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MANUFACTURING OF JATROPHA AND CALOPHYLLUM INOPHYLLUM BASED COMPLETE BIODIESEL AND INVESTIGATION OF OVERALL PERFORMANCE IN AN UNMODIFIED DIESEL ENGINE AT HIGH IDLING SITUATIONS

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ABSTRACT

Quick depletion of fossil fuels, increasing fossil-gas fee, carbon rate, and the hunt of low carbon gas for cleanser environment - these are the motive researchers are seeking out options of fossil fuels. Renewable, non-flammable, biodegradable, and non-toxic are a few reasons that are making biodiesel as a suitable solution to update fossil-gas in close to future. In latest years, in many nations of the sector manufacturing and use of biodiesel has gained popularity. On this research, biodiesel from Jatropha curcas oil and Calophylluminophyllum oil has been produced the use of the transesterification technique. Properties of the produced biodiesels have been compared with the BIS15607: 2005 standard: biodiesel well known and trying out techniques. Density, kinematic viscosity, flash point, cloud point, pour point and calorific fee, these are the six important physicochemical houses that were investigated. Each Jatropha curcas biodiesel and Calophylluminophyllum biodiesel have been within the popular limits, so that they both may be used as the alternative of diesel gas. Moreover, engine overall performance and emission parameters of a diesel engine run by both Jatropha curcasbiodiesel–diesel and Calophylluminophyllum biodiesel–diesel blends were evaluated at excessive idling conditions. Brake precise gasoline consumption accelerated for each the biodiesel–diesel blends compared to natural diesel gas; but, at maximum idling circumstance, this increase became almost negligible. Exhaust gasoline temperatures decreased as mixture percentages expanded for each the biodiesel–diesel blends. 20% Calophylluminophyllum biodiesel-diesel blends emitted lowest HC and CO emission.

Keywords: biodiesel, Jatropha curcas, calophylluminophyllum, idling, emission fuel, consumption, production.

1. INTRODUCTION

Diesel fuel is one of the important resources of energy in transportation, agricultural and commercial region. Adaptability, reliability, better combustion performance and managing centers – for these key traits diesel gas is widely used everywhere in the international [1]. However, emissions from fossil fuels are one of the main cause environment pollution [2]. Researchers suggests that if no strict policy is undertaken, those emissions will upward thrust up to 39% in 2030 [3]. Again, fossil gasoline depletion is some other predominant problem presently the sector is dealing with nowadays. To resolve these problems, researchers are focusing on developing renewable fuels on the way to be able to satisfy global power demand and also they should be technically feasible, environmentally appropriate, and regionally available. It is predicted that, within 2015, renewable fuels will be the second one biggest energy supply inside the electricity manufacturing sector. Increasing fossil gasoline price and carbon pricing in addition to reducing generation expenses – these factors are extremely responsible for the quick increase within the popularity of renewable energy. Biodiesel is considered as a vital source of renewable electricity because it has the capability to reduce greenhouse gases, satisfy electricity demand and reduce global warming [4]. In a quick time period, from 2001 to 2010, biodiesel production elevated to 294,690 barrels in keeping with day, whereas, intake expanded to 313,770 barrels per day from sixteen, 490 barrels according to day. Biodiesel, denoted also as the fatty acid methyl ester, are comprised of animal fat or vegetable oils via the use of dilution, pyrolysis, micro emulsion and transesterification process [5, 6]. Advantage of biodiesel is that it's miles surroundings pleasant, renewable, non-flammable, biodegradable, and non-poisonous [7, 8]. Certainly one of the largest plus point of biodiesel is that its houses are similar with diesel gas [9, 10]. Any other gain of the usage of biodiesel is that, pure or mixed with diesel, it can be used in an unmodified diesel engine [11]. While engine is administered with biodiesel and their blends with diesel gasoline it influences the engine performance and emissions of diesel engine. Many researches were done to assess engine overall performance and emissions the use of biodiesel and their blends [12–22]. Additionally, many researches has been achieved to evaluate the engine overall performance and emissions using best diesel gasoline at idling condition [23–31]. However, there was most effective one look at that turned into accomplished to investigate the impact of biodiesel on engine performance and emission at some point of high idling situation [32]. While the engine runs at low load and at rated speed it's miles called high idling circumstance. Currently this is the major hassle truck industry is presently facing. After driving for a certain period, it's miles mandatory for drivers to take a relaxation. Throughout this time, the drivers maintain the engine idling a good way to maintain cab comfort and to offer strength to the masses within the cab, which include heating, aircon, fridges, and microwaves [33-36]. Research imply that lengthy-haul trucks are idling for

