Review "Performance and Emission Characteristics of 4-Stroke 4-Cylinder Compression Ignition Engine Diesel Fuel Blended with Coconut Oil"

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Abstract

Coconut Oil-diesel is widely accepted as comparable fuel to diesel in compression ignition engines. It offers many advantages including; higher cetane number, reduced emissions of particulates, CO, NOX, and hydrocarbons, reduced toxicity, improved safety and lower lifecycle CO2 emissions. The objective of the present study is to reveal the effects of pure diesel fuel and coconut oil diesel fuel blends with indirectly heating of coconut-oil at 60°C before blending with diesel on the performance and emissions of a direct injection diesel engine. Operation of the test engine with pure diesel fuel and coconut oil-diesel fuel blends for a wide range of engine speed such as 800,1000,1200,1400 And 1500 Rpm and Full load (18 Kg) conditions will be shown to be successful even without engine modifications.

Keywords: Coconut Oil, Emissions, Biomass, Diesel, Blend

I. INTRODUCTION

The idea of using biomass-based fuels specifically, vegetable oil fuels as diesel fuel alternatives, is not new. Rudolf Diesel demonstrated that his engine would run on peanut oil fuel. Since then, various vegetable oils have been tested as diesel fuel alternatives with the increased availability of petroleum-based fuels, studies on vegetable fuels decreased.

A. *Tests with Coconut Oil Blends*

Coconut oil's special feature of readily mixing with diesel has been described already. There is a high production of coconut oil in tropical countries like India, Sri Lanka and Malaysia and so it could be a good partial replacement for conventional ODF. One major drawback is that the price of coconut oil is slightly higher than that of conventional petroleum fuels. But it could be the least cost alternative in terms of the global emissions management because coconut oil based fuels produce reduced exhaust emissions. Suitable proportions of 10% to 40% coconut oil blended diesel were prepared and the test engine was run for a long period of time using these samples.

II. LITERATURE REVIEW

Herchel Machacon et al [p1] studied objective of the present study is to reveal the effects of pure coconut oil and coconut oil diesel fuel blends on performance and emissions of a direct injection diesel engine. Operation of the test engine with pure coconut oil and coconut oil diesel fuel blends for a wide range of engine load conditions was shown to be successful even without engine modifications. It was also shown that increasing the amount of coconut oil in the coconut oil diesel fuel blend resulted in lower smoke and NOx emissions. However, this resulted in an increase in the BSFC. This was attributed to the lower heating value of neat coconut oil fuel compared to diesel fuel.

M.H. Jayed et al P2 studied the Environmental concerns and regulations to reduce green house gas emission and fluctuation of fossil fuel price have stimulated research on alternative fuels. Moreover, use of unproductive land to produce vegetable oil which is a potential biodiesel source has opened up a way to reduce oil bill. Biodiesel does not need major modification in engine, even though it causes some engine problems in long term use. This paper presents experimental results that evaluates the performance and exhaust emissions of a diesel engine operated on " Diesel" which consists of 5% palm diesel and 95% ordinary diesel fuel (also termed as P5) and C5 (5% coconut biodiesel and 95% ordinary diesel fuel. Experimental results showed that P5 and C5 reduced brake power compared to diesel fuel by 1.2% and 0.7% respectively. Emissions such as HC, smoke, CO and NOx concentration were lesser for P5 and C5. The results of this investigation will be used to partial replacement of diesel fuel using low percentage of methyl ester (maximum 5%) obtained from waste vegetable oils.

B. Durga Prasad et al P3 studied discusses the experimental study on the reduction of energy utilization and thereby abiding an indirect control on the emission strategies for a CI engine. Three different methods for the control of emission were carried out and the results were compared. The first method was to improve the combustion by incorporating a copper perforated medium beneath the atomized fuel spray and thereby improve the combustion through vaporization. The second method was to use coconut oil directly as an additive to diesel. The last method was to preheat the coconut oil blended diesel. The analysis showed that of all the coconut blends, namely, 10% to 50%, 20% blended ratio found a good place in both fuel efficiency and reduced emissions. Similarly, the preheated blends showed still drastic reductions in emissions even for higher proportions of coconut oil.

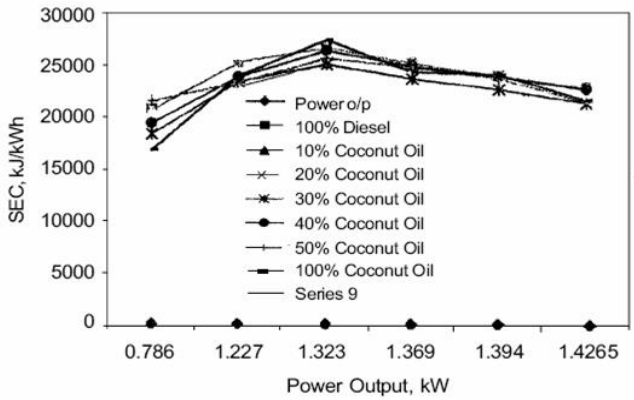


Fig. 1: Power Output Vs Specific Energy Consumption

The trend of the SEC curve had improved for preheated fuel from 100% diesel to 50% coconut oil. Optimum performance was obtained for 50% coconut oil (Figure-2.1), whereas, for blended coconut oil without heater it is only 20%. So, preheating decreases the SEC as a whole and it is less than non-preheated diesel. When the blending ratio was increased more than 50% it starts increasing.

