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A PERFORMANCE ANALYSIS BASED REVIEW OF A DIESEL ENGINE WITH BIO DIESELS STUDY

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Abstract :

The use of alternative fuels greatly reduces harmful exhaust emissions thinks carbon monoxide, carbon dioxide, sulfur dioxide and particulate matter. Another calling card for alternative fuels is that they can often be produced domestically using a country's resources and that in turn strengthens the economy. There are many different types of alternative fuels that are being developed these days which is an exciting innovation in the vehicle industry. Alternative fuels are the wave of the future as scientists look for cleaner burning fuels that won't damage the environment while providing great advantages to the vehicle owner. They have come up with several. But renewable energies face several obstacles. They are often characterized as "peanuts", and the principal issue is that it is too much of a "retail" commodity. And the gain of the hard-earned progress made by a few countries will have essentially come to naught by 2020 on the world-scene because of the additional gain in population. It follows that the impact of any progress made will not be felt on the world at large unless that progress carries with it the major parts of the world population. Present review will reveal the need of development of bio fuels which can be great help for further researchers.

Key words; Bio fuels as alternative fuels, Review of performance analysis.

Introduction

Probably the most well known type of alternative fuel is ethanol. Ethanol is often called grain alcohol as it is made from corn and/or soybeans. Right now on the market is E85 which is 85 percent ethanol and 15 percent gasoline. Even though it still has gasoline in it, ethanol burns much cleaner than regular gas and saves on gas mileage for those who use it. Ethanol can also be made from organic materials including agricultural crops and waste, plant material left from logging, and trash including paper. Another type of alternative fuel is methanol, a cousin of ethanol as they are both alcohol based products. Methanol is sometimes called wood alcohol and can be made from various biomass resources like wood, as well as from coal. However, today nearly all methanol is made from natural gas, or methane, because it is cheaper. .

Propane, or compressed natural gas has long been used to provide energy to homes, but it is rising in popularity as a type of alternative fuel for vehicles. Like oil, this common fuel comes from underground. However, natural gas, as the name implies, is a gas much like air, rather than a liquid like petroleum. It has been found to be one of the most environmentally friendly fuels, and its popularity is growing. You can find another type of alternative fuel in the form of good old fashioned electricity. In fact, electric vehicles have been around for a long time, and they are coming back in popularity due to environmental concerns. Electric vehicles don't burn gasoline in an engine. They use electricity stored on the car in batteries. Sometimes, 12 or 24 batteries, or more, are needed to power the car. One of the most interesting and promising type of alternative transportation fuels is hydrogen. While mostly only experimental vehicles are operating on this fuel now, the potential for this unique energy source is excellent. Hydrogen is the lightest of all elements and is easy to produce which is why it is sending excitement waves throughout the alternative fuel industry as they next big type of alternative fuel that can be used in vehicles. These are only a few types of alternative fuels and more are being developed all the time. With a growing concern over global warming, the use of alternative fuels will grow in popularity over time and you will likely begin to see many other types of alternative fuels make their appearance.

Problem statement

The world's energy needs will be growing much more steeply from now than at any time since the beginning of the industrial revolution. The population of the industrialized world was roughly a billion in 2009, and the energy consumed by it in that year was about 9 TW-h. The population in developing countries was about 4.7 billion and their total energy use about 4.5 TW-h—roughly 5 times the population and half the energy use. Thus, if all developing countries use as much per capita energy as industrialized countries, the energy demands will go up by a factor of 10. The world's population is still increasing. The population is expected to stabilize around 9 billion. If all 9 billion people were to use the same per capita energy as in industrialized countries today, we will need roughly twice as much yet again—or a factor of 20 more than we now do. These are upper bounds and asymptotic, and perhaps not very useful. One has to modify them for the time horizon we are considering; and 2050 is a useful target because it takes nearly that long to harness new technologies profitably and to change habits globally. During this period, increasing energy efficiency will make a dent in our needs. Developing countries will take a long time to catch up to the energy needs; and, regretfully, some of them never will. The industrialized countries will cut down on their wasteful energy habits and so forth.

