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Investigation of Al2O3/Oryza Sativa Oil Biodiesel on Performance and Tribological Characteristics

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Article Info
Volume 83
Page Number: 942 - 946
Publication Issue:
May-June 2020

Article History
Article Received*: 11 August 2019*
Revised*: 18 November 2019*
Accepted*: 23 January 2020*
Publication*: 09 May 2020*

Abstract:
The need for the alternate fuels has increased due to the depletion, negative impacts on the environment and the engine performance of the conventional fuel. There is a change in the mind of the researchers to identify the new alternative fuel as the replacement for conventional diesel. Biodiesel is mainly obtained from renewable feedstock by transesterification process upon preheating. In this Research work the kinematic performance for Oryza Sativa (Rice bran oil) Bio-diesel oil containing aluminium oxide nano particles.Different Weight Percentages were dispersed in this work.Aluminium oxide is amalalgamated in percentages of 0.3/0.5/0.7 Weight Percentages in each rice bran oil Biodiesel. It also reduced the piston wear to an extent due to good lubrication nature.

Keywords: *Rice Bran Oil (RB); Al_2O_3; Tribology; Nano Particles*

I. Introduction

The automobile is a very important requirement for the current scenario.The various works have been carried out in automobile parts in various components such as Brakes, Clutches and Engine Performances[1-5].Out of all the components the engine performances is considered as the important one.In recent years various nano particles have been added as an additive in the engine biodiesel to enhance the performance. The Diesel engines are predominately used because of its high persistence and thermal efficiency that uses conventional diesel as its fuel. Since the demand and usage of automobiles for the mobility has increased drastically leading to the depletion of conventional fuels, now it has become a tough situation to meet out such trend. Thus biodiesel will be a possible solution for such problems. Biodiesel has the vital advantages of abundant source, eco friendly, cheap, good engine tribological characteristics. Bio diesels are mainly obtained from ethanol, but there needs more catalyst and possesses some environmental issues that led to the usage edible oils, waste oils, vegetable oils. Vegetable oils are abundant sources due to the many sources available; it has long chain carbon structure resulting in good ignition.There many researchers worked in vegetable oils, namely mahuma oil, rapeseed oil, fish oil, etc., these oils can be used directly through blending and other processes. However, due to usage of these vegetable oils many glitches occurred leading to long term issues resulting in the malfunction of engine lubricating oil due to polymerization [3]. The viscosity level of these oils is the main reasons for all foresaid issues, which is 30 to 60 cSt at 40°C while it is 3 to 4 cSt for diesel at the same temperature. The Techniques Employed in reducing the viscosity are gasification dilution (blending), micro-emulsion etc.Transesterrification was widely employed [4-7]. Transesterification is the most appropriate and well-accepted method compared to others where vegetable oil is made to react with the alcohol chemically and mono alkyl esters are formed that blend with diesel in a ratio and in turn produces bio diesel. There are many researchers carried out on the biodiesel utilization for fuel since the blending of biodiesel fuel to the conventional diesel will reduce the importing charges. In India around Rs. 80,000 crores are spent on fuel import per year, if biodiesel fuel is blended with 5% around Rs.4000 crores per year will be saved [8]. Ramadhas et al. [9] identified that the volatility vegetable oils possess some serious concerns in compression ignition engine that leads to decrease the efficiency that could be reduced due to transesterification. Deepak agarwal et al. [10] investigated about the various emissions that are coming out of the usage of biodiesel in the engine. It was concluded that the percentage of emissions from exhaust gas could be easily reduced by incorporating biodiesel oil to the conventional diesel. Sukumar Puhan et al. [12] did a test to prove the NOx emission reduction of Mahua oil based biodiesel obtained by the transesterification process on a single cylinder, four stroke, direct injection, constant speed, compression ignition diesel engine (Kirloskar). It was concluded that the biodiesel performed well compared to conventional diesel in the performance as well as in the reduction of emissions. Bari et al. [13] did an experimental study on the preheating of the crude palm oil on the injection, performance and emission characteristics of the diesel engine. It was stated that heating produced good fuel flow, but did not affect any performance characteristics. There was also a slight increase in emission behaviour as seen in other biodiesel. Edible oils as well as non-edible oils biodiesels are used in most of the countries. Biodiesels is produced mainly from edible oils that are predominately used. The edible oil of a country is mainly dependent on the soil and weather conditions. Edible oils such coconut oil, mahua oil, jatropa oil, sunflower oil, corn oil, cotton oil etc are widely used but due to the presence of active lipase in the bran and lack of economic stabilization methods, most bran are used as livestock feed or boiler fuel which is not of edible gradeThe calculated yield potential of CRO in total is about 8 million metric tons out of this the produced rice kernel is utilized for extracting the oil. Therefore, the CRO can be utilized for producing the biodiesel [13]. Shiyu et al. [14] investigated the influence of the ZrO2 nanoparticles as lubricant additives, proved that nanofluids containing 0.5 wt.% had the better results than the conventional pure oil Wu et al. [15] tried the performace with the help of the MoS_2 nanosheets as an additives to assess the frictional properties of the conventional diesel .He concluded that the MoS_2 has good lubrication properties This, present work is summardsed onOryza Sataiva, using transesterification process, with Aluminium oxide nano additives to analyse the Tribological, viscosity and combustion parameters in direct ignition diesel engine.

