Grenze International Journal of Engineering and Technology, Special Issue

Performance Evaluation of Single Cylinder Diesel Engine using Neem Caster Bio-diesel

Md. Fakhruddin H.N[1], Umar UZ Zama[2], Dr. M. Yousuf Ali[3] and Dr. M. Manzoor Hussain[4]
[1, 2]Methodist College of Engineering & Technology/Department of Mechanical Engineering, Hyderabad, India
Email: mfhnn@yahoo.com, umaruzzama@gmail.com
[3]Professor & Principal, Avanthi Institute of Engineering & Technology, India
[4]Director of Admissions, JNTUH College of Engineering Kukatpally, Hyderabad, India
yousufonline@yahoo.com, manzoorjntu@gmail.com

***Abstract*—India was the fourth-largest consumer and net importer of crude oil and petroleum merchandises in the world after the United States, China, and Japan. India's petroleum product mandate reached nearly 3.7 million barrels per day (mbl/d), far above the country's approximately 1 million mbl/d of total liquids production. Most of India's claim is for motor gasoline and gasoil, fuels used mainly in the transportation and industrial sectors, and for kerosene and LPG in the residential and marketable sectors. Consumers receive large subsidies for retail purchases of diesel, LPG, and kerosene, placing upward pressure on overall oil demand. Insufficient investment in evolving more crude oil and liquids production has caused production to grow at a slower rate than oil demand.As there is an increase in the intake of the fossil fuels, their decrease in amounts are also increasing rapidly. Bio-Diesel as an Alternative Fuel from neem-castor oil is a promising resort to overcome lion's share of diesel. The diminishing of fossil fuel resources and the environmental degradation have stimulated research interest to find superior renewable alternative energy sources. Bio-fuels appear to be a solution to substitute fossil fuels, because resources for it will not extinct. Biodiesel is the fatty acid alkyl ester. Biodiesel be produced from low cost Neem seed oil using Trans esterification. This review has been taken up for identifying the effects of blending Neem Seed oil with diesel on engine and performance and emissions of CI engine.**

***Index Terms*— Neem-Castor Biodiesel, Performance, IC Engine, Blend B20.**

I. Introduction

IC engines have turn out to be a part of our life. Without them the world would stop stirring and can't meet its daily necessaries. They are the hearts of most of the prime movers. The input to these engines are the fuels which are non-renewable. In such a state the search for an alternate fuel, which promises to be in pleasant correlation with justifiable development, energy conservation, supervision, efficiency and conservation preservation, has become a prime subject of study in the transference and energy sector.

A. Economic Factors

In Economical point of view, the input fuel to these IC engines has occupied a big portion of our country's

Grenze ID: 01.GIJET.4.3.48

imports. They are also one of the main cause of our addiction on the other nations. Even India has the resources of crude oil but as there is a vast population growth and its needs are also gradually increasing, the amounts of oil production is unsatisfactory. So we have to import these from other countries. India ranked as the fourth-largest energy consumer in the world in 2011, following China, the United States, and Russia. According to World Bank data, India is the third-largest economy on a obtaining power parity basis and has the world's second-largest population.

B. Environmental Factors

One of the main sources of air pollution is burning fossil fuels like oil, gasoline, and coal. These fossil fuels come from the fossils of olden plants and animals that lived on earth millions of years ago. Fossil fuels are burned to create energy so that we can drive cars and trucks, fly planes, make electricity, and run factories. The chemicals that are unconfined through the burning of fossil fuels can lead to the release of nitric, carbonic and sulphuric acids into the atmosphere. This can create acid rain, which can cause damage to plants and buildings. Another unruly with fossil fuels is that they are non-renewable. They can cause important damage to the natural and built environments, and to the health of the people who are uncovered to the chemicals that are released when these fuels are burned. It is these type of problems that have made alternative, renewable causes of energy a more attractive option since they do not produce the same kinds of effluence and problems. There is only a limited amount of these fuels in the world, and once they are gone, they will be gone forever, which leads to devastation of world.

II. METHODOLOGY

The biodiesel is prepared from Neem Castor Oil sample. The biodiesel pigeon-holed for its physical and fuel properties using ASTM standard methods for biodiesel fuel quality assurance the alignment of final biodiesel was determined by physical properties such as density, viscosity, flashpoint, water content and acid value. From Production of biodiesel from Neem Castor Oil for diesel substitute is particularly important because the increasing cost of oil take out from petroleum source and also it is good for environment. Neem Castor Oil can be an important source for biodiesel production, it is ready, available and atmosphere pleasant.

