Performance of a DI Diesel Engine by using Bio Diesel (Palm Oil)

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Abstract— Now a day's Increase in energy demand, stringent emission norms and depletion of oil resources led to find alternate fuels for internal combustion engines. Many alternate fuels like Liquid Petroleum Gas (LPG), alcohols, biodiesel, Compressed Natural Gas (CNG), etc have been already commercialized in the transport sector. In this context, palm oil renewed interest. This palm oil can be converted in biodiesel using a process called trans-estrification. This biodiesel are blended with the diesel and used as an alternate fuel for the CI engines. In the present work the performance of characteristics and emissions are evaluated on single cylinder 4 stroke diesel engine fuelling with 20%, 30%, 50%, for biodiesel. Due to high viscosity of the biodiesel 60% and more percentages have been not taken into Palm oil-diesel blend. Experiments was carried out of a diesel engine by using palm oil as alternative fuel which is single cylinder, four-stroke, water cooled at constant speed engine capable of the developing a power output of 7.5kW at 1500 rpm. Performance parameters such as the brake power, specific fuel consumption and the indicated thermal efficiency are calculated based on experimental analysis of the engine.

Key words: Emissions, Internal Combustion Engine, Bio-Diesel, Efficiency

I. Introduction

Compression ignition engines are employed particularly in the field of heavy transportation and agriculture on account of their higher thermal efficiency and durability. However, diesel engines are the major contributors of oxides of nitrogen and particulate emissions. Hence more stringent norms are imposed on exhaust emissions. Following the global energy crisis in the 1970s and the increasingly stringent emission norms, the search for alternative renewable fuels has intensified.

II. Literature survey

The gradual depletion of world petroleum reserves, increases in prices of petroleum based fuels and environmental pollution due to exhaust emissions have encouraged studies to search for alternative fuels. In view of these, vegetable oil has been considered as alternative fuels for compression ignition engines. Vegetable oils are renewable, nontoxic, biodegradable, and have low emission profiles. However, there are some drawbacks related to the use of straight vegetable oils in diesel engines primarily due to their high viscosity, lower volatility and lower heat content [1-8].

A single cylinder stationary Scottiler engine is used to compare the Performance and Emission and Combustion characteristics between pure diesel and biodiesel oil blends. The Biodiesel oil blends are in percentage of 20%, 30%, 50% of Biodiesel oil to 80%, 70%, 50% of diesel. Results show that Biodiesel blend can be used in existing diesel engines without compromising the engine performance.

In the present work, Biodiesel oil, that is non-edible oil, was considered as a potential alternative fuel for compression ignition engines. Specifications of the Biodiesel oil investigated and compared these specifications with other vegetable oils and this was the basic motivation behind the research in this paper. The engine tests were carried out on a direct injection diesel engine fuelled with diesel fuel and 20%, 30% and 50% Biodiesel oil-diesel blends by volume. The results were summarized

III. Materials and methods of purification

Biodiesel is renewable and environmental friendly alternative diesel fuel for diesel engine. It can be produced by trans-esterification process. Trans-esterification is a chemical reaction in which vegetable oils and animal fats are reacted with alcohol in the presence of a catalyst. The products of reaction are fatty acid alkyl ester and glycerin, and were the fatty acid alkyl esters known as biodiesel.

A. *Trans-Estrification of Palm Oil:*

To convert the Palm Oil into biodiesel the transestrification process is been conducted with the palm oil. This procedure involved in this method is as follows: 1000 ml of Palm oil is taken in a three way flask. 5.6 grams of Potassium hydroxide (KOH) and 200 ml of methanol (CH_3OH) are taken in a beaker. The potassium hydroxide (KOH) and the alcohol are thoroughly mixed until it is properly dissolved. The solution obtained is mixed with Palm oil in three way flask and it is stirred properly. The methoxide solution with Palm oil is heated to 60 ^{0}C and it is continuously stirred at constant rate for 1 hour by stirrer. The solution is poured down to the separating beaker and is allowed to settle for 4 hours. The glycerin settles at the bottom and the methyl ester floats at the top (coarse biodiesel). Methyl ester is separated from the glycerin. This coarse biodiesel is heated above 100°C and maintained for 10-15 minutes to remove the untreated methanol.

