International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume-9, Issue-1, January 2021
https://doi.org/10.55524/ijircst.2021.9.1.12
Article ID 219112, Pages 55- 61
www.ijircst.org

Performance, Emission & Combustion Characteristics of I.C Engine Using Jatropha Methyl Ester Oil and Bio-Diesel Blends

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ABSTRACT- This essay is focused on the idea of suggesting an alternative fuel for diesel engines. The experiments show that the diesel-biodiesel blends can be used as substitute fuels for diesel engines. Recent studies have demonstrated that the use of diesel biodiesel blends can significantly lower emissions of carbon monoxide (CO), total hydrocarbons (HC), and particulate matter. The mixing of biodiesel with diesel significantly reduces the emission particulate matter (PM) because the blended biodiesel contains oxygen. It was recommended that some alternative fuels that are climate-friendly based on various experiments. There for in the present study these lected biodiesel is jatropha seed oil which was obtained by Trans-esterification process by crude seed oil, because the large availability and easily extract from seed by different process.

KEYWORDS- Biodiesel, Bio fuels, Blending Jatropha, Renewable energy, CO, HC, PM and Trans-esterification etc.

I. INTRODUCTION

In many industrial and agricultural applications, diesel engines are employed as one of the essential primary movers for generating power and energy. By 2030, there will be an unprecedented demand for petroleum fuels, according to reports from research studies on alternative or renewable fuels, and the impact has already been seen by the abrupt increase in petroleum prices. In addition to this need for petroleum fuel, its use is linked to worsening environmental issues. Many academics are interested in and focused on the study of numerous alternative, clean, and renewable sources of fuel due to concerns about future energy security, sustainability, and environmental damage. One of these is biodiesel, which is a popular alternative fuel for diesel engines.

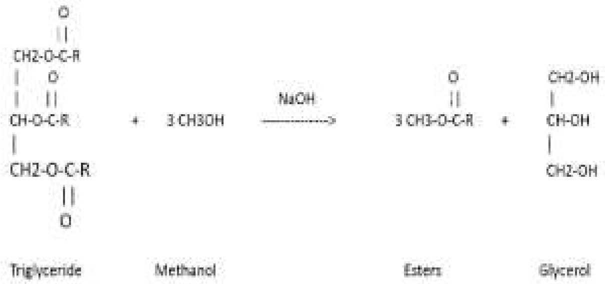
Typically, biodiesel is made from vegetable or animal fats by transesterifying them at high temperatures in the presence of a catalyst; greater fatty acid oil requires a multiple stage transesterification process. Through the trans-esterification process, triglycerides are converted into methyl or ethyl esters, which have a molecular weight that is one-third that of the triglyceride and a viscosity that is around eight times lower with only a slight increase in volatility. Because of this, the qualities of biodiesel following transesterification make it suitable for use in diesel engines. Recent research comparing biodiesel engine performance to diesel engine performance has revealed substantial gains. Additionally, it was discovered that emissions including smoke, HC (hydrocarbon), CO (carbon monoxide), and CO2 (carbon dioxide) have decreased at the expense of a minor rise in NOX (nitrogen oxides). However, because of its higher viscosity, lower calorific value, and lower horse power output, the usage of biodiesel has also raised some concerns.

II. LITERATURE REVIEW

This literature review serves as a medium to provide background information on the issues to be dealt in this project and to articulate there levance of the present study. This reviews circles some of their late aspects of bio fuels with special reference to the combination of bio oils.

