Bio Diesel as the Next Generation Sustainable Fuel

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Abstract:
Demand of petroleum based fuels is increasing and contrary to that the fossil fuels are depleting. India being a developing country, with multi fold increase in population needs more energy resources. The vegetable oils, edible and non edible, have promised an opportunity to utilize them as an alternative source as a fuel in place of diesel.Edible oil being costly, researchers have given more emphasis on non-edible oils and investigation was done after proper experimentation in IC engines. Major problems associated with vegetable oils are higher viscosities, lower heating values, chocking of nozzles, engine compatibility, higher engine wear and high price of bio diesel, cold start problem, lower energy content, higher copper strip corrosion etc. Esterification of vegetable oils and their conversion to bio-diesels have opened a new opportunity to experiment and know the performance in the existing CI engines with no modifications.

Keywords: Bio diesel, Transesterification, Vegetable oil, emission, viscosity.

I INTRODUCTION

In world and particularly in India, the diesel engine dominates the field of commercial transportation and agriculture machinery on account of its superior fuel efficiency. Consumption of diesel oil in India is much higher than petrol consumption. It has been found that vegetable oil hold special promise in this regard. Crude oil reserves are estimated to last only for few decades, therefore search for alternative fuel has become more necessity for researchers. Bio fuels are derived from vegetable oils and may prove to be one of the alternative fuels in future. The diesel fuels derived from fossil fuels may be replaced by biodiesel fuel due to the reason that it does not contribute to the global warming. It can be used in existing engines without any remarkable modifications. Since it does not contain any sulfur, aromatic hydrocarbons and CO_2 emitted is again absorbed by plants grown for vegetable oil and in turn production of bio diesels. It is a non flammable and due to its lubricating property, the life of engine is enhanced. Bio diesel being oxygenated fuel, emission of CO and soot is reduced when compared with diesel fuel. The problem in the use of vegetable oil is its high viscosity the resultant problem occurs in choking of fuel lines, filters, poor atomization and needs high opening pressure of nozzles and starting problem in cold conditions. Esterification of vegetable oil and conversion in bio diesel has solved the problem of high viscosity as this oil can be blended in any proportion with diesel and performance, combustion and emission characteristics in CI engines were studied. The studies have shown the favourable results for vegetable oils and more favourably in the tests of bio diesel blended with diesel in different proportion. This paper reviews the process of conversion of vegetable oil intobiodiesel by esterification and discusses the previous findings of researchers and effect of bio diesel in CI engines as compared to fossil fuel i.e. diesel for performance of engines, combustionresults and emission behavior. Owing to their availability, various vegitable oils are in use in different countries as feedstock for biodiesel production. The vegetable oils used for biodiesel are mainly Rapeseed and Sunflower oil in Europe; the USA and Canada uses Soyabean, Rapeseed, other waste oils and fats; frying oil and animal fat is the chosen option in Ireland; Castor oil and Soyabean oil is used in Brazil; Coconut oil is preferred in Malaysia and Philippines; Palm oil in Thailand, Malaysia Indonesia and the Philippines; Cotton Seed oil in Greece; Linseed and Olive oil in Spain; Jatropha and Karanja is used in India, Nicaragua and Africa to produce biodiesel (Frank et al., 2009; Altin et al., 2001, Arjun et al., 2008) Several other non-edible plants such as Neem (Azadirachta Indica), Meswak (Salvadora Species), Mahua (Madhuca indica), Rubber (Hevea Species), Castor (Ricinus communics), Diploknema Butracea, Garcinia Species and Thumba (Citrullus colocynthis) can also be used for producing biofuels in India (Barnwal and Sharma, 2005; Mohibbe et al., 2005; Augustus et al., 2003).

II CONVERSION OF VEGETABLE OIL INTO BIO DIESEL

There are many processes by which vegetable oils are converted into bio diesel. A few of them are Pyrolysio, mocro emulsification, Dilution and Transesterification. Commercial production of biodiesel is done mostly by transesterification.

The major problems associated with the straight vegetable oils operation in diesel engines are dueto their high viscosity and poor volatility. Transesterification of vegetable oils provides a significant reduction in viscosity, thereby enhancing the physical and chemical properties of vegetable oils to improve the engine performance. The transesterification process involves reacting triglycerides present in the vegetable oils with alcohols such as znethanote or ethanol in the presence of catalyst like sodium hydroxide at about 70^{0}C to glycerin and water.

