Energy Analysis of CI engine using Jatropha Bio diesel blends with Diesel

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Abstract: In ongoing year, vitality is the fundamental need of everybody on the planet and furthermore the vitality utilization is expanding with time. Essential wellspring of vitality are non-renewable energy source, for example, coal, flammable gas and oil based commodities, for example, fuel and diesel. Be that as it may, these wellsprings of vitality are constrained in amount and they are non-inexhaustible. They won't be accessible in close by future for utilize subsequently developing concern in regards to vitality assets and condition has expanded enthusiasm for the investigation of elective wellsprings of vitality. To meet expanding vitality prerequisite, these have been developing enthusiasm for elective fuel like biodiesel to give an appropriate diesel oil substitute for inside burning motor. Biodiesels are offers a promising option in contrast to diesel oil since they are sustainable and have been comparable properties. One of the efficient hotspots for biodiesel creation which duplicates in the decrease of fluid waste and the consequent weight of sewage treatment is Jatropha bio diesel. This examination work plans to conveyed vitality investigation of Compression Ignition (CI) Engine to consider execution and its attributes. The warm effectiveness and the vitality misfortunes in the framework are determined from the first law of thermodynamics. Vitality examination is done for biodiesel mixes (B10 to B50 with addition of 10). From this investigation best performed mix was picked and we get vitality examination.

Keywords: Analysis of different jatropha bio diesel blends.

1. INTRODUCTION

In the realm of today, vitality is a genuine presence line of each and every human activity. It has now become a requirement for regular calendar life. Oil is the greatest contributing imperativeness source to mankind, beating each other resource like: coal, nuclear, hydro, combustible gas and wind. It is key in the field of mechanical, sustenance and agrarian creation, as the fuel for transportation similarly with respect to the period of intensity. The quantity of diesel motor expanding consistently on account of having high productivity, upgraded efficiency. Diesel motors are favored over flash start motors in practically all substantial application because of their unwavering quality and solidness. Thusly, the world enthusiasm for diesel fuel extends every year. Since the non-sustainable power source resources are compelled and non-endless and will bit by bit lessen. Likewise remnant powers causes air contamination, an unnatural weather change and to give a successful method to battle against the issue of oil base fuel emergency and the impact on condition animating the scientists and designers required to discover sustainable power sources and energizes.

Biodiesel is a fuel delivered utilizing normal, supportable sources, for instance, new and used vegetable oils and animal fats, for use in a diesel engine (G. Antolın et al. 2002). Biodiesel has physical properties on a very basic level equivalent to oil decided diesel fuel, yet its release properties are common. Using biodiesel in a customary diesel engine altogether diminishes releases of unburned hydrocarbons, carbon monoxide, sulfates, polycyclic sweet-smelling hydrocarbons, nitrated polycyclic sweet-smelling hydrocarbons, and particulate issue(Canaski et al. 2006). Diesel blends containing up to 20% biodiesel called B20 can be used in practically all diesel-controlled equipment, and increasingly noteworthy level blends and unadulterated biodiesel, B100 can be used in various engines with close to zero change. Lower-level blends are immaculate with most amassing and scattering gear, yet special dealing with is required for progressively huge level mixes(Sekmen et al. 2011., Panigrahi et al. 2014).

Biodiesel can be utilized in any diesel motor when blended in with mineral diesel. In certain nations producers spread their diesel motors under guarantee for 100% biodiesel use. Numerous individuals have run their vehicles on biodiesel without issues. Be that as it may, most of vehicle producers limit their suggestions to 15% biodiesel mixed with mineral diesel. In numerous European nations, a 5% biodiesel mix, B5 is broadly utilized and is accessible at a large number of corner stores (K.V.Narayanan et al. 2015). Biodiesel can be produced using waste and virgin vegetable and creature oil and fats (fluids). Virgin vegetable oils can be utilized in altered diesel motors. Truth be told the diesel motor was initially intended to run on vegetable oil instead of petroleum product. There are also studies and efforts to commercialize biodiesel from algae (C. Sayin et al. 2016).considered the generation of biodiesel from Jatropha and its application to diesel motor. Execution and outflow tests were led on a solitary chamber diesel motor to fuelled with biodiesel mixes and diesel fuel. The test outcomes demonstrated that the decrease in execution for B5, B20 and B50 energizes were 2.2%, 6.3% and 11.2% individually than that of diesel fuel. These low decrease can be kill by increment in BSFC. For biodiesel mixes B5, B20 and B50 expanded in BSFC by 2.8%, 3.9% and 7.8% separately (Likita Bwonsi et al. 2017). Oxygen in biodiesel fuel leads to better combustion and hence combustion related irreversibility can be reduced means good energetic performance. Combustion process involve most of the irreversibility of the system hence combustion system must be analyzed for optimum performance on energetic way. Fuel consumption is always higher for biodiesel and in some preferable condition reaches near to diesel. Brake thermal efficiency of the engine with biodiesel fuel mostly higher than diesel fuel and it may be due to better combustion.

