PERFORMANCE EVALUATION OF DIESEL ENGINE USING VEGETABLE OILS

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Abstract*—the consumption of fuels throw improving global economy and economical cost of all countries to find the alternative fuel to reduce and even replace the usage of petroleum. Thus use of biodiesel from non-edible oil sources serves as an alternative to this problem. The present study focuses on impact assessment of rice bran and crude rice bran biodiesel and vegetable oil on diesel engine performance. The experimental investigation provides in depth detail of the biodiesel production process, evaluation of fuel properties and impact on engine performance. The study also investigates the optimization of the Compression ratio (CR) of a compression ignition engine fueled with blends of biodiesel. In order to find out the optimum CR of the engine, experiments were conducted at different CRs ranging from 12 to 18. The aim of this study is to investigate the production of biodiesel from waste. The optimization study was carried out by using a central composite response surface methodology with reaction conditions of methanol to oil ratio, catalyst loading and reaction temperature. The result showed at 95% confidence level that all the three factors affected the methyl ester yield. Significant yield of 91% was obtained at optimal operating conditions of temperature, methanol to oil molar ratio (22.5:1) reaction time and catalyst loading. The properties of the biodiesel produced were within the biodiesel standard specifications.

Index Terms*—Rice brand oil, C/R ration, Optimization, Trans-Esterification, Economical cost.

I. INTRODUCTION

Rice Bran Oil is a unique vegetable oil produced from the outer brown layer of rice which is removed in the form of rice bran during the polishing process of the rice milling industry. Besides having an almost ideally balanced fatty acid profile, it is rich in natural antioxidants. A number of scientific studies conducted in India & abroad have well documented the better cholesterol lowering properties of rice bran oil as compared to other conventional vegetable oils. All these studies have attributed these properties of the oil to the presence of unique nutraceuticals in this oil known as oryzanol & tocotrienols. Rice bran oil is the world's healthiest edible oil, containing vitamins, antioxidants and nutrients. It is not just delicate and flavourful; but also helps to lower cholesterol, fight diseases, enhance the immune system, and fight free radicals. It contains highest amount of all natural vitamin-E and contains unique component oryzanol which is linked with increase in good cholesterol and lowering down the bad cholesterol and triglycerides. Rice Bran Oil is extensively used in Japan, Korea, China, Taiwan and Thailand as premium edible oil. It is the conventional & the most favourite cooking medium of the Japanese and is popularly known as "Heart Oil" in Japan. It has acquired the status of a "Functional Food" or a "Health Food" in Western Countries.

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.

1. 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.
2. Development of the bio-diesel industry would strengthen the domestic, and particularly the rural agricultural economy of agricultural based countries like India.
3. It is biodegradable and non-toxic
4. It is a renewable fuel that can be made from agricultural crops and or other feed stocks that are considered as waste
5. It has 80% heating value compared to that of diesel
6. It contains low aromatics
7. It has a reasonable cetane number and hence possesses less knocking tendency
8. Low sulphur content and hence environment friendly
9. Enhanced lubricity, thereby no major modification is required in the engine
10. Personal safety is improved(flash point is 1000 C higher than that of diesel)
11. It is usable within the existing petroleum diesel infrastructure (with minor or no modification in the engine).

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 transesterified in the presence of alkaline catalyst at atmospheric pressure and at a temperature of approximately 60 to 700 C 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.

II. BIODIESEL PRODUCTION METHODOLOGY

Due to high FFA (15%) for crude rice bran oil transesterification was carried out in two stages. First stage is called acid catalyzed transesterification in which transesterification reaction was carried out in a water bath shaker and some quantity of crude rice bran oil was taken in a conical flask and it was preheated to the temperature of 60 C for 30 min. Then a mixture of known quantity of sulfuric acid (H2SO) as acid catalyst and methanol was then mixed with the preheated crude oil. The preheated oil mixture was then subjected to 1 h constant stirring at a constant temperature of 60 C inside a water bath shaker. After 1 h of constant stirring the mixture was poured into a separating funnel for impurities to settle down. After 4–5 h the settled down impurities are separated from the remaining oil. After this second stage of transesterification (base catalyzed) starts in which remaining oil quantity was measured and again heated up to 60 C. Potassium hydroxide (KOH) as base catalyst and methanol was then mixed with the remaining preheated oil. The preheated oil mixture was then again subjected to 1 h constant stirring at a constant tempera- 4 ture of 60 C inside a water bath shaker. After 1 h of constant stirring the mixture was poured into a separating funnel for glycerol to settle down. After 2–3 h settled down glycerol is separated and removed. The remaining portion is methyl ester (biodiesel) of crude rice bran oil (yield 82%) which is further pried through washing and drying for removal of excess KOH, methanol and water. The biodiesel yield of 90% is obtained using same procedure for rice bran oil.

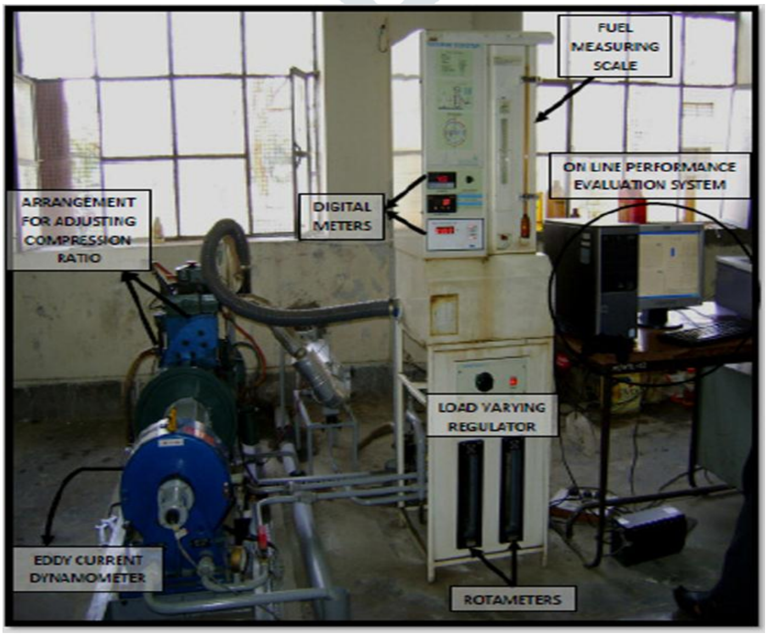
III. MEASUREMENT OF FUEL PROPERTIES

In Table shows the apparatus and standards used for evaluating the fuel properties.

FUEL PROPERTIES	RICE BRAN OIL BIODIESEL	JATROPHA CURCAS	DIESEL
Density(gm/cc)	0.872	0.840	0.831
Viscosity(cSt)	4.81	3.7	3.21
Flash point (℃)	157	160	76
Calorific value(KJ/KG)	41382	42227	44585
Cetane number	51.6	38.0–51.0	47.2

IV. ENGINE SPECIFICATION

Engine model	Kirloskar
No of Cylinders	Single cylinder
Number of Stroke	**4**
Fuel	Diesel
Stroke length	110 mm
Compression Ratio Range	18:1
Maximum power	5.2 kW
Speed	1500 rev/min
Dynamometer Eddy current Inj. Point variation	0 to 25 Btdc



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