PERFORMANCE TEST ON DIESEL ENGINE WITH BIODISEL BLEND MIXTURE

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ABSTRACT:

Biodiesel production is a modern and technological area for researchers due to constant increase in the prices of petroleum diesel and environmental advantages. This paper presents a review of the alternative technological methods that could be used to produce this fuel. Biodiesel from karanja oil was produced by alkali catalyzed transesterification process. Performance of IC engine using karanja biodiesel blending with diesel and with various blending ratios has been evaluated. The engine performance studies were conducted with a prony brake-diesel engine set up. Parameters like speed of engine, fuel consumption and torque were measured at different loads for pure diesel and various combinations of dual fuel. Brake power, brake specific fuel consumption and brake thermal efficiency were calculated. The test results indicate that the dual fuel combination of B40 can be used in the diesel engines without making any engine modifications. Also the cost of dual fuel (B40) can be considerably reduced than pure diesel.

Keywords: *transesterification, IC engine, Karanja, biodiesel.*

INTRODUCTION

An alternative fuel vehicle is a vehicle that runs on a fuel other than "traditional" petroleum fuels (petrol or diesel); and also refers to any technology of powering an engine that does not involve solely petroleum (e.g. electric car, hybrid electric vehicles, solar powered). Because of a combination of factors, such as environmental concerns, high oil prices and the potential for peak oil, development of cleaner alternative fuels and advanced power systems for vehicles has become a high priority for many governments and vehicle manufacturers around the world.

Alternative fuels, known as non-conventional or advanced fuels, are any materials or substances that can be used as fuels, other than conventional fuels. Conventional fuels include: fossil fuels (petroleum (oil), coal, propane, and natural gas), as well as nuclear materials such as uranium and thorium, as well as artificial radioisotope fuels that are made in nuclear reactors, and store their energy.

LITERATURE REVIEW

The history of bio fuels has less to do with technology advancements and more to do with political and economic greed. In order to understand the foundation for biofuel technology though, it is necessary to know the history of the diesel engine. In 1893, a German Inventor named Rudolph Diesel published a paper entitled "The theory and Construction of a Rational Heat Engine". In this paper, he described a revolutionary new engine where air would be compressed by a piston to increase pressure and therefore raise temperatures. (Planet Fuels, 2001) Because of the high temperatures, it was found that the engine could run off a variety of vegetable oils such as hemp and peanut oil. In 1911, at the World's Fair in Paris, Rudolph ran his engine on peanut oil, and later described that "the diesel engine can be fed with vegetable oils and will help considerably in the development of the agriculture of the countries which use it." Rudolph wanted an alternative to expensive and inefficient steam engine, and his new diesel engine was the answer.

Two years after the World's Fair, Diesel was found dead. It was rumored that the German government assassinated him in order to keep his new technology out of the UK submarine fleet. Shortly after this, the Germans introduced diesel engine technology in their U-boats, which contributed too much of their success during wartime. After his death, the petroleum industry capitalized on this new engine, altering it to run on the by-product of petroleum distillation called "Diesel #2". (Boyle, 2003)

Also during this time, Henry Ford, creator the Model T and contributor to the advancement of the assembly line became convinced that renewable resources were the key to success in the automotive field. Ford built an ethanol plant in the Midwest, and formed a partnership with Standard Oil to sell and distribute it in the states. In the early 1920's, biofuels made up 25 percent of all fuel sales. (Sahlman, 2003).

But, with the rapid growth of industry and economic growth of major players in the industrial field, biofuels and renewable resource growth was threatened. There were a few major players who had a lot of political pull and contributed to the downfall of biofuels and renewable resources. William Randolph Hurst produced nearly all the paper in the US, and was threatened by the many uses of the hemp plant. Andrew Mellon, secretary of the Treasurer and financial backer of the DuPont Company, patented a chemical necessary to produce wood pulp in paper. The Rockefellers were developing large empires from the use of petroleum, and biofuels threatened all of their niche their markets. These key players all had vested interests in seeing renewable resource use decreased, the hemp industry destroyed and biomass fuels forgotten. (PlanetFuels, 2003)

By the beginning of World War II, by undercutting biomass fuel prices, the petroleum companies monopolized on fuel causing the biomass industry shut down. The industry's agenda was to make more money, and they had no interest in the effects their greed would have on following generations.

Throughout the next couple decades, the petroleum and automotive industries grew tremendously, both in their economics and political power. Due to our increasing dependency for oil, the US began importing from other countries at low prices. In the early 1970's, the US supply of oil became limited and we had to rely on foreign imports to run our country. In 1973, OPEC, an organization in the Middle East that controls a majority of the world's oil, reduced its output, which caused prices in the US to increase dramatically. With the rising prices of gas, consumers began looking for other methods to support their obsession with travel. So, in 1978, diesel engines began re-gaining popularity and biofuels reentered the consciousness of the country. (NBB, 2005)

Now, almost thirty years later, ideas for alternative fuels are beginning to catch on. Over 200 major fleets in the US now run on biofuels, including US Post Office, US Military, and metropolis transit systems. (NBB, 2005) Hybrid vehicles are being produced by more car companies and sales are increasing throughout the country. Biodiesel is now being produced from many different products: from soybeans and corn in the Midwest, tallow from the slaughter industry, sugar cane in Hawaii and forest wastes in the North West. In Europe, they now have the option for biodiesel at many of their gas stations. Many private groups have caught onto the trend of alternative fuels and have made it their mission to educate people of the uses and technologies involved in using and creating alternative energies.

