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Performance Analysis of CRDI Engine Using Derivative of Jatropha Oil

Prof. R.K.KALAISELVAN
Assistant Professor
Department of Mechanical Engineering
CK College of Engineering & Technology
Cuddalore-607003.Tamilnadu, India
Mail Id: Kalai.boom@gmail.com ,

Prof V.JAYARAJ
Assistant Professor
Department of Mechanical Engineering
CK College of Engineering & Technology
Cuddalore-607003.Tamilnadu, India
Mail id: jayarajgreentech@gmail.com

ABSTRACT

In the present work we have tried to make an insight to the potential use of Jatropha oil as an alternate fuel in CI engines. The project investigated the performance of Jatropha oil blend when compared to diesel as a working fuel in stationary CRDI and PERKINS engines. A two stage trans-etherification process was carried out to produces biodiesel from crude oil (FFA). The important properties of methyl ester of Jatropha oil were compared with diesel. The blend of 5% Jatropha oil with diesel was tested in CRDI engine. Also variable speed test was conducted in PERKINS engine using various blends of oil. Performance parameters like fuel consumption. Efficiency were determined. Emission analysis was conducted and optimum condition while using biodiesel as fuel blend was determined. In CRDI engine a significant improvement in engine performance was observed for the blend. Project also consisted of the study of Indian scenario (fuel consumption) and availability waste lands in India. From the date of available waste land maximum quantity f bio diesel that could produced were estimated and possible savings in import bill was calculated (approx) under different scenarios.

Key words: CI engines, investigated, Jatropha oil, Performance, Efficiency, improvement

1. INTRODUCTION

“The world wide recognitions of limits in the availability of major fossil energy sources and the related rapidly rising energy prices has introduced a massive search for new energy source for new energy source for world economic development .Abundance and availability of energy resource largely determine the economic wellbeing of a country . Energy dependence has to be our first and foremost priority . Volatile price and import dependency of petroleum product urged the researchers to explore possible alternative energy source . In this context researchers to explore possible alternative energy sources. In the context research on energy from the nuclear , wind, tidal and biological origins gained great momentum but it needs special infrastructure facilities. Whereas bio fuels can be produced from a diverse set of crops. Each country is adopting a strategy that exploits the comparative advantages it holds in certain crops.

The use of non edible vegetable oils compared to edible oil is very significant because of the tremendous demand for edible oils as food and they are far too expensive to be used as fuel at present . From studies it is evident that there are various problems associated with vegetable oils being used as fuel in compression –ignition engines, mainly caused by the high viscosity .the high viscosity is due to the large molecular mass and chemical structure of vegetable oil which in turns leads to problem in pumping. Combustion and atomization in the injector system of a diesel engine. Due to high viscosity ,in long term operation . vegetable oil normally introduced the development of gumming ,the formation of injector deposit ,ring sticking as well as incompatibility with conventional lubrication oils. Therefore ,a reduction in viscosity is of prime importance to make vegetable oils a suitable alternative fuel for bio diesel engines. The problems for high viscosity of vegetable oils has been approached in several way such as preheating the oils , blending or dilution with other fuels. Transesterification and thermal cracking / pyrolysis.

Jatropha curcus oil a non-edible vegetable oil which has been considered as a potential alternative fuel for C.I has been chosen to find out its suitability for use us fuel oils. Jatropha curcuss is a large shrub or tree native to the American tropics but commonly found and utilized through out most of the tropical and subtropical regions of the world . several properties of the plant, including its hardness rapid growth, easy propagation and wide ranging usefulness have resulted in its spread far beyond its original distribution. The Jatropha oil is slow-drying oil which is odourless and colourless when fresh but becomes yellow on standing. Thee oil content of Jatropha seed ranges from 30 to 50% by weight and the kernel itself ranges from 45 to 60% .the fatty acid composition of Jatropha classifies it as a finoleic or oleic acid type . which are unsaturated fatty acids. The fatty acid composition of Jatropha oil consist of myristic, palmitic, stearic, arachidic, oleic and linoleic acids. The seed and the oil are toxic due to the presence of cursine and curcasive . however ,from the properties of oil it is envisaged that the oil would be suitable as fuel oil.