The added substances in biodiesel are utilized for the improve burning, mileage and to diminish the emanation. A metal based added substance will limit the thickness, pour point and increment the glimmer point properties of biodiesel fuel. The BSFC diminishes essentially because of their impetus impact by including the metal based added substances. the oxygenated added substances will influence legitimately the properties, for example, cetane number, thickness, consistency, instability, streak point and calorific worth. The oxygenated added substance helps in decreasing the thickness and thickness just as raising the amount of oxygen in biodiesel fuel. Typically all fumes discharges of carbon dioxide, carbon monoxide, hydrocarbon and smoke outflows are diminished particularly with the expansion of oxygenated added substances to diesel and biodiesel energizes. Cetane number added substances are significant in diminishing start defer period. Cancer prevention agent added substances are the best to increment cetane number and glimmer point, however calorific worth gets diminish with cell reinforcement. Cancer prevention agent is very effective in controlling NOx emanation (MVijay Kumar et al. 2016).

2. MATERIALS AND TEST METHODS

2.1. Experimental setup and test installations

The purpose behind blending Jatropha bio diesel with Diesel was to ask about the likelihood direct use of vegetable oils in Diesel engines. In this way, test energizes were set up by mixing (Diesel 90% + Jatropha 10%), (Diesel 80% + Jatropha 20%), (Diesel 70% + Jatropha 30%), (Diesel 60% + Jatropha 40%), (Diesel half + Jatropha half). A portion of the properties of the Jatropha Bio diesel and Diesel were assessed and are presented in table 1.

Table 1: Properties of fuel

	Jatropha Bio diesel	Diesel
FLASH POINT	135 °C	150°C
VISCOSITY	At 20°C (4.9 cP)	At 20 °C(6cP)
DENSITY	0.880 g/mL	0.832 g/mL
CETANE NUMBER	-	45-55
CALORIFIC VALUE	39100 kJ/kg	43000 kJ/kg

Calorific value and Density of the (Diesel 90% + Jatropha 10%), (Diesel 80% + Jatropha 20%), (Diesel 70% + Jatropha 30%), (Diesel 60% + Jatropha 40%), (Diesel 50% + Jatropha 50%). is show in table 2.

Table 2: Calorific value and density

	Calorific Value	Density
(Diesel 90% + Jatropha 10%)	42583.20 kJ/kg	838.4 kg/m^3
(Diesel 80% + Jatropha 20%)	42172.72 kJ/kg	844.8 kg/m^3
(Diesel 70% + Jatropha 30%)	41768.42 kJ/kg	851.2 kg/m^3
(Diesel 60% + Jatropha 40%)	41370.14 kJ/kg	857.6 kg/m^3
(Diesel 50% + Jatropha 50%)	40977.77 kJ/kg	864.0 kg/m^3

Schematic chart of primer game-plan is found in Figure. 1. The game-plan includes single chamber, four strokes, VCR (Variable Compression Ratio) Diesel motor related with vortex current sort dynamometer for stacking. The weight degree can be changed continually the motor and without modifying the beginning chamber geometry by especially composed tilting chamber square procedure. Game-plan is given critical instruments for expending weight and wrench edge estimations. This sign is interfaced to PC through motor marker for Pθ-PV follows. Strategy is additionally made for interfacing wind current, fuel stream, temperatures and weight estimation. The set-up has remained solitary board box containing air box, two fuel tanks for mix test, manometer, fuel evaluating unit, transmitters for air and fuel stream estimations, process pointer and motor marker. Rotameters are obliged cooling water and calorimeter water stream estimation. The course of action empowers assessment of VCR motor execution with EGR for brake control, displayed power, frictional power, BMEP, IMEP, brake warm capacity, showed warm proficiency, Mechanical sufficiency, volumetric productivity, express fuel use, A/F degree and warmth balance. Labview based Engine Performance Analysis programming pack "ICEngineSoft" is obliged on line execution examination. A robotized Diesel blend pressure estimation is then again given. Table 3 show the Specifications of the Diesel engine.

Figure 1: Schematic outline of trial arrangement

Table3: Specifications of the Diesel engine

Engine Manufacturer	**Apex Innovation**
Product	Research motor arrangement single chamber, 4-stroke, multi fuel, Electronic
Engine cylinder size	Stroke 110mm, Bore 87.5mm, limit 661 cc
Diesel mode	Power 5.2 kW, speed 1500 rpm, CR go 12:1-18:1, infusion variety 0-25º BTDC
Petrol mode	Power 4.5 KW at 1800 rpm, speed go 1200-1800 rpm, CR extend 6:1-10:1, flash variety 0-700 BTDC
Dynamometer	Whirlpool ebb and flow, water cooled with stacking unit
Temperature sensor	RTD type, PT 100 and thermocouple
Load indicator	Computerized, run 0-50 kg
Load sensor	Strain check, 0-50 kg
Software	Enginesoft, engine performance and analysis

2.2. CALCULATED PARAMETERS

Mass flow rate of engine cooling water mw = 300 LPH (litre per hour)

Mass flow rate of calorimeter water $mwcal$ = 75 LPH (litre per hour)

Mass of fuel consumed per unit time $\dot{m}f = \frac{volume\ of\ fuel\ consume}{time\ taken} \times density\ of\ fuel$ (kg/sec)

Mass of air consumption is theoretically given as follow

$$\dot{m}_a = c_d \times \frac{\pi}{4} \times d^2 \times \sqrt{2 \times 9.81 \times h_w} \times \sqrt{\rho_{water} / \rho_{air}} \times \rho_{air} \text{ (kg/sec)}$$

