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Performance Analysis of Four Stroke CI Engine using Bio-Diesel

S. Nagendra, A.V.N.S. Kiran, B. Santosh Kumar, D. Swetha, S.M. Saleemuddin

***Abstract:** With the decreasing trend of oil reserves and environmental changes due to burning of fossil fuels led to exploration of alternative energy sources for running vehicles. In regard to alternative energy, production of biodiesel will be the next choice for replacement of fossil fuels. It is well known fact that diesel engines when operated with biodiesels leads to lowering of global warming issues and emission levels. Second thing to note that biodiesel production should be cheap. In context to this edible and non edible oils combination for biodiesel production is a favorable choice. In the present work Biodiesel production using blends (coconut oil and cotton seed oil) is made from transesterification process and performance test is done on 4-stroke water-cooled diesel engine. It is noticed that coconut oil blend B10 is best alternative fuel and a replacement for diesel fuel in running 4-stroke water-cooled diesel engine.*

***Index Terms*: coconut oil, cotton seed oil, Diesel engine**

I. INTRODUCTION

The achievement of every researcher is to reduce the exhaust emissions and increasing the performance and efficiency of an engine. The exhaust emissions are harmful to human life and nature. To overcome these problems the emission reduction techniques like alternative fuels, catalytic converters and by adding the chemicals to the fuels etc are implemented to the engines. Majorly the compression ignition engines are releasing the exhaust emissions like hydrocarbons (HC), carbon monoxide (CO), nitrous oxide (NOx), to reduce the exhaust emissions by adding the alternative fuels with different proportions. Several researches has done there work on different alternative fuels and discussed. Yasutummi Yoshimot et.al (1999) took up the experimental work of operating a single cylinder diesel engine with emulsified frying oil.

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***** Correspondence Author (s)

S. Nagendra*, Assistant Professor, Department of Mechanical Engineering, Annamacharya Institute of Technology and Science, Rajampet, Kadapa Dist. INDIA.

A.V.N.S. Kiran, Assistant Professor, Department of Mechanical Engineering, Annamacharya Institute of Technology and Science, Rajampet, Kadapa Dist. INDIA.

B. Santosh Kumar, Assistant Professor, Department of Mechanical Engineering, Annamacharya Institute of Technology and Science, Rajampet, Kadapa Dist. INDIA.

D. Swetha, Assistant Professor, Department of Mechanical Engineering, Annamacharya Institute of Technology and Science, Rajampet, Kadapa Dist. INDIA.

S.M. Saleemuddin, Assistant Professor, Department of Mechanical Engineering, Annamacharya Institute of Technology and Science, Rajampet, Kadapa Dist. INDIA.

To reduce the viscosity, equal proportions of used frying oil and gas oil were mixed and emulations of this blended fuel and water prepared. The BSFC of neat bio diesel was lower than with gas oil of high loads and retarded injection timings, while the smoke density was reduced at all operating conditions. It was concluded that using biodiesel emulsions at a rated output, the trade – off relation NOx Vs bsfc and NOx Vs smoke density have improved slightly over the gas oil emulsion. It was considered that reduction in smoke, emissions, air: fuel ratio is because of the oxygen included in the fuel [1]. Ramadhas A.S et. al (2005), has done experimental work on characterization and effect of using rubber seed oil as fuel in the C.I engines. Initially problems like high viscosity, poor atomization, carbon deposits were encountered. In order to overcome these problems rubber seed oil was blended with diesel in various proportions. It was concluded that acceptable brake thermal efficiency and specific fuel consumption were noticed with blends containing upto 80% rubber seed oil. It was considered that the carbon deposits in the combustion chamber of engine are higher in the case of rubber seed oil blends because of incomplete combustion of fuel [2]. Lucio postioti et. al (2003) have carried out experimental work on the injection strategies turning for the use of bio derived fuels in a common rail HSDI diesel engine. It was concluded that at full load and part load operations appreciable reductions in combustion noise, CO, HC emissions could be achieved with a proper choice of pilot injection duration without significant penalties in smoke, NOx emission and brake specific fuel consumption. As far as the pilot injection timing is concerned, a significant sensitivity of CO, HC and combustion nose was observed, while FSN and NOx were less markedly influenced by pilot injection timing [3]. Ralph McGill et .al (2003) have conducted an experimental work on emission performance of selected biodiesel fuels. In this work they used rape methyl ester in 30% and neat for the test. They have also used soy methyl ester in 30% blend and used vegetable oil methyl ester in 30% blend. They presented the results for regulated emissions as well as for aldehydes and composition of particulate matter, and polyaromatic hydrocarbons. During their works they saw the emissions such as NOx, HC, CO and particulates are reduced [4]. Yu, C.W. et. al (2004) made investigations to determine engine performance and combustion analysis for waste cooking oil and diesel. It was observed that due to shorter ignition delay the premixed combustion phase of waste cooking oil was less intense than that of diesel. For waste cooking oil the peak pressures were 1.5 bar higher and occurred 1.1-3.8o earlier than diesel. He concluded that the energy released at the late combustion phase is higher due to heavier molecular weight material present in waste cooking oil. Due to carbon deposition the engine performance may deteriorate after prolonged use.