Due course of the usage of bio-diesel it was found that almost zero emission of sulphates, a small net contribution of carbon-di-oxide when the whole life cycle is considered and emission of pollutants comparable with that of diesel oil . for these reasons several campaigns have been planned in many countries to introduce and promote the use of bio-diesel . in oder to provide a wide and complete evaluation is required to shoe what the potential convenience of bio-diesel can be in a complete or partial substitution of diesel oil according to the actual condition. Other important aspect that have to be made considered are the global energy and material requirements and the environmental impact evaluated considering the whole life cycle of bio-diesel from the agricultural production of biomass to the end use.

1.2 AUTOMOBILE ENGINES

Automobile engines may be IC engines or EC engines. Most of the automobile engines used today are of the former type.External combustion engines are those in which combustion takes place outside the engine whereas in internal combustion engines combustion takes place inside the engine.

1.3 Classification of automobile engine

Automobile engines are classified in a number of ways; such as on the basis of thermodynamic cycle of operation, type of fuel used, method of charging the cylinder, type of ignition, type of cooling, cylinder arrangement etc…

1.3.1 Cycle of operation

According to the cycle of operation, IC engines are classified into two categories (i) Constant volume heat addition cycle engine or Otto cycle engine. It is also called a spark-ignition engine, SI engine or gasoline engine.(ii) Constant pressure heat addition cycle engine or diesel cycle engine. It is also called a compression ignition engine, CI engine or diesel engine

1.3.2 Type of fuel used

(i) Engines using volatile liquid fuels like gasoline, alcohol, kerosene, benzene, etc. The fuel is generally mixed with air to form a homogeneous charge outside the cylinder.

(ii) Engines using gaseous fuels like natural gas, LPG, blast furnace gas, CNG, biogas etc. The gas is mixed with air and the mixture is introduced into the cylinder.

(iii) Engines using solid fuels like charcoal, powdered coal, etc. Solid fuels are generally converted into gaseous fuels outside the engine and the engine works as a gas engine.

(iv) Engines using viscous and low volatile fuels like heavy and light diesel oils. The fuel is generally introduced into the cylinder in the form of minute droplets by a fuel injection system. Combustion of the fuel takes place due to its coming into contact with the high temperature compressed air in the cylinder

1.4 Types of diesel engines

There are two classes of diesel engines: two-stroke and four-stroke. Most diesels generally use the four-stroke cycle, with some larger diesels operating on the two-stroke cycle, mainly the huge engines in ships. Diesel two-strokes are ideal for such applications because of their high power density--with twice as many power strokes per crankshaft revolution compared to a four-stroke, they are capable of producing much more power per displacement.

2. AUTOMOBILE FUELS

IC engines can be operated on different types of fuels such as liquid, gaseous and even solid fuels. Designed on the type of fuel to be used the engine has to be designed accordingly. Nevertheless the major classification from our project perspective is as (i) renewable fuels and (ii) non-renewable fuels.

2.1 Non renewable fuels: These are fuels that will exhaust within a few years. Their source is limited. We cannot go on tapping these fuels.

2.1.1 Solid fuels: Solid fuels find little practical applications at present because of the problems in handling the fuels as well as in disposing off, the solid residue or ash after combustion.

2.1.2 Gaseous fuels

Gaseous fuels are ideal and pose very few problems in using them in internal combustion engines. Being gaseous they mix more homogeneous with air and eliminates the problem that are encountered with liquid fuels. Yet their storage and handling problems put them one step behind liquid fuels.

2.1.3 Liquid fuels

In most of the modern internal combustion engines, liquid fuels which are the derivatives of liquid petroleum are being used. The three principal commercial types of liquid fuels are benzyl, alcohol and petroleum products. However, petroleum products form the main fuels for the IC engines as on today.

2.1.3.1 Petroleum based fuels

More than 90% of the automobiles at present run on petroleum based fuels. These fuels are derived from petroleum using the process called petroleum refining process. Petroleum as obtained from oil wells is predominantly a mixture of many hydrocarbons with different molecular structure such as paraffin series, olefin series, naphthalene series and aromatic series.Fuels used in IC engine should possess certain basic qualities which are important for the smooth running of the engines. Now our interest is on diesel and bio-diesel fuels which we are dealt with.