Where $\rho_{water} = 1000 \text{kg/m}^3$

ρ_{air} =(P/R T)kg/m^3

c_d = co-efficient of discharge of orifice

d = diameter of tube orifice

Mass of exhaust gases per unit time $\dot{m}_{ex} = \dot{m}_a + \dot{m}_f$ (kg/sec)

Hence all the necessary values are available for the energy analysis and calculation for the same is given below:

1) Heat supplied to the engine per unit time

$\dot{Q_{in}} = m_f \times LCV$ (kW)

2) Brake power of the engine

$\dot{Q_{bp}} = 2\pi NT/60{,}000$ (kW)

3) Heat carried away by cooling water of the engine

$\dot{Q_{cw}} = m_{cw} \times c_{pw} \times (T_2 - T_1)$ (kW)

4) Heat carried away by exhaust gases

Heat gain by water in calorimeter = Heat loss by exhaust gases in calorimeter

$\dot{m}_{wcal} \times c_{pw} \times (T_4 - T_3) = \dot{m}_{ex} \times c_{pex} \times (T_5 - T_6)$ (kJ/kg. K)

Heat carried away by exhaust gases is now calculated as

$\dot{Q_{ex}} = \dot{m}_{ex} \times c_{pex} \times (T_5 - T_0)$ (kW)

5) Unaccounted losses

$\dot{Q_U} = \dot{Q_{in}} - (\dot{Q_{bp}} + \dot{Q_{cw}} + \dot{Q_{ex}})$ (kW)

6) Brake thermal efficiency (BTHE)

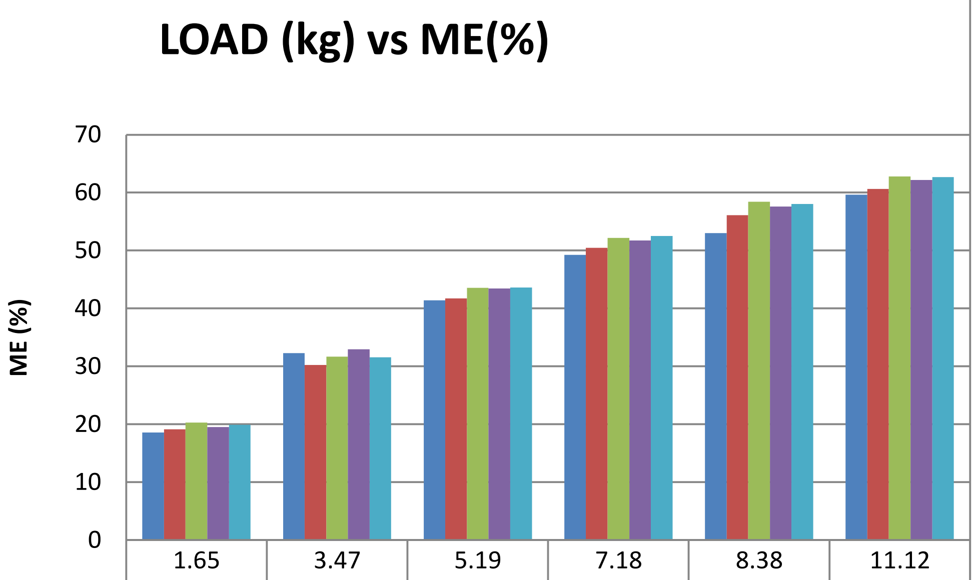
$\eta = \left\{\frac{\dot{Q_{bp}}}{Q_{in}}\times 100\%\right.$

3. EXPERIMENTAL RESULT AND DISCUSSION

results

Specific Fuel Consumption(SFC), Fuel Consumption(FC), Exhaust Gas Temperature, Mechanical Efficiency(ME%), Brake Thermal Efficiency(BTHE%) and Volumetric Efficiency effective efficiency of the engine according to the operation load, for all the test fuels are presented and analyzed in this section, as the performance parameters.