TABLE I. PROPERTIES OF BIODIESEL

S.NO	**Parameters**	**RESULTS**				
		Pure Diesel	**Neem Castor**	**B10**	**B20**	**B30**
1	Density:15degree C (kg/m3)	830	885	835	841	846
2	Kinematic Viscosity at 40degree C	4.5	8	6	6.6	7
3	Flash point (degree C)	90	140	100	119	131
4	Calorific Value (Kj/kgK)	43000	39984	42698	42397	42095
5	Water content(mg/kg)	60	60	59	58	59
6	Acid Value (mg KOH/gm)	0.5	0.5	0.49	0.51	0.51

TABLE II. TEXT MATRIX

Blends	Pure Diesel (%)	Neem Castor Oil (%)
Pure Diesel	100	0
B10	90	10
B20	80	20
B30	70	30

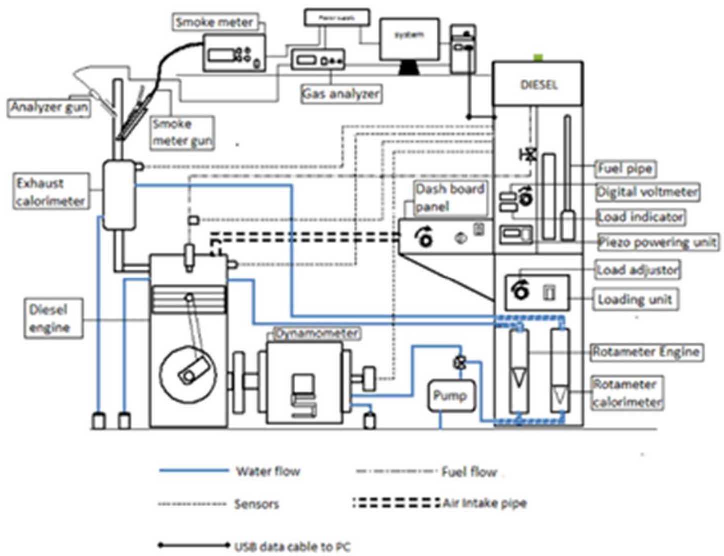

Figure 1. Schematic diagram of Engine Setup

III. Engine Performance

An engine's torque is a quantity of its rotational force exerted to transmit power from the engine to the wheels of the vehicle through the drive train. The torque and power shaped by an engine can be leisurely using a dynamometer which is mounted to the engine as a separate component.

Torque can be improved by addition of engine cylinders or accumulative the capacity of the engine although an increase in fuel feeding would be significant. The product of torque and angular speed gives the power developed by the engine.

$$P = \frac{2\pi N\tau}{60} \quad \text{or}$$

$$\tau = \frac{60P}{2\pi N}$$

Where,

τ	=	torque (N m)
P	=	power developed by engine (W)
N	=	engine speed (rpm)

A. Input Power

The input power of the engine refers to the maximum rate at which energy is supplied to the engine. It corresponds with the indicated power considered from a P-V diagram based on the work done during compression and expansion process of the diesel cycle, less the heat loss to exhaust and coolants. The heat of combustion of fuel is supplied to the engine and arrogant the cycle efficiency as unity where all the chemical energy of the fuel is renewed into useful work, the engine input power is given by,

$$IP = \dot{m}_f \times Q_{HV} \times 10^3$$

Where,

IP	=	Input power (kW)
$\dot{m}_f$	=	mass flow rate of fuel (kg/s)
Q_{HV}	=	lower calorific value of fuel (MJ/kg)

For diesel fuel, $Q_{HV,Diesel}$ = 42.5 MJ/kg

For Neem Castor fuel, $Q_{HV, NCO}$ = 39.9 MJ/kg

The lower calorific value of fuel is used in since all water complexes in the fuel are assumed to be in vapour phase without any reduction.

B. Brake Power

The brake power is the power output brought by the engine shaft. It is less than the indicated power since heat is lost to overcome the total friction generated in the engine which is summed as friction power.

Friction power consists of pumping friction during ingestion and exhaust, mechanical friction in bearings, valves and components such as oil and water pumps. Brake power refers to the rate at which work is done and shows a extreme value when engine speed is increased close to maximum before decreasing since friction becomes very substantial at high engine speeds.