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among 6 and sixteen h every day [37]. Whilst the engine is walking in idle conditions, it takes a rich mixture of air and fuel, such that the gas consumption rate is excessive. Furthermore, in the course of idling, the engine isn't always capable of work at peak working temperature and the combustion of gasoline is incomplete, which leaves gas residues within the exhaust and as a result, emission stages increases. As biodiesels application in diesel engine will growth daily, greater research desires be performed to discover the impact of the usage of biodiesel on fuel consumption and exhaust emissions of diesel vehicles at high idling circumstance. In this experiment manufacturing technique of Jatropha curcas biodiesel and Calophyllum inophyllum biodiesel has been discussed. Additionally, engine overall performance and exhaust emission test even as strolling blends of these biodiesels for the duration of idling circumstance has been said too. Also, comparison with the outcomes obtained whilst jogging the engine with diesel fuel has been reported too.

2. FEEDSTOCKS

2.1. Jatropha curcas oil

Amongst the plant households, arms are the most famous and substantially cultivated. Euphorbiaceae is the most especially efficient species. It could be cultivated in all tropical areas in which weather is humid and hot like India and Indonesia [38]. This precise range can yearly produce 10–35 tonnes/ha of Jatropha curcas fruits. Oil is extracted from both the pulp and the seed. Oil Jatropha curcas trees are commercially cultivated to serve fit to be medicine oil to the marketplace [39].

2.2. Calophyllum inophyllum

Calophyllum inophyllum, additionally referred to as PenagaLaut, is a nonedible oilseed decorative tree which belongs to Clusiaceae own family [40, 41]. It grows in coastal regions and regions wherein there are adjoining lowland forests. It grows in warm temperatures in moist or slight conditions and at the very least 1000–4000 mm rainfall is also needed in keeping with yr. Its kernels have excessive oil content material, the common oil yield is 11.7 kg-oil/tree or 4680 kg-oil/ha.

3. BIODIESEL PRODUCTION TECHNIQUE

All of the feedstock oils have been bought from neighborhood farm of Malaysia and Indonesia respectively. All essential chemical compounds for transesterification were bought from LGC scientific, Kuala Lumpur, Malaysia.

Biodiesel was produced the use of the subsequent two steps:

a) Acid esterification.

b) Base transesterification procedure.

Methanol became used as solvent with sulfuric acid (H2SO4) andpotassium hydroxide (KOH) for acid and base transesterification respectively. First step is needed if the acid cost of crude oil is higher than four mg KOH/gm. Acid fee become calculated at once by doing titration. For Calophyllum inophyllum oil, each stepshave been needed and for Jatropha curcas oil, simplest base trans-esterification changed into needed. The use of acid catalyst, the first step decreased free fatty acids (FFA) stage of crude vegetable oil up to one–2%. A fave jacket reactor of one l ability turned into used with IKA Eurostar virtual model stirrer and Wiscircu water bath arrangement. 1 Liter of crude vegetable oil with 2 hundred ml methanol and zero. Five% v/v sulfuric acid have been taken in the flask for acid catalyzed esterification. The aggregate changed into continuously stirred at seven-hundred rpm and a temperature variety of 50–60 C maintained at atmospheric strain by using circulating hot water through the jacket. To decide the FFA degree, 5 ml pattern turned into taken from the flask at each 10 min interval and trans-esterification procedure was accomplished till FFA degree was decreased up to at least one–2%. After finishing the acid esterification procedure the product became poured into a separating funnel wherein sulfuric acid and excess alcohol with impurities had been moved to the top. Top layer turned into separated and lower layer become gathered for base trans-esterification. Identical experimental setup turned into used for alkaline catalyzed transesterification system. In the meantime, 1% w/w of KOH dissolved in 25% v/v if methanol changed into poured into the flus. Then the mixture turned into stirred at same pace and temperature was maintained at 70 C. The combination turned into heated and stirred for 3 h and again poured into a separating funnel where it fashioned layers. Lowered layer contained glycerol and impurities and higher layer became methyl ester of vegetable oil. Lower layer became discarded and yellow higher layer become washed with hot distilled water (100% v/v) wand stirred gently to cast off closing impurities and glycerol. Biodiesel changed into then taken in an IKA RV10 rotary evaporator to lessen the moisture content. Sooner or later, moisture became absorbed by using using sodium sulfate and very last product turned into accrued after filtration.