Properties	Diesel	PALM Oil (Biodiesel)
Kinematic Viscosity at 40 ^{0}C (cSt)	3.52	4.88
Density at 15 ^{0}C (kg/m^3)	850	880
Flash point (^{0}C)	49	148
Calorific value (kJ/kg)	42000	38000
Sp. Gravity	0.85	0.88

Table 3.1: Properties of Palm oil (Biodiesel)

B. Preparation of Biodiesel

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IV. SPECIFICATION OF THE PROBLEM

In the present work the performance of characteristics and emissions are evaluated on single cylinder 4 stroke diesel engine fuelling with 20%, 30%, 50%, for biodiesel. Due to high viscosity of the biodiesel 60% and more percentages have been not taken into Palm oil-diesel blend. Experiments was carried out of a diesel engine by using palm oil as alternative fuel which is single cylinder, four-stroke, water cooled at constant speed engine capable of the developing a power output of 7.5kW at 1500 rpm. Performance parameters such as the brake power, specific fuel consumption and the indicated thermal efficiency are calculated based on experimental analysis of the engine.

A. Experimental Set Up

The experimental set up consists of engine, an alternator, top load system, fuel tank, exhaust gas measuring digital device and manometer.

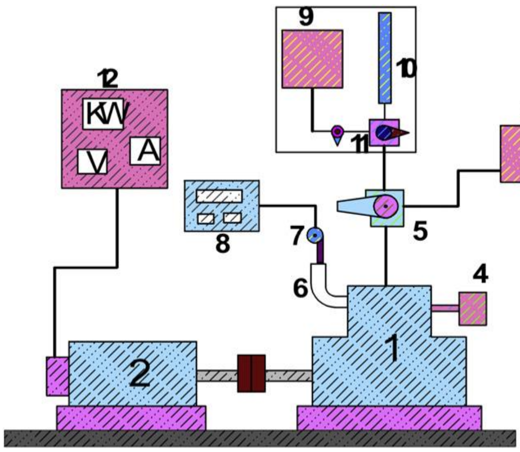

Fig. 4.1: Experimental Setup of the Test Engine

B. Various Parts of Experimental Setup

- Scottiler Engine
- Alternator
- Diesel Tank
- Air Filter
- Three Way Valve
- Exhaust Pipe
- Probe
- Exhaust Gas Analyser
- Alternative Fuel Tank
- Burette
- Three Way Valve
- Control Panel

C. Experimental Procedure

As first said, diesel alone is allowed to run the engine for about 30 min, so that it gets warmed up and steady running conditions are attained. Before starting the engine, the lubricating oil level in the engine is checked and itis also ensured that all moving and rotating parts are lubricated.

The various steps involved in the setting of the experiments are explained below

1) The Experiments were carried out after installation of the engine
2) Precautions were taken, before starting the experiment.
3) Always the engine was started with no load condition
4) The engine was started at no load condition and allowed to work for at least 10 minutes to stabilize.
5) The readings such as fuel consumption, voltage, amperes, Speed, manometer reading, emmission etc., were taken as per the observation table.
6) The load on the engine was increased by 1000W of FULL Load using the engine controls and the readings were taken as shown in the tables.
7) Step 3 was repeated for different loads from no load to full load.
8) After completion of test, the load on the engine was completely relieved and then the engine was stopped.
9) The results were calculated as follows.

V. RESULTS AND DISCUSSION

Experiments were conducted when the engine was fuelled with Biodiesel blends with diesel in proportions of 20:80, 30:70 and 50:50 (by volume) which are generally called as BD20, BD30, BD50 respectively. The experiment covered a range of loads. The performance of the engine was evaluated in terms of brake specific fuel consumption, mechanical efficiency and volumetric efficiency, indicated thermal efficiency, and brake thermal efficiency. The results obtained for Biodiesel blends with diesel were compared with the results of diesel.