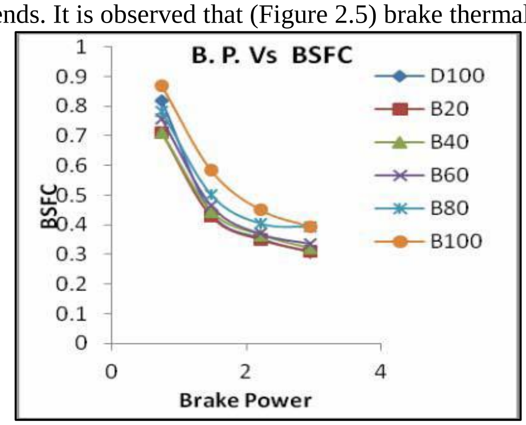
P. Venkateswara Rao et al P4 studied the biodiesel from edible oils is non-toxic, biodegradable and renewable alternate fuel that can be used as a substitute for diesel in diesel engines. The objective of present work is to study the performance and emission characteristics of single cylinder, direct injection diesel engine with coconut oil methyl ester (COME) and blends with diesel in varying proportions. Experiments were conducted when the engine fuelled with pure diesel and the blends of diesel - COME by volume for full load range. The exhaust conditions were measured using exhaust gas analyzer similarly AVL smoke meter for measuring smoke density. Results were compared graphically in performance of the engine for specific fuel consumption, brake thermal efficiency, exhaust temperatures and in exhaust emissions for concentrations of NOx and smoke density.

A. Engine Specification

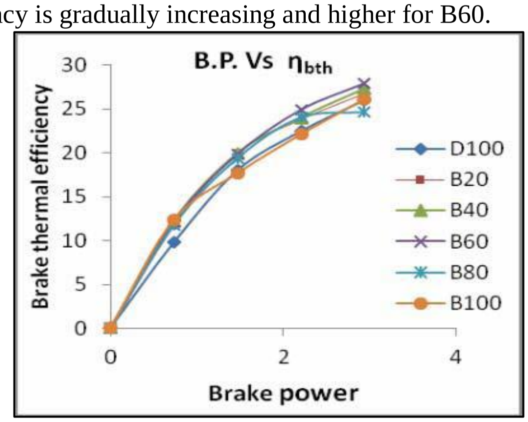
Table – 1
Engine Specifications

Model	***Vertical ,4-stroke, water cooled***
Rated power in KW	*3.68*
Speed	*1500*
Bore in mm	*80*
Stroke length	*110*
Compression ratio	*16:1*

At rated speed of the engine variation of brake thermal and BSFC are drawn with respect to brake power for diesel and diesel - COME blends. It is observed that (Figure 2.5) brake thermal efficiency is gradually increasing and higher for B60.



Fuel Consumption Vs Brake Power



Brake Power Vs Brake Thermal Efficiency

B. Engine Specification

Fig. 2: Engine Test Rig

Table - 2
Description

Make & Model	*Mahindra Engine*
General Details	*Four stroke, Four cylinder, Compression ignition, Water cooled, Indirect injection*
Bore	*90.9mm*
Stroke	*92.4 mm*
Compression Ratio	*16:1*
Lubricating Oil	*SAE 30/ SAE 40*
Max. Power	*40 B.H.P*

C. Physico-Chemical Properties

1) Density

Density is the mass per unit volume. The measurement was made at room temperature the density of coconut-oil was measured and then compared with that of diesel fuel.

2) Viscosity

When a fluid is subjected to external forces, it resists flow due to internal friction. Viscosity is a measure of internal friction. The viscosity of the fuel affects atomization and fuel delivery rates. It is an important property because if it is too low and too high then atomization and mixing of air and fuel in combustion chamber gets affected. Viscosity studies were conducted for different test fuels. Absolute viscosity sometimes called dynamic or simple viscosity is the product of Kinematic viscosity and fluid density. Kinematic viscosity of liquid fuel samples were measured using Kinematic viscometer shown in plate 3.2 at 40 ^{0}C

Where,

ν = Kinematic viscosity, cSt or mm^2/sec

c = constant; mm^2/sec^2

D. Flash and Fire point

Flash point is the minimum temperature at which the oil vapor, which when mixed with air forms an ignitable mixture and gives a momentary flash on application of a small pilot flame. The flash and fire point of the test fuels were measured as per the standard of ASTM D 93. The sample was heated in a test cup at a slow and constant rate of stirring for proper and uniform heating. A small pilot flame was directed into the cup through the opening provided at the top cover at the regular intervals. The temperature at which these vapour catches flash is observed and called as the flash point of that liquid. Fire point is an extension of flash point in a way that it reflects the condition at which vapor burns continuously for at least for 5 seconds.

E. Calorific Value

The calorific value is defined in terms of the number of heat units liberated when unit mass of fuel is completely burnt in a calorimeter under specified conditions. Higher calorific value of fuel is the total heat liberated in kJ per kg or m3. All fuels containing hydrogen in the available form will combine with oxygen and form steam during the process of combustion. If the products of combustion are cooled to its initial temperature, the steam formed as a result will condense. Thus maximum heat is abstracted. This heat value is called the higher calorific value. The combustion of fuel takes place at constant volume in a totally enclosed vessel in the presence of oxygen. The sample of fuel was ignited electrically. The water equivalent of bomb calorimeter was determined by burning a known quantity of benzoic acid and heat liberated is absorbed by a known mass of water. Then the fuel samples were burnt in bomb calorimeter and the calorific value of all samples were calculated. The Bomb Calorimeter used for determination of Calorific value.

III. CONCLUSIONS

The present study was carried on an unmodified diesel engine which was converted to run on a dual mode operation. The main objective of the present investigation was to evaluate suitability of Coconut oil (Preheated) as a fuel for use in a C.I. engine and to evaluate the performance and emission characteristics of the engine.

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