EXPERIMENTAL STUDY ON THE PERFORMANCE AND EMISSION OF CI ENGINE FUELLED WITH BLENDED PONGAMIA BIODIESEL

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Abstract:*To meet the growing global energy requirement, an ever increasing demand of fuels has been a challenge for today's scientific workers. The fossil fuel resources are dwindling day by day. Biodiesel seem to be a solution for future. The main objective of the present study is to compare the performance, emissions and combustion characteristics of biodiesel derived from non-edible Pongamia oil in an unmodified diesel engine and to compare the results with baseline results of neat diesel. The performance parameters are evaluated in the present study of Pongamia biodiesel with different compositions at 20%, 35% and 50% with mineral Diesel. Also, emissions parameters such as carbon monoxide, carbon dioxide, HC, oxides of nitrogen and smoke opacity for different test fuels were also measured. The combustion analysis was done using peak cylinder pressure and heat release rate with respect to crank angle. The results from the experiments suggest that biodiesel from non-edible oil like Pongamia and its blends with diesel could be a potential fuel for diesel engine and play a vital role in the near future especially for small and medium energy product.*

Keywords*: Pongamia, Performance, Emission, Blends.*

1.Introduction:

Biodiesel is a renewable fuel produced from vegetable and animal fats that can be used in diesel engine with little or no modification. Biodiesel is typically blended with diesel fuel. Biodiesel can also be used in its pure form (B-100), but it may require engine modifications to avoid maintenance and performance problems. Biodiesel is gaining more and more importance as ansubstitute fuel due to the depletion of petroleum resources and price hike of petroleum products. Biodiesel produced from various edible (groundnut, rapeseed, castor, soybean, sun flower) and non-edible (Pongamia oil, cotton seeds, jatropha etc.) vegetable oil. Moreover, edible oils would be more expensive to use as fuels as compared to conventional petroleum fuels. Hence, the use of non-edible oils such as Pongamia (Pongamia Pinnata) would be more sustainable for biodiesel production. Pongamia tree is one of the underutilize types grown for shade on the roadside. Its seeds remain unattended as a non-profitable business and goes waste. Such unused sources of biomass are required to be converted into a potential source of energy. In the present study, Pongamia oil has been identified as a potential non-edible vegetable oil for biodiesel production. Biodiesel from Pongamia oil was obtained by using transesterification and major physio-chemical properties were evaluated in accordance with relevant ASTM standards. The performance, emission and combustion studies were carried out on a medium capacitycompression ignition engine which was fueled with Pongamia methyl ester and its blends with diesel. Exhaustive experiments were carried out on the test rig to evaluate the performance, emissions and combustion characteristics of neat Pongamia biodiesel and its blends with diesel fuel and the results were compared with baseline data of diesel.

2. What is Pongamia Oil?

2.1 Pongamia Oil:

It belongs to the family leguminaceae, commonly known as *Pongamia Pinnata*. Other name of Pongamia oils are Karanja oil or Honge oil. Pongamia is widely distributed in tropical Asia. The tree is hardy, reasonably drought resistant and tolerant to salinity. It is attractive because it grows naturally through much of arid India, having very deep roots to reach water, and is one of the few crops well-suited to commercialization by India's largepopulation of rural poor.ThePongamia tree is of medium size, reaching a height of 15-25 meters. The tree bears green pods which after some 10 months change to a tan color. The pods are flat to elliptic, 5-7cm long and contain 1 or 2 kidney shaped brownish red kernels. The yield of kernels per tree is reported between 8 and 24 kg. The composition of typical air dried kernels is: Moisture 19%, Oil 27.5%, and Protein 17.4%. The oil content varies from 27%-39%.

2.2 Production of biodiesel through Transesterificationreaction:

The transesterification process is the reaction of triglyceride (fat/oil) with an alcohol in the presence of acidic, alkaline or lipase as a catalyst to form mono alkyl ester that is biodiesel and glycerol. However the presence of strong acid or base accelerates the conversion. It is reported that alkaline catalyzed transesterification is fastest and require simple set up therefore, in current study the oil of Pongamia Pinnata were transesterified with methyl alcohol in presence of strong alkaline catalyst like sodium hydroxide or potassium hydroxide in a batch type transesterification reactor.