4. BIODIESEL BELONGINGS

take a look at The houses of Jatropha curcas biodiesel (JCB100), diesel and Calophyllum inophyllum biodiesel (CIB100) were measured on the power Laboratory and the Engine Tribology Laboratory, department of Mechanical Engineering, Vels University. Density, kinematic viscosity, flash point, cloud factor, pour point and calorific cost, those six major physicochemical houses had been measured the usage of following strategies. Table 1 shows the character gasoline homes in conjunction with well-known biodiesel homes.

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5. ENGINE TEST

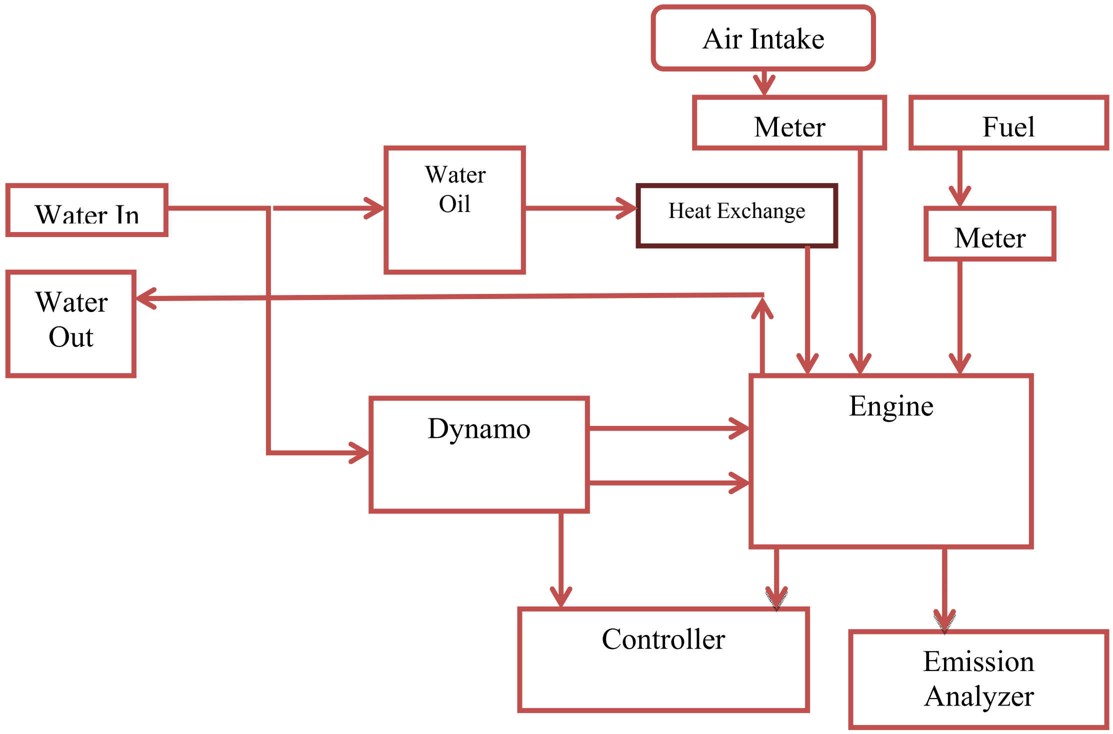

Figure-1. Schematic diagram of the engine test bed.

An inline four cylinder, water cooled: Kirloskar India Limited engine become used to perform the engine test. The engine changed into coupled with an eddy modern-day dynamometer which may be operated at a maximum electricity of 20 kW with running velocity ranged from a thousand to 4000 rpm. The engine test was conducted at 3 idling situations, which are: one thousand rpm at 10% load (1.25 kW), 1200 rpm at 12% load (1.8 kW) and 1500 rpm at 15% load (2.82 kW). Fuels tested had been: Diesel, JCB5 (5% Jatropha curcas biodiesel-diesel combination), JCB10 (10% Jatropha curcas biodiesel-diesel combo), JCB20 (20% Jatropha curcas biodiesel-diesel combo), CIB5 (five% Calophyllum biodiesel-diesel combination), CIB10 (10% Calophyllum biodiesel-diesel blend), and CIB20 (20% Calophyllum biodiesel- diesel blend).

