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Pongamia Oil, Methanol, Koh and its Effects on the Ci Engine Performance and Emission Characteristics of Organic Diesels

Jayendra Singh Dawer

Lecturer, Department of Mechanical Engineering, Government Polytechnic College,

Nowgaon (M.P), India

ABSTRACT: A growing demand for fuel was a dilemma for scientists today. The resources of fossil fuels are being reduced every day. We therefore need environmentally feasible biodiesel fuel as an option for the future. It is a viable fuel for the environment. Several researchers have systematically used petroleum and biodiesel as fuel in compression ignition engines. There are different raw materials, such as Pongamia Pinnata, Neem seeds, Cashew nut, Waste vegetables, Cotton seeds etc. In biodiesel fuel and lubricants non-edible oil seeds and other vegetable oils, including palm oil, soybean oil, Sunflower Oil, rapeseed oil and canola oil were used. Because of its simple availability in wild Pongamia pinnata might be a sure supply of raw material. Pongamia Pinnata is a semi-deciduous, nitrogen-resistant, dry-resistant leguminous tree. An experimental investigation has been conducted to evaluate the performances and emission characteristics of a compression fuel-ignition engine fueling Pongamia pinnata biodiesel with a mixture of 25%, 75% and 100% mineral diesel. The measurements were HC, CO, CO2 and smoke.

KEYWORDS: Pongamia Pinnata, Bio-Diesel, AVL Di Gas Analyzer, Kirlosker Engine, Dynamometer, Performance and Emission

I. INTRODUCTION

Biodiesel may be manufactured from a wide range of plant oils, edible as well as inedible biodiesel are produced from sunflower, peanut, palm and various other foodstuffs in most industrialised countries which are fundamentally edible in the Indian context. In developing countries such as India, then, biodiesel from non-edible oils can be produced extensively in the country's wastelands. The economic viability of biodiesel depends on the price of crude oil and the cost of transporting fuel to remote locations over vast distances. It is a truth that the cost of diesel will increase in the future as its demand and supply rises. Much research and development into internal combustion engines has been carried out not only in the design field, but also in the search for fuel. Many researchers found that biodiesel is a promising replacement fuel for diesel engines, given its near proximity to diesel fuel. Biodiesel's fuel qualities such as the number of cetane, combustion heat, gravity and viscosity impact on combustion and thus motor performance and emission.

Biodiesel is an alternative fuel exclusively formulated for diesel engines. It consists of vegetable oil or animal fats or is the name for a variety of ester based fuels commonly characterised as monoalkyl esters from vegetable oils by a simple process of transesterification. It is recommended as a petroleum-based diesel substitute mainly because biodiesel is a renewable domestic resources with an emission profile that is easily biodegradable. Biodiesel is biodegradable, non-toxic. It minimises hazardous emissions from diesel engines but increases emissions of nitrogen oxides. Biodiesel has a large amount of cetane. The Top Cetane



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Biodiesel numbers contribute to a smooth start to cold and low noise. The use of biodiesel may prolong the life cycle of diesel engines since they are more lubricant and because biodiesel does not influence power production. Pongamia pinnata is a lime-treated salt tolerant, dry nitrogen resistant to legumes and their seeds are well recognised for non-edible oil extraction. In this work, crude oil from Pongamia pinnate seed is utilised to synthesise biodiesel (fatty acid methyl ester) with methanol transesterification in the presence of two distinct base catalysts, NaOH and KOH at an ideal temperature of 60 ° C and a velocity of 300 rpm for 45 minutes. NaOH and KOH catalysed transesterification reactions yielded a percentage conversion of 68 percent and 73 percent respectively. The transesterified oil (biodiesel) obtained by two catalysts was also compared to crude Pongamia oil and a biodiesel mixture (B20). The density, viscosity and flash point were considered for the qualities of fuel[1].