Despite the resistance of major political and economic powers, biofuel technology and use is beginning to regain its popularity. At this point in history, with increased pollution, global warming, environmental degradation, health problems, and rising prices at the gas pump, the popularity and implementation of biofuels and renewable technology is extremely important for the continuation of our society.

History of Bio Diesel

Use of Bio diesel in Diesel engines is not a new concept but century old. In fact Rudolf Diesel, the inventor of the Diesel Engine just used Peanut oil in his engine as early as1901. But later on the cheap availability of petroleum diesel completely replaced the use of vegetable oil. Today, since the availability is becoming scarce, it will be wise to go back to the traditional natural fuels like vegetable oil

Day-by-day the diesel oil is becoming costlier and dearer and within a few years it may not be available at all. Even now its availability is influenced by various extraneous factors like political situations, wars, terrorist activities etc. The worst affected are the developing countries like India, who do not have adequate resources of Petroleum products.

To-day we import 70% of our crude oil and in the coming years the requirement will increase greatly. Of all the petroleum products diesel oil is the maximum consumed oil constituting more than 40%.Diesel run vehicles are the backbone of Indian Economy and with the ever-increasing price of it our economy is severely strained. Further the ever-increasing use of Diesel oil is polluting the atmosphere greatly affecting the health of the people and also changing the climatic conditions of the whole world.

Hence it is high time the world develops an alternate fuel devoid of all the above problems. Bio diesel fits the slot perfectly to replace Petroleum diesel. Bio diesel is nothing but processed vegetable oil or animal fats. The vegetable oil can be either edible or non-edible. Also used as cooking oil or fresh vegetable oil.

FUEL FROM ALCOHOL

Although fossil fuels have become the dominant energy resource for the modern world, alcohol has been used as a fuel throughout history. The first four aliphatic alcohols (methanol,ethanol, propanol, and butanol) are of interest as fuels because they can be synthesized chemically or biologically, and they have characteristics which allow them to be used in current engines. One advantage shared by all four alcohols is their high octane rating. This tends to increase fuel efficiency and largely offsets the lower energy density of alcohol fuels (as compared to petrol/gasoline and diesel fuels), thus resulting in comparable "fuel economy" in terms of distance per volume metrics, such as kilometers per liter, or miles per gallon. Bio butanol has the advantage that its energy density is closer to gasoline than the simpler alcohols (while still retaining over 25% higher octane rating); however, bio butanol is currently more difficult to produce than ethanol or methanol. The general chemical formula for alcohol fuel is $\mathbf{C_nH_{2n+1}OH}$.

Most methanols are produced from natural gas, although it can be produced from biomass using very similar chemical processes. Ethanol is commonly produced from biological material through fermentation processes. When obtained from biological materials and/or biological processes, they are known as **bio alcohols** (e.g. **bio ethanol**). There is no chemical difference between biologically produced and chemically produced alcohols. However, "ethanol" that is derived from petroleum should not be considered safe for consumption as this alcohol contains about 5% methanol and may cause blindness or death. This mixture may also not be purified by simple distillation, as it forms an azeotropic mixture.

ETHANOL FUEL

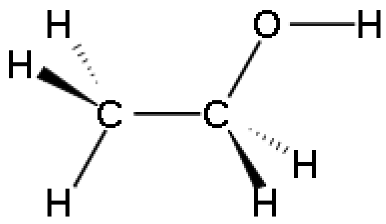
Ethanol (ethyl alcohol), the same type of alcohol found in alcoholic beverages. It is most often used as a motor fuel, mainly as a biofuel additive for gasoline. World ethanol production for transport fuel tripled between 2000 and 2007 from 17 billion to more than 52 billion liters. From 2007 to 2008, the share of ethanol in global gasoline type fuel use increased from 3.7% to 5.4%. In 2011 worldwide ethanol fuel production reached 22.36 billion U.S. liquid gallons (bg) (84.6 billion liters), with the United States as the top producer with 13.9 bg (52.6 billion liters), accounting for 62.2% of global production, followed by Brazil with 5.6 bg (21.1 billion liters). Ethanol fuel has a "gasoline gallon equivalency" (GGE) value of 1.5 US gallons (5.7 L).