S. No	Load	Speed	Time	B.P	TFC	I.P	F.P	Heat Input	BSFC	η_{bth}	η_{ith}	η_{mech}	η_{vol}	BMEP	IMEP
	W	Rpm	Sec	kW	kg/s $*10^{-4}$	kW	kW	kW	Kg/ kW h	%	%	%	%	kN/ m^2	kN/ m^2
1	0	760	50	0	1.7	1.7	1.7	7.14	0	0	23.8	0	42.3	0	141.72
2	1000	760.1	39	1.061	2.17	2.761	1.7	9.15	2.045	11.5	30.1	38.4	44.8	181.11	230.7
3	2000	755	30.8	2.12	2.75	3.83	1.7	11.55	1.29	18.3	33.3	55.35	57.8	355.7	323.7
4	3000	742	24.2	3.07	3.51	4.803	1.7	14.75	1.13	21.04	32.56	64.6	48	524.2	414.82
5	4000	742	19.2	4.12	4.42	5.82	1.7	18.59	1.074	22.15	33.3	70.7	54	708.8	500.65
6	5000	723	16.8	5.02	5.059	6.728	1.7	21.24	1.006	23.66	31.66	74	52.1	887.81	599.11

Table 5.1: Performance and emission test Results at Pure Diesel

S. N0	Load	Speed	Time	B.P	TFC	I.P	F.P	Heat Input	BSFC	η_{bth}	η_{ith}	η_{mech}	η_{vol}	BMEP	IMEP
	W	Rpm	Sec	kW	kg/s $*10^{-4}$	kW	kW	kW	Kg/ kW h	%	%	%	%	kN/ m^2	kN/ m^2
1	0	774.7	50.12	0	1.69	1.65	1.65	6.93	0	0	23.8	0	42.3	0	134.95
2	1000	764	40.32	1.04	2.10	2.69	1.65	8.621	2.019	12.06	31.2	38.6	50	173.3	224.1
3	2000	756	31.60	2.1	2.68	3.75	1.65	11	1.27	19.09	34.09	56	51	360	316.9
4	3000	747.3	25.24	3.07	3.36	4.72	1.65	13.79	1.09	22.2	34.2	65.04	52	526.2	404.5
5	4000	735.6	20.95	4.05	4.05	5.7	1.65	15.62	1	24.36	34.2	71	45	714.7	495.6
6	5000	725.7	18.1	4.88	4.69	6.53	1.7	19.25	0.94	25.3	34	74.7	45.1	853.64	570.72

Table 5.2: Performance and emission test Results at BD 20:

S. No	Load	Speed	Time	B.P	TFC	I.P	F.P	Heat Input	BSFC	η_{bth}	η_{ith}	η_{mech}	η_{vol}	BMEP	IMEP
	W	Rpm	Sec	kW	kg/s $*10^{-4}$	kW	kW	kW	Kg/ kW h	%	%	%	%	kN/ m^2	kN/ m^2
1	0	762.8	46.07	0	1.84	1.5	1.5	7.48	0	0	20.05	0	47.19	0	125
2	1000	758.3	40.78	1.034	2.08	2.53	1.5	8.45	2.01	12.18	29.94	40.71	57	176.5	213.8
3	2000	732.8	32.36	2.086	2.62	3.58	1.5	10.65	1.25	19.53	33.61	58.1	43.5	356.5	301.68
4	3000	743.5	26.21	3.06	3.24	4.56	1.5	13.16	1.05	23.25	34.65	67.10	51.36	524.5	390.85
5	4000	738.1	20.88	3.99	4.07	5.49	105	16.52	1.02	24.15	33.23	72.67	45.7	704.11	477.39
6	5000	730.2	17.88	4.88	4.75	6.38	1.5	19.29	0.97	25.29	33.07	76.48	40.27	848.69	554.78

Table 5.3: Performance and emission test Results at BD 30

S. No	Load	Speed	Time	B.P	TFC	I.P	F.P	Heat Input	BSFC	η_{bth}	η_{ith}	η_{mech}	η_{vol}	BMEP	IMEP
	W	Rpm	Sec	kW	kg/s $*10^{-4}$	kW	kW	kW	Kg/ kW h	%	%	%	%	kN/m^2	kN/m^2
1	0	769	54.2	0	1.586	1.5	1.5	6.32	0	0	23.7	0	38.21	0	123.59
2	1000	755.9	37.01	1.034	2.30	2.53	1.5	9.13	2.23	11.28	27.7	40.7	44.8	178.5	216
3	2000	747.6	32.04	2.086	2.68	3.58	1.5	10.62	1.28	19.64	33.7	58.26	57.5	357.6	306.8
4	3000	739.5	24.8	3.07	3.46	4.57	1.5	13.713	1.127	22.4	33.33	67.17	47.16	526.2	408
5	4000	727.6	21.37	4.01	4.02	5.51	1.5	15.93	1.002	25.17	34.5	72.7	43	699	486
6	5000	721.1	18.11	4.92	4.74	6.42	1.5	18.78	0.96	26.19	34.18	79.2	43.61	868	566.47