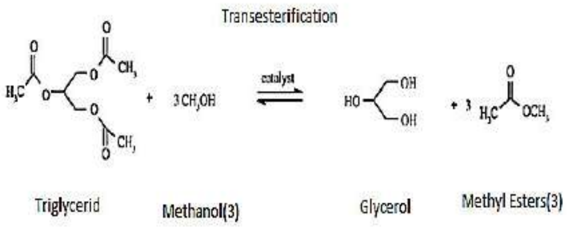

Figure 1: Transesterification Reaction

The transesterification reaction is given above has been widely used to reduce the high viscosity of triglycerides. To prepare biodiesel from Pongamia crude oil first sodium hydroxide was added in to the methyl alcohol to form sodium methoxide, simultaneously oil was heated in a separate vessel of transesterificaction reactor and subjected to heating and stirring. When temperature of oil reached at 60◦C then sodium methoxide was mixed in to the oil and reaction mixture was stirred for one and half hour. After reaction completion, the reaction mixture was transferred in separating funnel.

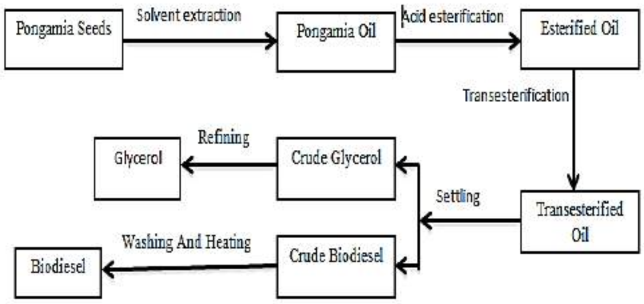

Figure 2: Biodiesel production from Pongamia seeds

The mixture of glycerol and methyl ester was allowed to settle for 8 hours. After settling for 8 hours glycerol and methyl esters was separated manually. The methyl ester was the washed with hot water to remove traces of sodium hydroxide impurity. The washed biodiesel then distilled to remove moisture and last good quality biodiesel was subjected for chemical analysis.

3. Experimental Setup:

A constant speed, Kirloskar make, single cylinder, air cooled, direct injection TV1 model diesel enginewas selected for the present experimentation. The detailed technical specifications of the engine are given in Table 1. The schematic diagram of the experimental setup along with all instrumentation is shown in Fig. 2. The engine trial was conducted as specified by IS: 10000. The fuel injection system was a traditional one consisting of single-hole pintlenozzle which injects the fuel at 200 to 205bar. AVL 437 smoke meter and AVL Di Gas Analyzer were used for the measurements of various exhaust gas emissions. Fuel tank is provided in the set up. By using a single way valve, the engine was then allowed to run on various blends. Three sets of experimental investigations were conducted in the present study and average of the three readings was taken for further analysis. The engine was gradually loaded in the range of no load, 20%, 40%, 60%, 80% and 100% load. The performance emission and combustion characteristics of, different blends of biodiesel and diesel (20% Biodiesel and 80% Diesel named as B20, 35% biodiesel and 65% Diesel named as B35, 50% biodiesel and 50% Diesel named as B50) were evaluated and compared with the baseline data of diesel fuel (D100).

Make/Model	Kirloskar/TV1 Engine
No. of cylinder	1
No. of strokes	4
Fuel	Diesel
Rated power	5.2KW
Speed	1500RPM
Cylinder diameter	110mm
Stroke length	17.5:1
Orifice diameter	20mm
Dynamometer arm length	185mm