Ethanol fuel is widely used in Brazil and in the United States, and together both countries were responsible for 87.1% of the world's ethanol fuel production in 2011. Most cars on the road today in the U.S. can run on blends of up to 10% ethanol, and ethanol represented 10% percent of the U.S. gasoline fuel supply in 2011. Since 1976 the Brazilian government has made it mandatory to blend ethanol with gasoline, and since 2007 the legal blend is around 25% ethanol and 75% gasoline (E25). By December 2011 Brazil had a fleet of 14.8 million flex-fuel automobiles and light trucks and 1.5 million flex-fuel motorcycles that regularly use neat ethanol fuel (known as E100).

Bioethanol is a form of renewable energy that can be produced from agricultural feedstocks. It can be made from very common crops such as sugar cane, potato,manioc and corn. There has been considerable debate about how useful bioethanol will be in replacing gasoline. Concerns about its production and use relate toincreased food prices due to the large amount of arable land required for crops, as well as the energy and pollution balance of the whole cycle of ethanol production, especially from corn. Recent developments with cellulosic ethanol production and commercialization may allay some of these concerns.

Cellulosic ethanol offers promise because cellulose fibers, a major and universal component in plant cells walls, can be used to produce ethanol. According to the International Energy Agency, cellulosic ethanol could allow ethanol fuels to play a much bigger role in the future than previously thought.

Chemistry



Structure of ethanol molecule. All bonds are single bonds

Glucose (a simple sugar) is created in the plant by photosynthesis.

$6\ CO_2 + 6\ H_2O + \text{light} \rightarrow C_6H_{12}O_6 + 6\ O_2$

During ethanol fermentation, glucose is decomposed into ethanol and carbon dioxide.

$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2 + \text{heat}$

During combustion ethanol reacts with oxygen to produce carbon dioxide, water, and heat:

$C_2H_5OH + 3\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O + \text{heat}$

After doubling the combustion reaction because two molecules of ethanol are produced for each glucose molecule, and adding all three reactions together, there are equal numbers of each type of atom on each side of the equation, and the net reaction for the overall production and consumption of ethanol is just:

Light → heat

The heat of the combustion of ethanol is used to drive the piston in the engine by expanding heated gases. It can be said that sunlight is used to run the engine (as is the case with any renewable energy source, as sunlight is the only way energy is added to the planet, except for tidal energy, which comes from the moon, and geothermal energy, which comes from the heat already present inside the earth).

Glucose itself is not the only substance in the plant that is fermented. The simple sugar fructose also undergoes fermentation. Three other compounds in the plant can be fermented after breaking them up by hydrolysis into the glucose or fructose molecules that compose them. Starch and cellulose are molecules that are strings of glucose molecules, and sucrose (ordinary table sugar) is a molecule of glucose bonded to a molecule of fructose. The energy to create fructose in the plant ultimately comes from the metabolism of glucose created by photosynthesis, and so sunlight also provides the energy generated by the fermentation of these other molecules.

Ethanol may also be produced industrially from ethene (ethylene). Addition of water to the double bond converts ethene to ethanol:

$C_2H_4 + H_2O \rightarrow CH_3CH_2OH$

This is done in the presence of an acid which catalyzes the reaction, but is not consumed. The ethene is produced from petroleum by steam cracking.

When ethanol is burned in the atmosphere rather than in pure oxygen, other chemical reactions occur with different components of the atmosphere such as nitrogen (N_2). This leads to the production of nitrous oxides, a major air pollutant.

Ethanol is a renewable energy source because the energy is generated by using a resource, sunlight, which cannot be depleted. Creation of ethanol starts with photosynthesis causing a feedstock, such as sugar cane or a grain such as maize (corn), to grow. These feed stocks are processed into ethanol.

About 5% of the ethanol produced in the world in 2003 was actually a petroleum product. It is made by the catalytic hydration of ethylene with sulfuric acid as the catalyst. It can also be obtained via ethylene or acetylene, from calcium carbide, coal, oil gas, and other sources. Two million tons of petroleum-derived ethanol is produced annually. The principal suppliers are plants in the United States, Europe, and South Africa. Petroleum derived ethanol (synthetic ethanol) is chemically identical to bio-ethanol and can be differentiated only by radiocarbon dating.

An alternative process to produce bio-ethanol from algae is being developed by the company Algenol. Rather than grow algae and then harvest and ferment it the algae grow in sunlight and produce ethanol directly which is removed without killing the algae. It is claimed the process can produce 6,000 US gallons per acre (56,000 liters per ha) per year compared with 400 US gallons per acre (3,750 l/ha) for corn production.

Production Process

he basic steps for large scale production of ethanol are: microbial (yeast) fermentation of sugars, distillation, dehydration (requirements vary, see Ethanol fuel mixtures, below), and denaturing (optional). Prior to fermentation, some crops require saccharification or hydrolysis of carbohydrates such as cellulose and starch into sugars. Saccharification of cellulose is called cellulolysis (see cellulosic ethanol). Enzymes are used to convert starch into sugar.