The work parameters 1) Temperature, 2) time, 3) NaOH and 4) Methanol/oil ratios in biodiesel production have been optimised by 24 Central Composite design with the aim to increase diesel yields and reduce reaction time and temperature, in two steps acid/base catalytic transesterification of a non-edible Pongamia pinnata vegetable oil. The HPTLC and GC-MS study validated biodiesel output and compostation. The optimum conditions were: 1.44 reaction hours, 65°C reaction temperature, 0.80 wt% NaOH, and a 7.4:1 ratio of methanol to oil. The optimum yield was observed at 98.84 percent under optimal experimental conditions[2]. Biodiesel was made with the non-edible oil Karanja in the presence of the catalyst NaOH by means of the transesterification of crude oil with methanol. A maximum conversion of 92% (oil to ester) at 600c was achieved. Important bio-diesel methyl esters fuel qualities, such as viscosity, flash point, fire point, calorification value, etc, produced from karanja oil have been identified and compared to the Indian standard bio-diesel values[3].

The steady increase in the use of fossil and petroleum commodities has been a matter of great concern for emerging countries such as India. Increasing inflation, pollution and associated health risks, global warming, energy security, and fossil-fuel exhaustion have driven alternative energy. An experimental analysis was conducted to assess the performance and emission characteristics of a compression ignition engine that is fueled with different compositions of Karanja biodiesel and its blend at 5%, 10%, 20%, 25%, 75% and 100% with mineral diesel. HC, CO, CO2 and smoke were measured, with karanja biodiesel fuel found lower. However, karanja biodiesel NOx emissions and its blend were higher than diesel emissions. The combustion analysis was performed with peak cylinder pressure and heat release rate for crank angles. For karanja biodiesel, the peak cylinder pressure and heat release rate were lower. The results show that the engine performing with biodiesel karanja and its fusion with diesel fuel is largely comparable to pure diesel. [4]

Self-dependence on energy is essential to our country's overall economic development. The necessity to look for sustainable, safe and non-polluting alternative energy sources is of the utmost importance given the uncertain supplies and frequent fossil-fuel price rises on the international market. Biodiesel (fatty acid methyl ester) generated from triglycerides through transesterification has, as a renewable, biologically degradable and nontoxic fuel, gained substantial interest throughout the last decade. Several biodiesel fuel production procedures have been devised, including the transesterification of triglycerides into their respective methyl esters in the short run utilising alkali as a catalyst. This technology has consequently been widely used in several countries for the manufacturing of biodiesel fuel. There are several oil vielding trees in India such as ratanjot, mahua (madhuca indica), pilu (salvodara oleoides), kokam (garcinia indica), rubber seeds and karanja (pongamia pinnata) etc. Among these species, which may produce oil as a source of energy in biodiesel form, Pongamia pinnata was discovered to be one of the most suited species due to its different favourable characteristics such as its resistant nature, its high oil recovery and its oil quality, etc. The acid value of this oil is high, so that it has to be reduced by the esterification procedure followed by transesterification. The methyl ester thus formed produces the good effect. The present study focuses on the transesterification of karanja oil, which contains 907ml of karanja oil methyl ester (KOME) and 109ml of methanol glycerol (13%) and catalyst sodium hydroxide (1 percent). Eigensities such as density, viscosity, flash point, cloud point and pour point were established in accordance with the ASTM criteria for access to KOME fuel quality [5].



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Pongamia pinnata is a medium-sized glabrous and adaptable trees that requires adequate drainage and sunny site for tropical and subtropical countries. It easily grows from seed. Historically, this plant has been long employed as a source of medicines, animal fodder, green manure, lumber, fish poison and fuel in India and nearby regions. The plant extract has considerable antidiarrheal, anti-hungary, anti-plasmodium, anti-ulcerogenic and anti-plasmodium.

Inflammatory activity and analgesic activity. Its oil is a biodiesel source. It also has a renewable, safe and non-pollutant alternative energy source. This page examines briefly the botany, distribution, ecology, plant use and biodiesel supply. This is an attempt to aggregate and document knowledge about various aspects of Pongamia pinnata and their potential usage as a biodiesel source[6].

Pongamia Pinnata trees are usually planted near roads and canals in order to stop soil erosion. Throughout India there are billions of trees. If seed is collected on the road and oil is produced from expellers at village level, a few million tonnes of oil is available in rural areas for lighting of lamps. It is the finest replacement for kerosene. As seed gathering is distributed across a broad area, it is not viable to collect seeds for biodiesel production. (The biodiesel plant can be supported by a tiny plantation. Pongamia seedlings can survive on one stretch in 1,5 metres of deep water submergence/flooding for 5 to 6 months. In India there are around 30,000 square kilometres of water reservoirs. The tree can be grown up to a depth of 1.5 metres in our water storage tanks and extracted from underutilised reservoir land. Annual production of oil from its seeds is estimated at over 50,000 tonnes. No meaningful commercial application has yet been found for oil. However, because of the development in research knowledge and growth in Pongamia, it can be developed by replacing diesel as an alternate source of fuel. In the current study the extent of Pongamia in India was attempted[7].

