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Testing the performance of Biodiesel-Diesel-Ethanol blend in Conventional diesel engine

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Abstract

Biodiesel is a renewable, biodegradable, environmentally benign fuel for use in the diesel engines. It can be produced from renewable sources such as vegetable oils or animal fats. Although this fuel has gained worldwide recognition for many years, it is not being widely commercialized mainly because it is more expensive than petroleum diesel. Jatropha curcas oil which is non edible can be used for production of biodiesel. Ethanol is also another important renewable fuel which is gaining attention world over. In this respect Ethiopian government taking every measure to encourage the plantation of jatropha, production ethanol in sugar factories and usage of them as fuels. In this context this project was done with main aim of producing biodiesel from jatrophacurcas and testing the performance of blends of biodiesel – proportion of biodiesel and ethanol with diesel were prepared and tested in CI engine to study their effect on the performance of the engine.

Keywords:

Biodiesel,
Ethanol,
Transesterification,
Brake torque,
brake Power;

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1. Introduction

The humankind is increasingly approach towards high energy crisis, on account of greater energy consumption than its supply. The demand is increasing further because of the world becoming more developed in new technologies. Plentiful and economical energy is the lifeblood of current nation. The world presently meets the energy requirements majorly from fossil fuels. These fuels include liquid fuel mostly petroleum based, solid fuel (coal)

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and natural gas. Liquid fuel predominantly remains the leading source of energy, which is expected to contribute the energy need for limited duration. The transition to alternative energy resources is required due to the fact that fossil fuel reservoirs are diminishing and trend in cost is rising. The environmental consequences from exhaust emission have further speed up the switch to alternative renewable fuels.

Biofuels, fuels derived from biomass have been gaining the attention as of highly renewable, biodegradable and locally available. Biomass liquid fuels are bio alcohols; ethanol is the most common, Biodiesel; obtained from vegetable oil or animal fats and Bio crude; synthetic oil. Biofuels are carbon-neutral, nontoxic and reduce emission of volatile organic compounds. These fuels are not only green in nature but also help to reduce dependence on imported oil.

2. Research Method

Table 2.1 list of materials used

S.No	Item
1	4-stroke, single cylinder diesel engine
2	Engine dynamometer
3	Thermometer
4	Hot plate with magnetic stirrer
5	Digital balance
6	Glassware
7	Chemical like methanol and potassium hydroxide

The methodology adopted in this work is mainly experimental which involves the following stages.

- Extraction of crude oil which is done using mechanical pressing.
- Production of biodiesel using trasesterification process
- Blending biodiesel with ethanol and diesel fuel
- Testing the biodiesel and its blends in diesel engine for its emission and performance characteristics.

3. Experimental procedure

1. Both engine and test rig in the was properly cleaned
2. The engine was connected to the test rig and dynamometer
3. The dynamometer was supplied with AC electric supply

Fig 3.11 Experimental setup of test engine with dynamometer

4. The engine was visually checked and both lubricant and diesel fuel was filled
5. The engine was supplied with DC electric supply then engine was cranked and operated until it reaches to its operating temperature
6. After warming up the test was conducted for pure diesel engine at different test speeds then different parameters has been read from the dynamometer
7. Then the test was repeated for different fuel blends at different speed.

4. Results and Analysis

4.1 Jatropha oil Extraction

The extraction of the oil done by mechanical oil extractor which is found in oil extracting house in Adama. Eight litre of oil is extracted from twenty five kilograms of jatropha seed. The oil extracted in percent is 33.33% (v/w ratio).

4.2 Biodiesel Yield

The biodiesel production was done by transesterification reaction process using methanol alcohol and KOH catalyst. After washing three times by 50ºC warm distilled water and drying the biodiesel production yield is found to be 95.5%.