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The emissions are higher for waste cooking oil compared to diesel [5].

M.A. Kalam (2004) et.al made investigation to evaluate exhaust gas emissions and deposit characteristics of diesel engine when operated on preheated crude palm oil. It was observed that preheated palm oil reduce exhaust emissions as its viscosity is decreased. But preheated palm oil increases NOx emissions due to highest fraction of ash deposits. Preheated palm oil is suitable for long time engine operation. Increase in water in palm oil increases HC and CO emissions due to incomplete combustion. But emulsified fuels decrease NOx emission in comparison to diesel and preheated palm oil fuels [6].

A.M. Liaquat (2013) et. al made investigation to evaluate Effect of coconut biodiesel blended fuels on engine performance and emission characteristics. It was observed that increase brake thermal efficiency and specific fuel consumption [7].

H.G. Howa (2014) et.al made investigation to evaluate Engine performance, emission and combustion characteristics of a common-rail diesel engine fuelled with bioethanol as a fuel additive in coconut oil biodiesel blends. It was observed and find out characteristics of diesel engine by using Ethanol and coconut oil [8].

Corsini (2015) et. al made investigation to evaluate Engine performance, emission and combustion characteristics of Vegetable oils as fuels in Diesel engine and find out characteristics of diesel engine by using Vegetable oils. Objective In the present trend of depleting of fossil fuels it is very essential to concentrate on the quantity of the fuel and its usage. In instead of using pure diesel, to increase the usage one can go for oil blends. In this direction the effect of the attention on it blends of cotton seed and coconut oil with diesel are studied on engine performance [9].

R.Thirunavukkarasu(2016)et.al The current study takes out an experiment of using methanol in VCR engine. They are blended with diesel at various mixing ratios. The results of methyl alcohol works in engine were checked in an exceedingly single cylinder, direct injection, water cooled and high speed VCR internal combustion engine at varied engine load with constant engine speed of 1500rpm conjointly we tend to mistreatment the limit coated piston with MgO-ZrO2 and Al2O3-13%TiO2 to investigation on performance and emission characteristics [10].

From the literature survey it is noticed that much of the research work is not carried by using combination of edible & non- edible blends. The present paper work is carried on blending of alternative fuel to the diesel with the different proportions for coconut oil B10 (10% of coconut oil & 90% diesel), B15 (15% of coconut oil & 85% of diesel), B20 (20% of coconut oil & 80% of coconut oil) and in the same for cotton seed oil B10 (10% of cotton seed oil & 90% diesel), B15 (15% of cotton seed oil & 85% of diesel), B20 (20% of cotton seed oil & 80% of coconut oil).

II. EXPERIMENTAL ANALYSIS

A single cylinder 4-stroke water-cooled diesel engine having 5 HP as rated power at 1500 rpm was used for the research work. The engine is coupled to a rope pulley brake arrangement to absorb the power produced. The fuel flow rate is measured on volumetric basis using burette and a stopwatch. Thermocouples in conjunction with a digital temperature indicator were used for measuring the engine and exhaust gas temperatures. Air consumption is measured by using a M.S. tank, which is filled with a standard orifice and a U-tube manometer that measure the pressure inside the tank.

Fig. Experimental setup of 5 HP Diesel Engine

Engine Specifications

Engine	Kirloskar Diesel engine
Speed	1500 rpm
Number of cylinders	1
Compression ratio	16.5:1
Orifice meter	20mm
Maxmium H.p	5 H.P
Stroke	110 mm
Bore	80 mm
Type	Water cooled
Method of loading	Rope brake

III. EXPERIMENTAL PROCEDURE

Calculate the maximum load to be applied for a engine. Check the fuel supply, water circulation in the water system and lubrication oil in the oil sump. Ensure no load condition. The engine started and allowed to run an ideal speed for a few minutes. Gradually the engine is loaded by mechanical brake method and the speed is maintained constant. Make sure the cooling water is supplied to the brake drum. Load of the engine in steps of 0%, 25%,50%,75% and 100% of maximum load to be applied. Note corresponding readings of weight of the hanger, engine speed, spring balance, fuel consumption (time for 10 CC), manometer reading. After taking the readings, unload the engine, allow it to run for few minutes and then stop the engine.