Abhishek Sharma et al. researchers have looked into and compared the impacts of fuel injection pressure on the output and exhaust emission characteristics of single-cylinder, constant-speed, and direct-injection diesel engines. The engine was running at five different fuel injection pressures in addition to the initial injection pressure of 200 bar. The engine was fueled using a blend of Jatropha methyl ester (JME)-Tyre pyrolysis oil (TPO) (JME 80%+TPO 20% on a volume basis). The results showed that, compared to the original injection pressure, as well as 230, 240, and 250 bar, the JMETPO20 blend performed better and had superior emission characteristics when the injection pressure was up to 220 bar. K. Muralidharan et al. investigated and contrasted the performance, emissions, and combustion characteristics of a single cylinder, four-stroke, variable compression ratio multi fuel engine running on waste cooking oil methyl ester and its 20%, 40%, 60%, and 80% blends with diesel (on a volume basis). This study has proven the viability of using methyl ester of used cooking oil as a biofuel. The trans-esterification process utilised in this study to create biodiesel from used sun flower oil. A set engine speed of 1500 rpm, 50% load, and compression ratios of 18:1, 19:1, 20:1, 21:1, and 22:1 were all used in the experiment. By Raghuram Pradhan et al. Studied on the creation, description, and prospective application of a bio-oil made from the theoretically accessible Mahua oilseed in India. For the creation of Mahua pyrolysis oil (MPO), pyrolysis was conducted between 450°C and 600°C in a reactor of the semi-batch type. At an optimal temperature of 525°C, the MPO yield was discovered to be roughly 50%. The MPO was also noted for its suitability for use as an alternative fuel for internal combustion engines. A fully instrumented, six-cylinder, water-cooled, turbocharged and after-cooled, heavy duty, direct injection (DI), Mercedes-Benz engine, installed at the authors' laboratory, is used to power the mini-bus diesel engine in the experimental study by D.C. Rakopoulos et al. The aim of the study is to determine the effects of using blends of n-butanol (normal butanol) with conventional diesel fuel, with 8% and 16% (by with the engine running at two speeds and three loads, the tests are carried out using each of the aforementioned fuel blends. Cenk Sayin et.al. Conducted research on the effects of ethanol-diesel (E5, E10) and methanol-diesel (M5, M10) fuel blends on engine performance and exhaust pollutants. A single-cylinder, four-stroke, direct-injection, naturally aspirated diesel engine was employed for this project. The engine torque was maintained at 30 Nm throughout the tests, which were run at engine speeds ranging from 1000 to 1800 rpm. The findings revealed that methanol-diesel and ethanol-diesel fuel mixes reduced total hydrocarbon emissions while increasing brake-specific fuel consumption and nitrogen oxide emissions while increasing brake thermal efficiency, smoke opacity, carbon monoxide.

Blends of ethanol and diesel fuel were researched for their physical-chemical properties by Eloisa Torres-Jimenez et al. The attributes that have a substantial impact on injection and engine characteristics are the center of attention. The tested fuels included neat mineral diesel fuel (D100), a 5% (v/v) ethanol/diesel fuel blend (E05D95), a 10% (v/v) ethanol-diesel fuel blend (E10D90), and a 15% (v/v) ethanol-diesel fuel blend (E15D85). It has been established that certain additives are necessary for ethanol-diesel fuel blends to maintain stability at low temperatures.



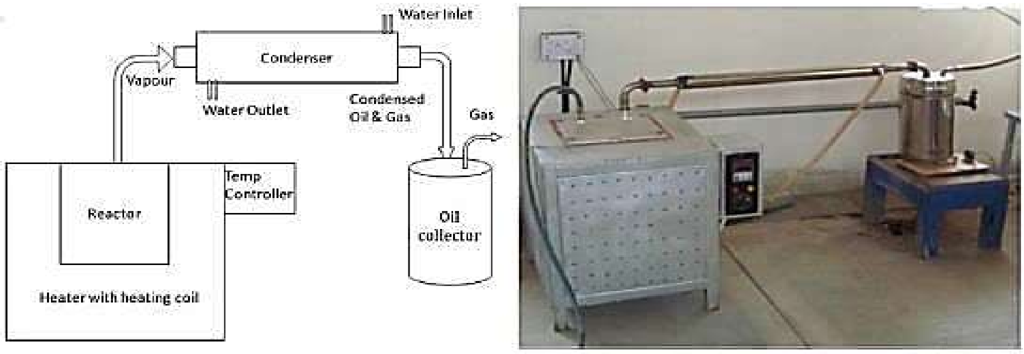


Fig. 1: Trans-esterification process using jatropha oil

Crude oil was transformed into jatropha methyl ester oil using the trans-esterification process using jatropha oil. The reaction conditions, alcohol type, quantity of catalysts, reaction duration, and temperature of the oil conversion process were all manually controlled. For Jatropha oil, base catalysed trans-esterification was utilised. Methanol is utilised as a reagent, and the base reaction is catalysed by H_2SO_4 and KOH.

Table 1: Jatropha oil and diesel's characteristics

Properties	Diesel	Jatropha Oil
Density@15°C (kg/m3)	860	916
Kinematicviscosity@40°C (cst)	2107	3.75
Flash Point(°C)	50	178
Fire Point(°C)	56	185
Gross calorific value(kJ/kg)	42,500	39,641
Cetane number	50	53

III. MATERIALS AND METHODS

A. Materials

This study examined the potential applications for jatropha seed oil methyl ester (JSOME/JME). JME was the subject of numerous tests, and the outcomes were documented.

