Investigation of Biodiesel Blend and Performance Characteristics in Diesel Engine

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***Abstract*: We investigated the effects of biodiesel blending on emissions and efficiency in a non-road diesel engine. Rapeseed based biodiesel blended in increments of 25% with fossil diesel. It showed a decrease in CO^2 emission (g/kwh) with increased engine load. Within the range of tests carried out, the NO_x emissions from the biodiesel and its blends proved to be higher than those of petro-diesel fuel. Furthermore, a correlation was found with the NO_x emissions and the flame temperature. The efficiency of the system improved with increase of biodiesel content in the fuel. As predicted, the results for CHP show a considerable improvement in overall efficiency.**

***Keywords*: Biodiesel Combustion, Biodiesel Blending, Greenhouse Gas Emissions, Alternative Fuels, Renewable Energy**

1. Introduction

Biodiesel is a fatty acid ethyl or methyl ester and has properties similar to petroleum diesel fuels. Firstly, we extracted oil from Karanja seeds using hydraulic press and then prepared blends through chemical reactions of transesterification and esterification. This process involves oils reaction with short-chained alcohol.

We made blends in the form of B25 (B represents biodiesel and 25 means 25% oil and remaining 75% of diesel), B30, B35, B40, B45, and B00 as pure diesel.

2. Setup of Experiment

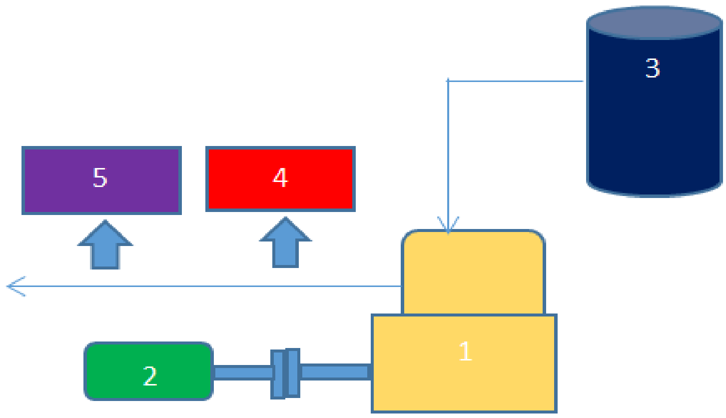


Figure 1 - (1) Engine, (2) Dynamometer, (3) Fuel Tank (B-d),
(4) Ex. Analyser, (5) Smoke Meter, (6) Exhaust Flow

Figure 1 shows setup of experiment conducted on bio diesel. The blends of 5% Biodiesel with 95% diesel fuel, 10% biodiesel with 95% diesel fuel, 15% biodiesel with 85% diesel fuel, and 20% biodiesel with 80% diesel fuel were used to conduct test on single cylinder four stroke water cooled diesel engine.

Specifications

Make	Kirlosker
Modal	TV1 Water-cooled
Power	8 HP at 1500 RPM
Stroke	110 mm
Bore	87.5 mm
Volume	661 cc
Compression Ratio	1:17

3. Results and Discussion

The following results are tabulated for **Pure Diesel (B00)** at different loads such as 0, 3, 6, 9 and 12 in Kg.

Sr. No.	Load (Kg)	Torque (Kg)	BP (KW)	IP (KW)	BMEP (bar)
1	0	0.00	0.00	2.90	0.00
2	3	5.44	0.865	3.766	0.041
3	6	10.899	1.7038	4.5981	0.08344
4	9	16.33365	2.49599	5.4387	0.12816
5	12	21.77820	3.35079	6.278	0.16972

Sr. No.	IMEP (bar)	A/F Ratio	BSFC (KG/KWh)	BT Efficiency	Mechanical Efficiency	Volumetric Efficiency
1	0.25111	70.79071	0.00	0.00	0.00	84.734
2	0.35684	51.51096	0.67870	0.1339	22.99	86.33
3	0.45340	40.60807	0.43357	0.2209	36.93	86.87
4	0.53990	35.65690	0.34033	0.2671	46.67	86.55
5	0.625	28.895	0.194	0.467	53.80	86.11

Result Table for Biodiesel (B25)