III PROPERTIES OF BIO DIESEL

Biodiesel is a better fuel than diesel fuel in terms of sulphur content, flash point, and aromatic content. The fuel characteristics of biodiesel are close to diesel fuels, and therefore biodiesel becomes a strong alternative to replace the diesel fuels (Demirbas, 2009). The conversion of triglycerides into methyl or ethyl esters through the transesterifcation process reduces the molecular weight to one-third that of the triglyceride, reduces the viscosity by a factor of about eight and increases the volatility marginally. Biodiesel has viscosity close to diesel fuels. These esters contain 10 to 11% oxygen by weight, which may improve combustion as compared to hydrocarbon based diesel fuels in an engine (Ejaz and Younis, 2008). The cetane number of biodiesel is around 50 which are higher than diesel. Since the volatility increases marginally, the starting problem persists in cold conditions. Biodiesel has lower volumetric heating values (about 12%) than diesel fuels but has a high cetane number and flash point (Sylvain et al, 2009; Achtenet al, 2008; Houfang et al., 2009) Some of the desirable fuel properties of biodiesel derived fromdifferent vegetable oils are presented in Table below.

IV EXPERIMENTAL PROCEDURE

PREPARATION OF BIO-DIESEL

Vegetable oils and animal fats are triglycerides, containing glycerin. The bio-diesel process turns the oils into esters separating out the glycerin. The glycerin sinks at the the bottom and the bio-diesel floats on top and can be siphoned off.

The process is called transesterification, which substitute's alcohol for the glycerin in a chemical reaction, using lye as a catalyst.

CH-$COOR_1$			CH_2-OH	R_1COOR
|			|	+
CH-$COOR_2$	+ 3ROH	catalyst	CH-OH	R_2COOR
|			|	+
CH-$COOR_3$			CH_2-OH	R_3COOR
Triglyceride	Methonal		Glycerol	Biodiesel

CHEMICALS NEEDED

The alcohol used can be either methanol, which makes methyl esters, or ethanol (ethyl esters). Most methanol comes from fossil fuels (though it can also be made from biomass, such as wood), while most ethanol is plant-based (though it's also made from petroleum). But the bio-diesel process using ethanol is much more difficult than with methanol. We have used Methanol as alcohol in our experimentation.

Methanol is also called methyl alcohol, wood alcohol, wood naphtha, wood spirits, methyl hydrate (or "stove fuel"), carbinol, colonial spirits, Columbian spirits, Manhattan spiri ts , methylol, methyl hydroxide, hydroxymethane, monohydroxymethane, pyroxylic spirit, or MeOH (CH_3OH or CH_4O) — all the same thing. (But, confusingly, "methylcarbinol" or "methyl carbinpl" is used for both methanol and ethanol.).The catalyst used in transesterification of vegetable oil as lye — sodiumhydroxide (NaOH, caustic soda).

PREPARATION OF BIO-DIESEL

Bio-diesel from refined vegetable oils were prepared. Following were the requirements for preparation of biodiesel:-

- 1 liter of refined new vegetable oil.
- 200 ml of methanol, 99% pure.
- Lye catalyst — sodium hydroxide (NaOH).
- Blender.
- Scales accurate to 0.1 grams or preferably less.
- Measuring beakers for methanol and oil.
- Half-litre translucent white HDPE (#2 plastic) container with bung andscrew-on cap.

- Two funnels to fit the HDPE container.
- Thermometer.

All equipments should be clean and dry.LYE
We should be quick when measuring out the lye because it very rapidly absorbs water from the atmosphere and water interferes with the bio-diesel reaction.
Measured the lye out into a handy-sized lightweight plastic bag on the scales (or even do the whole thing entirely inside a big clear plastic bag), then close the lid of the container firmly andclose the plastic bag, winding it up so there's not much air in it with the lye and no more air canget in. Adjust the scale for the weight of the bag .Exactly 3.5 grams of 96% pure NAOH shouldbe taken as lye.

MIXING THE METHOXIDE
Measure out 200 ml of methanol and poured it into the half-litre HDPE container via the funnel. Methanol also absorbs water from the atmosphere so it should be done quickly and replace the lid of the methanol container tightly. Methanol should be kept at arm's length to prevent the exposer from the dangerous fumes.Carefully add the lye to the HDPE container via the second funnel. Replace the bung and the screwed on the cap tightly.Shake the container a few times — swirled it round rather than shaking it up and down.The mixture get hot from the reaction. By swirling it thoroughly for a minute or so five or six times over a period of time the lye is completely dissolved in the methanol, forming sodium meth oxide. As soon as the liquid was clear with no undissolved particles the process began.The Container is swirled so as to lye dissolved faster. By using NaOH, it takes from overnight to a few hours.

