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Study of Performance and Emission Characteristics of C.I Diesel Engine Fueled With Different Blends Of Rice Bran Biodiesel

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ABSTRACT: Biodiesel comes in action due to fossil oil crisis. Biodiesel is a renewable replacement of petroleum fuel due to economic and environmental benefits. In this study, Rice bran a waste product of the rice milling industry is used for biodiesel production. This study was conducted to evaluate the effect of rice bran bio diesel and diesel blend on the performance and emission characteristics of C.I engine. The biodiesel blends are B10 B20, B40, B50, and B100 on a volume basis performed under constant speed at different load conditions. The study concludes that optimum conditions for transesterification of rice bran oil with methanol and NaOH as a catalyst found to be 55^{o}C reaction temperature,1h reaction time,6:1 molar ratio of methanol to rice bran oil and 0.5% catalyst. Results shows that biodiesel obtained under optimum conditions the properties like viscosity is similar to diesel and cetane no is more than diesel. The study showed that biodiesel blend B20 shows lower smoke, CO, HC and NO_x emissions in addition to higher thermal efficiency as compared to diesel fuel. Break specific fuel consumption for B20 lower than diesel fuel and increases as blend ratio increases.

I. INTRODUCTION

We can't imagine a world without fuels such as diesel or petrol to run every sector. But the question arises that how long we can survive with this petroleum fuel. How we can fulfill the needs of the mankind. Then need to give some attention to this topic. Then need to get alternative resource of energy. Biodiesel could be one of the best solution of energy crisis. The main resources for biodiesel production are non-edible oil, edible oil resources.

Speaking to the engineering society of St Louis , Missouri in 1912, Rudolph Diesel, said "The use of vegetable oils for engine fuels may seem insignificant today, but such oil may become in the course of time as important as petroleum and the coal tar products of the present times"

However these systematic efforts have been made to utilize oil as fuels in engine. The viscosity of vegetable oil is several times higher than that of mineral diesel due to their large molecular mass and chemical structure.

Several researches shows that the fuel properties of vegetable oils can be improved by transesterification. Today this is the method of choice of all the researches. Transesterification is a most common chemical reaction in which alcohol reacts with triglyceride of fatty acid in the presence of a catalyst. Methanol and ethanol are used most frequently, especially methanol because of its low cost and its physical and chemical qualities. it can quickly react with triglycerides and NaOH gets easily dissolves in it. Several researches tried transesterification without using any catalyst in supercritical methanol, which eliminates the need of water washing.

Most of the western countries use soyabean, sunflower, saffola, rapeseed, palm oil, etc for production of biodiesel and investigation on the engine. The oils are edible in nature and developing countries like India cannot afford edible oils as a fuel substitutes. Then developing nations have to focus their intentions on oils of non edible nature which are cheaper. In India, a variety of non edible oils like linseed, mahua, karanja, rice bran, and jatropha are available in surplus quantities.

India is the second largest producer of rice in the world next to China, with the potential about 1 million tons of rice bran oil per annum. Rice bran is a low value co product of rice milling, which contains approx. 15% to 23% oil.

Currently, the industry is processing about 3.5 million tons of rice bran, leading to a production of about 0.65 million tons of oil and an additional 0.33 million tons could be produced through modernizing the huller rice mills and installation of rice bran oil refineries. This non edible oil remains mostly under-utilized. A huge quantity of rice bran is produced which is agriculture waste. It has significant potential as an alternative low cost feedstock for biodiesel production.

Rice bran is a brown layer present between rice and the outer husk of the paddy. Rice bran oil is an important derivative of rice. Depending on variety of rice and degree of milling, the bran contains 16-32 wt% of oil. About 60-70% of the oil produced from this bran is non edible oil, due to the problems attributed to the stability and storage of the rice bran and the dispersed nature of rice milling. Rice bran oil (RBO) is considered to be one of the most nutritious oils due its favourable fatty acid composition and unique combination of naturally occurring biologically active and antioxidant compounds [1]. RBO has been difficult to refine because of its high content of free fatty acid (FFA), unsaponifiable matter and dark colour [2]. The results obtained show a 49% reduction in smoke, 35% reduction in HC and 37% reduction in CO emissions for the blends whereas the brake power and BTE are reduced by 2.4% and 3.2% respectively with 4.3% increase in the SFC [6] . Therefore it is concluded from the present experimental study that the blends of RBO and Diesel fuel can successfully be used in Diesel engines as an alternative fuel without any modification in the engine and it is also environment friendly by the emission standards. The research is aimed to investigate the performance and exhaust emission characteristics of a CI diesel engine when fuelled with conventional diesel fuel, rice bran oil biodiesel, a blend of diesel and rice bran oil biodiesel.

