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COMPARATIVE STUDY OF DIESEL ENGINE BY USING DIESEL & BIODIESEL AS FUEL

Anand Kumar Singh, Kaustubh R Natekar

Abstract— This experimental study gives the result analysis of emission parameter and thermal efficiency in terms of brake thermal efficiency (BTHE), volumetric efficiency (VE), brake specific fuel consumption (BSFC), brake mean effective pressure (BMEP). The biodiesel selected to conduct this experimental investigation is soybean biodiesel. The experimental study is conducted on a four stroke, single cylinder diesel engine using soybean biodiesel and its blends with diesel. The thermal performance and emissions characteristics are evaluated by operating the engine at different load condition, varying from 0kg to 6 kg difference of 3kg. The emission constituents measured are carbon monoxide (CO), un burnt hydrocarbons (HC), oxides of nitrogen (NOx), carbon dioxide (CO2), oxygen (O2).

Index Terms— Diesel, Biodiesel, brake thermal efficiency, volumetric efficiency, brake specific fuel consumption, brake mean effective pressure, carbon monoxide, un burnt hydrocarbons, oxides of nitrogen, carbon dioxide, oxygen.

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1 INTRODUCTION

N Nature gives an ultimate gift "Energy" in terms of petroleum product either Solid (Coal), Liquid (crude oil) and gas (Natural gas etc). But due to development of modern secience and unexpected growth of population, this gift is lost due to limited source. At this time question arises on the mind what is the future of automobile if the gift i.e crude oil finished and next generation asked us what we left for our future generation pollution and only pollution. This is a time were we wake and find the new way of getting energy. With increasing trend of motorization &industrialization, the world's energy demand is growing at a faster rate. World's energy consumption has increased continuously. Oil, gas, coal, and electricity markets followed the same trend. In contrast, the source and supply of primary energy sources like coal, oil and natural gas seem to decrease to a critical point. Although the exact date is debatable, most investigators agree that production peak of oil and natural gas is near. The point of maximum production of oil is called Hubbert Peak. At that point, half of all the recoverable oil that ever existed on our planet has been used. There is still oil left but it is much more difficult and expensive to recover it. Reaching the Hubbert Peak means that production will decrease in future and demand will continue to increase. In 2008, the energy supply by fossil fuels was nearly 81% of the total world's energy demand. This constitutes 33.5% by oil, 26.8% by coal and 20.8% by gas. The renewable energy sources like hydropower, solar power, wind power, geothermal power and bio fuels contributed to about 13% of the world's energy supply and nuclear power contributed to 5.8%. The facts show that oil is the most popular energy fuel. Since their exploration, the petroleum fuels continued as a major conventional energy source. On the other hand, they are limited in reserves and highly concentrated in certain parts of the globe. Those countries not having these resources are facing energy / foreign exchange crisis due to heavy import bill of crude petroleum. Increased extraction and consumption of fossil fuels have led to a fast depletion in the underground based petroleum derived fuels.

1. Research Scholar, RKDF University Bhopal, Madhya Pradesh India 462033 & Assistant Professor,Mechanical Department, K.J.Institute Of Engineering And Technology, Savli Dist. Vadodara 391770 India, PH +918103386336.E-mail: anandkumar.singh@kjit.org

2. Assistant Professor,Automobile Engineering Department, K.J.Institute Of Engineering And Technology, Savli Dist. Vadodara 391770 Gujarat, India Ph - +919033035534. E-mail: *kaustubh.natekar@kjit.org*

BIODIESEL

Biodiesels have recently been recognized as a potential substitute to Diesel oil. It is produced from oils or fats using a process called transesterification, in which oils are reacted with alcohols in order to form the esters which are called biodiesels. Feedstock for biodiesel include animal fats, vegetable oils like Soy, Rapeseed, Jatropha, Mahua, Sunflower, Palm, Hemp, Pongamia Pinnata (Karanja), Cotton seed, Neem, Rubber seed, Linseed, Corn, Sesame, Cotton seed and Algae. Biodiesel is a liquid closely similar in properties to fossil/mineral diesel. Chemically, it consists mostly of Fatty Acid Methyl (or Ethyl) Esters (FAME). Most of the biodiesels meet the American Society for Testing and Materials (ASTM) biodiesel standards. Several developed countries have introduced policies encouraging the use of bio diesels made from vegetable oils, bio mass etc. in transport, agriculture and other sectors with the idea of achieving the following goals.