Dehydration

There are basically five dehydration processes to remove the water from an azeotropic ethanol/water mixture. The first process, used in many early fuel ethanol plants, is called azeotropic distillation and consists of adding benzene or cyclohexane to the mixture. When these components are added to the mixture, it forms a heterogeneous azeotropic mixture in vapor-liquid-liquid equilibrium, which when distilled produces anhydrous ethanol in the column bottom, and a vapor mixture of water and cyclohexane/benzene. When condensed, this becomes a two-phase liquid mixture. Another early method, called extractive distillation, consists of adding a ternary component which will increase ethanol's relative volatility. When the ternary mixture is distilled, it will produce anhydrous ethanol on the top stream of the column.

With increasing attention being paid to saving energy, many methods have been proposed that avoid distillation altogether for dehydration. Of these methods, a third method has emerged and has been adopted by the majority of modern ethanol plants. This new process uses molecular to remove water from fuel ethanol. In this process, ethanol vapor under pressure passes through a bed of molecular sieve beads. The bead's pores are sized to allow absorption of water while excluding ethanol. After a period of time, the bed is regenerated under vacuum or in the flow of inert atmosphere (e.g. N2) to remove the absorbed water. Two beds are often used so that one is available to absorb water while the other is being regenerated. This dehydration technology can account for energy saving of 3,000 btus/gallon (840 kJ/L) compared to earlier azeotropic distillation.

ENERGY BALANCE

Country	Type	Energy Balance
United States	Corn ethanol	1.3
Brazil	Sugarcane	8

	ethanol	
Germany	Biodiesel	2.5
United States	Cellulosic ethanol[†]	2–36[††]

Table: Energy Balance

- ➢ Experimental, not in commercial production
- ➢ depending on production method

AIR POLLUTION

Compared with conventional unleaded gasoline, ethanol is a particulate-free burning fuel source that combusts with oxygen to form carbon dioxide, water and aldehydes. Gasoline produces 2.44 CO_2 equivalent kg/l and ethanol 1.94. Since ethanol contains 2/3 of the energy per volume as gasoline, ethanol produces 19% more CO_2 than gasoline for the same energy. The Clean Air Act requires the addition of oxygenates to reduce carbon monoxide emissions in the United States. The additive MTBE is currently being phased out due to ground water contamination; hence ethanol becomes an attractive alternative additive. Current production methods include air pollution from the manufacturer of macronutrient fertilizers such as ammonia.

A study by atmospheric scientists at Stanford University found that E85 fuel would increase the risk of air pollution deaths relative to gasoline by 9% in Los Angeles, USA: a very large, urban, car-based metropolis that is a worst case scenario. Ozone levels are significantly increased, thereby increasing photochemical smog and aggravating medical problems such as asthma.

INTERNAL COMBUSTION ENGINE

The internal combustion engine is an engine in which the combustion of a fuel (normally a fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine, the expansion of the high-temperature and high -pressure gases produced by combustion apply direct force to some component of the engine. This force is applied typically to pistons, turbine blades, or a nozzle. This force moves the component over a distance, transforming chemical energy into useful mechanical energy.

The term internal combustion engine usually refers to an engine in which combustion is intermittent, such as the more familiar four-stroke and two-stroke piston engines, along with variants, such as the six-stroke piston engine and the Wankel rotary engine. A second class of internal combustion engines use continuous combustion: gas turbines, jet engines and most rocket engines, each of which are internal combustion engines on the same principle as previously described.

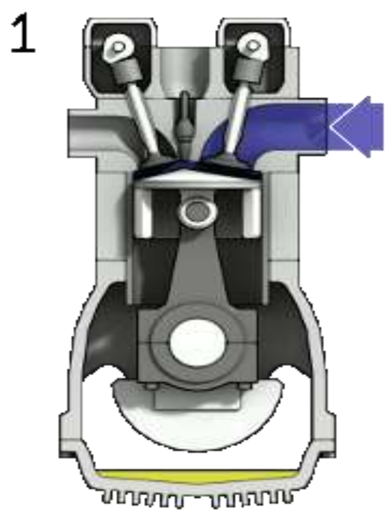


Figure: Single Cylinder four stroke diesel engine

The internal combustion engine (or ICE) is quite different from external combustion engines, such as steam or Stirling engines, in which the energy is delivered to a working fluid not consisting of, mixed with, or contaminated by combustion products. Working fluids can be air, hot water, pressurized water or even liquid sodium, heated in some kind of boiler.

A large number of different designs for ICEs have been developed and built, with a variety of different strengths and weaknesses. Powered by an energy-dense fuel (which is very frequently gasoline, a liquid derived from fossil fuels). While there have been and still are many stationary applications, the real strength of internal combustion engines is in mobile applications and they dominate as a power supply for cars, aircraft, and boats.

FOUR-STROKE ENGINE

A four-stroke engine, also known as four-cycle, is an internal combustion engine in which the piston completes four separate strokes—intake, compression, power, and exhaust—during two separate revolutions of the engine's crankshaft, and one single thermodynamic cycle.