Table 1: Engine Specification

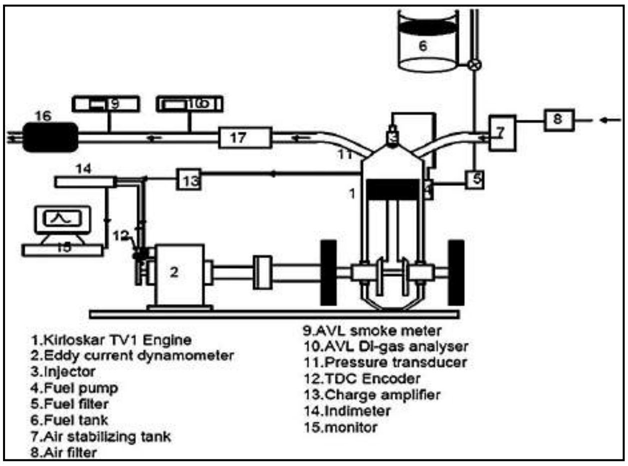

Figure 3: Experimental Engine Setup

4. Result and discussion:

The analysis of combustion characteristic of diesel and biodiesel of Pongamia were carried out. It is clear from Fig.4 using cylinder pressure difference with respect to crank angle, B20 have the peak cylinder pressure of 72bar which is very much nearer to base value of diesel and all the other blends comparatively have lower cylinder pressure. B50 have the very low cylinder pressure of 43bar, from this we can conclude that B20 have the combustion characteristics near to diesel fuel.

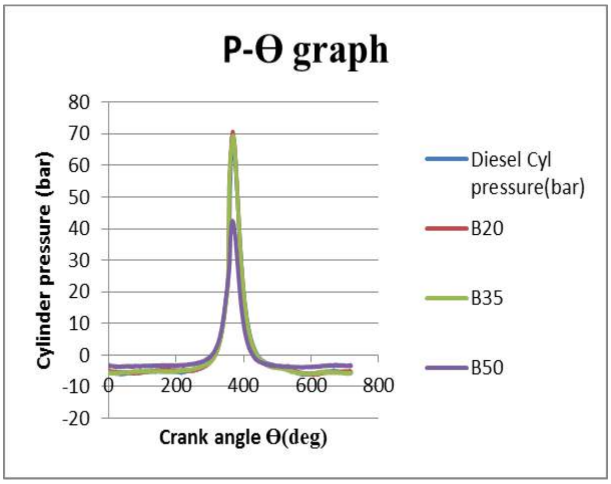

Figure 4: Pressure v/s Crank angle

Fig.5 shows the combustion characteristics between crank angle and net heat release rate. Similar to the cylinder pressure, B20 has peak heat release rate of 82.9W at the crank angle of 357θ and neat diesel has comparatively lower value of heat release than the B35. B50 has poor heatreleasehence engine needs a modification for this blend.

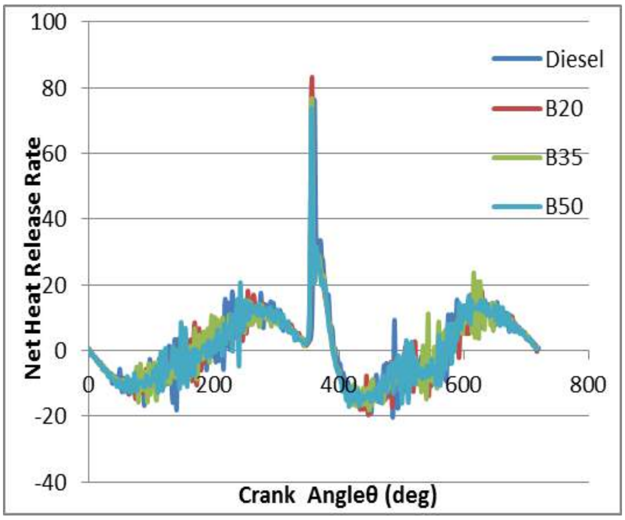

Figure 5: HRR v/s Crank angle

Fig.6 shows the variation of graph between the break thermal efficiency and the indicated thermal efficiency with that of full loading conditions. Indicated thermal efficiency of B50hasrelativelyhigher values than the neat diesel. B20 and B35 are lesser in value to the B20 at peak load. Brake thermal efficiency of B20 at different loads are nearer to the base line data while the other two blends are having low efficiencies.