Sr. No.	Load (Kg)	Torque (Nm)	BP (KW)	IP (KW)	BMEP (bar)
1	0	0.000	0.000	2.3	0.000
2	3	5.444	0.863	3.163	0.082
3	6	10.889	1.709	4.009	0.166
4	9	16.333	2.521	4.821	0.253
5	12	21.778	3.350	5.650	0.339

Sr. No.	IMEP (bar)	BSFC (kg/kwh)	BT Efficiency	Mechanical Efficiency	Volumetric Efficiency
1	0.206	0.000	0.000	0.000	84.684
2	0.301	0.650	0.131	27.292	86.616
3	0.390	0.401	0.213	42.637	86.890
4	0.485	0.329	0.259	52.298	87.143
5	0.572	0.306	0.278	59.297	86.822

Result table for Biodiesel (B30)

Sr. No.	Load (Kg)	Torque (Nm)	BP (KW)	IP (KW)	BMEP (bar)
1	0	0.00000	0.00000	2.55000	0.00000
2	3	5.44455	0.86334	3.41334	0.08234
3	6	10.88910	1.71414	4.26415	0.16589
4	9	16.33365	2.53873	5.08874	0.25201
5	12	21.77820	3.35079	5.90079	0.33945

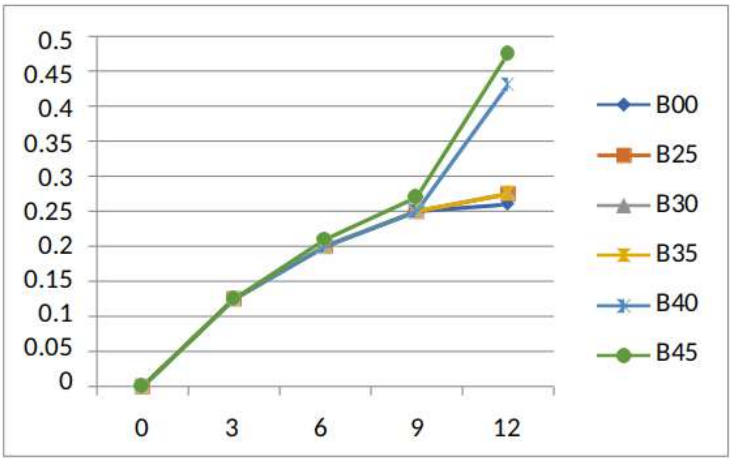
Sr. No.	IMEP (bar)	BSFC (kg/kwh)	BT Efficiency	Mechanical Efficiency	Volumetric Efficiency
1	0.222	0.00000	0.000	0.00000	86.13695
2	0.325	0.68550	0.125	25.29316	87.20002
3	0.412	0.43710	0.196	40.19906	87.83800
4	0.505	0.35768	0.239	49.88935	87.76768
5	0.597	0.33012	0.259	56.78547	87.44027

Result Table For Biodiesel (B35)

Sr. No.	Load (Kg)	Torque (Nm)	BP (KW)	IP (KW)	BMEP (bar)
1	0	0.00000	0.00000	2.95000	0.00000
2	3	5.44455	0.86334	3.81334	0.08234
3	6	10.8891	1.69249	4.64249	0.16801
4	9	16.3336	2.52164	5.47164	0.25372
5	12	21.7782	3.34851	6.29851	0.33968

Sr. No.	IMEP (bar)	BSFC (kg/kwh)	BT Efficiency	Mechanical Efficiency	Volumetric Efficiency
1	0.263	0.000	0.000	0.000	86.58077
2	0.363	0.706	0.122	22.640	87.77965
3	0.460	0.439	0.197	36.456	88.366
4	0.550	0.358	0.241	46.085	87.755
5	0.638	0.327	0.264	53.163	88.113

