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A Review on Bio-Diesel

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***Abstract*: This paper is an overview of previous research papers which implies to improve the performance and emission characteristics of stationary diesel engine using different biodiesel as a blends. The present impact on the study of biodiesel and its blends on the diesel engine performance. The test was performed using single cylinder four stroke diesel engine. The study investigates the Compression Ratio in engine fuelled with blends of biodiesel. The experiment provides the detail of the biodiesel production, fuel properties and impact on engine performance. The study investigates the performance of Brake Thermal Efficiency, Brake Power, Brake Specific Fuel Consumption and the emission provided by the blends of biodiesel.**

***Keywords*: biodiesel**

1. Introduction

Biodiesel is a clean burning alternative fuel was produced from renewable resources like virgin or used vegetable oils, both edible and non-edible. Biodiesel is obtained from the chemical transformation of oils (triglycerides) by a transesterification process and many oleaginous vegetable species. The first biodiesel from Schleichera Oleosa was produced in a HC reactor via transesterification under optimized conditions, such as oil to methanol molar ratio of 1:6 in the presence of 0.75wt% potassium hydroxide as the alkali catalyst at operating temperature [1]. Furthermore different blending ratios of SOME in B0, B10, B20, B30 and B50 were used in the diesel engine in order to study the performance and emission characteristics. In present study, non-edible Schleichera Oleosa was investigated as a potential feedstock for biodiesel production which has an estimated annual production potential of 66 thousand tons per year in India. The second Biodiesel can be produced from non-edible seed oil like Neem etc. These oils cannot be directly used in the engine due to their high viscosity and density, and low calorific value.The glycerol component should be removed by transesterification reaction. Biodiesels with edible and non-edible oils are widely investigated with respect to their performance, emissions and their impact on environment [2]. Blends of biodiesel can be directly used without much alteration in existing diesel engine. The third is rice bran oil ranks first among the non-conventional, inexpensive, low-grade vegetable oils. Furthermore, crude rice bran oil is a rich source of high value-added byproduct. In the present study, crude rice bran oil and refined rice bran oil are chosen as potential alternatives for producing biodiesel and use as fuel in four stroke compression ignition engines. Palm oil and palm kernel oil are found in the flesh and seed (kernel) of the palm fruit respectively. In addition to Jatropha, large numbers of other fuel substitutes have also been attempted as a fuel.

2. Biodiesel

A. Schleichera oleosa oil methyl Ester (some) blends

1) Experimental setup

The hydrodynamic cavitation reactor with a 10-L capacity, connected to a reciprocating pump, in a closed loop is used for biodiesel production. The optimized geometry plate with a 1.9 mm diameter and 7 holes was used for this study2 kgs of Schleichera Oleosa oil was heated up to the desired optimized temperature (60℃) in the reactor by circulating the liquid glycerine through the jacket surrounding the holding reactor tank. The optimized conditions of 0.75 wt% potassium hydroxide as alkali catalyst and 1:6 of oil to methanol molar ratio were used to produce the SOME.

The mixture was then passed through the optimized orifice plate for 30 min reaction time with respect to the optimized inlet B pressure of 3 bars to generate the constructive cavitation condition [3]. The reactant mixture was allowed to settle down in the reactor by gravity settling for 3 h. The by-products and catalyst were discharged out through the opening of the reactor. The products were washed with the warm water at 50℃ to remove residual catalysts and other by-products. The remaining methanol and water in the product were evaporated under rotary vacuum evaporator.

B. Neem biodiesel blends

One litre of Neem crude oil was measured and heated up to 75ºC using electric heater. A solution of 300 ml of methanol and NaOH crystals 1% by weight was prepared. When temperature of Neem oil reached 75ºC, the mixture of methanol and NaOH was added gradually to it. The mixture was stirred continuously for few minutes and then 1% by volume of H_2SO_4 was added [4]. The mixture was allowed to settle down for 24 h, so that all the glycerol settles down and biodiesel floats above it. After that the following blends were prepared.

