for different fuels. From the curve it is observed that the value of the Brake thermal efficiency is decreased from BB10 to BB40, after that the blending ratio are increases, increases in the Brake thermal efficiency. We get better Brake thermal efficiency at BB10 and BB20.

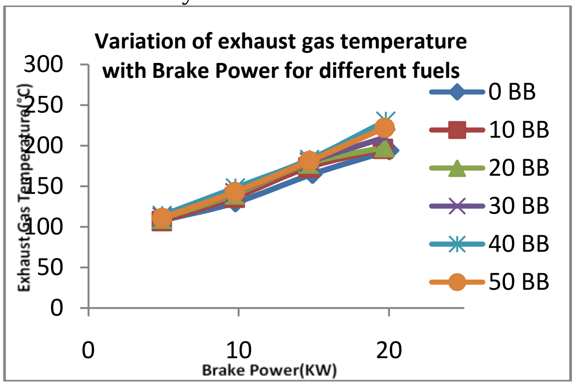

Figure 5: Variation of exhaust gas temperature with Brake Power for different fuels

FIGURE:5, Depicts about variation in Exhaust gas temperature with bp for different fuels. From the curve it is observed that the value of the Exhaust gas temperature is increased from BB10 to BB40, after that the blending ratio are increases, decreases in the Exhaust gas temperature. We get better Exhaust gas temperature at BB10 and BB20.

Table:3 PERFORMANCE ANALYSIS

Vegetable oil Blend	Calorific Value (MJ/kg)
Pure Diesel	44.00
10 BB	43.22
20 BB	42.44
30 BB	41.66
40 BB	40.88
50 BB	40.10

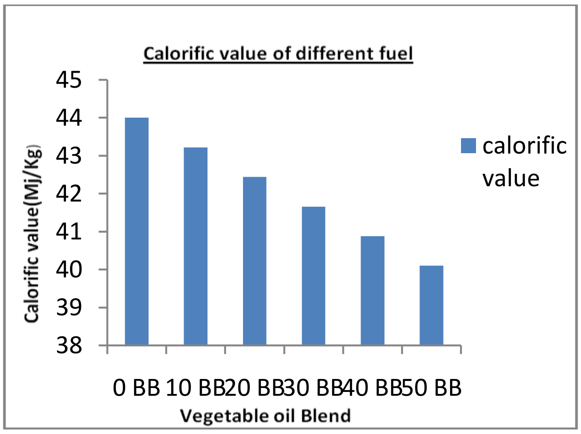

Figure 6: Graphical representation of Calorific value of different fuel

Table:4 RUNNING COST OF ENGINE WITH DIFFERENT BLENDS

Fuel	Cost (Rs./lr.)
Diesel	60.35
Mustard oil	80.00
Palm oil	55.00
BB10	61.06
BB20	61.78
BB30	62.49
BB40	63.21
BB50	63.92

IX. CONCLUSION

The value of the total fuel consumption is increased from BB10 to BB40, after that the blending ratio are increases, decreases in the total fuel consumption. We get better total fuel consumption at BB10 and BB20.

The value of the total fuel consumption is increased from BB10 to BB40, after that the blending ratio are increases, decreases in the Brake specific fuel consumption. We get better Brake specific fuel consumption at BB10 and BB20.

The value of the Brake thermal efficiency is decreased from BB10 to BB40, after that the blending ratio are increases, increases in the Brake thermal efficiency. We get better Brake thermal efficiency at BB10 and BB20.

The value of the Exhaust gas temperature is increased from BB10 to BB40, after that the blending ratio are increases, decreases in the Exhaust gas temperature. We get better Exhaust gas temperature at BB10 and BB20.

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APENDIX

OBSERVATION TABLE

Table 5: Pure Diesel

Sr. No.	LOAD-W(KG)	LOAD-S(KG)	N (RPM)	FUEL (ML)	TIME (SEC)	T1 (^{O}C)	T2 (^{O}C)	T3 (^{O}C)	T4 (^{O}C)	T5 (^{O}C)	T6 (^{O}C)
1.	2	0.2	1472	20	122	108	53	26	29	26	36
2.	4	0.4	1468	20	85	130	59	26	30	26	38
3.	6	0.5	1466	20	58	165	69	26	31	26	40
4.	8	0.6	1464	20	46	194	78	26	32	26	42

Table 6: 90%Diesel, 5% Palm oil, 5% Mustard oil

SR. NO.	LOAD-W(KG)	LOAD-S(KG)	N (RPM)	FUEL (ML)	TIME (SEC)	T1 (^OC)	T2 (^OC)	T3 (^OC)	T4 (^OC)	T5 (^OC)	T6 (^OC)
1.	2	0.2	1466	20	98	107	64	27	29	27	40
2.	4	0.4	1462	20	73	136	70	27	30	27	43
3.	6	0.5	1440	20	52	173	81	27	31	27	45
4.	8	0.6	1432	20	45	196	92	27	32	27	48

Table 7: 80% Diesel, 10% Palm oil, 10% Mustard oil

SR. NO.	LOAD-W(KG)	LOAD-S(KG)	N (RPM)	FUEL (ML)	TIME (SEC)	T1 (^OC)	T2 (^OC)	T3 (^OC)	T4 (^OC)	T5 (^OC)	T6 (^OC)
1.	2	0.2	1468	20	100	110	56	27	29	27	40
2.	4	0.4	1462	20	74	140	65	27	30	27	42
3.	6	0.5	1442	20	54	178	77	27	31	27	45
4.	8	0.6	1440	20	46	198	85	27	32	27	48