Transesterification of Karanja oil with methanol for the manufacture of biodiesel studies have been conducted. For Karanja oil methyl ester production, the reaction parameters such as the catalyst concentration, alcohol/oil molar relation, temperature and mixing rate have been optimised (KOME). The quantity of fatty acid methyl esters in the reaction mixture was quantified by HPLC and 1H NMR technique. The yield of Karanja oil methyl esters under ideal conditions was 97–98%[8].

II. EXPERIMENTAL PROCEDURE

In this paper pongamia oil is raw oil. Take one liter of pongamia oil; the oil was heated in temperature $65^{\circ}C$ to

70⁰C in magnetic stirrer. Then take methanol 200ml and potassium hydroxide 15 grams both are mixed to make a

solution. After the raw oil was reached the temperature 70^{0} C, then the methanol and potassium hydroxide solution was mixed in the oil. The raw oil and solution was heat with half an hour, finally biodiesel was produced. The bio diesel was transferred to separating funnel. The funnel was fixed in the clam table, it is allowed to few hours for settling down. At this stage two major products are obtained that are glycerin and biodiesel.



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Fig (1) Crude Pongamia Oil



Fig (2) Magnetic Stirrer of Pongamia Oil



Fig (3) Esterification Process



Fig (4) Pure Bio Diesel base from Pongamia Oil

A single cylinder constant speed diesel engine has been selected to conduct experiments and studies the performance. The engine is connected with a dynamometer. The voltage, current and speed were taken using a voltmeter ,an ammeter and rpm meter respectively .diesel engine selected for the experimentation is the made of the kirloskar oil engines limited, india. It is a single cylinder, 4-strokes, 1500 rpm constant speed diesel engine of 4.4 HP rated power. The kirlosker engine is used extensively in agriculture, pump sets, farm machinery and industrial sectors .The engine with stand high pressure encountered during test because of its rugged construction. The injection timing recommended by the manufactural was 27 BTDC. The governor used to maintain constant speed under varying load conditions which control the fuel flow as load changes. The engine as open combustion champers with over head valves operated through push rods. A provision was made in the cylinder head surface to mount a piezo electric pressure transducer for measuring the cylinder pressure.



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Fig (5) Kirlosker Engine

The engine was set to run at constant speed of 1500 rpm .The load of the engine was obtained from load cell reading .the speed of the engine was monitored using sensor along with digital speed indicator. The fuel was supplied to the engine from the diesel tank and burette was placed in the panel board .When the fuel cock was closed the fuel to the engine will flow from the burette the fuel flow rates were obtained noting the time taken for 10cc for fuel consumption. In this study hydrocarbon (HC), Carbon monoxide (CO), nitrogen oxides (NOx) and smoke emission from the exhaust gas of the test engine were measured. Exhaust gas was sample from exhaust pipe o the test engine .The HC,CO and NOx emission from the test engine were measured by a AVL Di GAS ANALYZER. It is the based on non-dispersive infrared rays technique to measure the pollutants. The analyzer is allowed to warm up for few hours and then checked for the leak test. Before starting the analyzer ensure the absence of water droplets in the tubes of exhaust probe. Also the smoke emission from the test engine was measured in this study. In order to measure smoke emission, an opacity (AVL make) type smoke meter was used.



Fig (6) AVL Di GAS ANALYZER(Five Gas Analyser)

III. RESULTS AND DISCUSSION

The performance and emission of internal combustion engine was tested by various load conditions such as 33.35 N, 67.68 N, 101.04 N, 135.37 N, 169.71 N and various ratio mixtures of diesel and biodiesel. Then tabulate the



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readings and calculate the various powers and efficiencies. The below tabulation B25 contains the mixture of 25% of bio diesel and 75% of diesel. The tabulation B50 contains the mixture of 50% of bio diesel and 50% of diesel. The tabulation B75 contains the mixture of 75% of bio diesel and 25% of diesel. The tabulation B100 contains the mixture of 100% of pure bio diesel without any other chemical proportion.