The findings of Jatropha Seed Oil Methyl Ester were gathered from a number of journals and research papers. JSOME findings were contrasted with those of traditional diesel. Below is a brief overview of the sources used in this research.

B. Jatropha Seed Oil

In the early Part of the 21stcentury, a plant known as Jatropha became exceedingly popular. The plant was praised for its yield parsed, which could return values as high as 40 percent. When compared to the15 percent oil found in soybean, Jatropha look to be a miracle crop.
Seedscontain50–60% oil Nonedible oil
Seedproduction7tons peracreJatrophaproducesseedsfor30-40years

Fig. 2: Jatropha oil Jatropha Seeds

C. Engine Performance Parameters

Jatropha seed oil and its methyl esters were blended with varying ratios of diesel to test the performance of a four-stroke twin-cylinder, water-cooled CI engine under variable load conditions. Below are some of the performance metrics. Indicated the r mal efficiency

- Brake the r mal efficiency
- Mechanical efficiency
- Volumetric efficiency
- Specific fuel consumption

D. Trans-esterification Process

It is stated that although supercritical approach produces higher results, catalyzed process is simple. There are four ways to adapt vegetable oil as a fuel for CI engines: pyrolysis, micro emulsification, dilution, and trans-esterification. Trans-esterification is employed in this work to create new compounds from these. There are two techniques to perform trans-esterification, the process used to create biodiesel from oils and fats. Catalytic Trans-esterification. (b) Supercritical Methanol Trans-esterification. Blending Percentages of fuel

The Flowchart to f trans-esterification process of JSOME/JME is shown in below Fig.

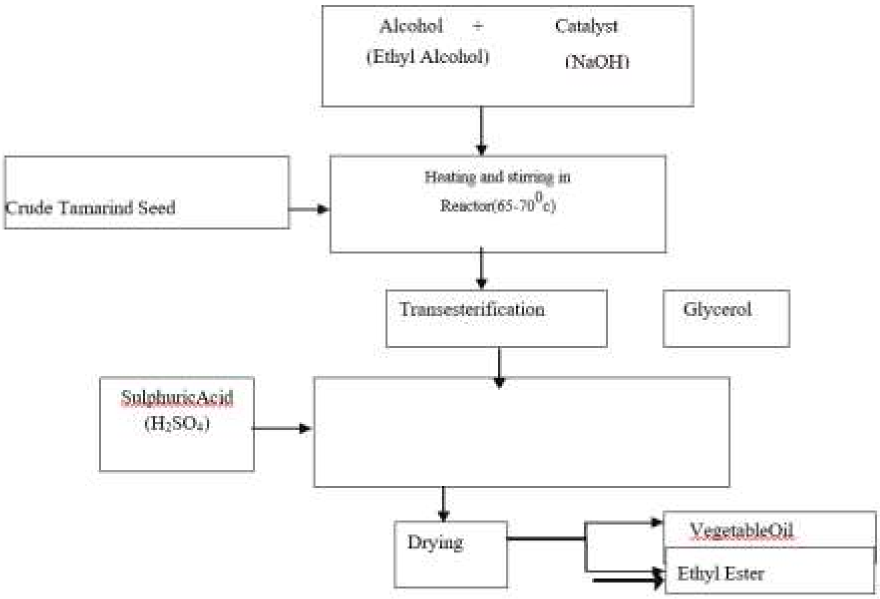


Fig. 3: Flowchart of Trans-Esterification Process of JSOME /JME

Table 2: Blending Percentages of fuel

Notation	Fuel Quantity	Jatropha Quantity	Diesel Quantity
Diesel	1LiterFuel	-	1000ml
J 10	1LiterFuel	100ml	900ml
J 20	1LiterFuel	200ml	800ml
J 30	1LiterFuel	300ml	700ml
J 40	1LiterFuel	400ml	600ml
J 50	1LiterFuel	500ml	500ml

Fig. 4: JME and Diesel Blend Samples

Table 3: Blending Percentages of fuel

Notation	Fuel Quantity	Jatropha Quantity	Diesel Quantity
Diesel	1LiterFuel	-	1000ml
J 10	1LiterFuel	100ml	900ml
J 20	1LiterFuel	200ml	800ml
J 30	1LiterFuel	300ml	700ml
J 40	1LiterFuel	400ml	600ml
J 50	1LiterFuel	500ml	500ml