4.3 Performance Test

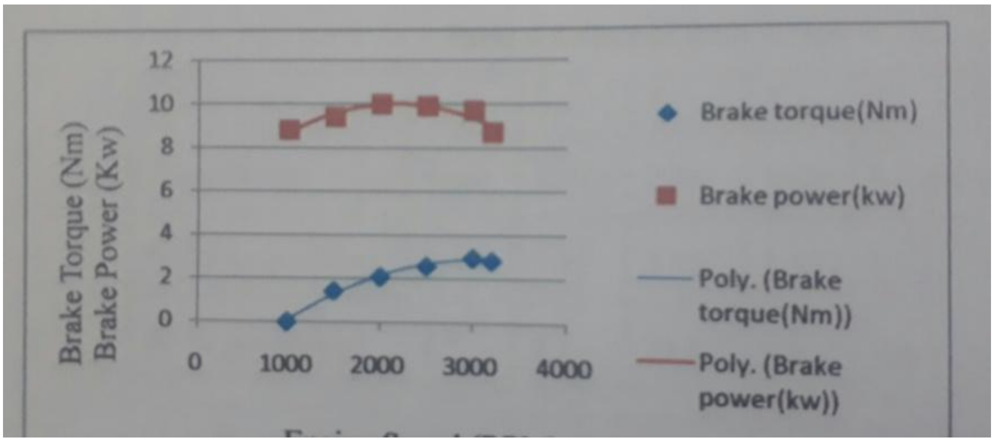
The test results are shown below in the tables and graphs. Due to high calorific value and the favorable property of the fuel, the torque recorded by B0 is the highest of all the test fuels.

4.4 Measured data for performance characteristics

Measured data during experimentation are shown on the table and figures below

Table 4.1 Data of diesel B0

Test number	1	2	3	4	5	6
Speed (RPM)	1000	1500	2000	2500	3000	3200
Brake torque (Nm)	0.88	1.43	2.08	2.58	2.96	2.84
Brake power (Kw)	8.8	9.4	10.0	9.9	9.7	8.7



Engine Speed (RPM)

Fig 4.1 Pure diesel/B0

Table 4.2 Data of fuel sample B5D93E2

Test number	1	2	3	4	5	6
Speed (RPM)	1000	1500	2000	2500	3000	3200
Brake torque (Nm)	0.87	1.41	2.08	2.57	2.95	2.84
Brake power (Kw)	8.8	9.3	10.0	9.9	9.5	8.7

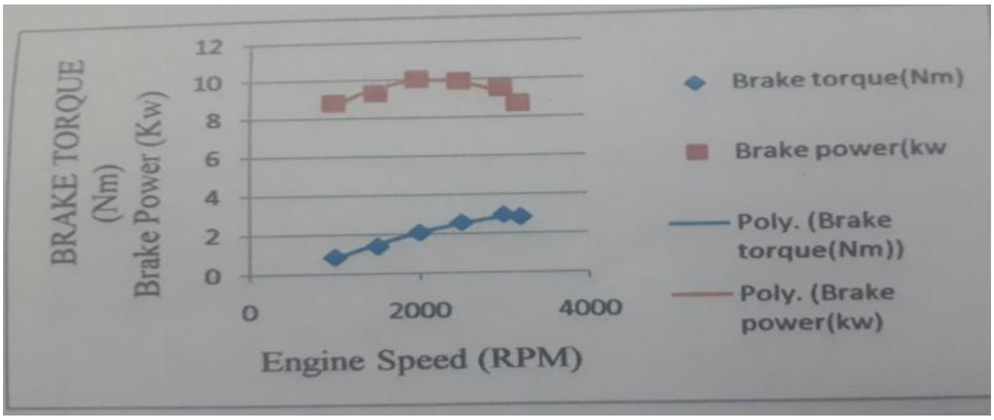


Fig 4.2 B5D93E2

Table 4.3 Data of fuel sample B10D87E3

Test number	1	2	3	4	5	6
Speed (RPM)	1000	1500	2000	2500	3000	3200
Brake torque (Nm)	0.87	1.39	2.07	2.55	2.93	2.83
Brake power (Kw)	8.7	9.2	10.0	9.8	9.4	8.6