Table 5.4: Performance and Emission Test Results at BD 50

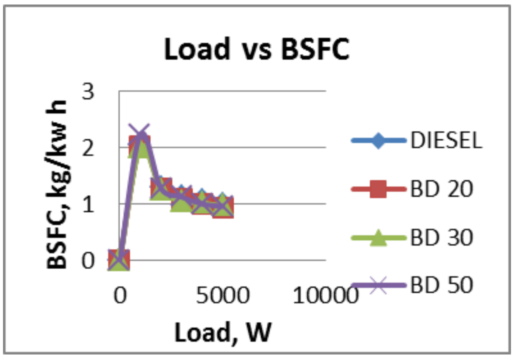

Fig 4.1: Load Vs BSFC

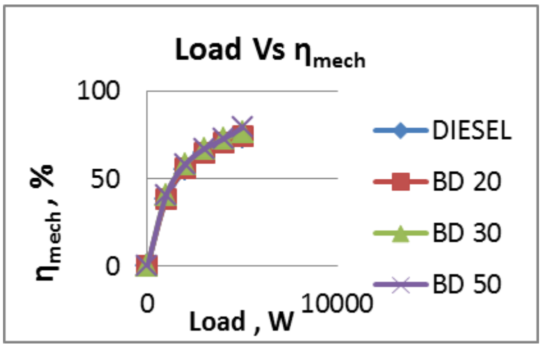

Fig 4.2: Load Vs ηmech

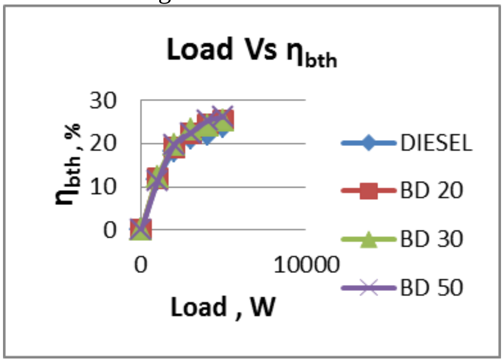

Fig 4.3: Load Vs ηbth

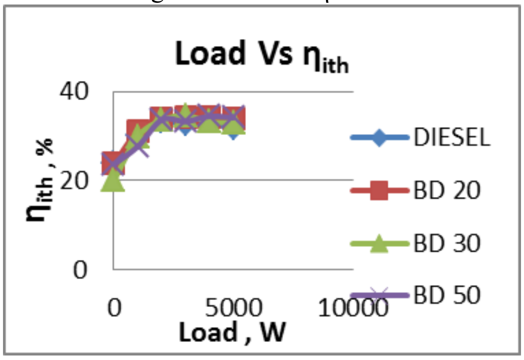

Fig 4.4: Load Vs ηith

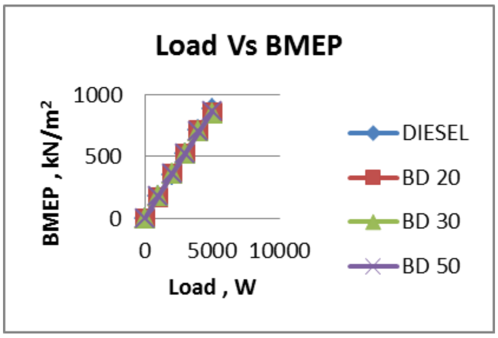

Fig 4.5: Load Vs BMEP

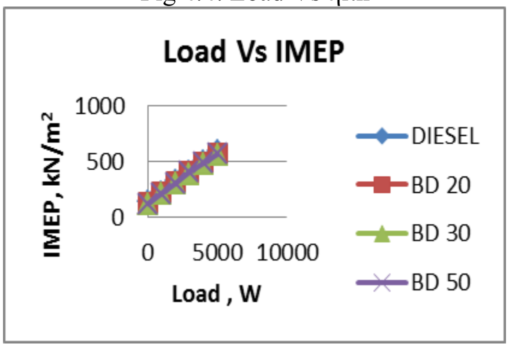

Fig 4.6: Load Vs IMEP

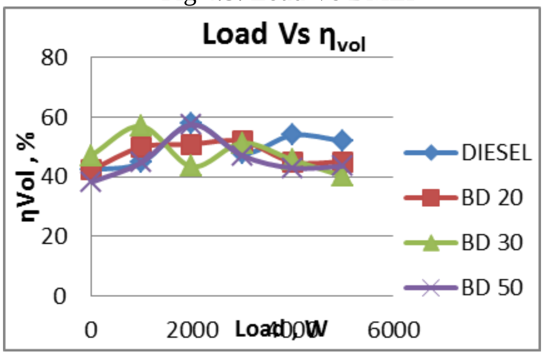

Fig 4.7: Load Vs η_{vol}

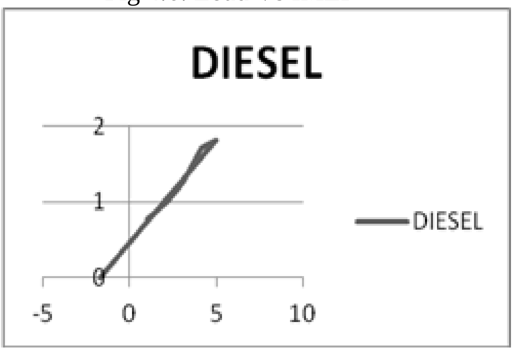

Fig 4.8: Friction power IC Engine of diesel fuel

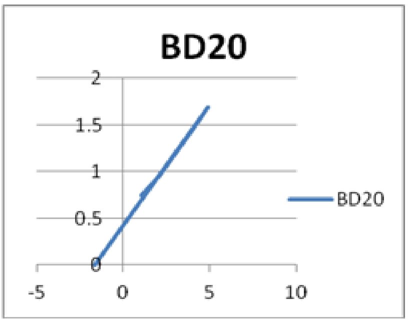

Fig. 4.9: Friction power IC Engine of BD20

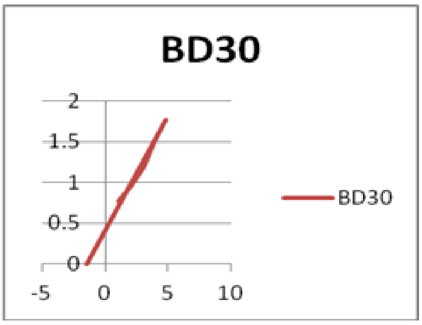

Fig. 4.10: Friction power IC Engine of BD30 fuel

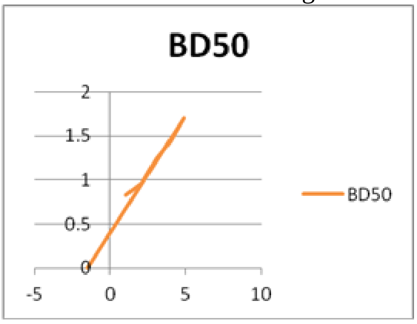

Fig. 4.11: Friction power IC Engine of BD50 fuel

VI. CONCLUSIONS

Following are the conclusions based on the experimental results obtained while operating single cylinder air cooled diesel engine fuelled with Biodiesel and its diesel blends.

- Brake Thermal efficiency of the tested diesel engine is improved when it is fuelled with Biodiesel blend BD50
- Mechanical efficiency for BD 50 is higher compared to Diesel fuel operation is observed.
- Brake mean effective pressure is also increased as the percentage of the biodiesel increases with the diesel, the values obtained on the biodiesel blends are slightly equal to that of Diesel. But this increment in Brake mean effective power is insignificant
- Indicated mean effective pressure is slightly high for BD50 when compared to Diesel.
- The volumetric Efficiency obtained higher for BD20, BD50 when compared to diesel

From all the above results and conclusion its suggested that from biodiesel blends BD50 could be used has alternative fuel could be used because of their satisfactory results. Due to Bharath Stage IV norm both the fuels could be used only upto 2000W load.

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