IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

REPSE-17

Sri Venkateshwara College of Engineering, Bengaluru

Vol. 4, Special Issue 7, May 2017

Performance and Emission Analysis of Bio Diesel from Cotton Seed and Rice Bran Oil

Raghu G[1], Rajesh T S[2], Ranjith Kumar S[3]

Asst. Professor, Mechanical Department, SRSIT, Bengaluru, India[1]

UG Scholar, Mechanical Department, SRSIT, Bengaluru, India[2,3]

Abstract: Biodiesel synthesized from various vegetable and animal fat oils has proven as a potential resource and shown neutral effect on environmental pollution. The cotton seed & rice bran oil has been explored for the synthesis of Biodiesel through transesterification from Potassium Hydroxide catalyst. Investigations carried out with bio-diesel operation in a single cylinder diesel engine. The performance and emission characteristics of cotton seed oil & rice bran oil bio-diesel compared with ordinary diesel in a diesel engine under varying load and results for various combinations of diesel and cotton seed & rice bran oil bio-diesel with blends B-20, and B-30, parameters like total fuel consumption, brake specific fuel consumption, brake thermal efficiency are calculated and tabulated. Experiments were conducted for various compression ratios which in turn alters injection parameter, Results obtained are plotted for these performance parameters. It was observed that fish oil bio-diesel shows higher fuel consumption rate, kinematic viscosity, brake fuel consumption. Most of the major exhaust pollutants such as CO, CO_2 and HC are reduced with the use of bio-diesel and the blend as compared to neat diesel. The exhaust gas temperature increases by increasing the blends as compared to neat diesel. Among the blends, B30 shows the better performance and emission characteristics.Results obtained at compression ratio 17.5 and injection pressure 200bar showed better performance characteristics when compared with others. In terms of fuel properties and exhaust emission characteristics, cotton seed & rice bran oil bio-diesel can be regarded as an alternative to diesel fuel.

Keywords: Cotton Seed, Rice Bran, Transesterification, Blending.

I. INTRODUCTION

The rate of petroleum reserve is declining while energy demand keeps increasing. The current expansion of the Indian economy has escalated petroleum demand, prices have surged, hurting the economies of poor and developing countries. In order to improve the economic status, the renewable, nontoxic bio-fuel comes with many advantages for the environment. Vegetable oils represent a ready, renewable, and clean energy source that has shown promise as a substitute to petroleum diesel for diesel engines. Edible oils like soybean, rapeseed, sunflower, and palm oil are being used for the production of biodiesel and have a very high value and market demand as food product causing food shortages and price increase especially in developing countries. To overcome this situation, researchers are looking for non-edible oil plants. Pongamia pinnata, Jatropha curcas, and other trees native to humid and subtropical environments can be grown on degraded and marginal land.

II. LITERATURE SURVEY

Liquid fuels from renewable resources are biodegradable and inexhaustible. In this regard vegetable oils having their physical and combustible characteristics close to diesel fuel may stand as immediate candidate subsite for alternative fuel to reduce its dependence on imports. The rural development ministry, government of India hopes to introduce biodiesel for commercial use especially for automobile very soon. Bio-diesel is already in use in Italy, Brazil, US, Malaysia and japan just that it's made from different natural sources in different places. In India biodiesel will be produced from oil-bearing trees available.

A.Murugean et al.conducted experiment on production &analysis of biodiesel from non-edible oils. Bio diesel has become more alternative recently because of its environmental benefits and it is derived from renewable resources, bio degradable and non-toxic in nature. Several bio diesel production methods have been developed among which transesterification using alkali catalyst gives high level of conversation of transesterification is effected by the reaction condition , molar ratio of alcohol to oil ,type of alcohol, type and amount of catalyst, reaction there temperature , purity of reactants free fatty acids and water content of oil's or fats. Alternative fuels for diesel engines have become increasingly important due to decreasing petroleum resource and environmentalconsequences of exhaust gases from petroleum fuelled engines.

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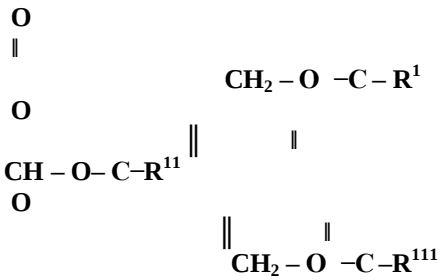
III.PRIMARY STUDY OF OIL

Vegetable oils are generally composed of triglycerides whose molecular structure are branched and complex. Figure shows the structure of a typical triglyceride molecule. On the other hand, diesel consists of straight chain molecular structure. Vegetable oils have comparably energy density, cetane number, heat of vaporization, and stoichiometric air / fuel ratio with mineral diesel fuel. The large molecular sizes of the component triglycerides result in the oils having higher viscosity compared with that of mineral diesel fuel.