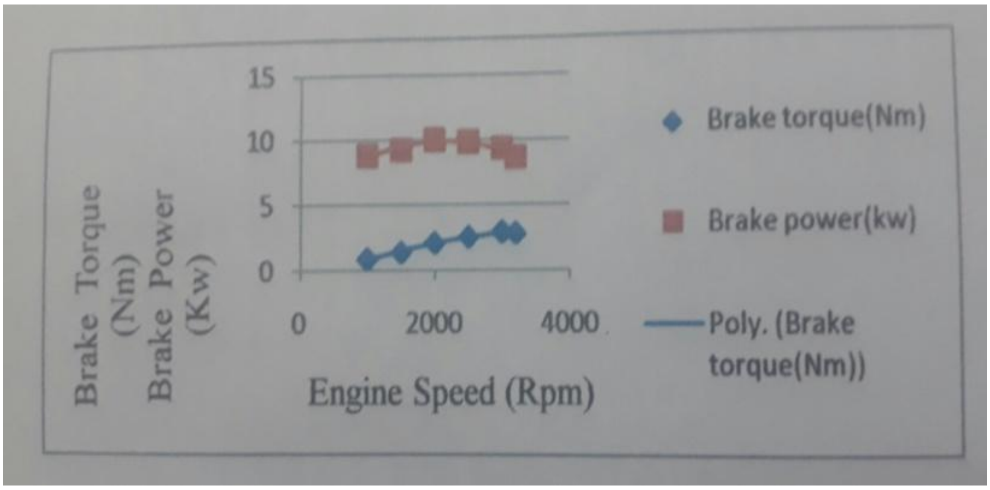


Fig 4.3 B10D87E3

Table 4.4 Data of fuel sample B15D80E5

Test number	1	2	3	4	5	6
Speed (RPM)	1000	1500	2000	2500	3000	3200
Brake torque (Nm)	0.88	1.38	2.09	2.55	2.92	2.83
Brake power (Kw)	8.8	9.2	10.0	9.8	9.33	8.6

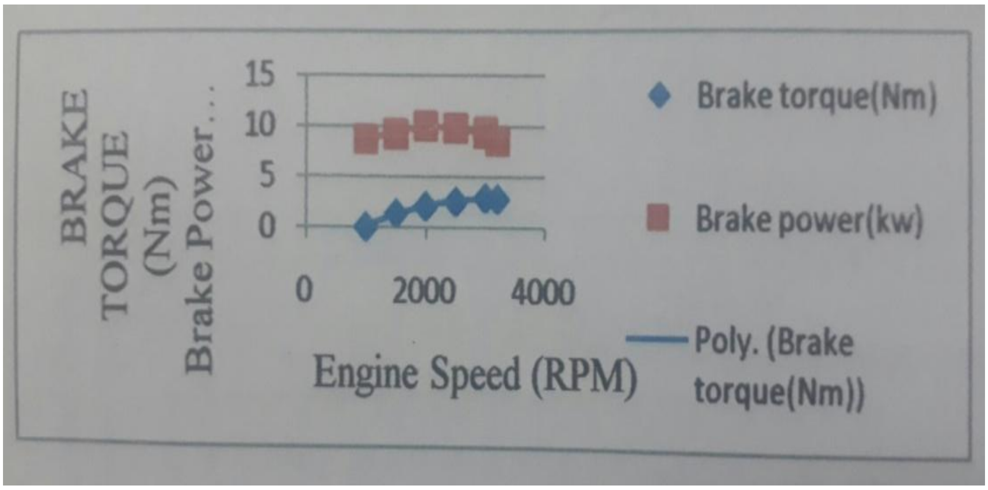


Fig 4.4 B15D80E5

Table 4.5 Data of fuel sample B20D75E5

Test number	1	2	3	4	5	6
Speed (RPM)	1000	1500	2000	2500	3000	3200
Brake torque (Nm)	0.86	1.39	2.10	2.58	2.97	2.87
Brake power (Kw)	8.6	9.2	10.10	9.9	10.5	8.9