2												
S. No	Fuel Consumption	Fuel Power	Brake Power	Indicated Power	Brake Thermal Efficiency	Indicated Thermal Efficiency	Mechanical Efficiency	Indicated Specific Fuel Consumption	Brake Specifi Fuel Consumption			
	×10 ⁻⁴ Kg\sec	KW	KW	KW	%	%	%	×10 ⁻⁵ Kg\kw.sec	×10 ⁻⁴ Kg\kw.sec			
1	1.8	7.92	1.02	5.2	12.88	65.66	19.62	3.46	1.76			
2	2.5	11	2.07	5.2	18.82	47.27	39.81	4.81	1.21			
3	3	13.2	3.09	5.2	23.41	39.39	59.42	5.77	0.97			
4	3.4	14.96	4.14	5.2	27.67	34.76	79.62	6.54	0.82			
5	4.01	17.64	5.19	5.2	29.42	29.48	99.81	7.71	0.77			

Table (1) B25

S. No	Fuel Consumption	Fuel Power	Brake Power	Indicated Power	Brake Thermal Efficiency	Indicated Thermal Efficiency	Mechanical Efficiency	Indicated Specific Fuel Consumption	Brake Specific Fuel Consumption
	×10 ⁻⁴ Kg\sec	KW	KW	KW	%	%	%	×10 ⁻⁵ Kg\kw.sec	×10 ⁻⁴ Kg\kw.sec
1	1.89	8.32	1.02	5.2	12.26	62.53	19.62	3.63	1.85
2	2.19	9.64	2.07	5.2	21.48	53.96	39.81	4.21	1.05
3	2.70	11.88	3.09	5.2	26.01	43.77	59.42	5.19	0.87
4	3.66	16.10	4.14	5.2	25.71	32.29	79.62	7.04	0.88
5	4.09	17 <mark>.9</mark> 9	5.19	5.2	28.83	28.89	99.81	7.87	0.78

TABLE (2) B50



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TABLE (3) B75

S. No	Fuel Consumption	Fuel Power	Brake Power	Indicated Power	Brake Thermal Efficiency	Indicated Thermal Efficiency	Mechanical Efficiency	Indicated Specific Fuel Consumption	Brake Specific Fuel Consumption
	×10 ⁻⁴ Kg\sec	KW	KW	ĸw	%	%	%	×10 ⁻⁵ Kg\kw.sec	×10 ⁻⁴ Kg\kw.sec
1	1.89	8.32	1.02	5.2	12.26	62.53	19.62	3.63	1.85
2	2.62	11.53	2.07	5.2	17.95	45.10	39.81	5.03	1.26
3	3.81	16.76	3.09	5.2	18.43	31.01	59.42	7.32	1.23
4	4.18	18.39	4.14	5.2	22.50	28.27	79.62	8.03	1.01
5	4.14	19.40	5.19	5.2	26.74	26.79	99.81	8.48	0.85

TABLE (4) B100

S. No	Fuel Consumption	Fuel Power	Brake Power	Indicated Power	Brake Thermal Efficiency	Indicated Thermal Efficiency	Mechanical Efficiency	Indicated Specific Fuel Consumption	Brake Specific Fuel Consumption
	×10 ⁻⁴ Kg\sec	KW	KW	KW	%	%	%	×10 ⁻⁵ Kg\kw.sec	×10 ⁻⁴ Kg\kw.sec
1	1.83	8.05	1.02	5.2	12.67	64.58	19.62	3.52	1.79
2	2.47	10.87	2.07	5.2	19.05	47.85	39.81	4.75	1.19
3	3.11	13.68	3.09	5.2	22.58	38	59.42	5.98	1.01
4	3.84	16.89	4.14	5.2	24.50	30.78	79.62	7.38	0.93
5	4.56	20.06	5.19	5.2	25.86	25.92	99.81	8.77	0.88