THE PROCESS
Using a blender: Check that the blender seals were in good order. It should be insured that allparts of the blender were clean and dry and the blender components were tightly fit.

Pre-heat the oil to 55°C (130°F) and pour it into the blender With the blender still switched off, carefully pour the prepared meth oxide from the HDPE container into oil. Secured the blender lid tightly and switched on. Lower speeds should be enough. Blend for at least 20 minutes. Proceed with processing as above; maintaining temperature at 55^0C (130^0F), process for one hour.

TRANSFER
As soon as the process is complete, pour the mixture from the blender into the 2- litre PET bottle for settling and screwed on the lid tightly (Otherwise as the mixture cools, it will contract and some more air can enter into the bottle later.)

SETTLING
Allow settling for 12-24 hours. Darker-colored glycerin by-product will be collected in a. distinct layer at the bottom of the bottle, with a clear line of separation from the pale liquid above, which is the bio-diesel. The bio-diesel varies somewhat in color according to the oil used (and so does the by-product layer at the bottom) but usually it's pale and yellowish.
Carefully decant the top layer of bio-diesel into a clean PET bottle. Care should be taken not

to get anyof the glycerin layer mixed up with the bio-diesel. The process should be repeated until all the glycerin is separated from bio-diesel.

V SUMMERY OF BENEFITS AND DRAWBACKS IN USING BIODIESEL AS A DIESEL SUBSTITUTES

Advantages

1. There is no need to modify a diesel engine when biodiesel/biodiesel blends are used speciallywhen a limited fraction of biodiesel is introduced to the blend.
2. Additional oxygen in biodiesel improves combustion due to fuel oxidation leading to more spontaneous combustion and better combustion efficiency.
3. Improved combustion of biodiesel substantially reduce unburned hydrocarbon and carbon monoxide emissions.
4. Free lubricity helps to prevent engine wear and extends engine life. Better lubricity is attributable to oxy-polarity of esters and high molecular weight fatty acid chains. The high lubricity of bio diesel extends the life time of fuel injection systems as well as metallic components that have sliding contacts with each other.
5. The low sulfur content in biodiesel also reduces emission of SO_2 and sulfate particulate matter.In fact Biodiesel produces 80% less CO_2 and 100% less sulfur dioxide emissions. It provides a 90% reduction in cancer risks.
6. It is safer to handle and store biodiesel at high temperature as biodiesel has a high flash point due to its composition of non-volatile methyl esters (FAME)

Disadvantages:

1. Changes in physical properties such as hardness and tensile strength in elastomeric seal. Degradability including shrinkage, swelling, embrittlement has been seen.
2. Thermal stability is reduced due to high cloud point and pour point temperatures of biodiesel and blends. High cloud point causes filter clogging.
3. Poor atomization and generally larger spray droplets is caused due to high viscosity and molecular weight. It directly reduces engine performance. Engine oil needs to be replaced more frequently.
4. Problems at the injector tip might occur when using biodiesel. It can shorten the life time and could cause injections failures.

VI CONCLUSIONS

It has been found that parameters like brake thermal efficiency, volumetric efficiency are decreased for neat oils. Brake specific fuel consumption and exhaust gas temperature are increased for neat oils and their blends. This is because of the lower heating value and high viscosity of fuels. For neat oils and blends, CO, CO_2 UMC and smoke are found to be increased as compared todiesel. The reason seems due to lower calorific value and high viscosity .At the rated load, exhaust gas temperature is increased as compared to diesel. Due to better combustion, CO emission is drastically reduced compared to diesel. Unburnt hydrocarbons are reduced due to excess oxygen present in the bio fuels. Smoke emission is reduced at rated loads due to better combustion of fuel and low aromatics in the biodiesel mixture.CO, CO_2 VHC and smoke for Methyle Esters are decreased as compared to diesel. Reduction in these emission parameters are due to complete combustion of fuels.Bio diesel and their esters may be used as substitute for diesel with preheating before entering into combustion chamber. Non edible oils being cheaper, may prove to be better alternative than edible oil andeconomically feasible for use as fuel with their esters and blends with diesel. More investigations are required with modified and more suitable CI engines such as how todetermine the ways of symbiosis of otto and diesel processes in the same engine cylinders. CVCR (continuous variable compression ratio) engine in which research is going on, is a new concept of the IC engine with has the possibility and versatility to work as an otto as a diesel engine and leading to the combined Otto (SI) and diesel (CI) cycle in the same cylinder. The fuel properties of bio diesel are close to diesel fuels and therefore biodiesel becomes a good alternative fuel for CI Engines.

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