There are two common types of four-stroke engines. They are closely related to each other, but have major differences in design and behavior. The earliest of these to be developed is the Otto cycle engine developed in 1876 by Nikolaus August Otto in Cologne, Germany, after the operation principle described by Alphonse Beau de Rochas in 1861. This engine is most often referred to as a petrol engine or gasoline engine, after the fuel that powers it. The second type of four-stroke engine is the Diesel engine developed in 1893 by Rudolph Diesel, also of Germany. Diesel created his engine to maximize efficiency, which the Otto engine lacked. There are several major differences between the Otto cycle engine and the four-cycle diesel engine. The diesel engine is made in both a two-cycle and a four-cycle version. Otto's company, Deutz AG, now primarily produces diesel engines.

The Otto cycle is named after the 1876 engine of Nikolaus A. Otto, who built a successful four-cycle engine based on the work of Jean Joseph Etienne Lenoir. It was the third engine type that Otto developed. It used a sliding flame gateway for ignition of its fuel—a mixture of illuminating and air. After 1884, Otto also developed the magneto to create an electrical spark for ignition, which had been unreliable on the Lenoir engine.

Today, the internal combustion engine (ICE) is use in motorcycles, automobiles, boats, trucks, aircraft, ships, heavy duty machinery, and in its original intended use as stationary power both for kinetic and electrical power generation. Diesel engines are found in virtually all heavy duty applications such as trucks, ships, locomotives, power generation, and stationary power. Many of these diesel engines are two-cycle with power ratings up to 105,000 hp (78,000 kW).

Figure: 4-stroke diesel engine with electrical loading

The four cycles refer to intake, compression, combustion (power), and exhaust cycles that occur during two crankshaft rotations per power cycle of the four-cycle engines. The cycle begins at Top Dead Centre (TDC), when the piston is farthest away from the axis of the crankshaft. A cycle refers to the full travel of the piston from Top Dead Centre (TDC) to Bottom Dead Centre (BDC)

INTAKE stroke:

On the intake or induction stroke of the piston, the piston descends from the top of the cylinder to the bottom of the cylinder, reducing the pressure inside the cylinder. A mixture of fuel and air, or just air in a diesel engine, is forced by atmospheric (or greater) pressure into the cylinder through the intake port. The intake valve(s) then close. The volume of air/fuel mixture that is drawn into the cylinder, relative to the volume of the cylinder is called, the volumetric efficiency of the engine.

COMPRESSION stroke: with both intake and exhaust valves closed, the piston returns to the top of the cylinder compressing the air, or fuel-air mixture into the combustion chamber of the cylinder head.

POWER Stroke:

This is the start of the second revolution of the engine. While the piston is close to Top Dead Center, the compressed air–fuel mixture in a gasoline engine is ignited, usually by a spark plug, or fuel is injected into the diesel engine, which ignites due to the heat generated in the air during the compression stroke. The resulting massive pressure from the combustion of the compressed fuel-air mixture forces the piston back down toward bottom dead centre.

EXHAUST stroke:

During the exhaust stroke, the piston once again returns to top dead center while the exhaust valve is open. This action evacuates the burnt products of combustion from the cylinder by expelling the spent fuel-air mixture out through the exhaust valve(s).

DESIGN AND ENGINEERING PRINCIPLE

Power Output Limitations

The maximum amount of power generated by an engine is determined by the maximum amount of air ingested. The amount of power generated by a piston engine is related to its size (cylinder volume), whether it is a two-stroke or four-stroke design, volumetric efficiency, losses, air-to-fuel ratio, the calorific value of the fuel, oxygen content of the air and speed (RPM). The speed is ultimately limited by material strength and lubrication. Valves, pistons and connecting rods suffer severe acceleration forces. At high engine speed, physical breakage and piston ring flutter can occur, resulting in power loss or even engine destruction. Piston ring flutter occurs when the rings oscillate vertically within the piston grooves they reside in. Ring flutter compromises the seal between the ring and the cylinder wall, which causes a loss of cylinder pressure and power. If an engine spins too quickly, valve springs cannot act quickly enough to close the valves. This is commonly referred to as 'valve float', and it can result in piston to valve contact, severely damaging the engine. At high speeds the lubrication of piston cylinder wall interface tends to break down. This limits the piston speed for industrial engines to about 10 m/s.

Intake/Exhaust Port Flow

The output power of an engine is dependent on the ability of intake (air–fuel mixture) and exhaust matter to move quickly through valve ports, typically located in the cylinder head. To increase an engine's output power, irregularities in the intake and exhaust paths, such as casting flaws, can be removed, and, with the aid of an air flow bench, the radii of valve port turns and valve seat configuration can be modified to reduce resistance. This process is called porting, and it can be done by hand or with a CNC machine.

Supercharging

One way to increase engine power is to force more air into the cylinder so that more power can be produced from each power stroke. This can be done using some type of air compression device known as a supercharger, which can be powered by the engine crankshaft.