Analysis for Mechanical Efficiency

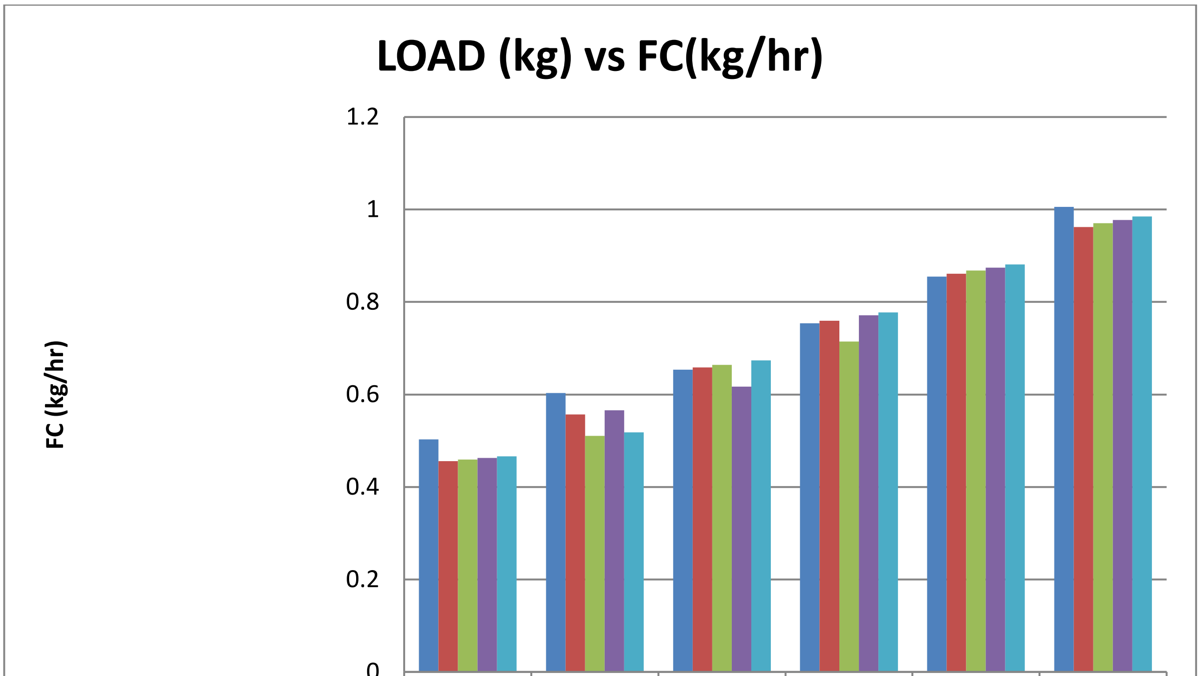


	1.65	3.47	5.19	7.18	8.38	11.12
DIESEL 90% + JATROTHA 10%	18.5778716	32.3146229	41.3810179	49.2476225	52.9946048	59.6547133
DIESEL 80% + JATROTHA 20%	19.143203	30.2245135	41.755538	50.4823501	56.098978	60.623562
DIESEL 70% + JATROPHA 30%	20.3204622	31.7032983	43.571336	52.1897417	58.3973881	62.777095
DIESEL 60% + JATROPHA 40%	19.5533572	32.954712	43.4601643	51.7490462	57.6171023	62.1782865
DIESEL 50% + JATROPHA 50%	19.9044278	31.5556603	43.6336775	52.5263242	58.0622661	62.6890025

Figure2: Load (kg) Vs ME %

- Mechanical efficiency vs Load graph for various blends is shown in figure 2.
- For all load conditions (Diesel 70% + Jatropha 30%) blend gives better result for Mechanical efficiency, which is less than Mechanical Efficiency when fueled with (D100%) but greater than rest of the blends.