Brake power = Indicated power – Friction power

In a diesel engine, the brake power can be varied by changing the fueling rate or air-fuel ratio to produce the desired power for an solicitation. In the investigation, brake power is gained from:

$$BP = \frac{2\pi N\tau}{60\times10^3}$$

Where,

BP	=	brake power (kW)
N	=	engine speed (rpm)
τ	=	torque (N m)

C. Specific Fuel Consumption

Specific fuel ingestion is the measure of fuel flow rate per unit power output and relates to the fuel efficiency of an engine. It is inversely comparative to the efficiency of the engine as lower values of specific fuel consumption are favorable for higher presentation. Specific fuel consumption is defined as:

$$sfc = \frac{\dot{m}_f}{P}\times3.6\times10^6$$

Where,

sfc = specific fuel consumption (g/kW.hr)

$\dot{m}_f$ = mass flow rate of fuel (kg/s)

P = power output

In the performance and comparison between engines running on diesel and dual-fuel for the investigation, the power output unhurried is the brake power. Therefore, brake specific fuel consumption is:

$$bsfc = \frac{\dot{m}_f}{BP}\times3.6\times10^6$$

Where,

bsfc = brake specific fuel consumption (g/kW.hr)

$\dot{m}_f$ = mass flow rate of fuel (kg/s)

BP = brake power (kW)

The brake specific fuel consumption varies with the compression ratio and fuel equivalence ratio. A higher compression ratio will produce lower bsfc since more power can be extracted from the burning fuel. Bsfc decreases as engine size becomes gradually smaller since heat losses from the combustion gas to the cylinder wall are condensed. Largely, compression ignition engines with diesel fuel harvest a higher amount of energy per unit fuel equated to spark ignition engines.

D. Brake Mean Effective Pressure

The brake mean effective pressure is a convenient measure of the relative performance of an engine. It refers to the mean pressure to be continued in the pistons of the cylinder to produce a power output during each power stroke. The brake mean effective pressure can be designed from the torque and is defined as

Where,

BMEP = brake mean effective pressure (kPa)

BP = brake power (kW)

ηr= number of crank revolutions for each power stroke per cylinder (one for two-stroke cycle and two for four stroke cycle)

A = area of engine bore (m^2)

L = length of engine stroke (m)

N = engine speed (rpm)

n = number of cylinders

It indicates the work done per cycle for every unit of cylinder volume expatriate and is the direct measure of brake torque, not engine power. A higher BMEP corresponds to a higher engine output since more pressure is conveyed through the connecting rods to the crankshaft. However, engine wear increases with increasing BMEP and leads to high mechanical stresses on engine components and imposing high thermal stresses on combustion chambers.The maximum value of BMEP for a compression ignition engine is obtained at the engine speed where maximum torque is obtained. The BMEP of the same engine is leisurely to be slightly lower at maximum rated power

E. Engine Thermal Efficiency

Generally, an IC engine loses almost 42% of its energy to the exhaust system and a further 28% to the cooling system (The Concept IC Engine). The engine thermal efficiency mentions to the ratio of work produced per cycle to the amount of fuel input to the engine per cycle.

$$\eta_f = \frac{W_c}{m_f Q_{HV}} = \frac{\dot{W}_c}{\dot{m}_f Q_{HV}} = \frac{P}{\dot{m}_f Q_{HV}}$$

Where,

η_f = engine thermal efficiency

P = output power produced per cycle (kW)

$\dot{m}_f$ = mass flow rate of fuel per cycle (kg/s)

Q_{HV} = lower calorific value of fuel (MJ/kg)

In the investigation, the desired output power per cycle is the brake power. Therefore, integrating equation

$$\eta_f = \frac{BP}{IP}$$

Another method of obtaining the engine thermal efficiency is by utilization of the specific fuel consumption. Substituting gives:

$$\eta_f = \frac{3600}{sfc \times Q_{HV}}$$

Where,

sfc = specific fuel consumption (g/kw-hr)

Q_{HV} = lower calorific value of fuel (MJ/kg)

We can see that specific fuel consumption is inversely comparative to the total engine thermal efficiency, as mentioned earlier.

IV. RESULTS AND DISCUSSION

A detailed analysis of results found from the investigational program is presented in this chapter. One of the objectives of the enquiry has been the evaluation of performance and emission characteristics of the compression ignition engine fueled with the HCNG and diesel. The results from the experiments made on the four stroke engine for maximum load operating conditions are shown in the graph form and conversed,the graphs of emission of carbon monoxide (CO), carbon dioxide (CO2), oxides of nitrogen (NOx), Hydrocarbon (HC) against brake power are shown.

A. Brake Thermal Efficiency

The below figure shows the effect of Brake Thermal Efficiency with BP. It was noticed that the recital brake thermal efficiency were growths by the increase of blends percentage when compared to pure diesel blends

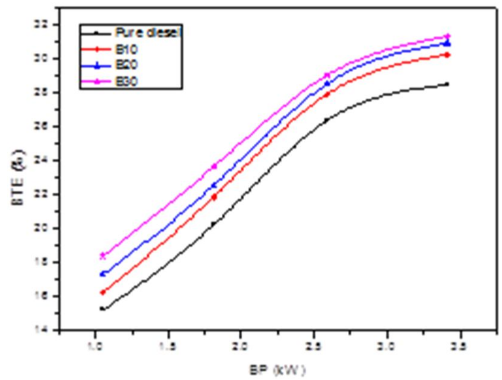

Figure 2. Influence of BTE Vs BP for different substitution of Biodiesel

gives an better efficiency.As the load was enlarged from 25% to 100% the performance of brake thermal efficiency increases. Which shows that the performance of BTE is increases for addition of blends.