1) Experimental setup

A single cylinder, four stroke, constant speed, water cooled, diesel engine was used for the experiment [5]. The engine was operated at a constant speed of 1500 rpm, with constant compression ratio of 18. Initially the engine was tested with pure diesel and then with different blends of neem biodiesel

(B10, B20, B30). An AVL 444 DIG as Analyzer was used for measuring CO, HC and NOX emissions and smoke density was measured using AVL437 smoke metre. Fuel consumption was measured with the help of a sensor and data acquisition system. The air flow to the engine is dispatched to through the cubical air tank. The air tank regulates the flow of air to the tank. The inlet of the air tank is contributed with an orifice, and the air flow rate is measured using the mass air flow sensor. Different engine performance parameters like brake power, brake thermal efficiency, Specific fuel consumption and emissions like CO, HC, NOX were measured and results were plotted with respect to load.

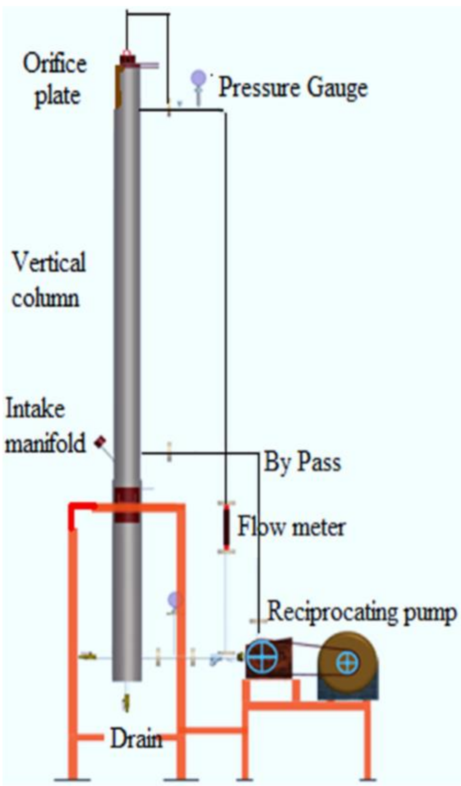

Fig. 1. Experimental setup

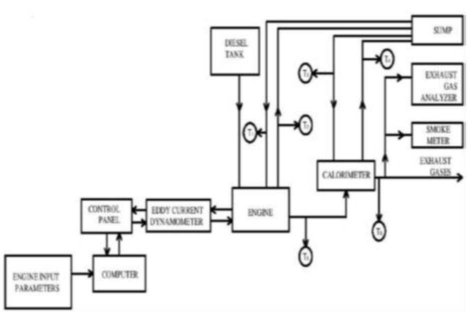

Fig. 2. Control diagram

C. *Rice bran biodiesel blends*

First stage is called acid catalysed 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℃ for 30 min. Then a mixture of known quantity of sulfuric acid (H2SO4) as acid catalyst and methanol was then mixed with the preheated crude oil. After this second stage of transesterification (base catalyzed) starts in which remaining oil quantity was measured and again heated up to 60℃[6]. 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 temperature of 60℃ 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 purified through washing and drying for removal of excess KOH, methanol and water [7]. The biodiesel yield of 90% is obtained using same procedure for rice bran oil. The kinematic viscosity of crude rice bran oil and refined rice bran oil is however several times higher than that of diesel oil and this leads to problems in pumping and atomization in the injection system of a diesel engine so their viscosity must be lowered. The combined effect of high viscosity and low volatility causes poor cold engine start up, misfire and ignition delay. Hence, it is necessary to bring their combustion related properties closer to those of diesel oil.

1) *Impact on engine performance*

Fig. 3. Engine performance

The set-up enables the study of engine brake power, fuel consumption, air consumption, heat balance, thermal efficiency, volumetric efficiency etc. [8]. The performance tests were carried out on the variable CR single cylinder four stroke diesel engine using various blends of crude rice bran oil biodiesel and refined rice bran oil biodiesel and diesel as fuels. The tests were conducted at various loads. The experimental data generated were documented and presented here using the biodiesel– diesel mixture for the engine test operation. In each experiment, engine performance parameters such as brake specific fuel consumption (BSFC), brake thermal efficiency (BTE) and variation of cylinder pressure with crank angle were measured [9]. The figure shows variable CR compression ignition engine test Rig.