Supercharging increases the power output limits of an internal combustion engine relative to its displacement. Most commonly, the supercharger is always running, but there have been designs that allow it to be cut out or run at varying speeds (relative to engine speed). Mechanically driven supercharging has the disadvantage that some of the output power is used to drive the supercharger, while power is wasted in the high pressure exhaust, as the air has been compressed twice and then gains more potential volume in the combustion but it is only expanded in one stage.

Turbo Charging

A turbocharger is a supercharger that is driven by the engine's exhaust gases, by means of a turbine. It consists of a two piece, high-speed turbine assembly with one side that compresses the intake air, and the other side that is powered by the exhaust gas outflow.

When idling, and at low-to-moderate speeds, the turbine produces little power from the small exhaust volume, the turbocharger has little effect and the engine operates nearly in a naturally aspirated manner. When much more power output is required, the engine speed and throttle opening are increased until the exhaust gases are sufficient to 'spin up' the turbocharger's turbine to start compressing much more air than normal into the intake manifold.

Turbo charging allows for more efficient engine operation because it is driven by exhaust pressure that would otherwise be (mostly) wasted, but there is a design limitation known as turbo lag. The increased engine power is not immediately available due to the need to sharply increase engine RPM, to build up pressure and to spin up the turbo, before the turbo starts to do any useful air compression. The increased intake volume causes increased exhaust and spins the turbo faster, and so forth until steady high power operation is reached. Another difficulty is that the higher exhaust pressure causes the exhaust gas to transfer more of its heat to the mechanical parts of the engine.

In more recent times, turbochargers have become advanced due to design improvements, and have little, to no turbo lag. Turbocharged automobiles are very gas efficient due to low compression at lower engine speeds (Turbocharger not spooled up).

Energy Balance

Otto engines are about 30% efficient; in other words, 30% of the energy generated by combustion is converted into useful rotational energy at the output shaft of the engine, while the remainder being losses due to friction, engine accessories, and waste heat. There are a number of ways to recover some of the energy lost to waste heat. The use of a Turbocharger in Diesel engines is very effective by boosting incoming air pressure and in effect provides the same increase in performance as having more displacement. The Mack Truck Company, decades ago, developed a turbine system that converted waste heat into kinetic energy that it fed back into the engine's transmission. In 2005, BMW announced the development of the turbo steamer, a two stage heat recovery system similar to the Mack system that recovers 80% of the energy in the exhaust gas and raises the efficiency of an Otto engine by 15%.By contrast, a six-stroke engine may convert more than 50% of the energy of combustion into useful rotational energy.

Modern engines are often intentionally built to be slightly less efficient than they could otherwise be. This is necessary for emission controls such as exhaust gas recirculation and catalytic converters that reduce smog and other atmospheric pollutants. Reductions in efficiency may be counteracted with an engine control unit using lean burn techniques.

In the United States, the Corporate Average Fuel Economy mandates that vehicles must achieve an average of 35.5 miles per gallon (mpg) compared to the current standard of 25 mpg. As automakers look to meet these standards by 2016, new ways of engineering the traditional internal combustion engine (ICE) could have to be considered. Some potential solutions to increase fuel efficiency to meet new mandates include firing after the piston is farthest from the crankshaft, known as top dead centre, and applying the Miller cycle. Together, this redesign could significantly reduce fuel consumption and NO x emissions.

TESTING PROCEDURE

The testing procedure is carried by mixing the specimen samples with diesel in calculated proportions. The mixture of specimen sample and diesel is used in single cylinder diesel engine and several tests are conducted under controlled atmospheric conditions.

Fig: Single cylinder diesel engine

Step 1: Take bio diesel blend say ethanol B10, the composition contains 100 ml of ethanol and 900 ml of diesel, as ethanol is very dangerous proper atmospheric condition are to be maintain, water is used as the cooling agent in the experiment when the fuel is added to engine and cranking is done. Calculated proportions are taken and constant atmospheric conditions are maintained.

Step 2: load to be added to engine to engine and increased simultaneously with the help of the electrical loading and the mean difference of the two gauges are calculated to fine the exact torque applied on engine Loads are added in ascending order. The adding of load the rpm of the engine will be changing simultaneously that will be displayed on the digital meter. All this testing will give the performance of the fuel used in the engine and will be used in calculating to find the brake power and mechanical efficiency of the engine with using different types of test specimens.