Figure-1 shows the schematic diagram of the experimental setup. The engine specification is indexed in Table-2. To degree gasoline consumption, exhaust gas temperature, strength, and speed of engine sensors had been established and facts have been collected via records logger thru software named ‘‘REO-dCA’’. Additionally, exhaust emissions were measured the use of BOSCH BEA-350 exhaust fuel analyzer and AVL 4000. The engine was related with check bed and a computer facts acquisition system. Statistics acquisition machine collects sign, rectify, filter out and convert the sign to the statistics to be study.

Table-1. Fuel properties of diesel, Jatropha curcas biodiesel and Calophyllum inophyllum biodiesel.

Properties	Unit	Diesel	Jatropha curcas biodiesel	Calophyllum inophyllum biodiesel	BIS15607 :2005 standard
Density	kg/m3	858	833.1	869	860–900
Cetane number	-	- 47	52	57	47 min
Viscosity	mm2 /s	3.556	4.63	4.0	1.9–6.0
Flash point	C	77.5	189	140	130 min
Cloud point C	C	8	6	13.2	3 to 12
Pour point	C	6	2	4.3	-15 to 10
Calorific value (lower)	kJ/g	44.664	39.907	41.397	-

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Table-2. Engine specification.

Engine type	4 Cylinder inline
Displacement	2.5 L (1800 cc)
Rated power:	3.7 KW at 1500 rpm
Loading device:	Eddy Current
Bore and stroke:	80 x 110 mm
Compression ratio	21:1

The information acquisition board is connected to the laptop, in which user can monitor, control and evaluation the statistics the usage of REO-dCA software. The use of this software the engine turned into operated at the three idling situations. When the engine is operated at idling situations engine performance and gasoline intake information's are stored in the computer thru the software program. For performance test, each fuel pattern has been tested for 3 times and their results are averaged.

RESULTS

Figure-2 indicates the brake specific electricity intake at one of a kind idling situation for diesel, Jatropha curcas biodiesel and Calophyllum biodiesel blends. At all idling situations, energy consumption charge for diesel fuel turned into lowest. As combo percentages expanded bsec increased due to having decrease heating fee as compared to diesel gas. However, at 1500 RPM, barely higher combustion temperature and further oxygen content material of the biodiesel facilitate better combustion and indicates much less growth in bsec as compared to diesel than that changed into visible in different speeds. The brake particular strength consumption of JCB20 in any respect idling situations have been higher than any different fuel sample. As Calophyllum biodiesel has higher heating cost than Jatropha curcas biodiesel, it confirmed progressed electricity intake charge in comparison to Jatropha curcasbiodiesel, nonetheless however, electricity consumption price became higher than diesel in all condition. Brake thermal efficiency is described as ruin power of a warmth engine as a function of the thermal enter from the gas. It's far used to evaluate how nicely an engine converts the heat from a fuel to mechanical power. Figure-3 demonstrates brake thermal performance at distinctive idling conditions for diesel calophyllum and Jatropha curcas biodiesel-diesel blends. The equation to calculate BTE is, BTE = 3600 106/(CV BSFC)%. From Fig. Three it could be visible that for conditions 1000 RPM 10% load and 1200 RPM 12% load BTE for both the biodiesel-diesel blends decreases significantly. This is because of the motive that, with growth in mixture percentages, calorific value decreases, so the gas intake of the engine must boom to hold same electricity output. However, those will increase were plenty higher than it became presupposed to be. As a end result there's speedy decline of BTE for those two conditions. However, at 1500 RPM and 15% load engines boom in bsfc is nearly inversely proportional to the lower of calorific cost of the blends. As a result at this situation, BTE of the engine is almost regular for all the fuels examined. Compare to Jatropha curcas biodiesel, Calophyllum done higher efficiency, but, diesel gasoline carried out highest efficiency at all situations. Heating price, cetane variety, density and kinematic viscosity these four physicochemical homes have ability effect on exhaust gasoline temperature (EGT). Diesel gas became found to have the highest EGT cost at all conditions examined. All biodiesel blendstested confirmed lower EGT than diesel gasoline due to better cetanevariety, better viscosity and density and decrease heating cost of biodiesels. Lower EGT is a sign of correct burning of gasoline internal cylinder. As mixture chances increased EGT reduced. As, in comparison to Jatropha curcas biodiesel, Calophyllum biodiesel have better cetanevariety, better viscosity and density and decrease heating value, in order a result, it changed into seen that Calophyllum biodiesel-diesel blends performed decrease EGT than the Jatropha curcas biodiesel-blends (Figure-4).

