ISSN No: - 2456 – 2165

Preperation of Ethanol and Performance Testing by Blending It With Rice Bran Oil

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Abstract— **The presence scenario of the world fuel consumption is massive. Increase demand and decrease in supply of petroleum fuels leads to explore new possibilities in fuel production sector. Hence the search for new alternative fuel sources has become inevitable. Initiating from this view point I selected fruit waste as the feasible raw material for bio ethanol production. The project is standing proof that ethanol production and blending can have bright future in india. Furnished with cost analysis, the project also discusses on performance of E-diesel blends and its effects this project covers a research and development possibilities and explores them to a maximum extent possible. Simplified method of production of bio ethanol and blending it into diesel to check the properties and performance characteristics of blends has been carried out in the project. All relevant aspects of this projects have been discussed in this report.**

Keywords—*rice bran oil; ethanol; blending; performance on ci engine.*

I. INTRODUCTION

Here, the bio-fuels typically composed of methyl (or ethyl) esters of long chain fatty acids derived from plant oils which have a high cetane number come into picture. Combining both ethanol and bio-fuel in certain proportions/blends, they exhibit the required qualities of a good fuel to replace diesel. Properties of ethanol in terms of octane number and latent heat of evaporation allows room for a large improvement in the engine performance. Simultaneously, the higher quantity of cetane number in the bio-fuel compensates for the required amount of CN to minimize knocking and to encourage the smooth running of the engine. Biodiesel also has superior lubricity, which reduces wear and tear on the engine and can increase the life of engine components. Manufacturers are gradually certifying their engines to operate on biodiesel blends In the present work, we obtain different blends of bio-diesel obtained from rice bran oil which has a higher cetane number, and lower percentages of 5%, 6%, 7%, 8%, 9% and 10% (by vol.) ethanol to tackle the problem of reduction of Cetane number when ethanol is added in larger ratios to the bio-diesel blends.

II. RICE BRAN OIL

A. What is a Rice Bran Oil

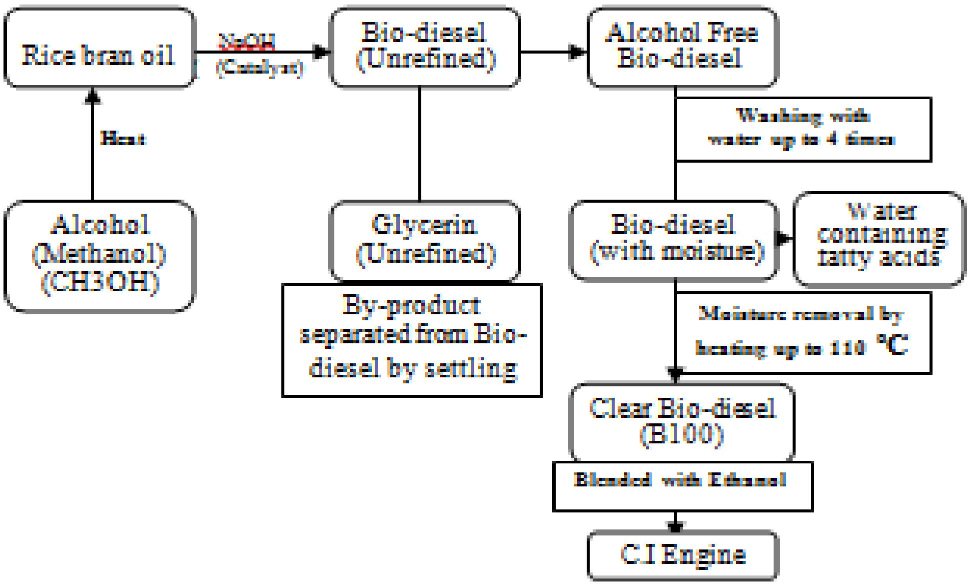
Rice bran oil is the oil extracted from the germ and inner husk of rice. It is notable for its very high smoke point of 490° F (254° C) and its mild flavor, making it suitable for high-temperature cooking methods such as stir frying and deep frying.

B. Transesterification

The Transesterification process involves mixing at room temperature, methanol (CH3OH) (50% excess) with NaOH (100% excess), then mixing vigorously with the rice bran oil and then heated on an heater (up to 60ºC) having an magnetic stirring equipment for continuously stirring the oil mixture, which sets up an reaction which is base-catalyzed transesterification that produces methyl esters and glycerin settle (about 15% of the biodiesel mix).