- Prevent environmental degradation by using cleaner fuels to reduce the burden on foreign exchange.
- Reduce the dependence on imported finite fossil fuel resources by replacing them with renewable domestic sources and to provide new demand for crops.
- Support the agriculture and thereby uplift the rural economy.

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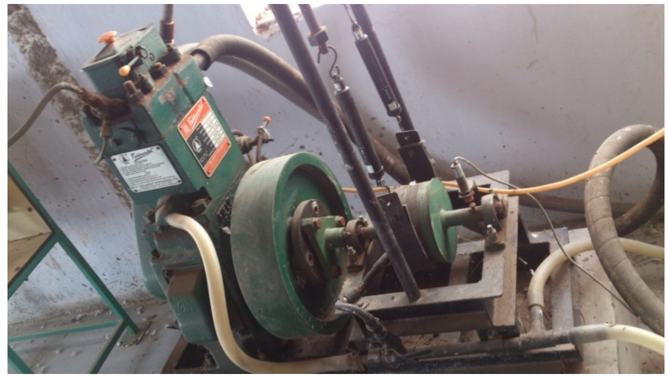
☐ Utilization of waste lands, promotion of Agro based industries.



2 Experimental Studies Using Biodiesel as Fuel

2.1 Technical Specification

Engine	Type - single cylinder, four stroke Diesel, water cooled, rated power 3.5 kW at 1500 rpm, bore 87.5 mm. 661 cc, CR 18, stroke 110 mm
Dynamometer	Rope Break Friction Dynamometer
Cooling system	Water cooling

2.2 Measurement System

Various measurement systems used to capture the experimental data used in the test rig are load measurement system, emission measurement system, Exhaust Gas Analyzer

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2.2.1 Load Measurement System

The load measuring system of this experimental test rig consists of a dynamometer of Rope Break Friction type. The load is applied by weight to the dynamometer using a loading unit.

2.2.2 Emission Measurement System

The emission measurement system is used to measure the constituents of exhaust gas and its opacity (smoke number). This system consists of an exhaust gas analyzer and a smokemeter. The exhaust gas analyzer measures the exhaust gas constituents of Carbon dioxide(CO_2), Carbon monoxide (CO), Oxides of nitrogen (NOx), Unburnt Hydrocarbons (HC),Oxygen (O_2) and Oxides of sulphur (SOx). The smoke meter is used to measure theintensity of exhaust smoke and it is measured in terms of Hartrigde Smoke Unit (%) andlight absorption coefficient (K expressed in m-1).The range, data resolution and accuracy of the exhaust measurement systems are given in Table A

Gas	Range	Data Resolution	Accuracy
CO	0-15.00%, 0-4000ppm	0.01%, 1ppm	±0.06%, ±5%
CO2	0-20.00%	0.01%	±0.5%
HC	0-30000ppm	0.01%	±12ppm
O2	0-25.00%	1ppm	±0.1%
NOx	0-5000ppm	1ppm	±3ppm
Sox	0-5000ppm	1ppm	±5%
Smoke	0-100%HSU	0.1%	±0.1%

2.2.3 Exhaust Gas Analyzer

An instrument used to analyze the chemical composition of the exhaust gasreleased by a reciprocating engine is called exhaust gas analyzer The instrument measures the concentrations of Carbon monoxide (CO in % & ppm), Carbon Dioxide (CO_2) andOxygen (O_2) in percentage, Hydrocarbons (HC), Nitric Oxide (NOx) and Oxides ofSulphur (SOx) in ppm in the engine exhaust gas. The technical specifications of theexhaust gas analyser are given in the Table B