D. Palm and palm kernel oil

Lipase production by A. niger via solid state fermentation was done as previously described, while lipase activity was determined using a combined method [10]. Spores of the mold was inoculated in medium containing rice bran, palm kernel cake, groundnut cake and starch (5:5:3:1 w/w), moistened with distilled water to 55% and incubated at 30ºC for 72 h. The fermented moldy bran was mixed with 50 Mm sodium phosphate buffer pH 8 (1:10w/v) and placed in an orbital shaker at 150 rpm at 28ºC for 2 h [11]. The mixture was filtered using glass microfiber and the clear filtrate was used as crude lipase.

Olive oil substrate emulsion was prepared by mixing 25 ml of olive oil with 75 ml of 7% Arabic gum solution in a conical flask and incubate at 37ºC for 15 minutes using a water bath (Nickel Electro Ltd, England). Trans esterification reaction for PO and PKO was carried out in a separate 250 ml conical flask, using a rotary orbital shaker accordingly. Lipase (2.5%) was added to 40 g of PO and PKO respectively and the mixtures were supplemented with methanol (5 ml) in a molar ratio 1:1 to the oil. Reaction mixture was left for 48 hours after which it was separated overnight using a separating funnel. Following separation, two layers were formed: the upper layer being the biodiesel product while glycerin settled at the bottom layer of the separating funnel.

1) Experimental setup

The experiments were carried out on a single cylinder, four stroke, water cooled, direct injection, naturally aspirated variable compression ratio engine. The compression ratio of the engine can be varied by lowering or raising the total head assembly by means of driving pinion from outside of the engine[12]. The engine is coupled with a starting unit consists of induction motor with the electromagnetic clutch. Two fuel tanks are attached to the engine, one for conventional fuel and second are for test fuel. Test fuel tank is attached to a weighing machine, the output signal of fuel weight is supplied to control panel. Eddy current dynamometer is coupled to the engine for applying brake load. The engine has rated capacity of 5 B.H.P. running at RPM of 1500 and CR of 17.5. The engine is fitted with a piezoelectric sensor for pressure measurement. The output signals from all sensors of load, pressure and temperature sent to control panel's board. Control panel's board can be connected to a personal computer by means of USB connection between them. "EPM Software" is provided by the manufacturer to analyse record and observe the real time combustion performance. The results can be saved in the format of the document or excel file. To record exhaust gas emissions AVL CDS 250 gas analyzer was attached to the computer. It depends on different constraints such as compression ratio, ignition delay, the inlet temperature of the air, heat release rate, mixing of fuel with air, fuel injection pressure, combustion duration and fuel properties like volatility, flash point, density, calorific value, pour point, viscosity etc. [13]. In the existent research, experimentations are carried out to the assessment of combustion, performance and emission parameters of a diesel engine by means of dual bio-fuel (turpentine oil & Jatropha biodiesel) blends and conventional diesel. The diesel engine was investigated in full load at the compression ratio range of 15.5, 17, 18.5 and 20 for the constant speed of 1500 rpm.

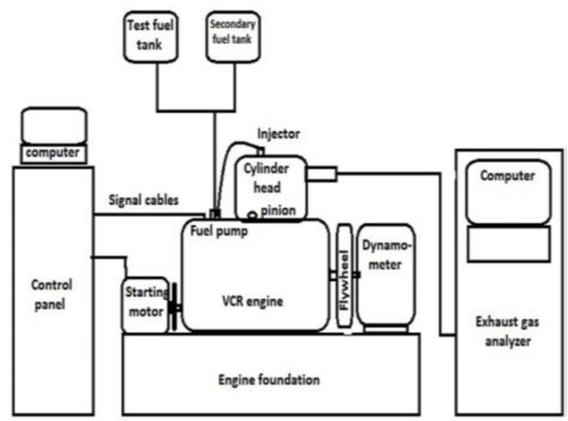

Fig. 4. Block diagram of experimental setup

E. Jatropha oil

A fuel tank of 5 L capacity was mounted at the back of the panel on the wall with manual fuel consumption measuring burette which is nearer to the engine at the highest position. AVL CDS 250 exhaust gas analyzer attached to the computer was used for the measurements of various exhaust gas parameters like CO, HC, CO2 and NOx. The accuracy and reproducibility of the instrument were 1% of full-scale reading. AVL 437 smoke meter attached to the exhaust manifold to measure the smoke emission, which work on light extinction principle [14].