The equipment is fitted with water cooling system for the condensation of methanol back into the mixture. After the oil has reached the optimum temperature of 60º to 65ºC, during which the excess methanol in the mixture starts evaporating, it is poured into a conical burette, which has an opening at the bottom to drain the mixture. The oil mixture is allowed to settle for 45 minutes. After the oil gets settled, two separate layers get formed. The upper part is the oil required for the production of bio-diesel. The lower layer which is denser and dark in color compared to the upper layer of oil is glycerin, which is then drained and then stored in a different container. It can be further refined to obtain glycerin in a purer form for medical and other purposes. The flow chart of process is shown below.

ISSN No: - 2456 – 2165



III. PREPARATION OF ETHANOL

A. Ethanol, also called ethyl alcohol, pure alcohol, grain alcohol, or drinking alcohol, is a volatile, flammable, colorless liquid. It is a powerful psychoactive drug and one of the oldest recreational drugs. Best known as the type of alcohol found in alcoholic beverages, it is also used in thermometers, as a solvent, and as a fuel.

To produce Ethanol, we obtained 5kgs of fruit pulp waste from one of the fruit-juice centers in the locality. The composition of the fruit pulp waste consisted of pulps of apple, pineapple, oranges, grapes, watermelon etc. The mixture was then collected in an air-tight container to which, 5 liters of water was added. To this mixture, yeast in proportional quantity was added so that the mixture could start fermenting.

In the absence of oxygen, yeasts can convert sugars to alcohol and carbon dioxide.

$$C_6H_{12}O_6 \rightarrow 2(CH_3CH_2OH) + 2CO_2$$

The above formula shows how a molecule of sugar on the left is converted to two molecules each of ethanol and carbon dioxide. This mixture is to be kept for 14 days in a container for the complete fermentation, after which the upper layer of fruit waste is separated and is disposed. The liquid obtained after this process is then allowed to continue fermentation for another 10 days. The liquid after a total of 24 days is then collected in a distillation unit and then distilled using fractional distillation equipment.

B. LABROTARY SETUP

Fractional distillation in a laboratory makes use of common laboratory glassware and apparatuses, typically including electric heater, a round-bottomed flask and a condenser, as well as the single-purpose fractionating column.

Fractional distillation is the separation of a mixture into its component parts, or fractions, such as in separating chemical compounds by their boiling point by heating them to a temperature at which several fractions of the compound will evaporate.

Collection of fruit waste and obtaining of ethanol through fractional distillation.

Ethanol boils at 78.4 °C while water boils at 100 °C. So, by gently heating the mixture, the most volatile component will concentrate to a greater degree in the vapor leaving the liquid. The vapor condenses on the glass platforms. The process continues until all the ethanol boils out of the mixture. This point can be recognized by the sharp rise in temperature shown on the thermometer. The Graham condenser is a spiral tube within a water jacket, increasing the surface area upon which the vapor constituents condense in the form of droplets. This obtained droplets is nothing but ethanol, by this process after few repetitions of the fractional distillation, pure ethyl alcohol is obtained which is 96% pure.

IV. BLENDING OF ETHANOL WITH BIODIESEL

Blending is simple process of mixing ethanol with bio diesel (rice bran oil) in required proportion. In this experiment, ethanol is mixed in 5%, 9% and 10% ratios for the 400 ml of bio diesel sample.

Taking 400ml of biodiesel – ethanol blends we perform the engine performance test.

- Firstly, 380 ml of bio diesel and 20ml of ethanol blend sample is blended in a flask and mixed well.
- Similarly for the above mentioned proportions the blending is done.
- The samples are kept for 20 hours under observation to see the proper blending ratio.
- If two layers are formed, ethanol and bio diesel they can be considered as improper mixture.

The complete blending details is shown below:

Sample	Blend	Bio diesel	Ethanol
B5	5%	380 ml	20 ml
B8	8%	368 ml	32 ml
B9	9%	364 ml	36 ml
B10	10%	360 ml	40 ml

V. PERFORMANCE TEST

Performance Test is conducted on a single cylinder 4-stroke water cooled engine and performance curves were drawn for Diesel, Rice Bran Bio-Diesel and Rice Bran Bio-Diesel Ethanol blends and the following are the results obtained and performance graphs. The results are tabulated and graphs are plotted for different blends of diesel.