IV. RESULTS AND DISCUSSIONS

Experiments have been performed, experimental data have been obtained, investigated and analyzed for a single cylinder 4-stroke, 5HP diesel engine using coconut, diesel and cotton seed oil at different blends.

Calculations of engine performance are derived in order to obtain the statistical differences between coconuts, diesel and cotton seed oil by using different blends.

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Most of the discussions emphasize on the comparison of engine performance for coconut, diesel and cotton seed oil by using different blends at minimum and maximum load condition at average speed (rpm) of the engine. During continuous running of a single cylinder 4- stroke, 5HP diesel engine for given time period, the mass flow rate of fuel, air flow rate for lambda (for getting engine performance), speed and oil temperature of engine, are studied and through overall performance of the engine has been shown. The variation of results appeared is according to load operations and type of fuel used.

V. ENGINE PERFORMANCE

Mechanical Efficiency (Table-1)

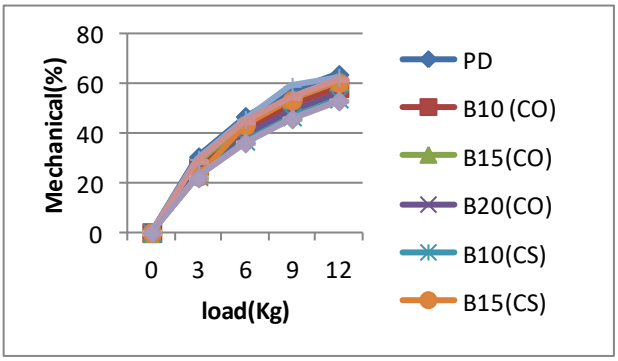

Fig. Load Vs Mechanical Efficiency

Mechanical efficiency at various loads of the engine is shown in Fig. This may be due to better lubricating property of the oil, which reduces frictional losses. Mechanical Efficiency is higher than that of B20 cotton seed oil at maximum load to compare other fuels and different blends.

Brake Thermal Efficiency(Table-2)

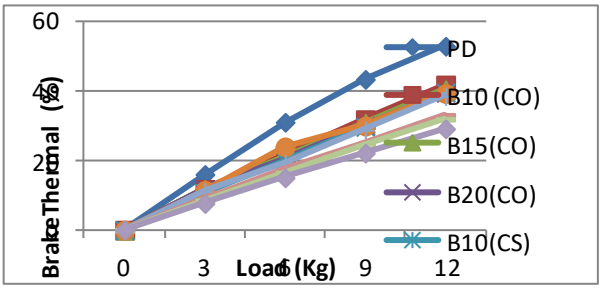

Fig load vs brake thermal efficiency

Fig. shows the variation of Brake thermal efficiency with variation of loads. It can be seen from graph that Brake thermal efficiency in all cases it increased with increased in load. The maximum Brake thermal efficiency was obtained at B10 coconut oil which are higher than other blends. The improved Brake thermal efficiency for lower concentration of cotton seed oil is due to more combustion and additional lubricates of oil. Indicated Thermal Efficiency (Table-3)

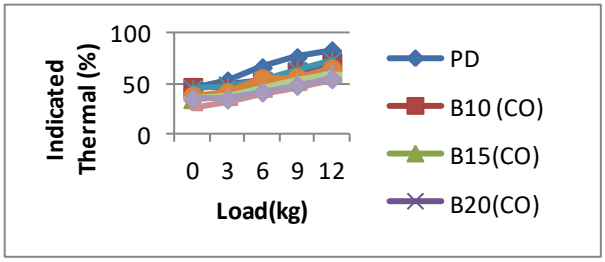

Fig..Load Vs indicated thermal efficiency

The variation of Indicated Thermal Efficiency with load for different fuels and blends is presented in Fig. It can seen from graph that Indicated Thermal Efficiency is higher than that of B10 coconut oil at maximum load to compare other fuels and different blends

TABLES

1. MECHANICAL EFFICIENCY

Load	PD	B10 (CO)	B15 (CO)	B20(CO)	B10 (CS)	B15 (CS)	B20 (CS)	B10B10D80	B15B15D70	B20B20D60
0	0	0	0	0	0	0	0	0	0	0
3	30.6	26.08	28.16	24.28	22.72	22.72	29.58	28.62	22.15	22.09
6	46.88	41.38	43.96	39.09	37.04	43.42	45.67	44.51	36.28	36.21
9	56.9	51.36	53.99	48.98	46.81	53.44	59.06	54.55	45.99	45.91
12	63.83	58.54	61.07	56.21	54.06	60.55	62.7	61.61	53.24	53.16