2.1.3.2 CI engine fuel characteristics

Diesel is produced from petroleum, and is sometimes called 'petrodiesel' when there is a need to distinguish it from diesel obtained from other sources such as bio-diesel. It is a hydrocarbon mixture, obtained in the fractional distillation of crude oil between 200 °C and 350 °C at atmospheric pressure.

The density of diesel is about 850 grams per liter whereas gasoline (British English: petrol) has a density of about 720 g/l, about 15% less. When burnt, diesel typically releases about 40.9 mega joules per liter, whereas gasoline releases 34.8 MJ per liter, about 15% less. Diesel is generally simpler to refine than gasoline and often costs less (although price fluctuations sometimes mean that the inverse is true; for example, the cost of diesel traditionally rises during colder months as demand for heating oil, which is refined much the same way, rises). Also, due to its high level of pollutants, diesel fuel must undergo additional filtration which contributes to a sometimes higher cost.

High levels of sulfur in diesel are harmful for the environment because they prevent the use of catalytic diesel particulate filters to control diesel particulate emissions, as well as more advanced technologies, such as nitrogen oxide (NOx) adsorbers (still under development), to reduce emissions. However, the process for lowering sulfur also reduces the lubricity of the fuel, meaning that additives must be put into the fuel to help lubricate engines. Bio-diesel is an effective lubricant.

2.2 Renewable fuels

Renewable fuels are those which do not extinguish. They are endless sources which we can tap on and on deliberately. Solar energy, wind energy etc can be used as fuels to propel automobiles. Fact file about some fuels are given below:Some alternate, non-conventional fuels (not particularly, necessarily renewable) are enunciated below.

2.2.1 Types of Alternative Fuels

Some alternate fuels are: wind power, solar power, tidal power, geothermal power, hydropower, thermal de polymerization, methanol, ethanol and bio-diesel.

Some alternative fuels and the cars they power are:

Gasoline type bio-fuels

- Butanol- as a direct replacement for gasoline
- E85- 15% Gasoline, 85% ethanol blend:
- P-series fuels- can be used in any E85 compatible engine
- Hydrogen internal-combustion car (see hydrogen car)

Diesel type bio-fuels

- Hempseed oil fuel or other Straight vegetable oils
- Biodiesel

3 BIO-DIESELS

Bio-diesel is a renewable, non-conventional fuel which gives many promises. Bio-diesel is biodegradable and non-toxic, and produces significantly fewer emissions than petroleum-based diesel when burned.

3.1 What is bio-diesel?

According to the National Biodiesel Board (NBB), the technical definition of biodiesel is as follows: A fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of ASTM D6751.

Another definition is like this:

Bio-diesel is defined as mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats for use in diesel engines. Bio-diesel refers to the pure fuel before blending with diesel fuel. Bio-diesel blends are denoted as, "BXX" with "XX" representing the percentage of bio-diesel contained in the blend (i.e.: B20 is 20% bio-diesel, 80% petroleum diesel).

General definition of bio-diesel: Generally speaking, bio-diesel is a domestic, renewable fuel for diesel engines derived from natural oils like jatropha curcas oil, soybean oil etc. which meets the specifications of ASTM D 6751.

Bio-diesel is an alternative or additive to standard diesel fuel that is made from biological ingredients instead of petroleum (or crude oil). Biodiesel is usually made from plant oils or animal fat through a series of chemical reactions. It is both non-toxic and renewable. Because biodiesel essentially comes from plants and animals, the sources can be replenished through farming and recycling.

Bio-diesel is defined as: Bio-diesel is the name of a clean burning alternative fuel, produced from domestic, renewable resources. Bio-diesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a bio-diesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications. Bio-diesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics.