II. Biodiesel evolution

The CRO was procured from Mannai Private limited, which is located near Chennai, India. Transesterification process was done to extract the Rice bran biodiesel in the laboratory. The process of producing ester and glycerol by reacting with ethyl alcohol and triglyceride in the presence of certain catalyst namely sodium hydroxide is known as transesterification. The transesterification method is mainly employed for reducing the viscosity of oils. Until the NaOH was completely dissolved in the methanol, manual stirring was done. Methoxide prepared was poured into the 50°C preheated oil that was present in the three-necked flask. The magnetic stirrer was used to stir the whole mixture at a speed of 250 m/s that varied upon quantity of mixture. One neck of the flask was closed using a thermo well with a thermometer inserted along the thermo well. The second neck was closed using a stopper for preventing the system and atmosphere contact. The last neck was closed with a condenser. 20°C temperature was maintained for the cooling water. At the interval of 10 minutes, reactant temperature was measured. Reactant temperature was maintained at 60°C i.e. the boiling point of methanol using a heating mantle regulator. The reaction took two hours upon which the heating mantle was switched off to terminate the reaction. The mixture was transferred from the flask to a two litre-separating funnel after opening all the three necks of the flask. The mixture was left undisturbed in a funnel for eight hours. Upon settling mixture is separated into two layers namely upper layer as mono alkyl ester while the bottom was glycerol owing to its high density. The glycerol removal was done by the

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opening of the funnel. The ester was washed in the warm distilled water to remove the traces of alcohol and catalyst present in it. 10 percentage of ester by the mass of distilled warm water in the range of 35 - 40°C was poured in the ester.

2.1 Nano lubricants formulation

In this particular research work aluminium oxide nano particles were used for the evaluation puposes.The aluminium oxide nano particles with the size of 50 nano metre were utilized for this work. It is procured from steadfast nano labs Chennai. The sem images was used to determine the size of the nano particles.The aluminium oxide nano particles were suspended in biodiesel at different concentrations such as 0.2,0.5 and 0.7 weight percentage.The ultrasonic shaker were used for uniform dispersion.

2.2 Engine performance

The various characteristics of the nano particles were dispersed at 0.3, 0.5 and 0.7 wt% in each rice bran oil Biodiesel. It is examined using the four-stroke, air cooled, direct injection compression ignition engine with a rated output of 4.4 kW at 1500 rpm and the specifications are same in which work has done before.