2. BRAKE THERMAL EFFICIENCY

Load	PD	B10 (CO)	B15 (CO)	B20(CO)	B10 (CS)	B15 (CS)	B20 (CS)	B10B10D80	B15B15D70	B20B20D60
0	0	0	0	0	0	0	0	0	0	0
3	15.98	11.71	11.72	11.74	10.74	11.4	11.01	8.83	8.47	7.62
6	30.96	21.57	20.89	20.38	19.78	23.88	19.2	17.37	16.43	15.01
9	43.27	31.71	30.69	29.97	29.58	29.86	28.72	25.1	24.19	22.1
12	52.78	41.66	40.31	39.38	39.55	39.21	38.4	32.98	31.82	29.07

3. INDICATED THERMAL EFFICIENCY

Load	PD	B10 (CO)	B15 (CO)	B20(CO)	B10 (CS)	B15 (CS)	B20 (CS)	B10B10D80	B15B15D70	B20B20D60
0	44.86	46.36	35.03	44.67	44.95	37.62	34.26	25.69	34.81	34.85
3	52.86	44.89	41.62	48.34	47.25	41.12	37.24	30.85	38.24	34.49
6	66.04	52.12	47.52	52.14	53.39	55	42.04	39.03	45.28	41.47
9	76.05	61.73	56.85	61.19	63.2	55.87	51.56	46.02	52.58	48.14
12	82.96	71.16	66.01	70.07	73.17	64.76	61.24	53.53	59.67	54.68

VI. CONCLUSION

The experimental investigation was carried out for different blends of Cotton Seed and Coconut oil and the performance was evaluated and compared with diesel. Cotton seed and Coconut based methyl esters (Biodiesel) can be directly used in Diesel engines without any modifications. The engine has been tested with two different oils blended separately with diesel. The Thermal efficiency of the engine is comparatively more when it is blended with coconut oil and increased by 5.33 % than Cotton seed oil and 26.31 % with coconut and cotton seed oils blends.

It is observed that among the coconut oil blend B10 performed better in terms of engine performance, compared to the other blends of cotton seed oil and coconut and cotton seed oils blends. Even through the viscosity of the coconut oil is low and is economically friendly. Considering the thermal efficiency, the coconut oil blend (B10) is preferable as it shows good characteristic curve.

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VII. SCOPE OF FUTURE WORK

The past studies reveal that variety of vegetable oils is investigated in CI engines with little or no modification. The blends of vegetable oils with diesel, pure vegetable oils were tried and the performance and emissions of these engines are reported. Since vegetable oils have high viscosity and low volatility, these have shown poor performance in the conventional CI engines. Engine starting, nozzle clogging, increased smoke, piston seizures due to deposit formation, lubricating oil deterioration are the problems reported. All these problems are persisting even with use of esterifies oils in engines. Though the researchers have recommended the use of some of the vegetable oils in diesel engines there is no evidence of any practical oil engines. Different levels of insulation are employed on a conventional CI engine as a first phase of the experimental work. It is planned to study the effects of various insulation levels and to identify the best method of insulation. In the best performed a single cylinder 4-stroke diesel engine, vegetable oils are tried to study the performance. For solving the problems associated with these oils, next phase of the work is planned with one of the oils which give better performance.

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AUTHORS PROFILE

Working as an Assistant Professor, having 07 years experience in Department of Mechanical Engineering, Annamacharya Institute of Technology and Science, (Autonomous) Rajampet, Kadapa Dist. INDIA. Published more than 1 International journal. Author area of interest in Internal Combustion Engines, Fluid Mechanics and Hydraulic Machines, Automobile Engineering, Power Plant Engineering.

Currently working as assistant professor in mechanical engineering at Annamacharya Institute of Technology and Sciences (Autonomous) Rajampet. Completed his UG at Intel engineering college anantapur, and completed P.G at Jawaharlal Nehru technological university (JNTUA), anantapur. He published 6 papers in reputed journals and also attended 1 international conference. His area of interest work on alternative fuels, IC engines,

Currently working as assistant professor in mechanical engineering at Annamacharya Institute of Technology and Sciences (Autonomous) Rajampet. Published more than 1 International journal. Author area of interest in Internal Combustion Engines, heat exchangers, conduction and heat mass transfer.

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