Yet, there is no doubt that we will need much more energy than now. If the poor parts of the world merely catch up to the world average (which is weighted heavily by the users at the low end), a factor of 2 or 3 more energy will be needed. This estimate is primitive yet realistic.

Types of fuels available in present market

- Compressed Natural Gas (CNG)
- Liquefied Natural Gas (LNG)
- Methanol (M85)
- Ethanol (E85)
- Biodiesel (B20)
- Electricity
- Hydrogen

BIOMASS

Biomass is the oldest form of renewable energy, has been used for thousands of years. However, its relative share has declined with the emergency of fossil fuels. Currently some 13% of the world's primary energy supply is covered by biomass, but there is a strong regional difference: developed countries source around 3%of their energy needs of biomass, while Africa's share ranges from 70-90%.With environmental effects such as climate change coming to the forefront, people everywhere are rediscovering the advantages of biomass. Potential benefits include:

- Reducing carbon emissions if managed (produced, transported, used) in a sustainable manner
- Enhancing energy security by diversifying energy sources and utilizing local sources;
- Providing additional revenues for the agricultural and forestry sectors;

2. LITERATURE SURVEY

BIODIESEL

Biodiesel is a safe alternative fuel to replace traditional petroleum diesel. It has high-lubricity, is a clean-burning fuel and can be a fuel component for use in existing, unmodified diesel engines. This means that no retrofits are necessary when using biodiesel fuel in any diesel powered combustion engine. It is the only alternative fuel that offers such convenience. Biodiesel acts like petroleum diesel, but produces less air pollution, comes from renewable sources, is biodegradable and is safer for the environment. Producing biodiesel fuels can help create local economic revitalization and local environmental benefits. Many groups interested in promoting the use of biodiesel already exist at the local, state and national level.

Biodiesel is designed for complete compatibility with petroleum diesel and can be blended in any ratio, from additive levels to 100 percent biodiesel. In the United States today, biodiesel is typically produced from soybean or rapeseed oil or can be reprocessed from waste cooking oils or animal fats such as waste fish oil. Because it is made of these easily obtainable plant-based materials, it is a completely renewable fuel source.

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.

Definition

Biodiesel refers to a non-petroleum-based diesel fuel consisting of short chain alkyl (methyl or ethyl) esters, made by Transesterfication of vegetable oil or animal fat (tallow), which can be used (alone, or blended with conventional petro-diesel) in unmodified diesel-engine vehicles. Biodiesel is distinguished from the straight vegetable oil (SVO) (sometimes referred to as "waste vegetable oil", "WVO", "used vegetable oil", "UVO", "pure plant oil", "PPO") used (alone, or blended) as fuels in some converted diesel vehicles. "Biodiesel" is standardized as mono-alkyl ester.

There are three basic routes to bio diesel production from bio-lipids (biological oil and fats):

i. Base Catalyzed Trans-Esterification of the bio-lipid.

ii. Direct Acid Catalyzed Trans-Esterification of the bio lipid.

iii. Conversion of the bio lipid to its Fatty Acids and then to bio diesel.

Almost all bio diesel is produced using case catalyzed Trans-Esterification, as it is the most economical process requiring only low temperatures and pressures and producing in 98% conversion yield. For this reason only this process will be used mainly.

Discussions

Biomass is produced in nature through photo synthesis achieved by solar energy conversion. Bio-mass can be obtained from different sources comprising

1. Organic wastes that accumulate at specific locations such as municipal solid wastes (MSW), timber wastes and sewage sludge.
2. Bio-mass in nontraditional form (converted in to liquid fuels).
3. Fermenting the biomass aerobically to obtain a gaseous fuel called biogas. Bio-mass is a renewable energy so long as it is grown at a rate at least equal to the rate of its consumption.