Fig. 5: Diesel Engine Setup

Fig. 6: EGR setup

IV. PERFORMANCE TEST

A. Engine Specifications

Table 4: Specification of Engine used for Test

Make and Model	Kirloskar, TV1,
No. of Cylinders	One
Orientation	Vertical
Cycle	4 stroke
Ignition System	Compression Ignition
Bore X Stroke	87.5mm X 110mm
Displacement Volume	660cc
Compression Ratio	17.5 : 1
Arrangement of valves	Overhead
Combustion Chamber	Open chamber (Direct Ignition)
Rated Power	5.2Kw (7HP) @ 1500rpm
Cooling Medium	Water cooled

B. Experimental Observations

1) Diesel

Table 5: Experimental Results for Diesel (J20) :(Diesel80%+JME20%)

S. No.	BP (kw)	TFC (kg/hr)	BSFC (kg/kwh)	FP (kw)	IP (kw)	IFSC (kg/kwh)	ηmech	ηbth	ηith
1	0	0	∞	2	2	0.245	0	0	22.89
2	1.134	0.93	0.93	2	3.134	0.244	36.18	9.06	25.04
3	2.27	0.54	0.54	2	4.27	0.240	53.16	15.63	29.41
4	3.40	0.44	0.44	2	5.4	0.257	62.92	19.33	30.70
5	4.54	0.43	0.43	2	6.54	0.274	69.42	19.72	28.41

Table 6: Observations for Diesel(J30)

S. No	Load in Watts	Speed in RPM	Timefor10 CC of Fuel Consumption
1	0	1500	53.56
2	1000	1500	44.28
3	2000	1500	33.56
4	3000	1500	27.47
5	4000	1500	22.47

Table 7: Experimental Results for Diesel (J30): (Diesel70%+JME30%)

S. No.	BP (kw)	TFC (kg/hr)	BSFC (kg/kwh)	FP (kw)	IP (kw)	IFSC (kg/kwh)	ηmech	ηbth	ηith
1	0	0	∞	2	2	0.245	0	0	22.89
2	1.134	0.93	0.93	2	3.134	0.244	36.18	9.06	25.04
3	2.27	0.54	0.54	2	4.27	0.240	53.16	15.63	29.41
4	3.40	0.44	0.44	2	5.4	0.257	62.92	19.33	30.70
5	4.54	0.43	0.43	2	6.54	0.274	69.42	19.72	28.41

6.3.5. J40: (Diesel60%+JME 40%):

Table 8: Observations for Diesel (J40)

S. No.	Load in Watts	Speed in RPM	Time for 10CC of Fuel Consumption
1	0	1500	77.22
2	1000	1500	52.09
3	2000	1500	34.22
4	3000	1500	30.16
5	4000	1500	24.03

Table 9: Experimental Results for Diesel (J40)

S. No.	BP (kw)	TFC (kg/hr)	BSFC (kg/kwh)	FP (kw)	IP (kw)	IFSC (kg/kwh)	ηmech	ηbth	ηith
1	0	0	∞	2	2	0.245	0	0	22.89
2	1.134	0.93	0.93	2	3.134	0.244	36.18	9.06	25.04
3	2.27	0.54	0.54	2	4.27	0.240	53.16	15.63	29.41
4	3.40	0.44	0.44	2	5.4	0.257	62.92	19.33	30.70
5	4.54	0.43	0.43	2	6.54	0.274	69.42	19.72	28.41

Table 10: J50: (Diesel50%+JME50%): Observations for Diesel(J50)

S. No.	Load in Watts	Speed in RPM	Time for10CCof Fuel Consumption
1	0	1500	79.16
2	1000	1500	52.72
3	2000	1500	40.75
4	3000	1500	30.41
5	4000	1500	20.59

Table 11: Experimental Results for Diesel(J50)

S. No.	BP (kw)	TFC (kg/hr)	BSFC (kg/kwh)	FP (kw)	IP (kw)	IFSC (kg/kwh)	ηmech	ηbth	ηith
1	0	0	∞	2	2	0.245	0	0	22.89
2	1.134	0.93	0.93	2	3.134	0.244	36.18	9.06	25.04
3	2.27	0.54	0.54	2	4.27	0.240	53.16	15.63	29.41
4	3.40	0.44	0.44	2	5.4	0.257	62.92	19.33	30.70
5	4.54	0.43	0.43	2	6.54	0.274	69.42	19.72	28.41