4. IMPORTANT OF BIO-DIESEL

Bio Diesel is the most valuable form of renewable energy that can be used directly in any existing, Unmodified diesel engine .Bio Diesel and can be produced from oilseed plants such as rape seeds, sunflower, canola and or JATROPHA CURCAS.Bio diesel is environmental friendly and ideal for heavily polluted cities.Bio Diesel is a biodegradable as salt.Bio Diesel produces 80% carbon dioxide and 100% less sulphur dioxide emissions. It provides a 90% Reduction in cancer risks..Bio Diesel can be used alone or mixed in any ratio with mineral oil diesel fuel. The preferred ratio if mixture range between 5 and 25% (B5-B20).

- Bio diesel extend the live of diesel engine.
- Bio diesel oil is cheaper than mineral oil diesel.
- Bio diesel is conserving natural resources.

4.1 Storage conditions for biodiesel

The containers should be protected from weather, direct sunlight and low temperatures. Avoid long term storage in partially filled containers, particularly in damp locations like dock boxes. Condensation in the container can contribute to the long term deterioration of the bio-diesel. Low temperatures can cause the Biodiesel to gel, but the Biodiesel will quickly liquefy again as it warms up. In cold weather (near or below freezing), additives can be used to prevent gelation.

Fuel tanks should be kept as filled as possible, particularly during rainy winter months or periods of inactivity, to minimize the condensation of moisture. Condensed moisture accumulates as water in the bottom of your tank and can contribute to the corrosion of metal fuel tanks. The condensed water in the fuel tank can also support the growth of bacteria and mold that use the bio-diesel hydrocarbons as a food source. These hydrocarbon-degrading bacteria and molds will grow as a film or slime in the tank and accumulate as sediment over long periods of time.

The accumulation of the newly released slime and sediment can be very dangerous if it clogs the fuel filters and causes the engine to suddenly stop. It is very important to monitor the filters on a diesel engine that has been switched over to Biodiesel, particularly if the tank is old and has not been cleaned. Accumulated sediment in fuel filters can interrupt the flow of fuel and shut down the engine, potentially with disastrous consequences.

4.2 WHY JATROPHA

Energy independence.

- ➢ Foreign exchange savings.
- ➢ Rural development.
- Job opportunity
- Waste land development

- ➢ Environmental benefit.
- Emission benefits .
- Energy cycle and gree house gas balance.
- ➢ Better lubricity.
- ➢ Bio-diesel is a light to dark yellow liquid.
  - It is practically immiscible with water, has a high boiling point and low vapor pressure.
  - Typical methyl ester bio-diesel has a flash point of ~ 150 °C, making it rather non-flammable.
  - Bio-diesel has a density of ~ 0.86 g/cm^3, less than that of water.
  - It can be used as an additive in formulations of diesel to increase the lubricity of pure Ultra-Low Sulfur Diesel (ULSD) fuel.
  - It's 11 to 17 times thicker than petro-diesel.

4.3 Bio-diesel and carbon cycle

Bio-diesel is part of the carbon cycle. Carbon from the atmosphere is converted into biological matter by photosynthesis. On decay or combustion the carbon goes back into the atmosphere. This happens over a relatively short timescale and plant matter used as a fuel can be constantly replaced by planting for new growth. Therefore a reasonably stable level of atmospheric carbon results from its use as a fuel.

4.4.1The chemical analysis of JATROPHA oil given in table .

ITEM	VALUE
Acid value	33.2
Saponification value	195.0
Iodine value	101.7
Viscosity (31°C) “fatty acid”	40.4
Palmitic acid %	4.2
Stearic acid %	6.9
Oleic acid %	43.1
Lincleic acid %	34.3
Other acid %	1.4

The comparison of properties of Jatropha oil and standard specification of diesel oil are shown in table

Specification	Std specification of Jatropha oil	Standard specification of Jatropha oil
Specific gravity	0.9/86	82/0.84
Flash point	240/1.0°C	50 °C
Carbon residue	0.64	0.150 less
Cetane value	51	50 up

Distillation point	295 °C	350°C
Kinematic viscosity	50.78CS	2.7CS
Sulpher %	0.13%	1.2% less
Caloric value	94/0Kcal/kg	101/0Kcal/kg
Pour point	8°C	10°C
Colour	-40	40 less