BIO-GAS:

Bio-gas can be produced by fermenting organic materials in the absence of air or oxygen with the help of bacteria (micro organisms) to break down the materials into intermediates like alcohols and fatty acids and finally to methane, carbon dioxide and water. This process is called anaerobic fermentation. The appropriate composition of biogas produced is as follows: methane 50-60%, CO_2 30-40%, hydrogen 5-10%, nitrogen 4-6%, oxygen 1-2% and hydrogen sulfide in traces. Methane and hydrogen when burnt with oxygen give energy in the form of heat.

1. $CH_4 + 2O_2 \rightarrow 2H_2O + CO_2 + 978.6$ KJ

2. $2H_2 + O_2 \rightarrow 2H_2O + 572.6448$ KJ

The CO_2 in bio-mass does not contribute to the heat energy; indeed it is unfavorable to any burning process. The amount of heat energy generated is 36476.804 KJ/m3 for methane and 11712.428 KJ/m3 for hydrogen. It is impracticable to store large volumes of biogas at low pressure. It is therefore more economically used as it is produced, for example, to meet space and water heating or cooking needs in forms.

NATURAL GAS:

Natural gas is generally associated with petroleum and coal deposits. It consists of mainly methane with small percentages of ethane, propane, butane and CO_2 and nitrogen. Natural gas is nearly odorless and colorless. The usual range of consumption is 68% to 96% of methane and 3% to 30% of ethane in natural gas. The range of calorific value of the natural gas is 37674-46046 KG/m3. Gaseous fuel has number of advantages over solid or liquid fuels as they burn without any smoke and ash. The control of gases relatively easy and main disadvantage is its storage.

HYDROGEN:

Hydrogen can play an important role as an alternative to conventional fuels provided, its technical problems of production, storage and transportation can be resolved satisfactorily and cost could be brought to the acceptable limits. One of the most attractive features of hydrogen as an energy carrier is that it can be produced from water, which is abundantly available in nature. Hydrogen has the highest energy content per unit if mass than any chemical fuel and can be substituted for hydrocarbons in a broad range of applications, often with increased combustion efficiency. Its burning process is non- polluting and it can be used in fuel cells to produce both electricity and useful heat.

METHANE:

Methane is clear gas with high calorific value. It can be used on site, and into the gas mines. Natural gas is 955-methane or converted into methanol by treatment with a catalyst at high temperature and pressure. It can also be compressed and used in limited range vehicles like tractors and forklift trucks. However, to store or transport the energy equivalent of a single gallon of petrol as compressed requires a large tank. At 115bar pressure the tank dimensions would need to be 0.45m in diameter and 1.45m in height.

LIQUIFIED PETROLEUM GAS:

During the refining of petroleum, large quantities of butane are liberated from the top of the column and from the other refining processes. These gases can be compressed and liquefied at atmospheric temperature. Butane and propane are also present in natural gas and can be separated and removed. Thus large volumes of the gas can be stored under pressure in steel cylinders. It is an ideal fuel for domestic and mobile use. LPG contains some fraction of methane and unsaturated hydro carbons in addition to butane and propane.

2.9 VEGETABLE OILS:

Vegetable oils can be classified as edible and non-edible oils. In India the consumption of edible oils is more than the production. Hence, we can depend on non-edible oils for use in CI engines. Edible oils such as sunflower, coconut, rice bran etc. can be used. Non-edible oils such as mahua, karanji, rapeseed, cottonseed etc. can be substituted in CI engines.

PROPERTIES OF VEGETABLE OILS:

If fuel shall be used in the existing engines, some required properties of the fuel such as kinematic-viscosity, the self ignition response, the net heating value, the grass heating value and density must be considered.