C. Variation of the load

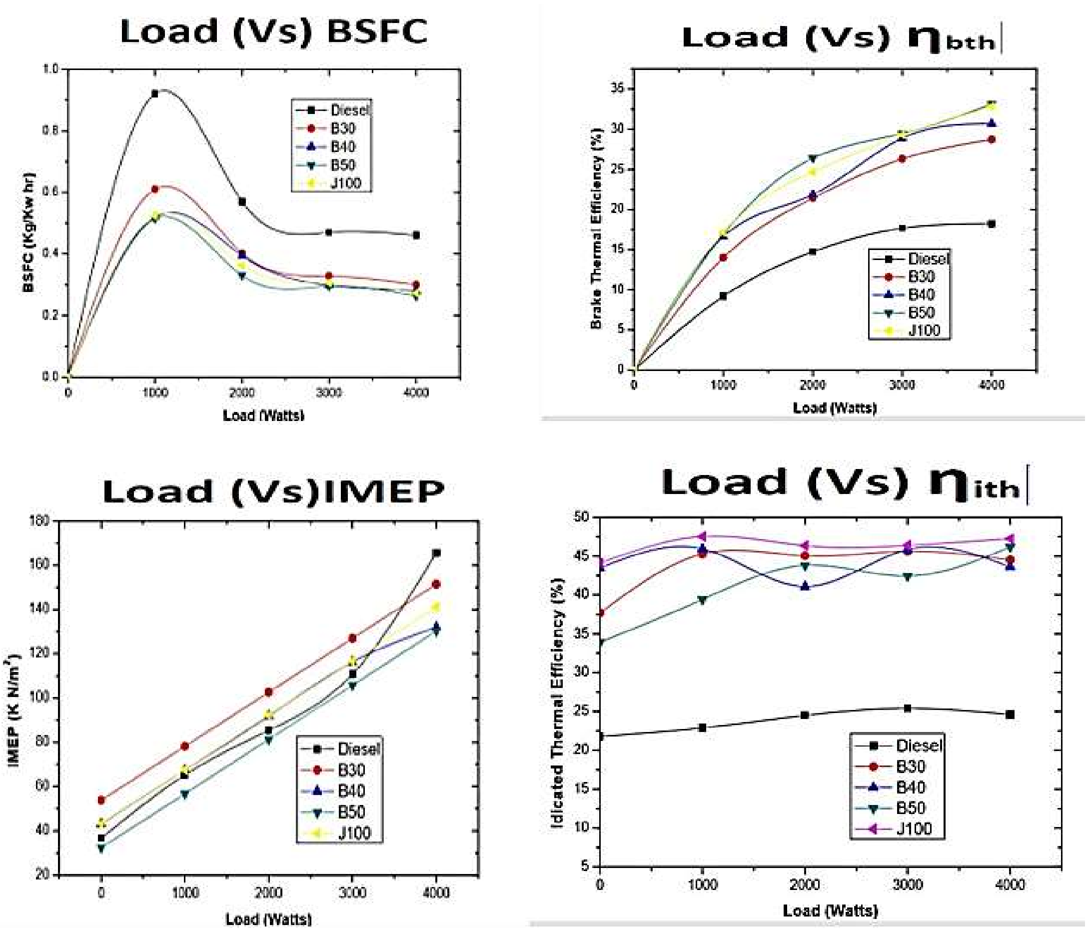


Fig. 7: Variation of the load vs. BSFC, ηbth, IMEP, ηith

V. RESULT AND DISCUSSION

A stationary single cylinder 4-S diesel engine has a heat exchanger built into it to lessen the quantity of NOX that corn biodiesel produces. There is no way to recycle all of the exhaust gas. Recirculating exhaust gas is permitted up to 20% of the time. However, in our trial, we used 10% of EGR for B20 fuel (20% biodiesel from maize and 80% diesel). 10% less water column manometer value indicates that 10% more exhaust gas has been computed. According to the studies mentioned above, diesel-biodiesel blends are suitable as substitute fuels for diesel engines. Recent studies have demonstrated that using diesel-biodiesel blends can significantly lower emissions of carbon monoxide (CO), total hydrocarbons (HC), and particulate matter.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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