The problem of viscosity has an adverse effect on the combustion of vegetable the fuel, such as spray atomization, consequent vaporization, and air/ fuel mixing. But vegetable oils have oxygen molecules present in them.



Structure of a typical triglycerides molecules

Fig. 1 Cotton Seeds

Fig. 2 Cotton Seed Oil

Rice is a grain belonging to the grass family. It is related to other plants such as wheat, oats and barley which produce grain for food and are known as cereals. Rice refer to two species (oryza saliva and oryzaglaberrima) of grass, native to tropical and subtropical south-eastern Asia and to Africa, which together provide more than one-fifth of the calories consumed by humans.

The plant, which needs both warmth and moisture to grow, measure 2-6 feet tall and as long. Flat, pointy leaves and stalk-bearing flowers which produce the grain known as rice. Rice is rich in genetic diversity, with thousands of varieties grown throughout the world.

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Fig. 3 Rice Bran Powder

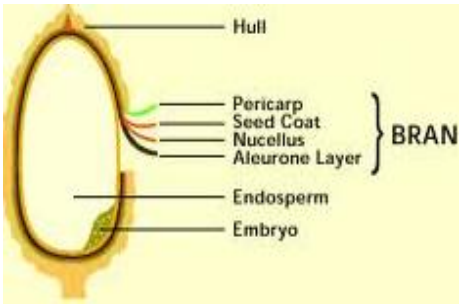

Fig. 4 Rice Bran

Fig. 5 Rice Bran Oil

IV. EXPERIMENTAL INVESTIGATION

Transesterification is the chemical reaction between triglycerides and short-chain alcohol in the presence of catalyst to produce mono-ester. The long-and branched-chain triglyceride molecules are methanol, ethanol, propanol and butanol. Methanol is used commercially because of its low price.Among these various conversion methodologies, the transesterification process has become commercial success.

The transesterification is the method of biodiesel production from oils and fats and can be carried out by two ways:-

(a) Catalytic transesterification

(b) Supercritical methanol transesterification

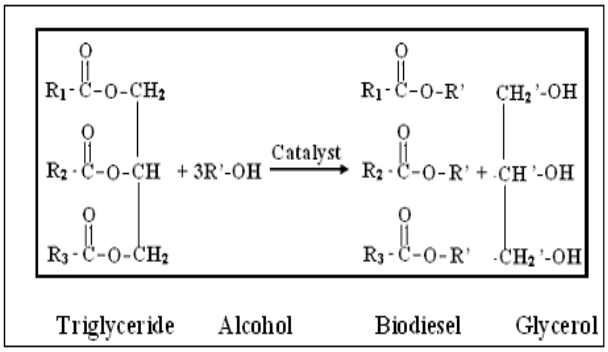

Fig. 6 Transesterification Reaction

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Where R1,R2,R3 are the Palmitic acid, oleic acid, stearic acid, linoleic acid, arachidic acid, linolenic acid the cotton seed oil in the flask was heated on a heating mantle with a mechanical stirrer arrangement. The oil is heated until the temperature is 60^0 c. Then, the catalyst KOH was mixed with methyl alcohol to dissolve and added to the heated cotton seed oil in the reactor. After the mixture was stirred for 1 hour at a fixed temperature of about 60^0 c, it was transferred to another container and the separation of the glycerol, was allowed. Once the glycerol layer was settled down, the methyl ester layer, formed at the upper part of the container, was transferred to another vessel after that, a washing process to remove some unreacted remainder of methanol and catalyst was carried out, using distilled water and blown air. Then, a distillation process at about 110 c was applied for removing the water contained in the esterified cottonseed oil. Finally, the produced cottonseed oil methyl ester was left to cool down and dried.

Fig. 7Separation of Bio Diesel

Fig. 8 Methanol Recovery

V. PERFORMANCE EVALUATION

A diesel engine is an internal combustion engine which operates using the diesel cycle (named after Dr.Rudolph Diesel). Diesel engines have the highest thermal efficiency of any internal or external combustion engine, because of their compression ratio.

The defining feature of the diesel engine is the use of the heat of compression to initiate ignition to burn the fuel, which is injected into the combustion chamber during the final stage of compression. This is in contrast to a petrol (gasoline) engine or gas engine, which uses the Otto cycle, in which a fuel/air mixture is ignited by a spark plug. The exhaust of automobiles is one of the major contributors to the world's air pollution problem. Recent research and development has made major reductions in engine emissions, but a growing population and a greater number of automobiles mean that the problem will exist for many years to come. During the first half of the 1900s, automobile emissions were not recognized as a problem, mainly due to the lower number of vehicles. As the number of automobiles grew along with more power plants, home furnaces, and population in general.