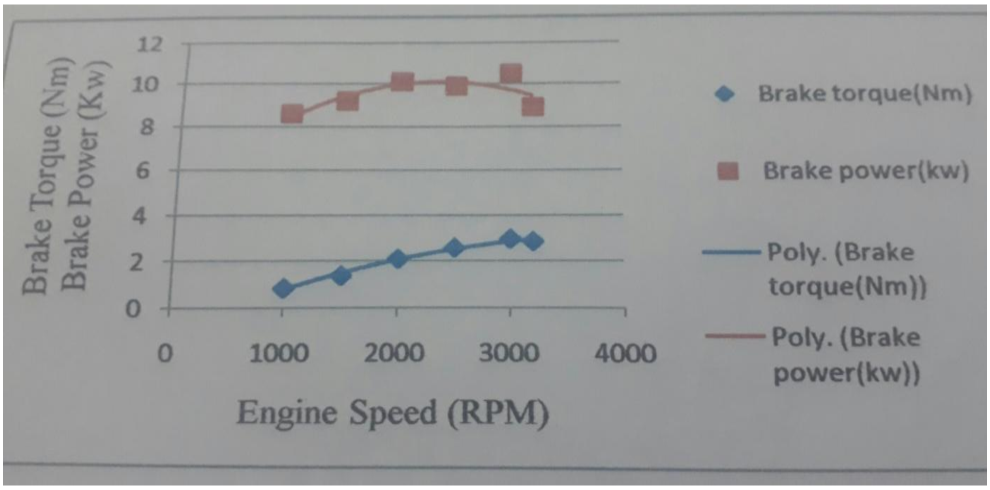


Fig 4.5 B20D80E5

Table 4.6 Brake power

Speed (RPM)	1000	1500	2000	2500	3000	3200
B0	8.8	9.4	10.0	9.9	9.7	8.7
B5	8.8	9.3	10.0	9.9	9.5	8.7
B10	8.7	9.2	10.0	9.8	9.4	8.6
B15	8.8	9.2	10.0	9.8	9.3	8.6
B20	8.6	9.2	10.10	9.9	10.5	8.9

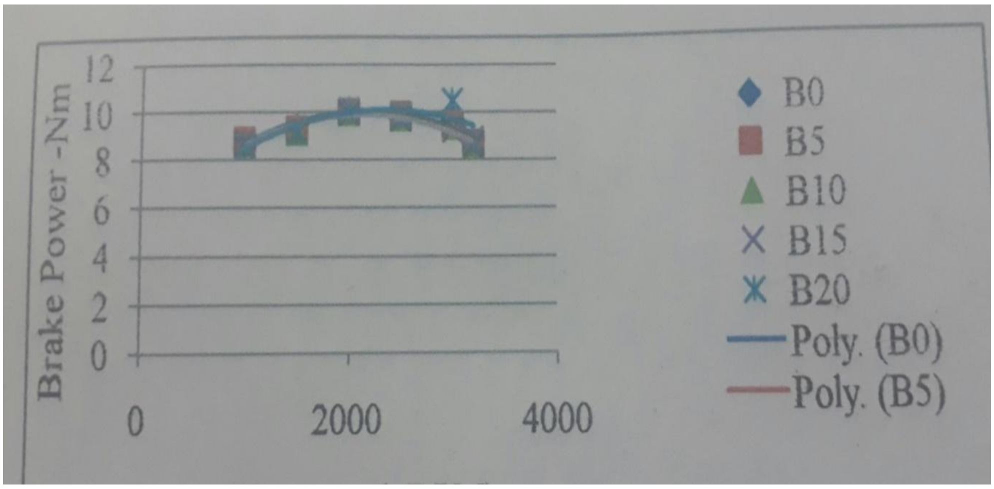


Fig 4.6 Brake power vs engine speed

Table 4.7 Brake torque

Speed (RPM)	1000	1500	2000	2500	3000	3200
B0	0.88	1.43	2.08	2.58	2.96	2.84
B5	0.87	1.41	2.08	2.57	2.95	2.84
B10	0.87	1.39	2.07	2.55	2.93	2.83
B15	0.88	1.38	2.09	2.55	2.92	2.83
B20	0.86	1.39	2.10	2.58	2.97	2.87