Figure: blending diesel with mahua biodiesel

Step 3: The temperature rise in the engine will noted with help of thermo couples placed inside the engine and the time taken for consumption of 10 ml of fuel will be calculated with help of stop watch

The readings for the gauge and temperature indicators are tabulated, with help of these readings the work done by the engine is calculated and the fuels efficiency is calculated with help of calculating the following:

1. Volumetric efficiency
2. Brake power
3. Specific fuel consumption
4. Brake thermal efficiency
5. Indicated thermal efficiency
6. Mechanical efficiency

Different graphs are plotted to find the effectiveness of specimen fuel and there consistency on the engine working

Table: B0 (pure diesel)

Volts	192	195	215	226	228
Ammeter reading	0	0.9	2.6	4.2	5.8
Speed(rpm)	1530	1525	1512	1500	1477
Manometer h1	25	25	24	24	21
h2	10	9	8	8	7
Time taken for 10ml of fuel consumption(sec)	76	62	48	37	33
Time taken for water(sec)	7	7	7	6	8
Brake power(KW)	0	0.1755	0.559	0.9492	1.3224
TFC(kg/hr)	0.3884	0.4761	0.615	0.797	0.894
SFC(kg/hr)	0	2.712	1.1001	0.839	0.676
Volumetric efficiency (%)	36.59	40.74	43.92	42.93	46.18
Brake thermal efficiency (%)	0	3.041	7.5	9.817	12.199

Table: B10

Volts	175	204	221	228	229
Ammeter reading	0	0.9	2.7	4.4	5.9
Speed(rpm)	1530	1523	1512	1505	1483
Manometer	27	27	27	26	26

h1					
h2	8	8	7	7	7
Time taken for 10ml of fuel consumption(sec)	104	79	56	45	37
Time taken for water(sec)	5	5	5	5	5
Brake power(KW)	0	0.1836	0.5967	1.0032	1.3511
TFC(kg/hr)	0.3235	0.4259	0.6008	0.7477	0.9094
SFC(kg/hr)	0	2.3197	1.0068	0.7453	0.673
Volumetric efficiency (%)	32.97	43.96	46.08	46.41	47.061
Brake thermal efficiency (%)	0	4.163	9.592	12.958	14.35

Table: B20

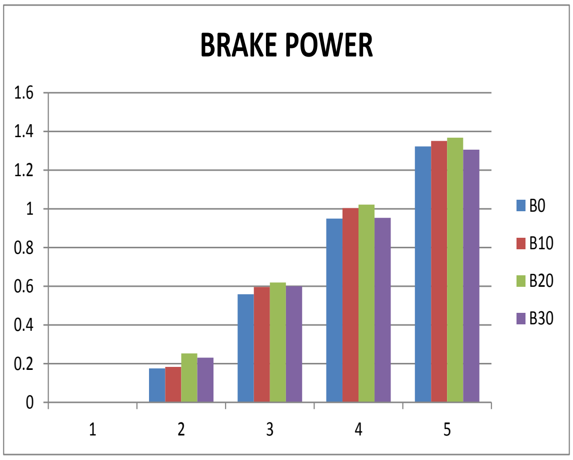
Volts	192	211	221	227	228
Ammeter reading	0	1.2	2.8	4.5	6
Speed(rpm)	1515	1506	1490	1475	1450
Manometer h1	27	27	27	26	26
h2	7	7	7	7	6
Time taken for 10ml of fuel consumption(sec)	108	77	59	46	38
Time taken for water(sec)	5	5	5	5	5
Brake power(KW)	0	0.2532	0.6188	1.0215	1.368
TFC(kg/hr)	0.3115	0.4369	0.5703	0.7314	0.8855
SFC(kg/hr)	0	1.7255	0.92162	0.716	0.6472
Volumetric efficiency (%)	47.52	47.81	47.58	48.32	48.177
Brake thermal efficiency (%)	0	5.597	10.48	13.48	14.92