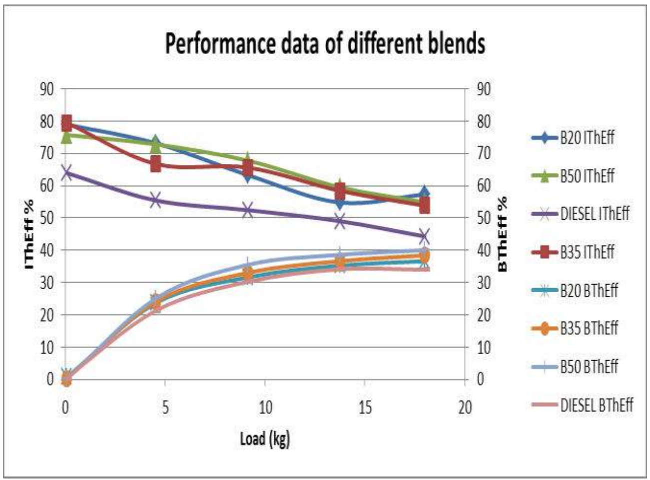

Figure 6: Performance Graph

EMISSION	Diesel	B20	B35	B50
CO %	0.153	0.317	0.287	0.259
HC PPM	45	88	75	67
CO_2 %	9.02	9.65	9.59	9.39
O_2 %	7.8	6.92	6.86	7.28
NO_X %	2049	2218	2318	2530
OPACITY %	76.6	65.5	72.9	75.5

Table2: Emission data at 100L

The carbon monoxide, HC and carbon dioxide contents of B50 is most suitable and leads to better combustion when compared to other blends B20 and B35. However the NOx emission of B50 is significantly more than the emission results of diesel. Smoke opacity percentage of B20 is even than lesser than that of the diesel, so cleaner air is ensured with B20.

5. Conclusion:

The present study carried on an unmodified diesel engine had the objectives of investigating the efficiencies, heat release, and maximum cylinder pressure and emission characteristics of different blends of Pongamia biodiesel. The performance results indicate that an increase of 5-8% with Pongamia biodiesel and its blends with respect to neat diesel. The peak cylinder pressure and the maximum heat release rate with respect to the crank angle were observed in Blends B20 and B35 respectively. The emission results indicate that B50 has lesser levels of CO, UBHC and CO_2, but NO_x emissions are of high value. The study has shown that biodiesel from non-edible oil source like Pongamia has the capacity to give effective performance and emission results even more than, that of neat diesel, thus the biodiesel derived from Pongamia and its blends could be used a conventional fuel for diesel Engines.

References:

1. Chauhan BS, Kumar N, Jun YD, Lee KB. Performance and emission study of preheated Jatropha oil on medium capacity diesel engine. Energy 2010; 35: 2484e92.
2. Magin L, Jose RF, Agudelo RJ. Diesel particulate emissions from used cooking oil biodiesel. Bioresource Technology 2008;99:731e40.
3. Sahoo PK, Das LM. Combustion analysis of Jatropha, Karanja and Polanga based biodiesel as fuel in a diesel engine. Fuel 2009; 88(6):994e9.
4. [15] Agarwal AK, Rajamanoharan K. Experimental investigations of performance and emissions of Karanja oil and its blends in a single cylinder agricultural diesel engine. Applied Energy 2009;86(1):106e12
5. S. N. Bobade, V. B. Khyade,"Detail study on the properties of pongamia piñata for the production of Biodiesel", Research journal of chemical science, July (2012) Vol2 (7), 16-20.
6. Avinash Kumar Agrawal,"Bifouls (alcohols and biodiesel) application as fuels for internal combustion engines" progess in Energy and Combustion Science33 (2007) pp.233-271.
7. P. L. Naik, D. C. Katpatal "Performance Analysis of CI Engine using Pongamia Pinnata (Karanja) Biodiesel as an Alternative Fuel" International Journal of Science.
8. Saroj K. Padhi and R. K. Singh, "Non-edible oils as the potential source for the Production of biodiesel in India: A review" Journal of chemical and pharmaceutical Research 2011, 3(2):39- 49.