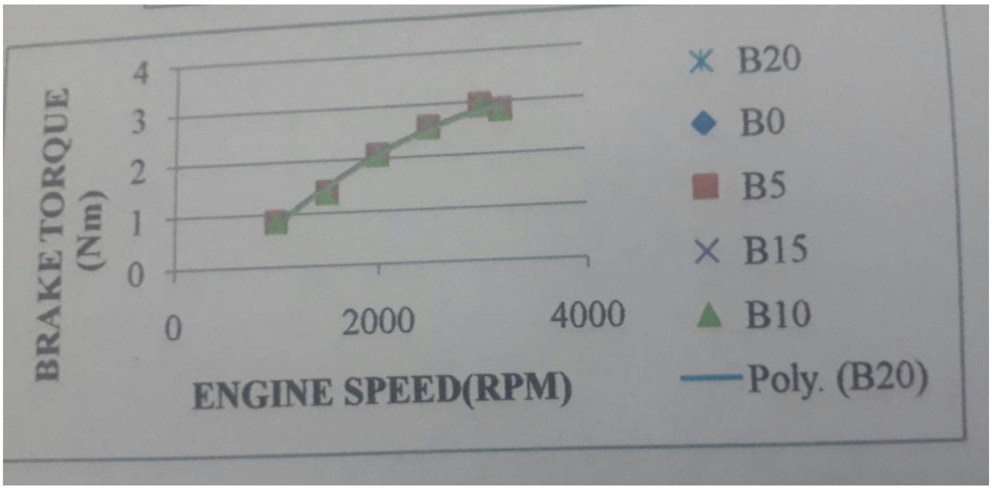


Fig 4.7 Brake torque vs engine speed.

4.5 Evaluations of Power and Torque

The power actually at the engine shaft is called the brake power, since it is usually obtained from the engine measurements of the engine torque when driving against brake. The brake can be mechanical friction, band acting on the flywheel, a fluid dynamometer and an electric dynamometer. The 15LD315 engine test rig uses an electric dynamometer, which places a load on the engine and the power is dissipated in a resister network. Torque of the engine obtained using the electric read out from a linear potentio-meter, which measures the displacement of a spring, the force of which balances the force generated by the dynamometer casing it attempts to turn with the engine. Therefore, brake power and brake torque are related by equation below tabulated for all types (B0, B5, B10, B15, B20) of fuel on the table above. Brake power is the useful power output from the engine available at the crankshaft.

$P_b = \omega \times T_b$

ω = angular velocity of crankshaft = rad/sec

N= RPM of the engine

T= torque of the engine in Nm

4. Conclusion

Jatropha plantation could be establishing on arid lands of mountain and on marginal lands of farms which results protection to soil erosion. The increase in vegetation reduces global warming and can create additional income generation.

For oil extraction it is better to use mechanical pressing than chemical and enzymatic extraction. The mechanical extraction method is very much cheaper than the other extraction methods. As the amount of ethanol in B20 increases the performance of the fuel increases however using more than forty milliliter of ethanol per liter drops the viscosity of the fuel that could affect the lubrication property of the fuel on which the life of the fuel pump depends.

In this work transesterification reaction was carried using the jatropha oil. The quality of potassium hydroxide catalyst for optimal biodiesel yield of 95.5% was 20gm per liter at reaction time of one hour, reaction temperature of 65^{o}C to 85^{o}C and volume ratio of oil to methanol as 5:1.

Based on the experimental results, the following conclusions are drawn. The brake power of B20 is found to be higher than that of other biodiesel blends but lower than B0. The higher power after the additions of ethanol to JOME is due to its oxygen content and effect on lowering the viscosity of the blend, which lead to an improvement in the combustion process. The higher torque is registered be B0, however the percentage of the additive in the B20 increases the torque also increase throughout all the speed differences.

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