SPECIFICATION of the ENGINE:

Sl. No.	Parameters	Specification
1.	Type	TV 1 (Kirloskar made)
2.	Software used	Engine soft
3.	Nozzle Opening Pressure	200 to 225 bar
4.	Governor Type	Mechanical Centrifugal Type
5.	No of Cylinders	Single Cylinder
6.	No. of Strokes	Four Stroke
7.	Fuel	Diesel, Biodiesel and Biodiesel blends
8.	Compression Ratio	16:5:1
9.	Cylinder Diameter (Bore)	80mm
10.	Stroke Length	110mm
Electrical Dynamometer		
11.	Type	Foot Mounted, Continuous rating
12.	Alternator Rating	3 KVA
13.	Speed	2800-3000 rpm
14.	Voltage	220 V AC

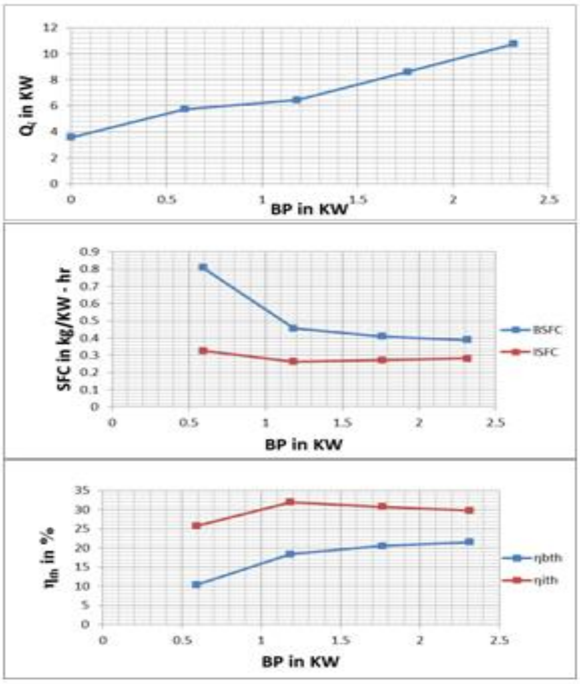
A. Results For Diesel

Sl. No.	Heat Supply (Qi) [KW]	Brake Power (BP) [KW]	Indicated Power (IP) [KW]	Mechanical Efficiency (η_{m}) [%]	Brake Thermal Efficiency (η_{bth}) [%]	Indicated Thermal Efficiency (η_{ith}) [%]	Brake Specific Fuel Consumption (BSFC) [kg/KW-hr]	Indicated Specific Fuel Consumption (ISFC) [kg/KW-hr)
1.	3.58	0	0.880	0	0	24.58	-	0.340
2.	5.73	0.594	1.474	40.29	15.36	25.72	0.808	0.326
3.	6.45	1.184	2.064	57.36	23.36	32.00	0.456	0.262
4.	8.60	1.762	2.642	66.69	26.49	30.72	0.409	0.272
5.	10.75	2.315	3.195	72.46	27.48	29.72	0.389	0.282

HEAT BALANCE SHEET

Heat Input	KJ/min	%	Heat Output	KJ/min	%
F. By Burning of Fuel i.e., Heat Supplied (Q_i)	645	100	G. Heat equivalent to BP BP*60	138.90	21.53
			H. Heat carried by cooling Water = m_w x C_{pw} x (T_1~T_2)	121.42	18.81
			I. Heat carried away by exhaust gas = m_g x C_{pg} x (T_6~T_5)	95.433	14.79
			J. Heat unaccountable [A-(B+C+D)]	289.24	44.87
Total Input		100	Total Output		100

Performance Graph:



B. Results For Rice Bran Oil And Diesel

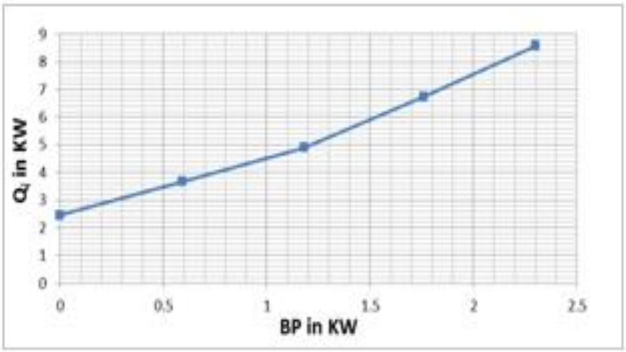
Sl. No	Qi [KW]	BP [KW]	IP [KW]	η_{m} [%]	η_{bth} [%]	η_{ith} [%]	BSFC [kg/KW-hr]	ISFC [kg/KW-hr)
1.	2.45	0	0.60	0	0	24.49	-	0.400
2.	3.67	0.59	1.19	49.58	10.08	32.42	0.610	0.303
3.	4.90	1.18	1.78	66.29	18.08	36.33	0.407	0.270
4.	6.74	1.76	2.36	74.58	20.11	35.01	0.375	0.280
5.	8.57	2.30	2.90	79.31	20.84	33.84	0.365	0.290

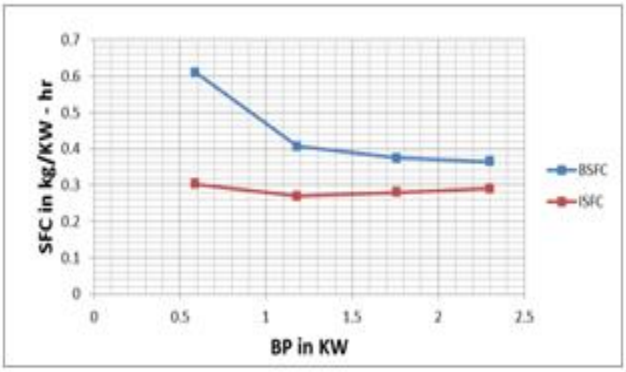
HEAT BALANCE SHEET

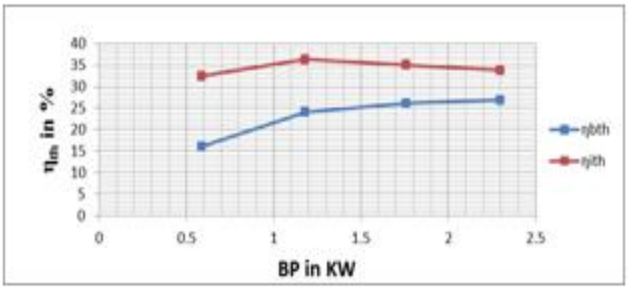
Heat Input	KJ/min	%	Heat Output	KJ/min	%
A. By Burning of Fuel i.e., Heat Supplied (Q_i)	514.2	100	B. Heat equivalent to BP BP*60	138.00	26.85
			C. Heat carried by cooling Water = m_w x C_{pw} x (T_1~T_2)	114.49	22.27
			D. Heat carried away by exhaust gas = m_g x C_{pg} x (T_6~T_5)	85.402	16.61
			E. Heat unaccountable [A-(B+C+D)]	176.30	34.27
Total Input		100	Total Output		100

Performance Graph:

Test 2:







C. Results For Biodiesel With 5%Ethanol Blend

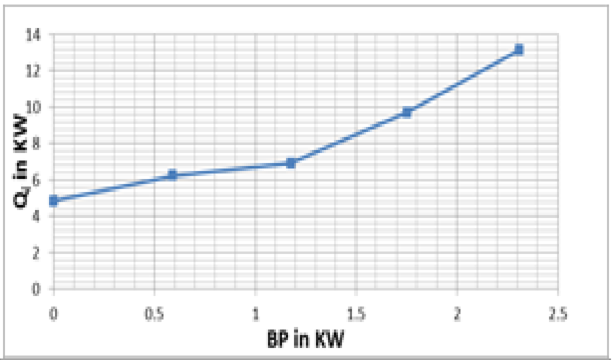
Sl. No.	(Qi) [KW]	(BP) [KW]	(IP) [KW]	(η_{mech}) [%]	(η_{bth}) [%]	(ηith) [%]	(BSFC) [kg/KW-hr]	(ISFC) [kg/KW-hr)
1.	4.847	0	1	0	0	20.63	-	0.42
2.	6.232	0.592	1.592	37.19	11.49	25.55	0.912	0.34
3.	6.924	1.177	2.177	54.07	18.99	31.44	0.509	0.26
4.	9.694	1.752	2.752	63.66	20.07	28.39	0.479	0.31
5.	13.156	2.312	3.312	69.81	21.57	25.17	0.493	0.34