VI. RESULTS AND DISCUSSION

The preliminary studies to determine the optimum quantity of methanol, catalyst, reaction temperature and reaction time required for esterification of cotton seed oil and rice bran oil have been conducted by varying the concentration content of above parameters.

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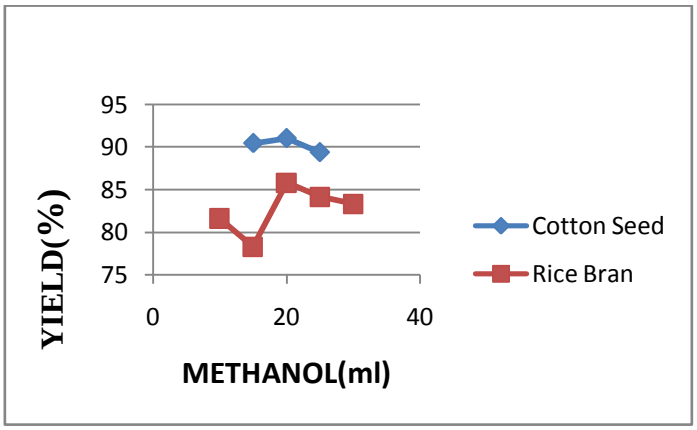

Fig. 9 Methanol vs. Bio – Diesel Yield

VII. CONCLUSION

1. The alkaline catalyst Tran esterification process converts the FFA of refined oil to its mono- esters and glycerol. The effects of alcohol to oil molar ration, catalysts amount, and reaction temperature and reaction duration are analysed in each step. It has been also found that the conversion efficiency is strongly affected by molar ratio of alcohol to oil.
2. The maximum ester conversion is achieved at the reaction temperature of 50 ± 5^{0}C. The viscosity of biodiesel is nearer to that diesel. The flash point of biodiesel ($>130^{0}$C) is greater than that of diesel and the calorific value is slightly lower than that of diesel. This Trans esterification method reduces the overall production cost of the bio-diesel, as it uses low cost unrefined non- edible oils.
3. The present analysis of cotton seed oil and rice bran oil have been trans esterified using methanol in presence of alkali and reveals that biodiesel from unrefined cotton seed oil and rice bran oil is quite suitable as an alternative to diesel. However, further research and development on additional fuel property measures, long term run and wear analysis of biodiesel fuel property measures, long term run and wear analysis of biodiesel-fuelled engine is also necessary.
4. Engine performance test show that cotton seed oil and rice bran oil as a fuel does not differ greatly from that of diesel. A slight power loss, combined with an increase in fuel consumption, has been experienced with cotton seed oil and rice bran oil. This may be due to lower heating value of mono alkyl ester.
5. The cotton seed oil and rice bran oil can be used as good alternative fuels in a diesel engine instead of diesel fuel. Break thermal efficiency of an engine depends on number of factor but when we are discussing about fuel the most meaning value and mass flow rate indicate energy input to the engine. This energy input or consumption to the engine in case of cotton seed oil and rice bran oil is more compared to diesel. And it is very clear that reduction in efficiency is very low compared to diesel fuel, which is due to the oxygen content in the mono alkyl ester, which results in better combustion.
6. The exhaust gas temperature of the engine on all the blends of methyl ester of rice bran oil bio-diesel was found to be lower than that of diesel at different load. The emission of carbon monoxide from the engine was found to be lower on all the blends of methyl ester of rice bran oil-diesel compared to diesel at different load. The emission of unburnt hydrocarbon from the engine at higher loads was found to be more on all the fuel blends as compared to diesel. The emission of NOx from the engine found to be higher on the all fuel blends as compared to diesel.
7. The exhaust gas temperature of the engine on all the blends of methyl ester of cotton seed oil bio-diesel was found to be lower than that of diesel at different load. The emission of carbon monoxide from the engine was found to be lower on all the blends of methyl ester of rice bran oil – diesel compared to diesel at different load. The emission of unburnt hydrocarbon from the engine was found to be lower than that of diesel at different load. And NO_X from the engine found to be higher on the 20%, 30%, 40% blends as compared to diesel.

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BIOGRAPHY

RAGHU G, Graduated in BE (Mechanical Engineering) from SJCIT, Chickkaballapur and M.Tech from SRSIT,Chikkajala Bengaluru.I have 7 years of teaching experience and also worked in various sectors.