Analysis for Fuel Consumption

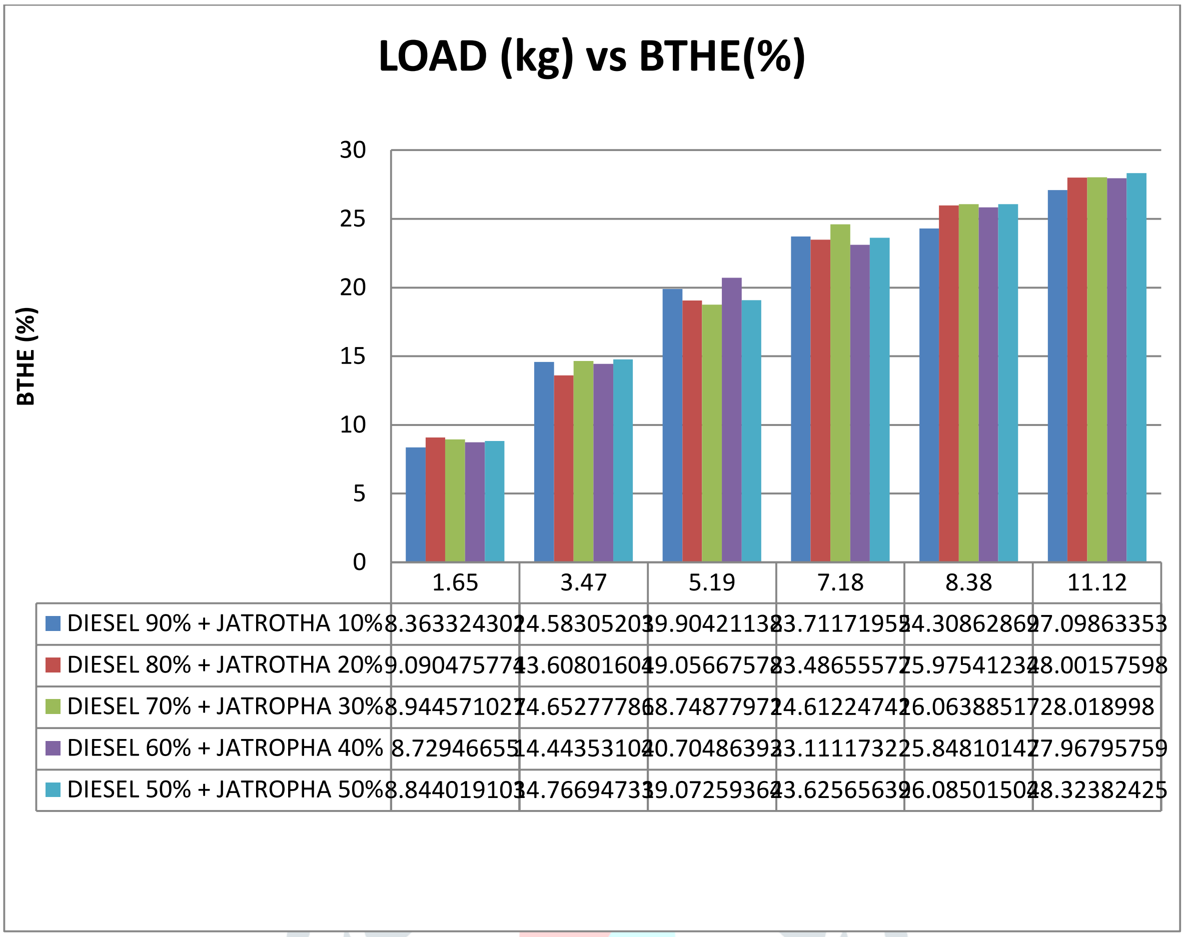


	1.65	3.47	5.19	7.18	8.38	11.12
DIESEL 90% + JATROTHA 10%	0.5028	0.60336	0.65364	0.7542	0.85476	1.0056
DIESEL 80% + JATROTHA 20%	0.45576	0.55704	0.65832	0.7596	0.86088	0.96216
DIESEL 70% + JATROPHA 30%	0.45954	0.5106	0.66378	0.71484	0.86802	0.97014
DIESEL 60% + JATROPHA 40%	0.46278	0.56562	0.61704	0.7713	0.87414	0.97698
DIESEL 50% + JATROPHA 50%	0.46656	0.5184	0.67392	0.7776	0.88128	0.98496

Figure 3: Load (kg) Vs FC (kg/hr)

- Fuel consumption vs Load graph for various blends is shown in figure 3.
- For 3kg load conditions (Diesel 70% + Jatropha 30%) blends gives good result for Fuel Consumption. It is less than Fuel Consumption when fueled with (Diesel 50% + Jatropha 50%) blend.
- For 7kg load conditions (Diesel 70% + Jatropha 30%) blends gives good result for Fuel Consumption. It is less than Fuel Consumption compare to all blends.
- For 11kg load conditions (Diesel 70% + Jatropha 30%) blend gives good result for Fuel Consumption.

Analysis for Brake Thermal Efficiency



	1.65	3.47	5.19	7.18	8.38	11.12
DIESEL 90% + JATROTHA 10%	8.36332430	14.5830520	19.9042113	23.7117195	24.3086286	27.09863353
DIESEL 80% + JATROTHA 20%	9.09047577	13.6080160	19.0566757	23.4865557	25.9754123	28.00157598
DIESEL 70% + JATROPHA 30%	8.94457102	14.6527778	18.7487797	24.6122474	26.06388517	28.018998
DIESEL 60% + JATROPHA 40%	8.72946655	14.4435310	20.7048639	23.1111732	25.8481014	27.96795759
DIESEL 50% + JATROPHA 50%	8.84401910	14.7669473	19.0725936	23.6256563	26.0850150	28.32382425

Figure4: Load (kg) Vs BTHE %

- Brake thermal efficiency vs Load graph for various blends is shown in figure 4.
- For 5kg load conditions (Diesel 70% + Jatropha 30%) blend gives better result for Brake Thermal Efficiency. It is less than Brake Thermal Efficiency when fueled with B10, B20, B40and B50 blends.
- For 5kg load conditions (Diesel 70% + Jatropha 30%) blend gives good result for Brake Thermal Efficiency.