5 . TRANS – ESTRIFICATION

There are various problems associated with vegetable oils being as fuel in compression – ignition engines, mainly caused by the high viscosity . The high viscosity is due to the large molecular mass and chemical structure of vegetable oils which in turn leads to problem in plumbing , combustion and atomization in the injector system of a diesel engine . due to high viscosity ,in long term operation ,vegetable oil normally introduce the development of gumming ,the formation of injector deposits, ring sticking , as well as incompatibility with conventional lubrication oils. Therefore , a reduction in viscosity is of prim importance to make vegetable oils a suitable alternative fuel diesel engines. The process of reducing the viscosity and makes it almost comparable with standard diesel is known as trans-esterification.

5.1 MECHANISUM OF TRANS ESTRIFICATION

In transestrification , KOH and methanol are mixed to create potassium methoxide (k+ CH3 O-) . when mixed in with the oil this strong polar- bonded chemical break the transfatty acid in to glycerine and ester chain (bio-diesel) , along with some soap if you are not careful. The esters become methyl esters. They would be ethyl esters if reacted with ethanol instead of methanol.

TRANS-ESTERIFICATION PROCESS

Transesterification is a reversible reaction of a fat or oil (mainly triglycerides) with an alcohol to form esters and glycerol.

Ingredients

Reaction raw materials:

1. Jatropha Oil
2. Methanol (CH3OH) 99% + pure

3.Potassium hydroxide (must be dry)

Material of Titration:

1. Isopropyl alcohol 99% +pure
2. Distilled water
3. Phenolphthalein solution

Materials for Washing:

1. Vinegar
2. Water

For 0% Jatrapha

Time (s)	Temperature (C◦)	Weight (g)	Kinematic viscosity (Cs)	Density(Kg/cubic m

29.5	42	41	1.839492	820
27.3	53.6	40.9	.797634	818
26.4	62.5	40.9	.348848	818

For 5% jatropha

Time(S)	**Temperature(C◦)**	**Weight(g)**	**Kinematic viscosity(Cs)**	**Density (Kg/cubic m)**
32.1	32.5	41.2	2.987745	824
29.4	46.5	41.15	1.747639	823
27.5	57.3	41.1	0.895455	822
26.6	67.5	41.1	0.449835	822
25.95	82.5	41	0.118869	820

Jatropha

Time(S)	**Temperature(C◦)**	**Weight(g)**	**Kinematic viscosity (Cs)**	**Density (Kg/cubic m)**
33.4	32	41.5	3.534299	830
29.8	46.5	41.4	1.976188	828

28.5	53.3	41.4	1.374912	828
26.9	68	41.3	0.599948	826
26.1	81.5	41.3	0.195962	826

For 20% Jatropha

Time(S)	**Temperature(C◦)**	**Weight(g)**	**Kinematic viscosity (Cs)**	**Density (Kg/cubic m)**
33.9	34	41.9	3.740254	838
30.3	50.5	41.8	2.201432	836
28.3	61.5	41.8	1.280261	836
27.6	71.5	41.8	0.944166	836

For 40% Jatropha

Time(S)	**Temperature(C◦)**	**Weight(g)**	**Kinematic viscosity (Cs)**	**Density (Kg/cubic m)**
35.6	33.6	42.7	4.424539	854
32	49.6	42.6	2.945	852
29.4	66.5	42.6	1.79366	852

28.6	75.6	42.5	1.422014	850
27.3	84.5	42.4	0.797634	848

For 60% Jatropha

Time(S)	Temperature(C◦)	Weight(g)	Kinematic viscosity (Cs)	Density (Kg/cubic m)
36.9	36.3	43.5	4.932753	870
34.8	43.5	43.4	4.105471	868
33.5	51.2	43.4	3.575672	868
31.5	61.5	43.4	2.729683	868
28.1	83	43.3	1.185004	866

For 80% Jatropha

Time(S)	Temperature(C◦)	Weight(g)	Kinematic viscosity (Cs)	Density (Kg/cubic m)
40.6	35.6	44.4	6.319547	888