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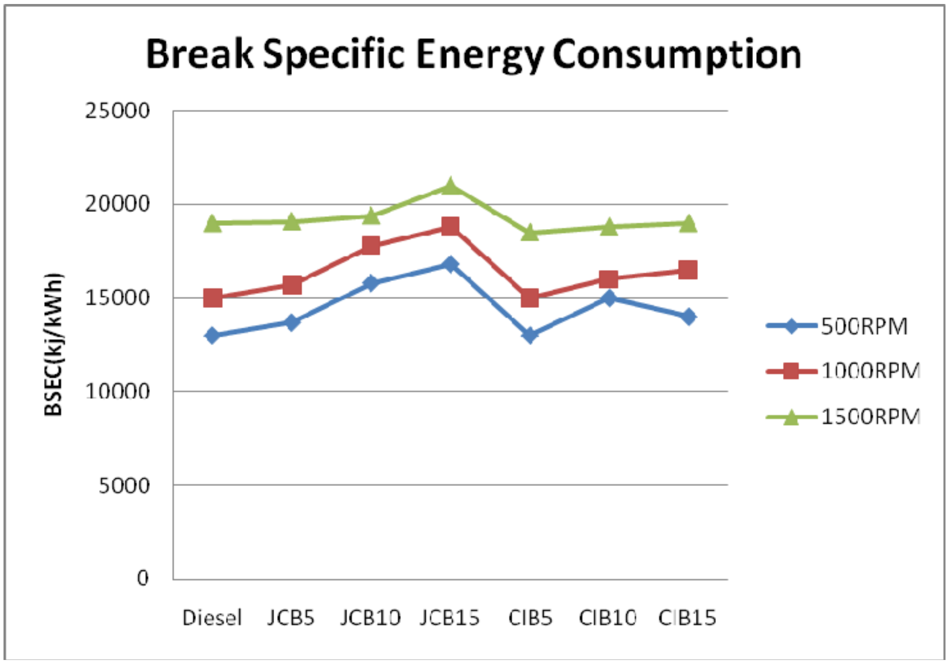

Figure-2. Brake specific energy consumption at multiple idling situations for diesel, Jatropha curcas biodiesel and Calophyllum biodiesel blend.

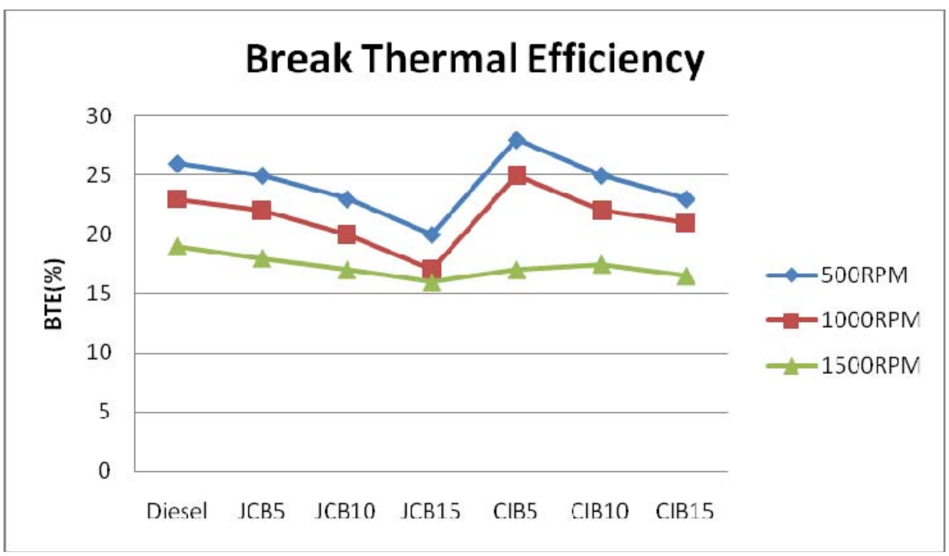

Figure-3. Brake thermal efficiency at multiple idling situations for diesel, Jatropha curcas biodiesel and Calophyllum.

