VEGETABLE OIL AS FUEL IN C.I. ENGINE: PROBLEMS AND POSIBLE SOLUTIONS

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Abstract

Vegetable oil has slightly lower calorific value than diesel oil. This can be attributed to presence of oxygen in the molecules of vegetable oils. Vegetable oil has cetane number about 35 to 40 depending upon the composition where as diesel fuel have a cetane number around 45.certain functional groups and poor volatility is responsible of their comparatively low cetane number. Vegetable oil and diesel differs greatly in other properties. Their kinematic viscosity is several times greater than for diesel oil the high viscosity of vegetable oils lead to pumping and atomization problems in the normal diesel fuel injection system, which creates filter plugging and cold starting high carbon residue causes heavy smoke emission and carbon deposition on the injection nozzle tips and in the combustion chamber. There are also problems of incompatibility with engine lubricants. The poor volatility makes vegetable oil difficult to vaporize and ignite, this leads to thermal cracking resulting in heavy smoke emission and carbon deposition in the combustion chamber. This tendency is partly due to higher fuel viscosity. Vegetable oil dilutes the lubricating oil and forms sludge on all parts of the engine. Which come in contact with lubricating oil. Filter plugging can be minimized if crude degummed oils are passed through a four-micrometer in the paper author has suggested various ways t overcome the difficulties associated with vegetable oil to be used in CI engine.

Key words: - Vegetable oil, cold starting, degumming, plugging.

Introduction

Vegetable Oil as Fuel for Compression Ignition Engines

After the first commercial shock in 1973 and secondly in 1979 due to sudden increase in prices of petroleum products by the supplying countries attention was diverted to find out the substitute to diesel fuel [8] . The various alternative fuel options considered for diesel substitute are hydrogen, biogas, producer gas, methanol ethanol, natural gas, coal water slurry and vegetable oils. Hydrogen appears better alternate but problem related to its production, hazardous nature, storage and handling are yet to be sorted out. Biogas and producer gas are of low calorific value and can be substitute to diesel only up to 80% in stationary application. More ever there is problem of storage because of gaseous state in nature. Beside producer gas being a poisonous gas may cause serious health hazards for the operator. Methanol and ethanol has poor energy content, have a low cetane number a poor lubrication properties, hence it may lead to problems in fuel injection system. Further alcohols cannot be used in compression ignition engine by conventional methods. It requires a very high compression ration of the order of 28 for its use in conventional compression ignition engines. Alcohols show a better response to spark ignition engines the cylinders. Storage of the gas in cylinders and possibility of leakage while in use are the hurdles to overcome. Coal water slurry is the coal fuel that makes the economic sense. A coal fueled diesel engine holds the promise of rugged, modular heat engines that uses cheap, abundant fuel, the concept of coal water slurry as compression ignition engine fuel is still in initial stage due to problems associated with wear of position rings, cylinder liners and erosion of fuel nozzle. Further the use is restricted in slow and medium speed engines.

Difficulties and remedies with Vegetable Oil as Fuel

Advantages

From the review of literature available in the field of vegetable oil usage, many advantages are noticeable the following are some of the advantages of using vegetable oil as I.C. engine in India:

I. Vegetable oil is produced domestically which helps to reduce costly petroleum imports.
II. Development of the bio-diesel industry would strengthen the domestic, and particularly the rural agricultural economy of agricultural based countries like India.
III. It is biodegradable and non-toxic:

IV. It is a renewable fuel that can be made from agricultural crops and or other feed stocks that are considered as waste:
V. It has 80% heating value compared to that of diesel:
VI. It contains low aromatics:
VII. It has a reasonable cetane number and hence possesses less knocking tendency:
VIII. Low sulphur content and hence environment friendly:
IX. Enhanced lubricity, thereby no major modification is required in the engine:
X. Personal safety is improved(flash point is 100^0C higher than that of diesel):
XI. It is usable within the existing petroleum diesel infrastructure (with minor or no modification in the engine):

Challenges and Difficulties

The major challenges the face the use of vegetable oil as L.C. engine fuels are listed below
I. The price of vegetable oil is dependent on the feed stock price:
II. Feed stock homogeneity, consistency and reliability are questionable:
III. Homogeneity of the product depends on the supplier, feed stocks and production methods:
IV. Storage and handling is difficult(particularly stability in long term storage):
V. Flash point in blends is unreliable:
VI. Compatibility with I.C. engine material needs to be studied further:
VII. Cold weather operation of the engine is not easy with vegetable oils:
VIII. Acceptance by engine manufacturers is another major difficulty:
IX. Continuous availability of the vegetable oils needs to be assured before embarking on the major use of it in I.C. engines.

Technical Difficulties

The major technical areas (with respect to the use of vegetable oils as fuels in I.C. engines), which need further attention are the following:
I. Development of less expensive quality tests:
II. Study of the =effects of oxidized fuel on engine performance and its durability:
III. Emission testing with a wide range of feed stocks:
IV. Studies on developing specific markets such as mining, municipal water supplies etc. Which can specify bio-diesel as the fuel choice for environmentally sensitive areas:
V. Co-product development like the recovery of glycerol at reduced cost:
VI. Efforts to be focused on responding to fuel system performance, material compatibility, petroleum additive compatibility and low fuel stability under long term storage:
VII. Continued engine performance, emissions and durability testing I a veriety of engine types and sizes need to be developed to increased consumer and manufacture confidence:
VIII. Environmental benefits offered by vegetable oil over diesel fuel needs to be popularizes:
IX. Studies are needs to reduce the production cost, develop low cost feed stocks and identify potential markets in order to balance cost and availability:
X. Research on the effect of glycerol on engine durability, emission and material compatibility:
XI. Development of additives for improving cold flow properties, material compatibility and prevention of oxidation in storage, etc.