Analysis for Specific Fuel Consumption

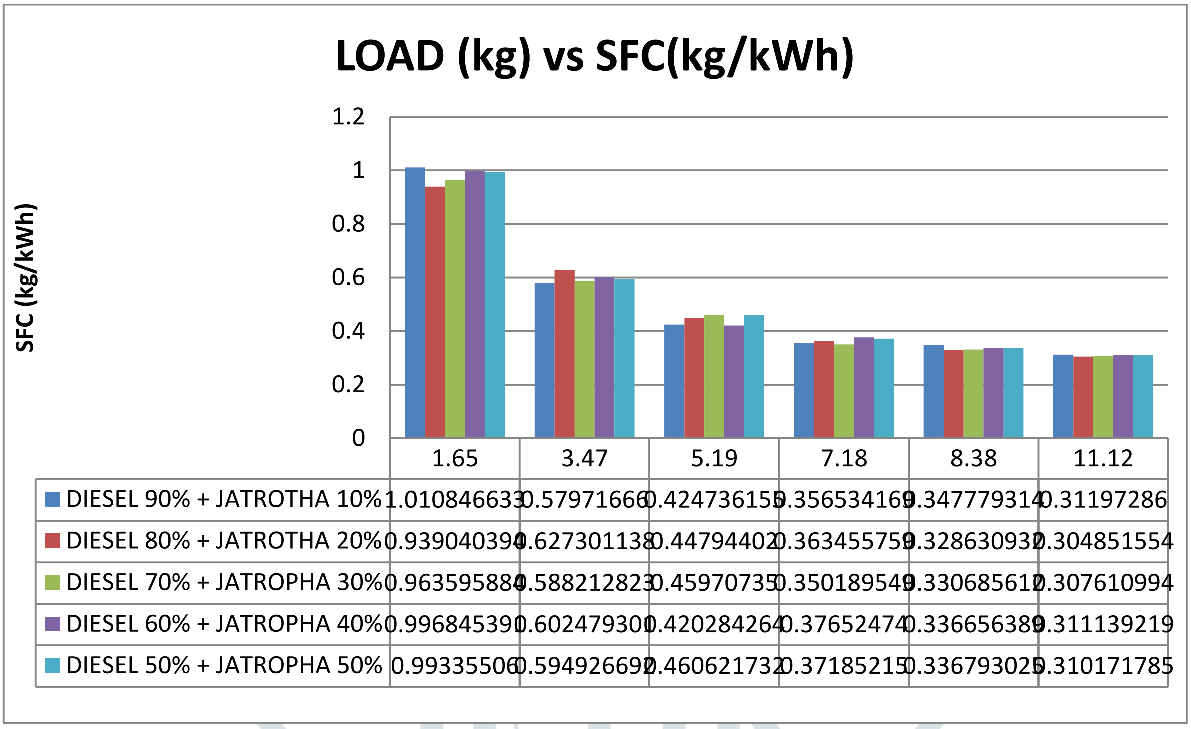
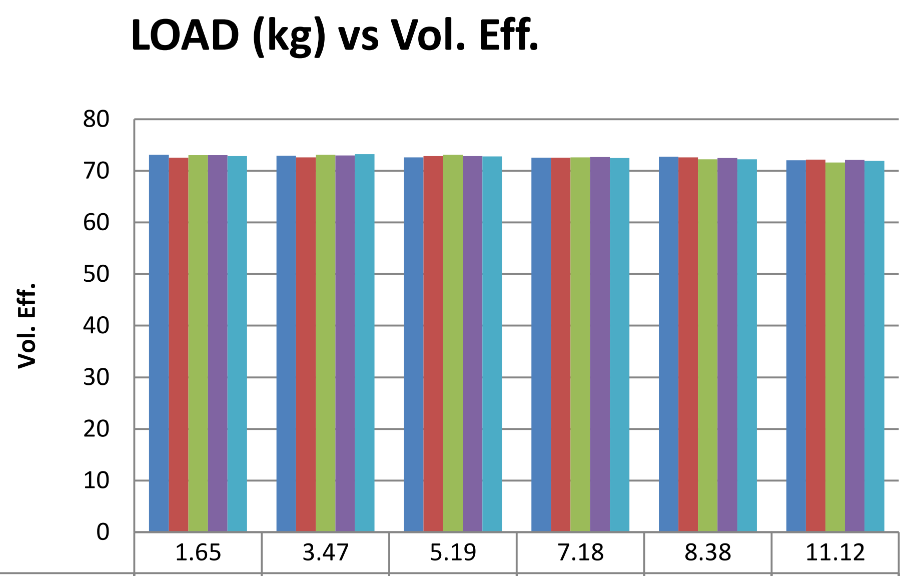


Figure5: Load (kg) Vs SFC (kg/kWh)

- Specific fuel consumption vs Load graph for various blends is shown in figure 5.
- For 2kg load conditions (Diesel 80% + Jatropha 20%) blend gives better result for Specific Fuel Consumption. It is less than Specific Fuel Consumption when fueled with B10, B30, B40 and B50 blends.
- For 5kg load conditions (Diesel 70% + Jatropha 30%) blend gives better result for Specific Fuel Consumption. It is less than Specific Fuel Consumption when fueled with B10, B20, B40 and B50 blends.