1) Materials and methods

Lipase-producing strain of Aspergillus niger was obtained from the Culture Collection Center of Department of Microbiology, Federal University of Agriculture, Abeokuta, Nigeria. Palm oil (PO) and palm kernel oil (PKO) were obtained locally from an oil palm industry. All chemicals used including tween 80, gum arabic, thymolphtalein, sodium dihydrogen phosphate, monosodium hydrogen phosphate, sodium potassium tartarate, copper sulfate pentahydrate were of analar grade [15]. Lipase production by A. niger via solid state fermentation was done as previously described, while lipase activity was determined using a combined method. Spores of the mold was inoculated in medium containing rice bran, palm kernel cake, groundnut cake and starch (5:5:3:1 w/w), moistened with distilled water to 55% and incubated at 30ºC for 72 h. The fermented moldy bran was mixed with 50 mM sodium phosphate buffer pH 8 (1:10w/v) and placed in an orbital shaker at 150 rpm at 28 _C for 2 h [16]. The mixture was filtered using glass microfiber and the clear filtrate was used as crude lipase.

F. Engine performance parameters

1) BTE vs. BP of some blends

The BTE is indicating the inverse of BSEC. The figure representing the variation of brake thermal efficiency (BTE) with BP. The values of BTE were increased with increasing load in all cases. This was due to reduction in heat losses at higher load [17]. The BTE of SOME blends showed lower brake thermal efficiency compared to diesel fuel. The increase in fuel consumption requires the increase of volume and duration of fuel injection.

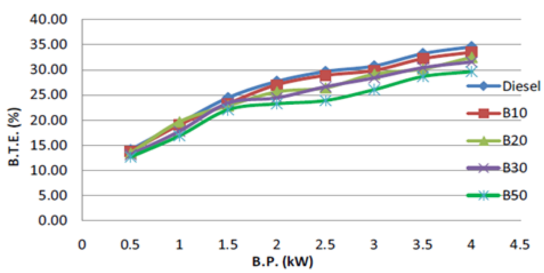

Fig. 5. BTE vs. BP of some blends

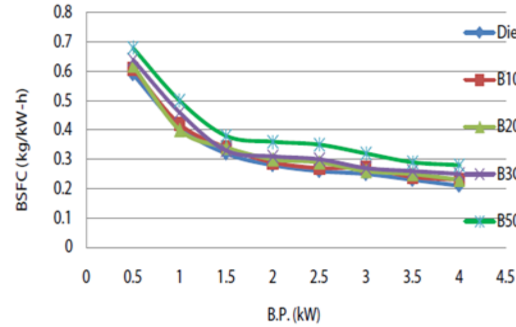

Fig. 6. BSFC vs. BP of neem blends

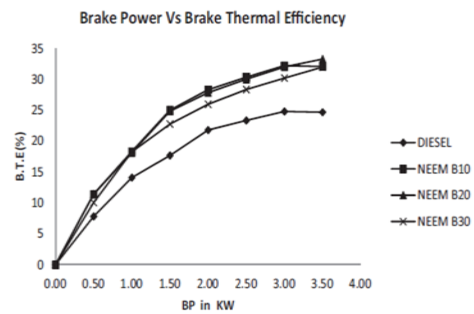

Fig. 7. BP vs. BTE of neem blends

BSFC is the ratio of mass flow rate of fuel to brake power output of the engine. Variation in BSFC of blends B10, B20, B30, B50 and it was observed that the brake specific fuel consumptions of diesel as well as the blends were decreasing with increasing load [18]. The variations in the specific fuel

Table 1
Performance analysis

FUELS	BP VS BTE	BSFC VS BP	EMISSION
SOME BLENDS	The values of BTE were increased with increasing load.	The brake specific fuel consumptions of diesel as well as the blends were decreasing with increasing load.	There was an increase in CO emission level at higher load due to rich mixture which results incomplete combustion of fuel.
NEEM BLENDS	The brake thermal efficiency of neem biodiesel blends are higher than that of diesel at all loads.	The concentration of neem biodiesel increases in the blends with brake power, it is found that B.S.F.C also increases.	The CO emissions were reduced for Neem blends compared to pure diesel. The CO emissions were reduced for Neem blends compared to pure diesel.
RICEBRAN BLENDS	It was observed that BTE increases when the break power was increased.	As break power increases the cylinder wall temperature also increases, which reduces the ignition delay. Thus shortening of ignition delay improves combustion and reduces fuel consumption.	Longer ignition delay along with increased BSFC decreases the air–fuel ratio inside the cylinder leaving less amount of air for complete combustion which in turn gives rise to higher CO emissions.

