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COMPARATIVE STUDY ON OIL PRODUCTS OF RICE BRAN

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Abstract: This paper dealt with comparative study of different processes of rice bran oil products. When rice bran oil is thermally decomposed using different loads of calcium oxide as catalyst, it can be used as a diesel fuel. We also analyzed in this paper the performance analysis of compression ignition engine using alternative fuels as rice bran oil and their ester after esterification for different engine load. When rice bran oil is physically refined through combined degumming, it can be used as edible oil.

Keywords: Rice bran oil, thermally decomposed, Alternative fuels, and Degumming agents.

INTRODUCTION

With the gradual depletion of the world petroleum supplies, a possibility occurs that petroleum-based fuels will be available neither in sufficient quantities nor at reasonable price in the near future. This revived interest in exploring alternate fuels for automotive vehicles such as methanol, ethanol, biogas, hydrogen and vegetable oils. However, they have certain inherent problems when used as fuels in diesel engines, generally attributable to inefficient combustion. The high viscosity and low volatily of vegetable oils are responsible for most of the combustion problems of neat oils. Several approaches have been investigated to reduce the oil viscosity by physical and chemical modifications. Chemical modification of vegetable oils to less viscous products can be made either by esterification with short chain alcohols [5,7,8,16,17] or by cracking in presence of a suitable mineral catalyst[2,4,6].

The feasibility of utilizing thermally cracked oil as a fuel for diesel engines was investigated [13].

The research has shown that alternative fuels are typically produced through the reaction of a vegetable oil or animal fat with alcohol in the presence of the catalyst to produce their esters[14]. With the help of above fuels in different blending ratio and different load the exhaust emission was found in terms of CO emission, smoke density and comparative performance analysis of both the fuel i.e. bio-fuels and their ester.

The studies were conducted to improve quality of rice bran oil by degumming to make it edible grade [9]. Oil contains phosphatides, carbohydrates mucilages, proteins and resins as a gummy substance which impact colour turbidity and odour to rice bran oil. The phosphoric acid and water mixture (0.75+ 3 %) appear to be most effective degumming agent. The transmittance of oil improved from 37 to 57 % at 570 nm. The Viscosity and melting point decrease and Iodine value and Saponification value increased in degummed rice bran oil as compare to rice bran oil. The investigation has focused on the removal of gummy materials under various conditions prior to physical refining, so that the quality of rice bran oil is not impaired.

PRELIMINARIES AND METHODOLOGIES

The crude rice bran oil produced as a byproduct from rice milling industry was used to be thermally decomposed in the study [13]. The rice bran oil cracking was carried out in one litre reaction flask attached to a condensing and receiving units. Then oil, 500 g oil was mixed with calcium oxide at a load ranging between 0.5-3% of the oil weight and the mixture was then heated to 450^{o}C. The cracking period was recorded as the time elapsed between the start and end of cracked oil distillation and the weight of the collected distillate was then determined which gave an estimate for the process yield. Then after the cracked oil products were then tested for their fuel properties using the ASTM standard methods. Estimate for the cetane number of the fuel was calculated.

A Constant speed, single cylinder, four stroke, naturally aspirated, water cooled, direct injection diesel engine of 3.75kW rating Kirlosker was used for doing the experimental work of esterification[14]. Hydraulic dynameter was used to measure the brake power and Neptune make exhaust gas analyzer was employed to measure the concentration of emissions of carbon mono-oxide and hydrocarbons. A smoke meter of Netel make was employed to measure the smoke density of exhaust gas emitted from the diesel engine. Two fuel tanks were installed one holds the vegetable oil and its blends with diesel and the other tank holds the diesel oil. Fuel was fed to the injector pump under gravity and the volumetric flow rate was measured by the use of 10cc graduated burette and a stopwatch and the speed was measured by tachometer. Then the engine was started on the diesel tank and runs on diesel for the first few minutes. Exhaust gases were used as heat source. The engine is switched over to the second tank and runs on the blended fuel, when the fuel reaches the required temperature. The engine was switched back to diesel before stopping the engine. Diesel and soyabeen oil, Rice Bran oil and Jatropha oil were mixed in the following proportion by volume to obtain three blends of each vegetable oil.

100% Vegetable Oil (B100)
75% Vegetable Oil + 25% Diesel (B75)
50% Vegetable Oil + 50% Diesel (B50)
25% Vegetable Oil + 75% Diesel (B25)
100% Diesel (B0)

Then the engine was run using blended fuel and mineral diesel and experiments were carried out.

Rice bran oil, extracted from rice bran with n-hexane as solvent at 60º C was used in the study of refining through degumming [9]. The dewaxed rice bran oil was degumming by adding degumming agents [1,3]. Specific gravity and Viscosity of rice bran oil were determined by using Pycnometer and Synchroelectric Viscometer (VLT) modol, respectively [15]. The melting point was determined using Toshniwal melting point apparatus [10]. The wax content of oil was estimated with some modification using Colorimeter instead of turbidity meter [11]. The degumming of dewaxed rice bran oil was carried out with 3 per cent water + 0.25 to 1 per cent phosphoric acid.