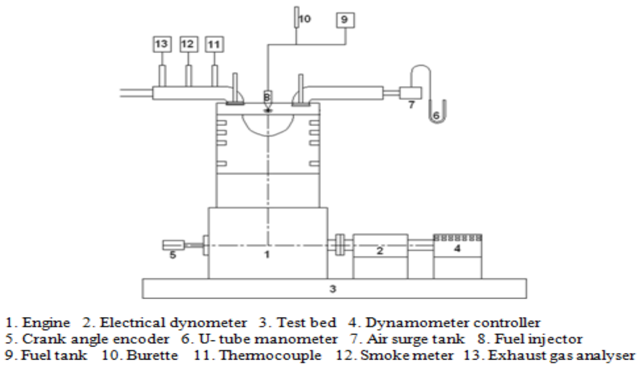

Fig. 1. Test Rig Of Engine

The setup used to carry the research, is given in the schematic form in figure 2. The exciting type DC generator was linked with the swinging type electric dynamometer in order to carry out the readings by applying varying loads. Different investigations were done at different levels such as 25%, 50%, 75%, and 100% (full load) of the load in proportion to the high power at an average speed of 1500 rpm. In this present study three-way, hand operated, two-position DCV was used for fuel supply, for rapid switching between diesel and the other test fuels. Orifice meter was made in connection with the surge tank to measure airflow. The fuel flow rate was measured on carrying oil. Upon reaching balanced operating condition, consumption of the fuel & exhaust gas temperature were measured.The K-type (Chrome-Alumel) thermocouple with digital indicating unit was employed for measuring the exhaust gas temperature. The emissions such as NOx, CO, and HC were measured with DELTA 1600-L make MRU OPTRANS 1600 exhaust gas analyzer.

2.3 Measurement of Kinematic Viscosity and Tribological properties

The conventional method was employed in this work.The performances of all the three nano particles concentrations were measured in percentages of 0.3/0.5/0.7 Weight Percentages .The sliding distance and speed is kept constant and it is measured as per IS2014 Standards.

III. RESULTS AND DISCUSSION:

3.1. Properties of Fuel

The fatty acid profile of RB is given in Table 3. The properties given are as per ASTM standards.

Table 3. Rice bran biodiesel (Composition of Fatty Acid)

Fatty acid chain	C:N#	Type	Weight (%)	
			Present Work	Literature Values [14]
Lauric	C12:0	Saturated	0.2	0.2
Myristic	C14:0	Saturated	0.3	0.8
Palmitic	C16:0	Saturated	11.4	17.7
Stearic	C18:0	Saturated	7.6	2.2
Oleic	C18:1	Unsaturated	27.9	40.6
Linoleic	C18:2	Unsaturated	37.6	35.6
Linolenic	C18:3	Unsaturated	13.4	1.8

#C-number of carbon atoms and N -number of double bonds of carbon atoms in the fatty acid chain

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The RB consists primarily of linoleic and oleic fatty acids; which are 37.6 % and 27.9 % respectively, followed by 13.4 % of linolenic acid. The contribution of palmitic acid, which is saturated type in nature, is also relatively considerable (11.4 %). In overall, the contribution of unsaturated fatty acids is significant (78.9 %) as compared to saturated fatty acids as shown in table 4. The fatty acid composition of biodiesel will generally remain same as that of its parent oil and these values obtained are similar to the literature [14], there are some variations with the literature that are due to the nature of the rice bran chosen i.e. it is soil and climatic specific

3.2 Influence of Kinematic viscosity on piston wear and fuel flow

If the viscosity was getting higher it will be having high frictional values.This Viscosity will be affecting the process of combustion which in turn affects the formation of engine particulates which creates engine noise in the chamber.The atomization fuel will be reduced so the spray of fuel during ignition will be reduced drastically which leads to the combustion problem [19]. The transesterification process reduces the viscosity of vegetable oil. At 40°C, the kinematic viscosity of rice bran oil with 2 weight percentage of Aluminium oxide is found to be near 25 cSt. This is 9.7 times more than the viscosity of conventional diesel. However, after converting into biodiesel, the viscosity was brought down significantly [20]. On the effect of this viscosity in IC engines mechanical friction [21]. On comparing with the conventional diesel, the viscosities of CRO and RB may be attributed higher because of long chain hydrocarbon structure. The viscosities are also then reduced upon preheating at 160 °C; the kinematic viscosity is 3.63 cSt for RB biodiesel with 2 weight percentage of aluminum oxide nano particles, though it is lesser even then higher than conventional diesel [13,22].

IV.CONCLUSION

Aluminium oxide nano particles and Rice bran oil biodiesel is evaluated. The following results can be concluded.Nano particles addition with rice bran bio diesel increased the viscosity due to the concentration of nano particles. By using diesel fuel the maximum wear occurred. Due to this, the damage of piston in reduced considerably. The SEM images of conventional diesel and rice bran biodiesel with nano additives is tested ad it shows deep grooves when compared to other one which in turn is due to the lack of lubrication nature of the diesel, while the RB based biodiesel fuelled showed less groves.

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