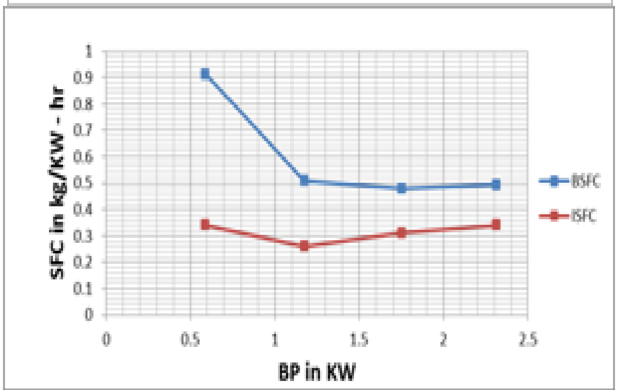
HEAT BALANCE SHEET

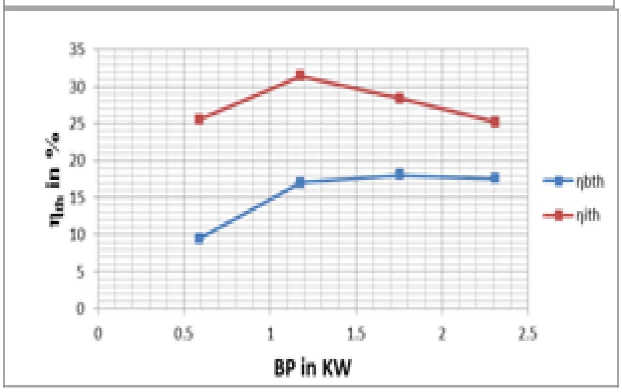
Heat Input	KJ/min	%	Heat Output	KJ/min	%
A. By Burning of Fuel i.e., Heat Supplied (Q_i)	789.36	100	B. Heat equivalent to BP BP*60	138.72	17.57
			C. Heat carried by cooling Water = m_w x C_{pw} x (T_1~T_2)	123.75	15.68
			D. Heat carried away by exhaust gas = m_g x C_{pg} x (T_6~T_5)	94.562	11.98
			E. Heat unaccountable [A-(B+C+D)]	432.32	54.77
Total Input		100	Total Output		100

Performance Graph:

Test 3:







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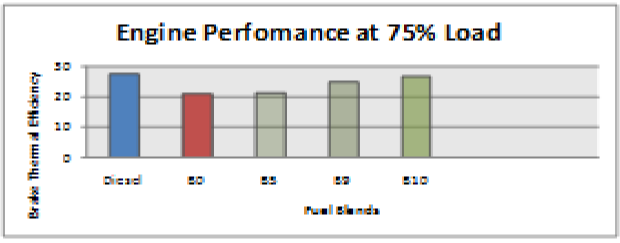
VI. OVERALL PERFORMANCE CURVES