B. Brake Specific Fuel Consumption

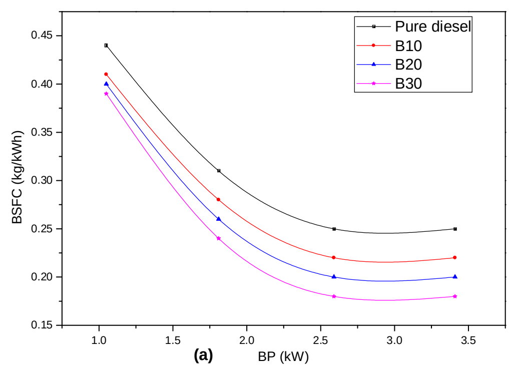

Figure 3. Influence of BSFC Vs BP at different mixtures of Biodiesel

The above figure shows that the lessening of efficiency with increase of load from 25% to 100%. The increase of percentage of blends decreases the performance Brake Specific Fuel Consumption, the BSFC value is lesser than the pure diesel which shows a better performance with lesser feeding of fuel.

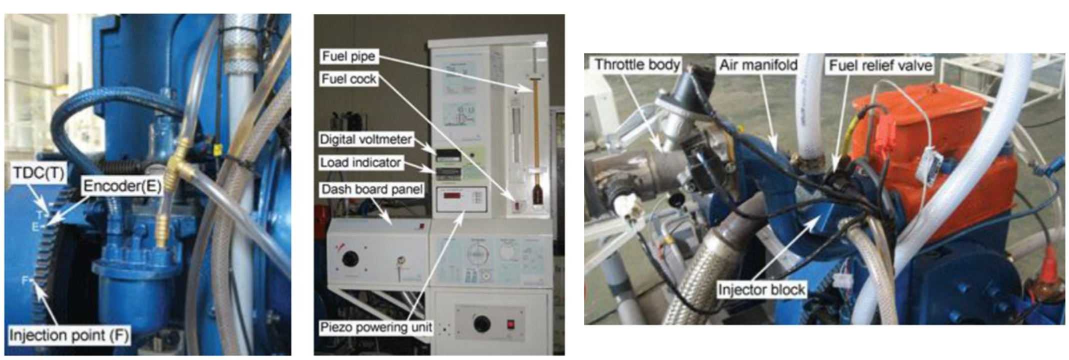

Figure 4. Real time experiment setup

V. Conclusion

- Performance of engine is concluded without adjusting.
- Engine test was done in the rated condition of compression ratio of 17.5 and Injection opening pressure of 200bar.

- Graphs shows a variation of performance parameters with Brake Power at 25%,50%,75% and 100% of load variance.
- from the graphs that the best blend that can be used for the performance parameter is B-30 Blend.
- As the load was enlarged from 25% to 100% the performance of brake thermal efficiency increases.
- The increase of percentage of blends decreases the performance Brake Specific Fuel Consumption
- It gives the least amount of BSFC and extreme of Brake thermal efficiency.

REFERENCE

[1] Dharmadhikari.H.M, Puli Ravi Kumar, SrinivasaRao.S. (2012) Performance and Emissions of C.I. Engine using Blends of Biodiesel and Diesel at Different Injection Pressures. International Journal of Applied Research in Mechanical Engineering (IJARME) ISSN: 2231–5950, Vol-2, Iss-2.

[2] Amba Prasad Rao. G, Prasad USV, Madhu Murthy. K. (2012) Influence of Fuel Injection Parameters of DI Diesel Engine with Biodiesel and Diesel Blends.International Conference on Mechanical, Automobile and Robotics Engineering (ICMAR) Penang. Malaysia.

[3] Lakshmanan.T, Nagarajan.G(2010). Experimental investigation of timed manifold injection of acetylene in direct injection diesel engine in dual fuel mode.Energy 35 3172–3178.

[4] Gerhard Vellguth., 1983, “Performance of Vegetable oils and their Monoesters as fuel for Diesel Engine”. Society of Automotive engineers, Paper No.831358, USA.

[5] Gopalakrishna, K.V., and Rao,P.S., 1983, “Use of Non Edible Vegetable oils as alternate fuels in Diesel engines”. DNES Project Report, I.C engine Lab, Indian institute of technology Madras, Chennai,India.