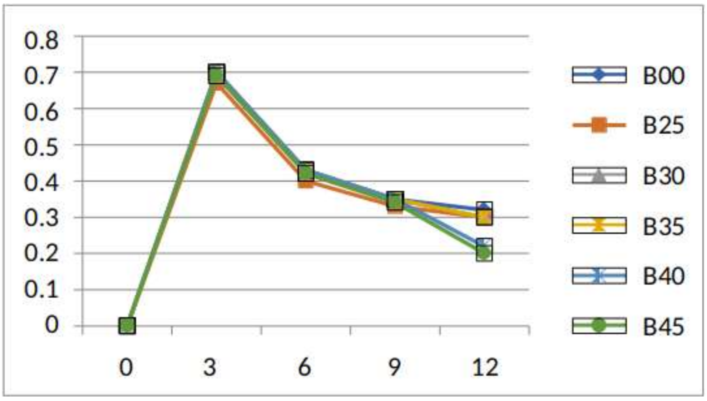
Brake Thermal Efficiency (BTE)



X-axis: BTE (%), Y-axis: Load (Kg)

Figure 2 - Variation of brake thermal efficiency with load

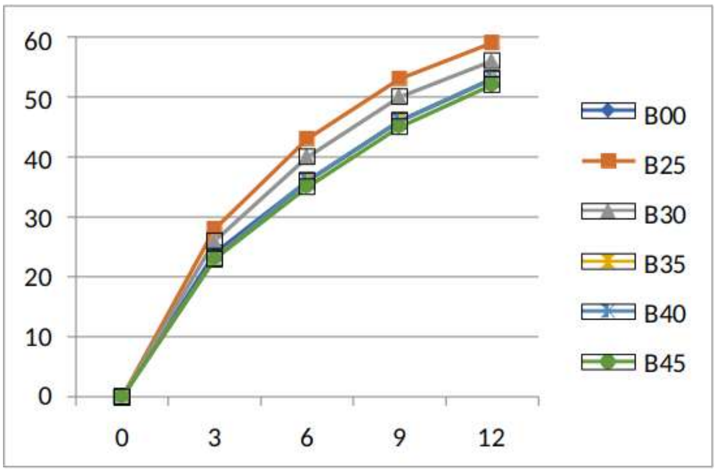
Brake Specific Fuel Consumption (BSFC)



X-axis: BSFC (Kg/KWh), Y-axis : Load (Kg)

Figure 3 - Variation of brake specific fuel consumption with load

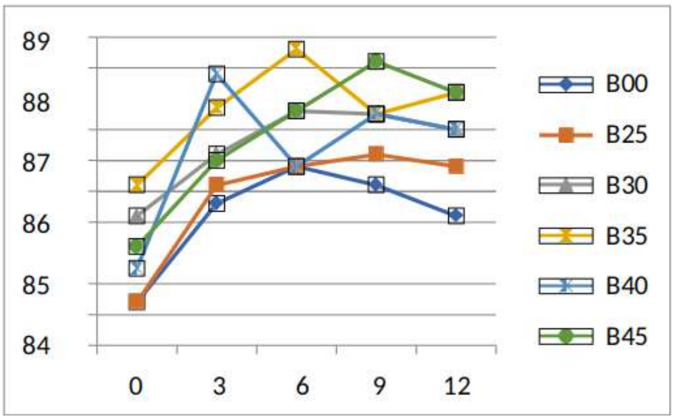
Mechanical Efficiency



X-axis: Mechanical Efficiency (%), Y-axis: Load (Kg)

Figure 4 - Variation of mechanical efficiency with load

Volumetric Efficiency



X-axis: Volumetric Efficiency (%), Y-axis: Load (Kg)

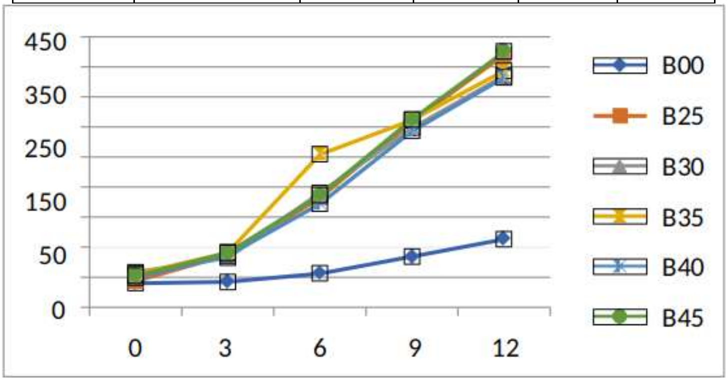
Figure 5 - Variation of Volumetric efficiency with load

Emission Parameters

As per procedure of experiment, following readings about emissions are taken for various Biodiesel blends.