VISCOSITY:

The direction injection in open combustion chamber trough nozzle and pattern of fuel spray decides the case of combustion and thermal efficiency of the engine. Viscosity plays a vital role in the combustion. Low viscosity can lead to excessive internal pumping leakage where as high viscosity can increase system pressure to unacceptable levels and will effect injection during spray atomization. This effect is critical particularly at low speed or light load condition as pure vegetable oils have high viscosity. The derivatives of vegetable oils are called monsters and have low kinematics viscosity than that of oils. The monoesters are able to give stable solutions in wide range of proportions with diesel fuel, vegetable oils and with alcohol too. They can be solubilizers and can also make it possible to influence the viscosity of blended oils.

SELF-IGNITION RESPONSE:

It is expressed by the cetane number and for a good diesel fuel the value has to be not lower than 45. The cetane number of vegetable oils is less than the diesel. The cetane number of monoesters, on an average, is above that of vegetable oils. For example neem and karanji oils with diesel blends of 10% level have cetane number about 40-45 and at 20% level have cetane number about 35-40.

THE ENERGY CONTENT or HEATING VALUE:

The specific heating values of the different vegetable oils are nearly the same. They range from 30.5-40.5MJ/Kg and for fuels it are approximately 42.4MJ/Kg. if calorific or heating value of vegetable oils is more, it helps to reduce the quantity handled and to maximize equipment operating range.

DENSITY:

Density of the vegetable oils is 0.91-0.94gm/cc at 15oC. In comparison to the density of diesel fuel (0.81-0.86gm/cc) the density of vegetable oils 10% higher, and for ester about 5% higher. For example mahua oil-0.92, neem oil-0.921 & karanji oil-0.95 while the density of ethyl and methyl ester of rape oil is 0.87 and 0.88gm/cc respectively.

POUR POINT, CLOUD POINT AND FLASH POINT:

First two properties are important for cold weather operation. For satisfactory working, the values of both are well below freezing point of oil used. Flash point is important from safety point of view. The temperature should be practically as high as possible. Typical values of vegetable fuels range between 50 & 110 c addition of vegetable oil with diesel to form a blend should not decrease the flash point temperature.

SEPERATION OF VEGETABLE OIL FUELS:

Solution to the viscosity problem has approached in at least four ways:

- by dilution
- by preparation of methyl esters transesterification
- by micro emulsification
- by Pyrolosis(or)thermal cracking

DILUTION:

Dilution or blending of vegetable oil with neat diesel fuel, to improve fuel property of vegetable oil, is one of the well known methods. Dilution of sunflower oil with diesel fuel (1.3v/v) provides a fuel with a viscosity of 4.88 at 40 c, which is higher than the specified ASTM value of 4.0 at 40c. The viscosity is moderately less than that of neat sunflower oil. However Ziejewsks concluded that the blend could not be recommended for long term use in the direction diesel, engine because of closing of injector nozzle.

METHYL ESTER TRANS ESTERFICATION:

The second method for reducing the viscosity is the conversion of the triglyceride oil to simple esters, which reduces the molecular weight of the original oil to 1/3 of its former value and so reduces the viscosity. Transesterification is a chemical reaction that aims at substituting the glycerol of the glycosides with their molecules of mono alcohols such as methanol and ethanol there by obtaining three molecules of methyl ester of the vegetable oil. A mixture of anhydrous alcohol and reagent (NaOH) in proper proportions is combined with moisture free vegetable oil. The materials are maintained at 65 to 75 c and allowed to settle by gravity for 24 hours. Alkali catalyzed transesterification is known to proceed much fatter than acid catalyzed transesterification.

Fatty acid methyl esters are considered as a possible substitute for a conventional automotive diesel engine.

Vegetable oil + alcohol --------------> glycerin + esters

MICRO EMULSIFICATION:

Another method of reducing vegetable oil viscosity has been discovered through the formation micro emulsion with short chain as methanol (or) ethanol. A micro emulsion is defined as colloidal equilibrium dispersion of optically isotopic fluid micro structures, with dimension generally in 1 to 150 square meter range, formed spontaneously from two normally immiscible liquids and one or more amhophilous. The preliminary engine tests gave the following results for micro emulsions.