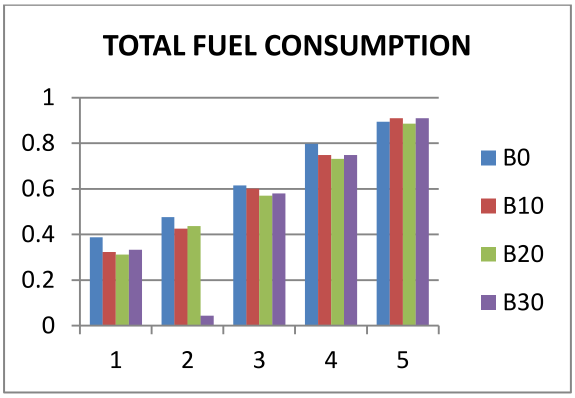
Table:B30

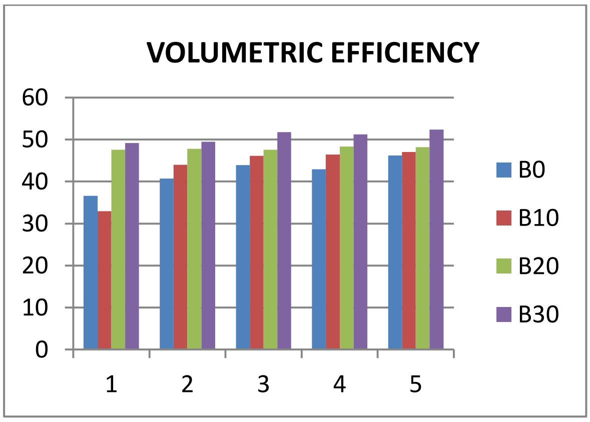
Volts	190	210	222	227	229
Ammeter reading	0	1.1	2.7	4.2	5.7
Speed(rpm)	1535	1525	1493	1475	1450
Manometer (h1)	28	28	28	28	28
Manometer (h2)	6	6	5	5	5
Time taken for 10ml of fuel consumption(sec)	101	76	58	45	37
Time taken for water(sec)	6	6	6	6	6
Brake power(KW)	0	0.231	0.5994	0.9534	1.3053
TFC(kg/hr)	0.3331	0.0442	0.58014	0.7477	0.9094
SFC(kg/hr)	0	0.1913	0.9678	0.7842	0.6966
Volumetric efficiency (%)	49.168	49.49	51.71	51.191	52.34
Brake thermal efficiency (%)	0	50.39	9.97	12.31	13.86

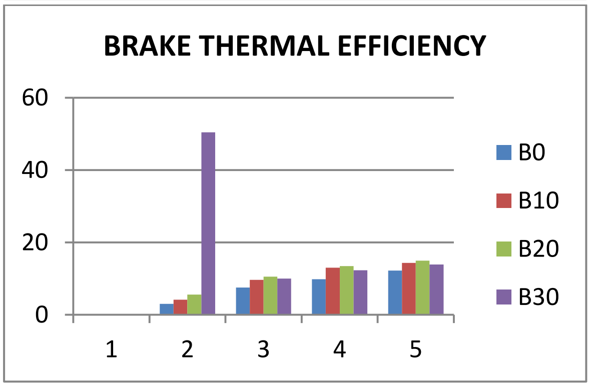
COMPARISION OF MAHUA BIODIESEL BLENDS WITH PURE DIESEL

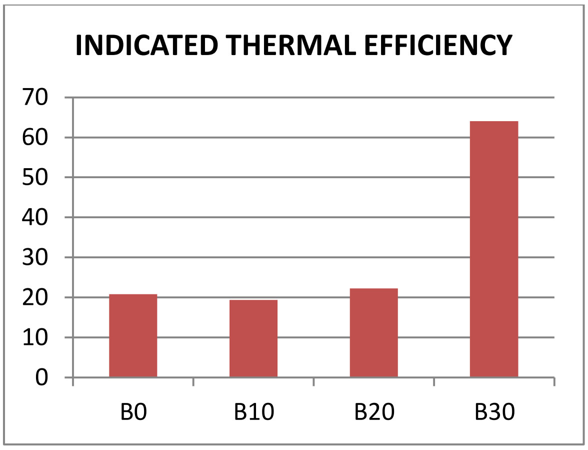
BRAKE POWER

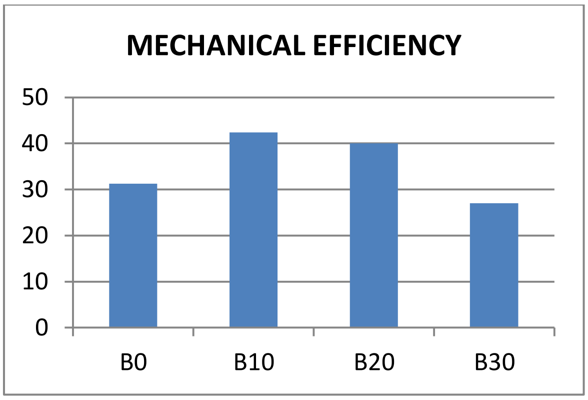












CONCLUSIONS

The experiments are conducted on the Single-cylinder 4 Stroke diesel engine with electrical loading test with pure diesel and blends of pure diesel and the following conclusions were made:

- Brake power is high for B30
- TFC is also high for B30
- Volumetric efficiency of all blends are nearer to diesel
- Brake thermal efficiency is high for pure diesel
- Indicated thermal efficiency is high for B30
- Mechanical efficiency is high for B10 and B20

THE FUTURE OF BIODIESEL FUEL

The future of biodiesel is growing. More companies are offering this solution to the consumers. At this stage, only diesel powered automobiles can use the new fuel. This is expected to change in the upcoming years. The mounting concern of off-shore oil as well as the environmental issues has groups in an uproar. Already there are several types of companies using biodiesel as their main source for transportation. The Yellowstone Nation Park bus system uses a mixture of biodiesel and petroleum to run the whole fleet. Tests by the government have proven that this type of fuel is overall more functional and safe than petroleum based products. As fossil beds run dry, everyday scientists come closer to new alterative. Soon biodiesel will become the new source of power. Through research and constant testing, biodiesel is more productive that the petroleum based fuel. It has been discovered that this type of product will become the new source of power. Not only for diesel automobiles but for other power sources individuals desperately require living and surviving. Before long, this type of supply will be not only in vehicles but also in homes and factories.

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