Vegetable oil has slightly lower calorific value than diesel oil. This can be attributed to presence of oxygen in the molecule of vegetable oils. Vegetable oil has cetane number about 35 to 40 depending on composition whereas diesel fuels have a cetane number around 45. Certain functional groups and the poor volatility is responsible for their comparatively low cetane number.

Vegetable oil and diesel differs greatly in other properties. Their kinematic viscosity is several times greater than for diesel oil. The kinematic viscosity of vegetable oil at 40 C is in the range of 35 to 45 cSt whereas for diesel oil is 2-4 cSt. Other disadvantages of vegetable oil are large carbon residue

1. The high viscosity of vegetable oils lead to pumping and atomization problems in the normal diesel fuel injection system, which creates filter plugging and cold starting.
2. High carbon residue causes heavy smoke emission and carbon deposition on the injection nozzle tips and in the combustion chamber.
3. There are also problems of incompatibility with engine lubricants.
4. The poor volatility makes vegetable oil difficult to vaporize and ignite. This leads to thermal cracking resulting in the heavy smoke emission and carbon deposits in the combustion chamber. This tendency is partly due to higher fuel viscosity
5. Vegetable oil dilutes the lubricant oil and forms sludges on all parts of engine, which come in contact with lubricating oil.

Remedies

1. Filter plugging is minimized if crude degummed oils are passed through a four micrometer filter.
2. Starting problems should be overcome by starting aids such as glow plugs and fuel heaters.
3. Modification of fuel

Modification of Fuel

The alternative diesel fuels must be technically and environmentally acceptable, and economically competitive. From the viewpoint of these requirements, triglycerides (vegetable oils/animal fats) and their derivatives may be considered as viable alternatives for diesel fuels. The problems with substituting triglycerides for diesel fuels are mostly associated with their high viscosity, low volatility and polyunsaturated character. The problems have been mitigated by developing vegetable oil derivatives that approximate the properties and performance and make them compatible with the hydrocarbon-based diesel fuels through the pyrolysis, micro emulsification, dilution and Transesterification.

Pyrolysis:

Pyrolysis refers to a chemical change caused by the application of thermal energy in the absence of air or nitrogen. The liquid fractions of the thermally decomposed vegetable oil are likely to approach diesel fuels. The pyrolyzate had lower viscosity, flash point, and pour point than diesel fuel and equivalent calorific values. The cetane number of the pyrolyzate was lower. The pyrolyzed vegetable oils contain acceptable amounts of sulphur, water and sediment and give acceptable copper corrosion values but unacceptable ash, carbon residue and pour point.

Micro-emulsification:

The formation of micro emulsions (co-solvency) is one of the potential solutions for solving the problem of vegetable oil viscosity. Micro-emulsions are defined as transparent, thermodynamically stable colloidal dispersions. The droplet diameters in micro-emulsions range from 100 to1000 A. A micro-emulsion can be made of vegetable oils with and ester and dispersant (co-solvent), or of vegetable oil, and alcohol and a surfactant and a cetane improver, with or without diesel fuels. Water (from aqueous ethanol) may also be present in order to use lower-proof ethanol, thus increasing water tolerance of the micro-emulsions.

Dilution:

Dilution of vegetable oils can be accomplished with such materials as diesel fuels, solvent or ethanol.

Trans-Esterification:

Trans-Esterification also called alcoholysis is the displacement of alcohol from an ester by another alcohol in a process similar to hydrolysis. This process has been widely used to reduce the viscosity of triglycerides. The trans-Esterification reaction is represented by the general equation. RCOOR'+R"=RCOOR"+R'OH. If methanol is used in the above reaction, it is termed methanolysis. The reaction of triglyceride with methanol is represented by the general equation. Triglycerides are readily trans-esterified in the presence of alkaline catalyst at atmospheric pressure and at a temperature of approximately 60 to 70^0C with an excess of methanol. The mixture at the end of reaction is allowed to settle. The lower glycerol layer is drawn off while the upper methyl ester layer is washed to remove entrained glycerol and is then processed further. The excess methanol is recovered by distillation and sent to a rectifying column for purification and recycled. The trans-Esterification works well when the starting oil is of high quality. However, quite often low quality oils are used as raq materials for biodiesel preparation. In cases where the free fatty acid content of the oil is above 1%, difficulties arise due to the formation of soap which promotes emulsification during the water washing stage and at an FFA content above 2% the process becomes unworkable.

Conclusion

Researchers in various countries carried out many experimental works using vegetable oils as I.C. engine fuel substitutes. These results showed that thermal efficiency was comparable to that of diesel with small amounts of power loss while using vegetable oils. The particulate emissions of vegetable oils are higher than that of diesel fuel with a reduction in NO_x. Vegetable oil methyl esters gave performance and emission characteristics comparable to that of diesel. Hence they may be considered as diesel fuel substitutes. Raw vegetable oil can be used as fuel in diesel engines with some minor modifications. The use of vegetable oils as I.C. engine fuels can play a vital role in helping the developed world to reduce the environmental impact of fossil fuels.

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