Analysis for Volumetric Efficiency

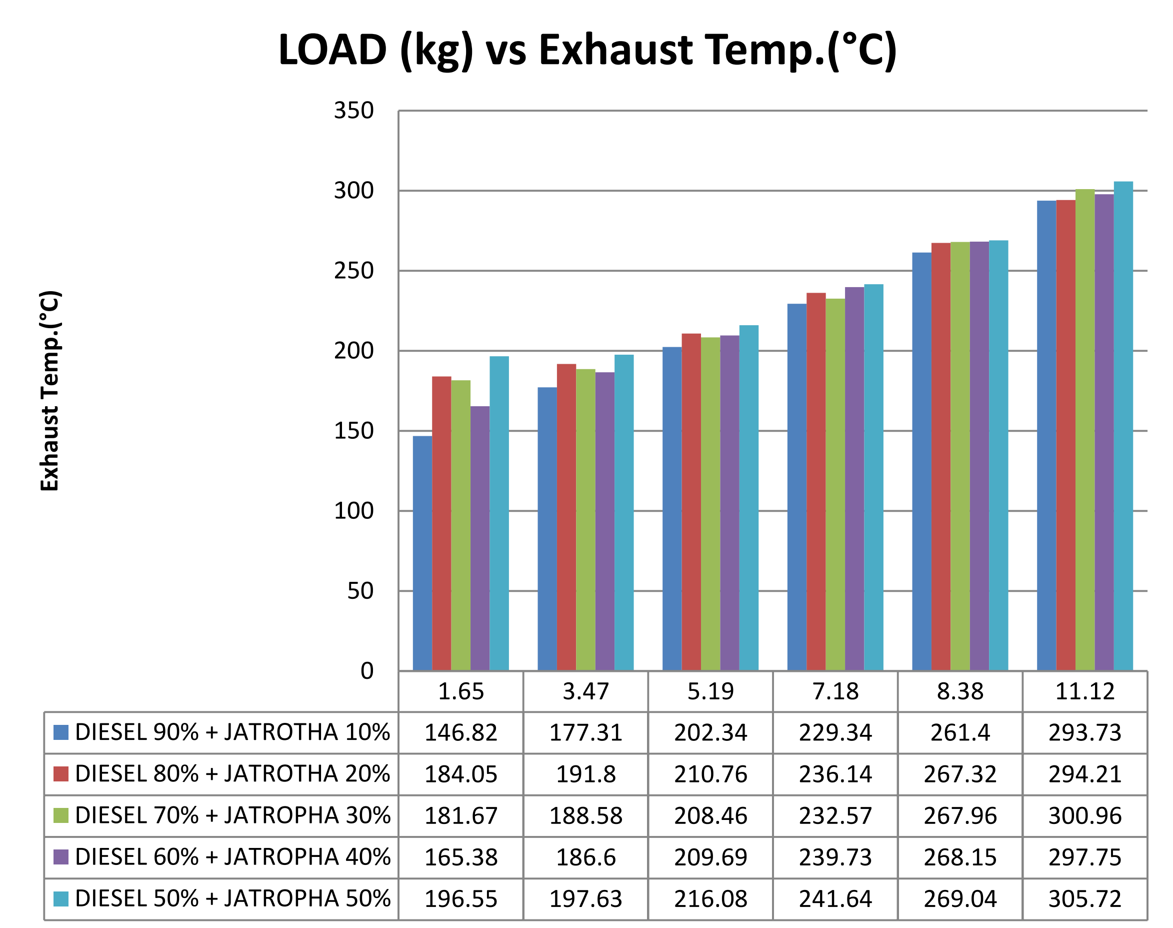


	1.65	3.47	5.19	7.18	8.38	11.12
DIESEL 90% + JATROTHA 10%	73.085053	72.915699	72.61466	72.547987	72.728173	72.046898
DIESEL 80% + JATROTHA 20%	72.558598	72.628505	72.860896	72.560854	72.628399	72.188705
DIESEL 70% + JATROPHA 30%	73.073287	73.11561	73.13155	72.617812	72.245562	71.64119
DIESEL 60% + JATROPHA 40%	73.06947	72.9984	72.894324	72.701081	72.511486	72.097297
DIESEL 50% + JATROPHA 50%	72.875037	73.246539	72.799199	72.49622	72.218906	71.921966

Figure6: Load (kg) Vs Vol.Eff.

- Volumetric efficiency vs Load graph for various blends is shown in figure 6.
- For 1kg load conditions (Diesel 70% + Jatropha 30%) blend gives good result for Volumetric Efficiency. It is greater than Specific Fuel Consumption when fueled with B10, B20, B40 and B50 blends.
- For 5kg load conditions (Diesel 70% + Jatropha 30%) blend gives good result for Volumetric Efficiency. It is greater than Specific Fuel Consumption when fueled with B10, B20, B40 and B50 blends.
- For 11kg load conditions (Diesel 80% + Jatropha 20%) blend gives good result for Volumetric Efficiency. It is greater than Specific Fuel Consumption when fueled with B10, B30, B40 and B50 blends.

Analysis for Exhaust Gas Temperature



	1.65	3.47	5.19	7.18	8.38	11.12
DIESEL 90% + JATROTHA 10%	146.82	177.31	202.34	229.34	261.4	293.73
DIESEL 80% + JATROTHA 20%	184.05	191.8	210.76	236.14	267.32	294.21
DIESEL 70% + JATROPHA 30%	181.67	188.58	208.46	232.57	267.96	300.96
DIESEL 60% + JATROPHA 40%	165.38	186.6	209.69	239.73	268.15	297.75
DIESEL 50% + JATROPHA 50%	196.55	197.63	216.08	241.64	269.04	305.72

Figure7: Load (kg) Vs Exhaust Temp.(°C)

- Exhaust gas temperature vs Load graph for various blends is shown in figure 7.
- For 1kg load conditions (Diesel 90% + Jatropha 10%) blend gives better result for Exhaust Gas Temperature. It is less than Exhaust Gas Temperature when fueled with B20, B30, B40 and B50 blends.
- For 5kg load conditions (Diesel 90% + Jatropha 10%) blend gives better result for Exhaust Gas Temperature. It is less than Exhaust Gas Temperature when fueled with B20, B30, B40 and B50 blends.
- For 11kg load conditions (90% + Jatropha 10%) blend gives better result for Exhaust Gas Temperature. It is less than Exhaust Gas Temperature when fueled with B20, B30, B40 and B50 blends.