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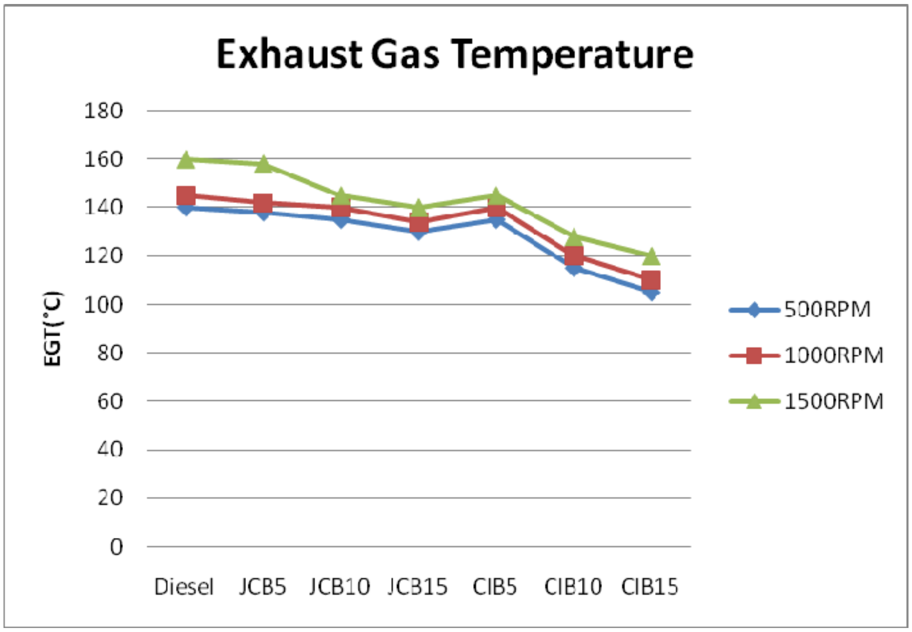

Figure-4. Exhaust gas temperature at multiple idling situations for diesel, Jatropha curcas biodiesel and Calophylluminophyllum biodiesel blend.

7. CONCLUSIONS

Pure Jatropha curcas and Calophyllum inophyllum biodiesel had been produced and their gasoline characteristics have been evaluated. An experimental investigation has been done to parent out the engine overall performance and emission parameters at excessive idling conditions. The most crucial conclusions derived are summarized as follows:

- Biodiesel constructed from Jatropha curcas and Calophyllum inophyllum biodiesel each satisfies the BIS standards and consequently may be used as alternative to diesel gasoline.
- At excessive idling situations, brake unique power consumption for each Jatropha curcas biodiesel and Calophyllum inophyllum biodiesel blends improved examine to diesel gas. However, at the highest idling velocity the difference of power consumption become almost negligible. As blend probabilities of biodiesel increased power intake extended.
- due to having better heating value in comparison to Jatropha curcas biodiesel, Calophyllum inophyllum biodiesel blends produced better BSEC.
- CO and HC emission reduced with increase in combo possibilities and in any respect tested conditions they were decrease than diesel gas. CIB20 completed lowest emission in both the instances.
- boom in NOX emission for small mixture possibilities were negligible in comparison to diesel, but, JCB20 and CIB20 emission improved notably.
- Exhaust gasoline temperature was lower for all biodiesel blends in comparison to diesel gasoline at all tested conditions. Lower EGT suggests higher burning of gasoline. With the growth in blend possibilities of Jatropha curcas biodiesel and Calophyllum biodiesel EGT additionally reduced, CIB20 achieved the lowest EGT amongst all blends.
- compare to Jatropha curcas biodiesel, Calophyllum accomplished better efficiency, however, diesel gasoline achieved maximum performance at all conditions.
- For situations a thousand RPM 10% load and 1200 RPM 12% load BTE for both the biodiesel–diesel blends reduced appreciably.

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