RESULT AND DISCUSSION

When rice bran was thermally decomposed the results are used to show the physical properties, fuel properties and other properties such as calorific value, cetane number and flash point properties, listed in Table (1). The viscosity of rice bran oil was markedly reduced by cracking to less than one third its original value. All samples are free from sulfur which if present in the fuel may give rise to low temperature sulfur corrosion. They are also free from non-burnable materials which may cause some abrasion of the fuel injection components, as detected by the ash % which is zero in all samples. The carbon residue from combustion of all cracked products is within the standard limits (0.1%). Increased deposits of carbon may cause injector coking which results in a lot of ignition troubles due to poor fuel atomization. The cetane numbers of all samples are close to that recommended for standard diesel fuel, which indicates that these samples might produce similar combustion noise as diesel fuel.

Results of In the study of esterification, the results are listed in the tables below. Table (2) and (3) show the properties before and after esterification.

The results of the study of refining through degumming are listed in Table (4). The phosphoric acid and water mixture (0.75 + 3%) was the most effective degumming agent therefore, it was used for degumming in the investigation. Degumming of dewaxed rice bran oil reduced its phospholipids content from 3.90 to 0.51%. [12] also made similar observations. The process of degumming had little or no effect on its specific gravity, smoke point and acid value. The viscosity and melting point of degummed oil decreased as compared to dewaxed oil, however, iodine value and saponification value increased upon degumming of dewaxed oil. The colour of rice bran oil was effectively improved by the removal of phospholipids by water and phosphoric acid mixture.

Table 1: Different properties of the cracked samples of rice bran oil, compared to diesel fuel

Catalyst Load Kg/100 kg oil	**0.5**	**1.0**	**2.0**	**3.0**	**Diesel fuel**
API Gravity	32.08	35.74	33.80	33.98	31-41
Specific Gravity	0.864	0.846	0.856	0.856	0.82-0.87
Pour Point ^{0}C	+12	+6	0	+6	4.5-15
Kinematic Viscosity $m^2S^{-1}\times10^6$	8.61	7.19	9.43	9.38	≤7
Water Content Vol. %	0.6	0.6	1.2	1.0	≤0.15
Sulphur Content (wt %)	nil	nil	nil	nil	≤1.2
Ash (wt %)	nil	nil	nil	nil	≤0.01
Carbon Residue (wt %)	0.023	0.051	0.038	0.041	≤0.1
Calorific Value(MJ/kg)	40.435	38.199	39.673	35.861	44.3
Flash Point (^{0}C)	54	51	55	51	≥55
Cetane Number	59.68	52.24	52.26	59.67	≥55
Cetane Index	51	54	52	54	–

Table 2: Readings before esterification

Properties/BR	**B0**	**B25**	**B50**	**B75**	**B100**
Specific Gravity	0.835	0.8556	0.8765	0.8943	0.918
Calorific Value (KJ/kg)	42500	41900	41200	40550	39900
Load(kg)/BR	**CO emission(%) for different blend ratio**				
1.8	0.09	0.10	0.13	0.13	0.15
3.6	0.13	0.12	0.11	0.15	0.18
4.8	0.14	0.15	0.14	0.19	0.16
5.5	0.15	0.24	0.15	0.15	0.14
Load(kg)/BR	**Smoke density(%) for different blend ratio**				
1.8	02	02	02	02	02
3.6	11	10	07	07	06
4.8	15	13	12	12	11
5.5	35	35	33	35	34

Table 3: Experimentation result after esterification

Properties/ BR	**BO 0**	**BO 10**	**BO 20**	**BO 50**	**BO 75**	**BO 100**
Specific Gravity	0.835	0.838	0.843	0.855	0.865	0.875
Calorific Value (KJ/kg)	42500	42400	42100	41550	41000	40500
Load(kg)/BR	**CO emission(%) for different blend ratio**					
1.8	0.09	0.18	0.15	0.15	0.1	0.2
3.6	0.13	0.30	0.34	0.2	0.16	0.18
4.8	0.14	0.70	0.5	0.34	0.29	0.2
5.5	0.15	1.06	0.96	0.9	0.86	0.3
Load(kg)/BR	**Smoke density(%) for different blend ratio**					
1.8	02	04	04	04	04	04
3.6	11	04	03	05	04	05
4.8	15	10	05	09	06	08
5.5	35	20	04	16	12	15

Table 4: Physico-chemical characteristics of degummed rice bran oil

Characteristics	Value
Specific gravity at 30°C	0.923
Viscosity(centipoise)	41.20
Colour(% transmittance)	57.0
Melting point(°C)	10.5
Smoke point (°C)	211
Iodine value	99.30
Saponification value	190.59
Acid value(as oleic acid)	28.06
Free fatty acids (%)	14.03
Wax (%)	0.07
Phospholipid(%)	0.51

CONCLUSION

It has been observed that the fuel properties of the decomposed oil were quite similar to those of standard diesel fuel. The calorific value was 80-90% that of diesel fuel and the viscosity was slightly higher. In the study of esterification, with the help of alternative fuels in different blending ratio and different load the exhaust emission was found in terms of CO emission, smoke density and comparative performance analysis of both the fuel i.e. bio-fuels and their ester. And in the study of degumming it has been observed that degumming agent, phosphoric acid and water mixture (0.75 + 3%) has more colour reduction power of oil. The oil so obtained is the best in quality.

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