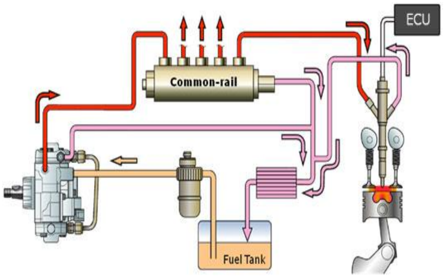
35.1	52.8	44.3	4.225715	886
32.1	63.5	44.2	2.987745	884
30.2	73.6	44.2	2.156636	884
28.8	82.5	44.1	1.515778	882

For 100% Jatropha

Time (S)	Temperature (C◦)	Weight(g)	Kinematic viscosityCs)	Density (Kg/cubic m)
49.6	32.5	45.2	9.428258	904
44.8	42.6	45.1	7.808714	902
42.6	47.3	45	7.038441	900
34.5	64.5	44.9	3.984493	898
29.4	81.9	44.9	1.79366	898

6. EXPERIMENTAL SETUP FOR COMMON RAIL DIESEL ENGINE(CRDe)

A four cylinder four stroke **common rail diesel engine** available in the models lab was employed for conducting the experiment. Table show the details of the engine



Mahindra Scorpio engine

Engine TypE	**In-line engine**
Engine description	2.6L 115bhp turbocharged,intercooled 4stroke CRDe
Engine isplacement(cc)	2609
No: of cylinder	4
max: power	116.6 @ 3800(ps@rmp)
Max: torque	28.3@1,700-2,200(kgm@rpm)
Valves per cylinder	4
Fuel supply system	CRDI
Turbo charger	yes
Bore x stroke	94 x 94 mm
Compression ratio	18:5:1

Same injection system was used for the experiment. A single fuel tank with an indicate was used for diesel and also for various blends of jatropha oil. Fuel consumption was measured with the help of a stopwatch on volume basis. An air tank with an orifice plate and U-tube manometer containing mercury was used to measure air flow rate.

6.1 Heater setup

We used here is copper tube as heating coil. To heat the coil we used the temperature of exhaust ie the coil is wounded around the silencer which is as shown in the fig6.1

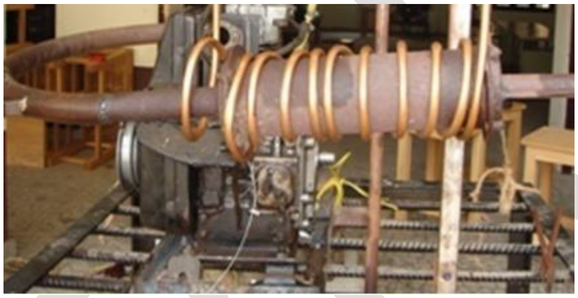


Figure6.1 Heating coil

6.2 Why heater setup?

We had two ways of using bio-diesel in our engine. One way is to reconstruct the whole engine so as to make it viable for bio-diesel. That is we have to increase the compression ratio, redesign a sturdier pump as well as injector, use high quality hoses and pipes, more efficient seals, make a slight change in cycle timing etc. And filter must be redefined (This is very important) If this were done, we could have avoided the heater setup. That is we need not admit the fuel in to the cylinder at a temperature higher than ambient. Also we could have started, ran and stopped with any of the fuel, particularly bio-diesel. But this method is comparably expensive.

So we adopt the simple and cheap method of heating the fuel. We heated the fuel (bio-diesel) to such a temperature that its density becomes almost equivalent to that of petro-diesel so that it can flow freely through the pump, high pressure as well as low pressure fuel lines and finally atomizes very similar to petro-diesel. This method didn’t allow us to start and stop the engine in bio-diesel.

7. PERFORMANCE OF AN IC ENGINE

So many terms have to be dealt with, while appraising the performance of an IC engine. Some are described below:

7.1 Indicated Horse Power (IHP)

The power developed inside the cylinder of the engine due to the combustion of fuel is called the indicated horse power. The formula for calculating the indicated horse power for a single cylinder engine is given as:

- ✓ For 2-stroke engine:Number of power strokes in a 2-stroke engine = rpm of the crankshaft
- ✓ For 4-stroke engine:Number of power strokes in a 4-stroke engine =1/2 × rpm of the crankshaft

In case of a multi-cylinder engine, the IHP should be multiplied by the number of cylinders, to obtain the total indicated horse power of the engine.