Table - Emission Table for Nitrogen Oxide (ppm)

Sr. No.	Load (Kg)	B00	B25	B30	B35
1	0	40	43	58	55
2	3	42	87	82	91
3	6	56	182	190	354
4	9	84	309	298	311
5	12	113	420	385	393

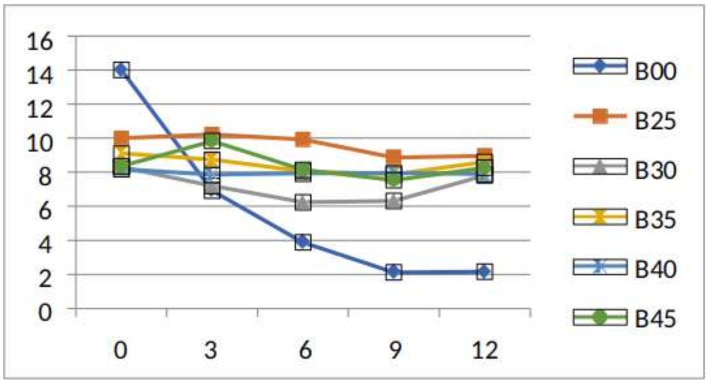


X-axis: NO (ppm), Y-axis: Lo (Kg)

Figure 6 - Variation of Nitrogen Oxide emission with load

Table - Emission table for Hydrocarbons (ppm)

Sr. No.	Load (Kg)	B00	B25	B30	B35
1	0	14.0	10.0	8.30	9.10
2	3	6.91	10.21	7.20	8.72
3	6	3.88	9.92	6.24	8.05
4	9	2.12	8.87	6.32	7.86
5	12	2.16	8.96	7.81	8.60

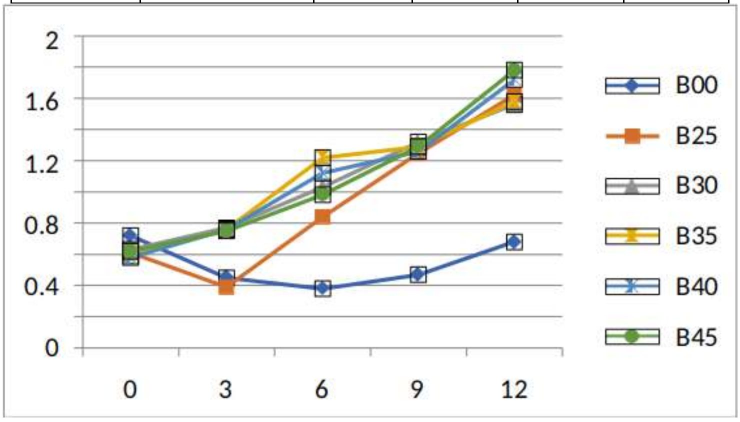


X-axis : HC (ppm), Y-axis : Load (Kg)

Figure 7 - Variation of hydrocarbon emission with load

Table - Emission table for Carbon Dioxide (%)

Sr. No.	Load (Kg)	B00	B25	B30	B35
1	0	0.72	0.61	0.63	0.59
2	3	0.45	0.39	0.77	0.76
3	6	0.38	0.84	1.03	1.22
4	9	0.47	1.5	1.32	1.29
5	12	0.68	1.62	1.56	1.58



X-axis : CO^2 (%), Y-axis: Load (Kg)

Figure 7 - Variation of carbon dioxide emission with load

Conclusions

Karanja methyl ester seems to have a potential to be used as an alternative fuel in diesel engines. Blending with diesel increases the viscosity considerably. The following results are made from the experimental study:

1. The brake thermal efficiency of the engine with Karanja methyl ester diesel blend B45 was approximately same to the diesel fuel.
2. Brake specific fuel consumption is lower for B25, B30 Blends then diesel as 2.374% and 9.012% respectively.
3. The mechanical efficiency achieved with B25 and B30 is higher than diesel at lower loading conditions as 11.628 and 6.821% respectively.
4. The emission characteristics are higher than pure diesel but the B25 and B30 has relatively better performance with respect to other blends.
5. B25 and B30 can be accepted as a suitable fuel for use in standard diesel engines.

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