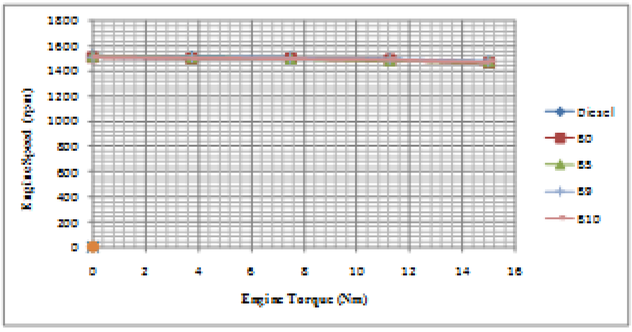


Figure 1: Relationship b/w Engine Speed and Torque for Different Fuel Blends

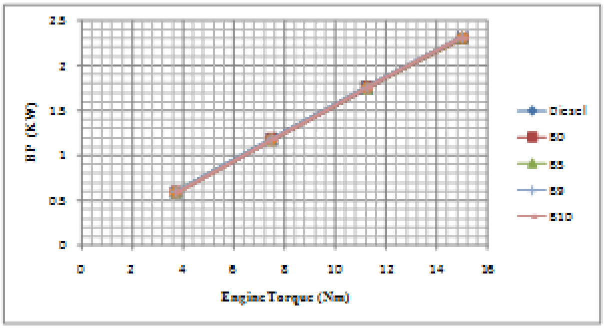


Figure 2: Relationship b/w BP and Torque for Different Fuel Blends

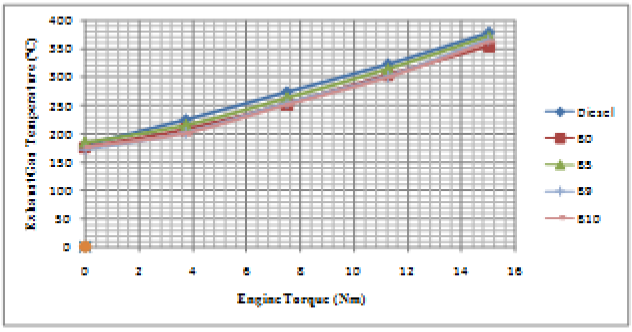


Figure 3. Relationship b/w Exhaust Temperature and Torque for Different Fuel Blends

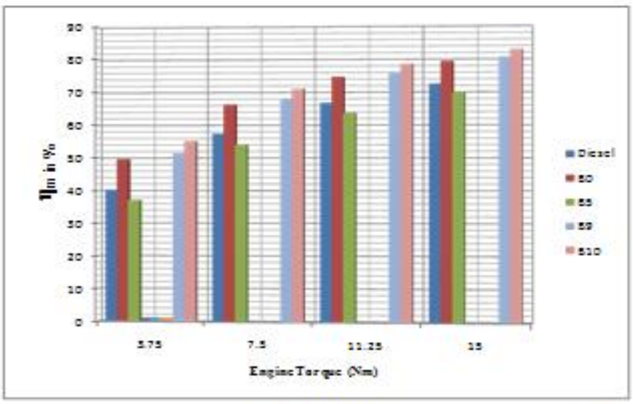


Figure 6: Relationship b/w Mechanical Efficiency and Engine Torque for Different Fuel Blends

VII. DISCUSSIONS

When the blends of biodiesel and ethanol were tested in the laboratory, results obtained were as follows:

1. With the increase in blend, Flash and Fire point decreases.
2. With the increase in blend the viscosity decreases.
3. With the increase of the blend percent there is decrease in Calorific value of the fuel.
4. With the increase of the blend percent there is increase in specific gravity of the fuel.

A. Brake Thermal Efficiency v/s 75% Load

1. Performance of engine was observed to be better when operated on diesel as compared to biodiesel.
2. Biodiesel-Ethanol blended fuels showed better performance in terms of higher brake thermal efficiency and lower emissions of smoke.
3. In BIODIESEL-Ethanol blended fuels 10% Ethanol blend showed better performance in comparison with 5% and 8% blends.

B. Engine Speed v/s Torque

It is observed that as there is increase in the torque there is decrease in the speed of the crank.

C. BP v/s Torque

1. It is clear that as the torque increases the power developed also increases.
2. The bp is slightly higher for higher percentage of ethanol fuel as compared to neat diesel because more amount of air is available for combustion of ethanol diesel blends as the stochiometric air fuel ratio of ethanol is less than diesel.
3. These characteristics are confirming the fact of combustion performance improvement due to ethanol fuel addition with neat biodiesel.

D. Exhaust Gas Temperature v/s Torque

1. It is clear that as the torque increases, the exhaust gas temperature increases.
2. The maximum exhaust gas temperature of about 379ºC was observed at maximum torque (75%) when the engine was on diesel fuel, whereas the average maximum exhaust temperatures were 355, 373, 365, 378, 368, 367 and 363ºC when the engine was run on Biodiesel, 5% EB, 9% EB and 10% EB blends, respectively.
3. Since ethanol is partially oxidized (OH radicals), and while burning has a lower burning temperature, reduced exhaust gas temperatures were observed when running on blends. Another reason is that the lower calorific value of blended fuel as compared to diesel alone.

ISSN No: - 2456 – 2165

E. BSFC v/s Torque

1. BSFC decreases with load as the power increases at higher rate than the fuel consumption rate for higher loads due to better combustion.
2. The BSFC is less for ethanol diesel blends in comparison with neat diesel and in general it can be interpreted that with the increase in ethanol concentration BSFC decreases.
3. This is due to the fact that more power is developed for the same load in case of ethanol biodiesel blends because more air is available for combustion of ethanol biodiesel blends as the stoichometric air-fuel ratio of ethanol (9.0) is less than diesel (14.5), thus indicating better combustion.

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