7.2 Brake Horse Power (BHP)

BHP of the engine actually runs the vehicle. Rotational force available at the delivery point of the engine, i.e. at the engine crankshaft, also called driver shaft develops corresponding power. This power is referred to as brake horse power (BHP).

This power delivered by the engine is measured by the rope brake of the absorption dynamometer. The output shaft of an engine is mounted with a rotating drum. A rope is wound around the rotating drum. One end of the rope is tied with a spring balance and the other end of the rope is connected to a loading device. When the engine is rotating, power is absorbed due to friction between the rope and drum. Therefore the drum has to be cooled. It is found by the formula:

$$\text{Power} = \frac{\text{Torque} \times \text{Speed}}{K}$$

Where Torque = mean effective radius of the drum × force applied

7.3 Frictional Horse Power (FHP)

The input power in an engine is greater than the output power, i.e. the indicated house power is greater than the brake horse power. The difference between the input and output energy is due to the loss of power in overcoming friction between the various moving parts of the engine. The power loss due to friction while the engine is running is called frictional horse power.The friction horse power is the difference between IHP and BHP

Therefore **FHP= IHP – BHP**

The friction horse power of an engine can be determined by the following test. The engine is kept at the operating temperature, with no fuel in the carburetor and the throttle opened wide. Under these conditions, the engine is driven by an electric motor. The horse power required to drive the engine is measured from the consumption of current by this electric motor.

8.Loading device

Mechanical friction brake dynamometer

Figure 8.5: Dynamometer pulley

8.1 Maximum load calculation

Maximum load = [Rated power (kW) × 60× 1000]/ [2 × π × N× Re × 9.81] (unit: kgf)

Where Re =effective radius of brake drum (unit: m)

Maximum load **=** [4.774 × 60× 1000]/ [2 × π × 2500× 0.1225× 9.81] **= 15.88 kg f**

9. EQUATIONS USED FOR CALCULATIONS

1.Brake power,Pb = 2πNT/60 : Where **N** speed in rpm **T**-torque in Nm.

2.Total Fuel Consumption,TFC = 10×ρ×3600/t×1000 Kg/hr

Where , **t-** Time taken for 10cc of fuel consumption in sec

ρ –Density of fuel gm/cc(p=0.815gm/cc for diesel)

3.Specific fuel consumption, SFC = TFC/Pb kg/kWhr

4.Break thermal efficiency, η = Pb×3600×100/TFC×CV%,Where **Pb** –Brake Power in Kw and **CV** – calorific value of fuel.

5. Indicated power, Pi = Pb + Pf kW:Pf – Frictional power which can be obtained from the graph of TFC versus Brake Power.