TABLE (5) DIESEL

S. No	Fuel Consumption	Fuel Power	Brake Power	Indicated Power	Brake Thermal Efficiency	Indicated Thermal Efficiency	Mechanical Efficiency	Indicated Specific Fuel Consumption	Brake Specific Fuel Consumption
	×10 ⁻⁴ Kg\sec	KW	KW	KW	%	%	%	×10 ⁻⁵ Kg\kw.sec	×10 ⁻⁴ Kg\kw.sec
1	1.76	7.74	1.02	5.2	13.17	67.15	19.62	3.38	1.73
2	2.09	9.19	2.07	5.2	22.51	56.55	39.81	4.02	1.01
3	2.73	12.01	3.09	5.2	25.72	42.29	59.42	5.25	0.88
4	2.86	12.58	4.14	5.2	32.89	41.32	79.62	5.5	0.69
5	3.27	14.39	5.19	5.2	36.07	36.07	99.81	6.29	0.63

PERFORMANCE CHARACTERISTICS

Brake thermal efficiency shows the performance of the particular fuel. Brake thermal efficiency increasing with increase of load. The variation of the brake thermal efficiency with respect to load for diesel fuel and pongamia methyl ester-diesel fuel blends. It can be observed from the figure that, diesel shows higher brake thermal efficiencies at all load conditions compared to that of pongamia biodiesel fuel. Almost all blends show slightly



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better BTE than diesel at higher load conditions. The higher thermal efficiencies may be due to the additional lubricity provided by the fuel blend.

BTE for pungamia biodiesel is lower than the diesel. This may be due to higher viscosity and its reduced energy content and lower calorific value compared to diesel. This results in poor atomization, incomplete combustion and lower heat release.

The variation of the brake specific fuel consumption with different loads and two different fuels of different heating values are blended together, the fuel consumption may not be reliable, since the heating value and density of the two fuels are different. In such cases, the brake specific energy consumption (BSEC) will give more reliable value. The brake specific fuel consumption was determined for pongamia bio diesel -diesel fuel blends as the product of the specific fuel consumption and the calorific value. It can be observed from the figure that the BSEC for diesel is lower as compared to that of biodiesel. The availability of the oxygen in the pongamia methyl ester-diesel fuel blend may be the reason for the lower BSEC.

In the case of lower load conditions, the incomplete mixture of high viscosity KME may lead to incomplete combustion and require additional fuel air mixture to produce the same power output as that of diesel fuel.



Fig (8) Brake Power Vs Brake Specific Fuel Consumption

Indicated thermal efficiency is decreasing while increasing the load. It is seen that indicated thermal efficiency for diesel is lower than the pongamia biodiesels. Indicated thermal efficiency of diesel is lower compare to the pongamia biodiesel. This may be due to high viscosity compare to diesel. It gives poor atomization and hence increasing ignition delay.

EMISSION CHARACTERISTICS

The below graph states that the brake power vs carbon mono oxide of the four blends and diesel. Comparing the four blends with diesel B50 gives the lower carbon mono oxide among the other blends such as B25, B75, B 100.



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Fig (9) Brake Power Vs Indicated Thermal Efficiency

From the below graph we can easily observe that the hydro carbon from blend B25 is lower than the other blends whereas diesel gives high amount of hydro carbon.







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The below graph determined the value of the brake power vs carbon di -oxide by comparison of four blends. The range of all the blends is same throughout the brake power, whereas the diesel rises at the point of brake power 4.14.



Fig (12) Brake Power Vs Carbon Di Oxide

From the below graph, observed that the range of oxygen level for four blends. From the observation the blend B100 gives the oxygen emission as much as possible.



Fig (13) Brake Power Vs Oxygen



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The below graph is states that the value of comparison of four blends for nitrogen oxide. From the graph the Blend B100 is much better than the diesel and then compare to other blends.



Fig (14) Brake Power Vs Nitrogen Oxide

IV. CONCLUSION

Based on the performance analysis and emission characteristics graph, we have investigated information on the pongamia oil biodiesel base. The performance analysis used constant brake power to create braking thermal efficiency graphs, brake specific fuel consumption and suggested thermal efficiency. By observing the graph, the B25 and B50 mixtures are significantly closer to diesel. However, the blends B25 and B50 are not adequate for emission characteristics.

We study emission gas characteristics using 5 gas analyzers to determine five different types of emitted gases such as carbon monoxide (CO), hydrocarbon (HC), carbon dioxide (CO2), oxygen(O2) and nitrogen oxide (NOX). The calculated emission characteristics chart shows that the B100 blend provides a lesser harmful material near the diesel engine for the CI engine. B50 is picked as the appropriate fuel fraction from the study, both performance and emission characteristics, to run the CI motor with less hazardous gas beside the B100.

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