1. Lower exhaust temperature, and reduced emissions. Lower carbon monoxide/nitrogen oxide emissions than that is observed for diesel fuel.
2. Heat release4 patters indicated that the micro emulsion fuels burned faster than diesel fuel and had higher levels of pre mixed burning and lower levels of diffusion flame burning.

PYROLYSIS OR THERMAL CRACKING:

Thermal and catalytic decomposition of vegetable oils to produce substitutes for diesel fuel has been studied by a number of researchers using a variety of methods. The method involves cleavage of chemical bonds to yield smaller molecules. Essentially two different methods of processing vegetable oils to obtain fuel have been used.

1. Passing of the oil over a heated catalyst in a tube.
2. Distillation of the oil while in the presence of metallic salts.

The seeds contain 30-40 per cent fatty oil called mahua oil, which is edible and is also used in the manufacture of various products such as soap and glycerin. The oil cake is used as bio fertilizer, organic manure and as feed for fish and cattle. The leaves are used as fodder and as green manure. The flowers are used for extracting ethanol, which is used in making country liquor.

Potential income:

The tree is found in abundance in Thanjavur, Tiruchi and Perambalur regions of Tamil- Nadu and along the Cauvery River basin. About 30-40 percent of the tribal economy in north India such as in Bihar, Madhya Pradesh and Orissa is dependent on the mahua seeds and flowers. The tree has a potential of enhancing rural income. Being an evergreen variety, it reaches a height of 45-60 feet, and is well adapted to varied weather conditions. With its wide spreading branches and circular crown the trees present a visually appealing structure. Though the tree starts bearing seeds from the seventh year of planting, commercial harvesting of seeds can be done only from the tenth year. Seed yield ranges from 20-200 kg per tree every year, depending on its growth and development. Being hardy and pest resistant, the tree requires little attention once it has taken root.

Propagation technique:

Elaborating on the technique for propagating the trees, he said the variety can be propagated through seeds and transplanted seedlings. Seeds are sown at a depth of 1.5-2.5 cm on raised beds. The seeds germinate in about ten days. One-month-old seedlings are transplanted in plastic containers of 15 x 25 cm. Six to twelve-month old-seedlings are used for planting in the main field.

Case study

Comparison of mahua oil with diesel oil:

(a) Calorific Value and Carbon Residue: The calorific value of mahua oil was observed as 88.26% of diesel on weight basis and 96.30% on volume basis. The calorific value of mahua oil was found nearer to diesel fuel in comparison with other liquid fuel options like ethanol and methanol. The carbon residue of mahua oil was found higher than that of the limit specified for gradeA diesel and this may increase the chances of carbon deposition in the combustion chamber. The higher carbon residue may be due to the difference in chemical composition and molecular structure of mahua oil.

(b) Flash point: the flash point of mahua oil was very high as compared to diesel thus indicating its low volatile nature. The results of increase in concentration of mahua oil in diesel revealed that the power output decreases at all compression ratios.

(c) Brake thermal efficiency and a/f ratio: Brake thermal efficiency decreased with the increase of mahua oil in diesel at all three compression ratio in comparison with pure diesel. Exhaust gas temperature increased with the increase in concentration of mahua oil in diesel. The air-fuel ratio and volumetric efficiency decreased with increase in concentration of mahua oil in diesel.

Table 1: Characteristics of mahua oil

Properties	Value
Refractive index	1.452-1.462
Saponification value	187-197
Iodine value	55-70
Unsaponifiable matter,%	1-3
Palmitic acid,%	24.5
Stearic acid,%	22.7
Oleic acid,%	37.0
Linoleic acid,%	14.3

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Conclusion

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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