6. Indicated thermal efficiency: ηnth = Pb×3600×100/TFC×CV%

7. Volumetric efficiency: It is defined as the ratio of actual discharge to theoretical discharge.

8.Actual discharge Qa =Cd*a* $\sqrt{2gh}$

Where Cd – coefficient of discharge

a –Area of orifice

h –manometer reading in meters of air

9. Theoretical discharge Q th = 2×A×L×N/60

A – Area of piston , L – stroke length, N-rpm

9.1 Calculations

Calculation: Diesel

Maximum Load

BP = (2πNT)/60000

Where T = Re × W

W **=** (16.4 × 60000) / (2 ×3.14 ×2500 .1225 =15.58

TFC = (5/t) × ρ_{diesel} × $(3600/10^6)$

= (5 / 45.57)×840 ×$(3600/10^6)$ = 0. 3278

BP = (2πNT)/60000

= (2 ×3.14 ×1730 ×)/60000 = .835

SFC = TFC/BP = 0. 3278 / .835 = .392

IP = BP+FP =.835+1.35 =2.185

η_{mech} = BP/IP =.835/2.185 =.3821

η_{bth} = (BP×3600×100)/ (TFC×CV) = (.835×3600×100)/ (0. 278×10300) =20.2

η_{ith} = (IP×3600×100)/ TFC×CV) =(2.185×3600×100)/(0.3278×10300) =55.34

Calculation: Bio-Diesel

TFC = (5/t) × ρ fuel × $(3600/10^6)$ = (5 / 46.61)×880 ×$(3600/10^6)$ = 0.3398

BP = (2πNT)/60000 = (2 ×3.14 ×1730 ×4×9.81×.1225)/60000 = .835

SFC = TFC/BP = 0.3398 / .835 = .4069

IP = BP+FP =.835+0.9 = 1.735

η_{mech} = BP/IP =.835/1.735 = .481

η_{bth} = (BP×3600×100)/ (TFC×CV) = (.835×3600×100)/ (0.3398×10300) = 23.16

η_{ith} = (IP×3600×100)/ (TFC×CV) =(1.735×3600×100)/ .3398×10300) = 64.47 100%

DIESL EMMISSION

LOAD(kg)	N%	K	T(deg C)	T(deg C)
0	0.5	0.01	37	47
5	3.4	0.08	39	79
10	4.9	0.11	39	89
15	8.9	0.21	39	98
25	12.4	0.31	39	112

JATROPHA (B5) EMISSION

LOAD(kg)	N%	K	T(deg C)	T(deg C)
0	0.3	0.0	42	88
5	1.6	0.03	41	94
10	2.3	0.05	41	99
15	4.3	0.10	40	108
25	7.2	0.17	40	111

10. ENGINE TEST RESULT AND DISSCUSSIONS

1. EFFECT OF BREAK OPWEW ON BREAK THERMAL EFFICIENCY

The variation of break thermal efficiency of the engine with B5 blend and brake thermal efficiency obtained with diesel is shown in fig. there was a small increase in efficiencies for B5 blend as compared to the efficiency of 100% diesel at higher loads. The general trend of dropping of the curves was not obtained as we could not load to full rated condition

2. EFFECT OF BREAK POWER ON SFC

Fig compare the specific fuel consumption of diesel and B5 blend at varying break loads in the range 0-8 kw. It was observed that the specific fuel consumption of blend was decreased with increasing load from 1KW to 8 KW . The trend of further increase in the specific fuel consumption could not be traced out as we could not load the engine up to rated power and further overload it. Also the SFC of B5 blend is lower than that of pure diesel.

3.EFFECT ON BREAK POWER ON TFE

Fig compare the total fuel consumption of diesel and B5 blend of Jatropha at varying break loads in range 0-8 KW.The highest value of total fuel consumption obtained for B5 blend was 2.455 Kg/hr where as that for diesel was 2.758 Kg/hr. the volume that would be consumed can be calculated from TFC plots for pure diesel it was found to be 3.64 liters/hr while that for B5 blend was 2.98litres/hr . considering cost /litter for diesel as Rs 40 and Jatropha as Rs 25, when commercialized the running cost of CRDIe engine for 1 hour are found to be as 131.2 for diesel and 114.13 for B5 blend. **Comparisons (BP vs. TFC)**

4.EFFIECT OF BREAK POWER ON INDICATED THERMAL EFFICIENCY

Indicated thermal efficiency goes on increasing for B5 blend corresponding to the break power. Indicated thermal efficiency is the ratio of energy in the indicated power to the input fuel energy in appropriate unit ._Indicated thermal efficiency goes on increasing for all the blends corresponding to break power is constant but the break power . Frictional power is constant but the break power increases with the increase in load . so it is clear that the indicated power increases with the increase in break power and there by indicated thermal efficiency increase as shown in fig

CONCLUSION

Viscosity of jatropha oil has been reduced by trans-etherification process and made comparable to that of diesel by blending In the case of CRDI engine ,the performance(brake thermal efficiency &SFC)are better for diesel than bio-diesel The jatropha oil blends gives better values of fuel consumption and thermal efficiencies with little engine modification.Bio-diesel and diesel exhibit almost similar characteristics. Our considerations are routed this way:

1. Which is inexhaustible?
2. Which is cheap?
3. Which is environment friendly?
4. Here is where bio-diesel makes it to the top.