Gases Measured	Carbon Monoxide , Hydrocarbon , Carbon Dioxide , Oxygen , NOx , SOx
Principle	Non-Dispersive Infrared Sensors for CO, CO2, HC and Electrochemical

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	Sensors for O2 , NOx , SOx
Data Resolution Accuracy and Range	Given in Table 5.1
Startup Time	< 2 minutes from power ON. Full accuracy in 3 minutes
Auto Zero	Every 24 minutes with automatic fresh air intake
Gas Flow Rate	500 – 1000 ml per minute
Sample Handling System	S.S. Probe, PU Tubing with easily detachable connectors, water separator cum filter, disposable particulate fine filter.
Operating Conditions	Temperature : 5 to 45 0C Pressure : 813 to 1060mbar Humidity: 0-90%

2.2.4 Exhaust Gas Analyzer

The analyzer uses the principle of Non-Dispersive Infra Red (NDIR) for measurement. In this technique, an infrared light is passed through the exhaust gas. Most molecules of gas can absorb the infrared light, causing it to bend, stretch or twist. The amount of infrared light absorbed by the gas molecules is proportional to their concentration in the exhaust gas. This method of detection does not cause ionization of gas molecules because the energy of the photons is not high enough. The source of infrared light is an incandescent bulb. The type of molecule absorbing the light depends on the wavelength of light absorbed by the molecule. CO, HC & CO2 are sensed measured by NDIR principle while O2 ,NOx, SOx use Electro Chemical (EC) sensors, for their measurement.

3. Observation

Load(kg)	Fuel	Co2%	Co%	Nox(ppm)	HC(ppm)	Sox(ppm)
3	Diesel	1.30-1.40	0.0130-0.0140	37-40	5.1-7	10.2-15
6	Diesel	1.60-1.70	0.0142-0.0150	75-80	5-7.3	5.4-8
9	Diesel	2.00-2.10	0.0203-0.0210	118-120	6-9.1	4.1-9
12	Diesel	2.50-2.57	0.020-0.030	160-165	7.8-10	4.1-8
3	B20	1.00-1.10	0.011-0.020	15-120	3.5-7	8.1-12
6	B20	1.00-1.10	0.012-0.020	42-50	5-6.1	4.2-8
9	B20	2.11-2.20	0.015-0.020	81-85	6-9.2	4-8.3
12	B20	2..2-2.10	0.013-0.020	161-170	6.3-10	3.1-5

4. Calculation

Compression ratio : 18
Ignition pressure : 200 bar
Speed : 1500rpm
Cylinder Bore Diameter : 87.50mm
Stroke length : 110mm
Connection rod length : 234.00mm
Swept Volume : 661.45cc
Calorific value of fuel : 33640 kcal/kgK
Density of Air : 1.127kg/m³

Fuel Used	Weight (kg)	Flow rate of fuel (Kg/hr)	Tension (Nm)	Brake power (kW)	Brake mean effective power (bar)	Brake specific fuel consumption (Kg/hr)	Brake thermal efficiency (%)
Diesel	3kg	0.46	4.97	0.78	0.95	0.6	13.95
	6kg	0.60	9.04	1.73	1.78	0.42	19.8
B20	3kg	0.54	5.48	0.86	1.04	0.63	13.08
	6kg	0.78	10.70	1.68	2.03	0.46	18.67
B100	3kg	0.6	4.65	0.73	0.88	0.82	12.28
	6kg	0.77	9.23	1.45	1.75	0.53	19.03

5. Conclusion

- Biodiesels can be successfully used in existing diesel engines without any hardware modifications.
- The thermal efficiency of a biodiesel fuelled engine is observed to be slightly lesser than that of a diesel fuelled engine.
- The harmful exhaust emissions are generally lesser for all biodiesels as compared to pure diesel.

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