B20 blend analysis

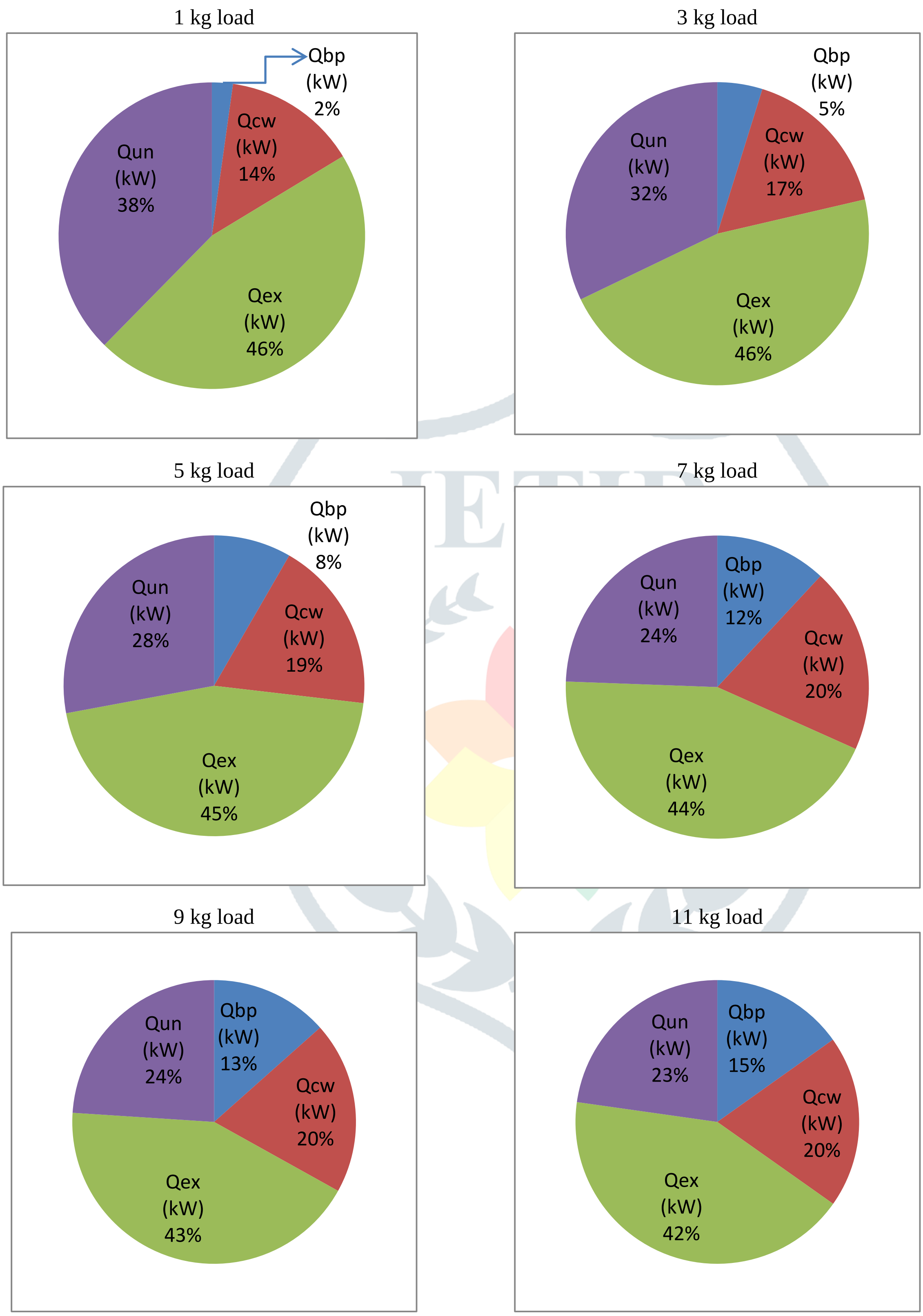


Figure8:B20 blend energy analysis for different load

From the energy analysis it can be said that B20 blend performance is better in comparison to other blends at different load and performance is equal compare to the diesel.

That means more than 50% of energy input is got wasted in terms of heat energy into atmosphere hence this should be utilising. All amount of this heat energy is not available because of limitations from nature which is also indicated by the second law of thermodynamics. From the figures it can be also seen that more than 20% energy is unaccounted which includes friction loss and other heat loss such as radiation heat loss to atmosphere and heat loss to engine oil.

4. CONCLUSIONS

From the vitality investigation it very well may be presumed that brake warm effectiveness of the biodiesel mixes will in general increment toward that of regular diesel fuel as burden increments from low to high. At the high burden brake warm productivity of all the biodiesel mixes is watched higher than the diesel so it very well may be inferred that the biodiesel mixes have somewhat higher calorific qualities than diesel however improved burning procedure and less exergy decimation or less irreversible procedure of ignition may be the explanation behind the better than the diesel. Fuel utilization of biodiesel mixes is found relatively higher than the diesel at all heap condition aside from B20 mix which shows practically comparative qualities as that of diesel. Purpose behind the higher fuel utilization is their nearly higher calorific worth. So from this exhibition investigation it very well may be presume that lower mix proportion of biodiesel can be effectively utilized for diesel motor without alteration. Impact of working parameter must be checked to upgrade the exhibition for lower mixes. For higher mix proportion fuel utilization is higher which may limit the utilization of higher mixes proportion in motor. In this trial B20 mix has nearly better than others.

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