Table 2
Performance analysis

FUELS	BSF/BTE	EMISSIONS
PALM OIL	Average **6%** reduction in **BSFC** was found in blend including nanoparticles compared to Biodiesel + ethanol blend	Average of **19%** reduction of CO and **6%** of NOx was found compared to B10 without nanoparticles. The **total hydrocarbon** was reduced when nanoparticles were introduced
	BSFC reduced to significant level with increase in BTE of **12%** compared with pure biodiesel	**60%** reduction of CO and 30% of NOx was found compared to pure biodiesel

consumption with load follow a similar trend with the test results reported in the literature.

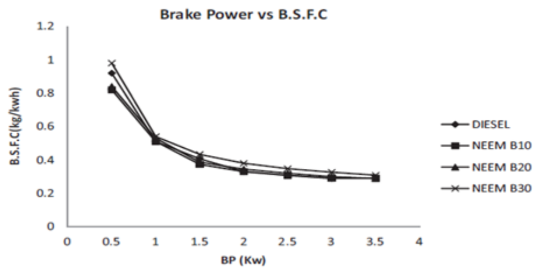

Fig. 8. BP vs. BSFC of ricebran blends

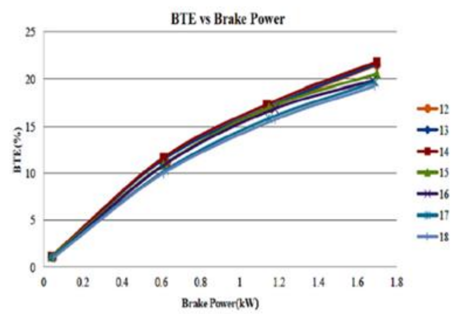

Fig. 9. BP vs. BTE of ricebran blends

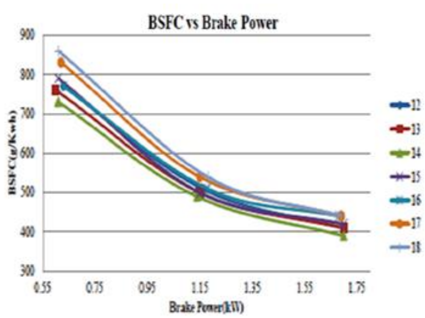

Fig. 10. BSFC vs. BP

3. Conclusion

The performance and emission characteristics of diesel fuel and biodiesel derived from Schleichera Oleosa Oil based on HC The better yield (95%) obtained for hydrodynamic cavitation process at the optimized conditions of 0.75 wt. % KOH as alkali catalyst and 1:6 of oil to methanol molar ratio, in very less time (30 min) Blended Biodiesel fuel gives lesser CO emission and higher carbon dioxide and NOx emissions than mineral diesel. From the experimental investigation on performance and emission test on diesel engine with blends of neem biodiesel Neem biodiesel blends are showing higher brake thermal efficiency than diesel [19]. In terms of brake power, neem biodiesel can replace diesel in the form of blends as there is no significant drop in engine performance. CO, HC, CO_2, and NOX emissions of neem biodiesel are decreasing than diesel. O2 emissions of neem biodiesel are increasing than diesel. From the experimental investigation on performance and emission test on diesel engine with blends of ricebran biodiesel Hydrocarbon emissions were observed for both CB20 and diesel at both CR. CB40 had highest hydrocarbon emission in both cases. CB10 and CB20 showed better carbon monoxide and carbon dioxide emissions than diesel at both CRs.

Higher NOX emissions were observed as compared to diesel. Similar performance results were observed for CB10 and CB20 as that of diesel [20]. Lower emissions as compared to diesel were observed for CB10 and CB20 except the NOX emissions which were higher in both cases. Jatropha methyl ester has lower volatility and higher viscosity compared to turpentine oil, which might have turpentine oil caused proper mixing and complete combustion; therefore, dual fuel blends shows lower emissions.

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