II. MATERIALS AND METHODOLOGY

A. Extraction of Biodiesel

The transesterification is an equilibrium reaction and the transformation occurs essentially by mixing the reactants. However, the presence of a catalyst (typically a strong acid or base) accelerates considerably the adjustment of the equilibrium. In order to achieve a high yield of the ester, the alcohol has to be used in excess. The various process variables like temperature, catalyst concentration, amount of methanol and reaction time were optimized with the objective of producing high quality rice bran oil biodiesel with maximum yield [12]. Transesterification of rice bran oil with methanol and NaOH or KOH used as catalyst. Different molar ratios of rice bran oil to methanol and % catalyst (w/w oil) were optimized. A magnetic stirrer was used for the reaction of methoxide solution and oil. Gravity separator was used for separation of biodiesel and glycerol. Water washing was done for 3-4 times to remove the glycerin from biodiesel. In water washing the water was heated up to 70^0C and then added to biodiesel. Biodiesel was heated above 100^0C for removal of water content and methanol. Rice bran oil methyl ester thus produced was characterized to find its suitability to be used as a fuel in diesel engine.

B. Experimental setup for properties test of biodiesel

Fuel specifications of rice bran oil, rice bran oil methyl ester and mineral diesel property test like Kinematic Viscosity @ 40^0C (cSt) was measured by viscosity meter. The flash point was measured by cone type test cup and calorific value was determined by bomb calorimeter. The cetane number was measured by aniline point.

C. Experimental Setup for Engine Performance Test

A four stroke, single cylinder water-cooled diesel engine is employed for the present study. Five gas analyzer was used to measure the concentration of gaseous emissions such as Oxides of nitrogen, unburned hydrocarbon, carbon monoxide, carbon dioxide and oxygen level. The performance and emission tests are carried out on the C.I. engine using various blends of diesel-biodiesel blends as fuels. The tests are conducted at the constant speed of 1500 rpm at various torque. First, the experimentation was performed with diesel (for getting the base line data of the engine) and then blends of different percent volumes of Biodiesel B20, B40, B60, and B80 were carried out. The performance of the engine is evaluated in terms of brake thermal efficiency, brake specific energy consumption, exhaust gas temperature, and emission of the engine is analyzed (HC, CO, CO_2, O_2 and NO_x).

III. RESULTS AND DISCUSSION

A. Transesterification parameters optimization

NaOH was selected as catalyst for the base catalyzed transesterification of rice bran oil for further investigation.

B. Effect of Molar Ratio

The effect of methanol in the range of 6:1 to 15:1 (molar ratio) was investigated, keeping other process parameters fixed. The reaction temperature was kept constant at 55^0C, and reaction was performed for 1 h. The reaction was performed with different concentrations of NaOH. It was found that the ester yield increases with increase in molar ratio of methanol to vegetable oil, and for low values of molar ratio, the ester yield was sensitive to the concentration of NaOH [10].

C. Effect of catalyst concentration

It was found that the ester yield decreases as the amount of catalyst increased from 0.5% to 1.5%. Ester yield decreases drastically as the NaOH concentration increases above 1% and reduces to almost 50% for 1.5% NaOH concentration [10].

D. Effect of reaction temperature

For studying the effect of temperature on the transesterification reaction, the reaction temperature was varied as 50^0C, 55^0C, 60^0C and 65^0C Several researchers found that the temperature increase influences the reaction in a positive manner [3,4,5,7,8]. Dorado et al. [9] found that the ester yield slightly decreases above 50^0C reaction temperature.

E. Effect of reaction time

Several investigators found that the reaction starts very fast and almost 80% of the conversion takes place in first 5 min, and after 1 h, almost 93–98% conversion of the triglycerides into ester takes place [3, 4, 5, 8, and 11]. It was found that as the reaction time was increased beyond 1 h, the ester yield decreased slightly.

IV. CONCLUSION

The study concludes that optimum conditions for transesterification of rice bran oil with methanol and NaOH as a catalyst found to be 55^oC reaction temperature,1h reaction time, 6:1 molar ratio of methanol to rice bran oil and 0.5% catalyst followed by 3-4 times water washing. The fuel properties of rice bran biodiesel except calorific value, all other properties of RBO found to be higher compared to diesel. Viscosity of Biodiesel is higher than that of any other blend & as its concentration increases in the blend, the viscosity of blend increases Brake specific fuel consumption for B20 is lower than the diesel fuel and it increases as blend ratio increase. The maximum thermal efficiency for B20 (25.02%) was higher than that of diesel. The brake thermal efficiency obtained for B40, B60, B80 were less than that of diesel. The exhaust temperature increases as a function of the concentration of biodiesel blend i.e. higher the percentage of blend.

The mechanical efficiency increases with increase in BP for all fuel modes. Mechanical efficiency of the different blends B0, B40, B60 and B80 were found to be lower than that of the B20. The maximum efficiency obtained is 71.25% for B20 at maximum load. On the whole it may be concluded that 20% RBOME-diesel blends can be used in existing diesel engine without any engine modifications besides giving good performance characteristics and even better results in emission level remarkably.

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