Table 8: 70% Diesel, 15% Palm oil, 15% Mustard oil

SR. NO.	LOAD-W(KG)	LOAD-S(KG)	N (RPM)	FUEL (ML)	TIME (SEC)	T1 (^OC)	T2 (^OC)	T3 (^OC)	T4 (^OC)	T5 (^OC)	T6 (^OC)
1.	2	0.2	1470	20	102	112	56	27	29	27	39
2.	4	0.4	1464	20	74	142	64	27	30	27	45
3.	6	0.5	1446	20	56	180	76	27	31	27	50
4.	8	0.6	1444	20	45	210	85	27	32	27	56

Table 9: 60% Diesel, 20% Palm oil, 20% Mustard oil

SR. NO.	LOAD-W(KG)	LOAD-S(KG)	N (RPM)	FUEL (ML)	TIME (SEC)	T1 (^OC)	T2 (^OC)	T3 (^OC)	T4 (^OC)	T5 (^OC)	T6 (^OC)
1.	2	0.2	1472	20	105	114	55	27	29	27	38
2.	4	0.4	1468	20	75	148	62	27	30	27	41
3.	6	0.5	1448	20	56	183	78	27	31	27	42
4.	8	0.6	1446	20	46	230	87	27	32	27	45

Table 10: 50% Diesel, 25% Palm oil, 25% Mustard oil

SR. NO.	LOAD-W(KG)	LOAD-S(KG)	N (RPM)	FUEL (ML)	TIME (SEC)	T1 (^{O}C)	T2 (^{O}C)	T3 (^{O}C)	T4 (^{O}C)	T5 (^{O}C)	T6 (^{O}C)
1.	2	0.2	1470	20	108	111	59	27	29	27	37
2.	4	0.4	1462	20	77	143	65	27	30	27	39
3.	6	0.5	1446	20	57	181	79	27	31	27	42
4.	8	0.6	1440	20	48	222	92	27	32	27	45

Table 711: Total Fuel Consumption & BP of Different blending ratio with Diesel

0 BB		**10 BB**		**20 BB**		**30 BB**		**40 BB**		**50 BB**	
TFC	BP(kW)	TFC	BP(kW)	TFC	BP(kW)	TFC	BP(kW)	TFC	BP(kW)	TFC	BP(kW)
1.474	4.897	1.669	4.877	1.728	4.884	1.782	4.890	1.800	4.897	1.785	4.890
2.115	9.767	2.241	9.727	2.335	9.727	2.457	9.741	2.520	9.767	2.504	9.727
3.100	14.902	3.146	14.638	3.200	14.658	3.246	14.699	3.375	14.719	3.382	14.698
3.909	20.023	3.635	19.585	3.756	19.695	4.040	19.749	4.109	19.776	4.017	19.694

Table 8: BSFC & Break Powers of different blending ratio with Diesel

0 BB		**10 BB**		**20 BB**		**30 BB**		**40 BB**		**50 BB**	
BSFC (kg/kW-hr)	BP (kW)	BSFC (kg/kW-hr)	BP (kW)	BSFC (kg/kW-hr)	BP (kW)	BSFC (kg/kW-hr)	BP (kW)	BSFC (kg/kW-hr)	BP (kW)	BSFC (kg/kW-hr)	BP (kW)
1.084	4.897	1.232	4.877	1.274	4.884	1.312	4.890	1.323	4.897	1.314	4.890
0.779	9.767	0.829	9.727	0.864	9.727	0.908	9.741	0.929	9.767	0.927	9.727
0.749	14.902	0.774	14.638	0.786	14.658	0.795	14.699	0.825	14.719	0.828	14.698
0.703	20.023	0.668	19.585	0.686	19.695	0.736	19.749	0.748	19.776	0.734	19.694

Table 9: BTE & Break Powers of different blending ratio with Diesel

0 BB		10 BB		20 BB		30 BB		40 BB		50 BB	
BTE	BP(kW)	BTE	BP(kW)	BTE	BP(kW)	BTE	BP(kW)	BTE	BP(kW)	BTE	BP(kW)
7.550	4.897	6.761	4.877	6.66	4.884	6.587	4.890	6.655	4.897	6.832	4.890
10.495	9.767	10.043	9.727	9.816	9.727	9.517	9.741	9.481	9.767	9.688	9.727
10.925	14.902	10.766	14.638	10.793	14.658	10.87	14.699	10.669	14.719	10.838	14.698
11.641	20.023	12.466	19.585	12.355	19.695	11.734	19.749	11.774	19.776	12.227	19.694

Table 10: Exhaust Gas Temperatures & Break Powers of different blending ratio with Diesel

0 BB		10 BB		20 BB		30 BB		40 BB		50 BB	
Temperature (°C)	BP(kW)	Temperature (°C)	BP(kW)	Temperature (°C)	BP(kW)	Temperature (°C)	BP(kW)	Temperature (°C)	BP(kW)	Temperature (°C)	BP(kW)
108	4.897	107	4.877	110	4.884	112	4.890	114	4.897	111	4.890
130	9.767	136	9.727	140	9.727	142	9.741	148	9.767	143	9.727
165	14.902	173	14.638	178	14.658	180	14.699	183	14.719	181	14.698
194	20.023	196	19.585	198	19.695	210	19.749	230	19.776	222	19.694