ETI ENGINEERING AND TECHNOLOGY IN INDIA
Volume 3 | Issue 2 | October, 2012 | 102-106

RESEARCH ARTICLE

Emission characteristics of pongamia (*Pongamia pinnata* L.) biodiesel and its blends with petro diesel

SATISH R. DESAI AND P. VENKATACHALAM

ABSTRACT : The acid rain, global warming and health hazards are ill effects of increased polluted gases like SOx, CO and particulate matter in the atmosphere due to use of fossil fuels. Among the various alternative sources to petroleum products, oil from tree seed/crops has a potential for meeting the increasing requirements of diesel. A study was conducted with different bio diesel (pongamia) blends (B20 to B100) to study the emission profile of a 3.73 Kw diesel engine. The study indicated that the exhaust gas temperature was less using pongmia biodiesel blends and was at par with petro diesel, with less amount of CO and CO_2 emission and more NOx emission. The exhaust gas profile of the engine during pumping of water using a centrifugal pump was similar to the laboratory load test of the engine indicating usage of pomgamia biodiesel as an alternative to petro diesel being eco friendly and non health hazards.

KEY WORDS : Biodiesel, Emission characteristics, Nox emission

Article Chronicle : Received : 01.09.2012; **Accepted :** 01.10.2012

How to cite this Article : Desai, Satish R. and Venkatachalam, P. (2012). Emission characteristics of pongamia (*Pongamia pinnata* L.) biodiesel and its blends with petro diesel. *Engg. & Tech. in India,* **3**(2) : 102-106.

INTRODUCTION

India is the world's sixth largest consumer of energy and fifth largest in diesel consumption (Joshi, 2005). In India, the high-speed diesel is used up to 56.75 and 18.86 per cent for transport and agricultural sector, respectively. In India consumption of diesel is about five times more than gasoline. The energy demand for both industry and agricultural sectors is enormously increasing every year. The increase in energy demand for agricultural sector is mainly due to introduction of the machineries like tractors, power tillers, combine harvesters, power sprayers, irrigation pumps and other power operated machineries. The share of mechanical and electrical power has increased from 40 per cent in 1971 to 84 per cent in 2004 (Economic survey, 2005). The agriculture sector of the country is completely dependent on diesel for its motive power and to some extent for stationary power applications. Thus the increased farm mechanization in agriculture has further increased the requirement of this depleting fuel sources.

The alternative fuel technology usage will become more common in the coming decades for both automobile and stationery motive power applications in agriculture. The promising alternative is the usage of vegetable oils instead of fossile fuels. The esters produced from esterification process of vegetable oil present a very promising alternative to diesel fuel since they are renewable, non volatile and safer due to increased flash point, biodegradability, contain little or no sulphur. The main advantage of using of biodiesel is that its properties are similar to diesel fuel. Biodiesel being a superior fuel than diesel fuel from environment point of view. The use of diesel makes net addition of carbon to the atmosphere when burnt. The use of biodiesel also reduces dependence on crude of imports. As the flash point of the biodiesel is higher than diesel it has no storage problems. Biodiesel does not contain volatile organic compounds that give rise to poisonous and noxious fumes. It has no lead or sulphur to react and release of any harmful gases. Hence, an attempt has been made to study the emission characteristics of a 3.73 Kw engine using pongamia biodiesel and it's blends with petro diesel.

MEMBERS OF RESEARCH FORUM
Address for correspondence :
SATISH R. DESAI, Department of Agricultural Engineering, College of Agriculture, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA
Email: srdesaicae@gmail.com

Coopted Authors :
P. VENKATACHALAM, Department of Bio Energy, Tamil Nadu Agricultural University, COIMBATORE (T.N.) INDIA

EXPERIMENTAL PROCEDURE

A 3.73 Kw diesel engine was selected for the study had the specification as given in Table A. A test rig was developed / fabricated to test the performance of the diesel engine. The engine was coupled to the prony rope brake dynamometer to measure the power at different loads of no load, 25 per cent, 50 per cent, 75per cent and 100 per cent load. The engine was fueled with B0, B20, B40, B60, B80, and B100 biodiesel blends. The engine was tested at laboratory conditions and also for pumping water using a centrifugal pump.

Table A : Specification of the diesel engine

Specification	Remarks
Make	M/s. Rocket Engineering, Kolhapur, Maharastra state
Description	Four stroke, single cylinder engine
Fuel used	Diesel
Bore	80 mm
Stroke	110 mm
Piston displacement	50.272.cm^3
Speed	1500 rpm
Compression ratio	16:1
Output rated power	3.73 kW (5 hp)
Cooling system	Jacket type water cooling system
Lubricating system	Forced feed type

An Iron – Constantan thermocouple with digital temperature indicator was used to measure the exhaust temperature of the engine during the study at various loads. The emission of exhaust gas like carbon dioxide, carbon monoxide, nitrogen dioxide etc. during operation of the engine under laboratory and field condition with biodiesel and it's blends with petro diesel were measured using a KM900 Plus analyzer (Fig A).

Fig. A: Exhaust gas analyzer assembly (KM900 plus)

EXPERIMENTAL FINDINGS AND ANALYSIS

The experimental findings of the present study have been presented in the following sub heads:

Emission characteristics of the engine load test under laboratory condition :

Exhaust gas temperature :

The results of exhaust gas temperature of the engine at different loads using various blends of biodiesel are presented in Fig. 1. It was observed that the exhaust gas temperature increased with the increase in load for all the blends tested. This may be due to ignition delay and increased quantity of the fuel injected. The exhaust gas temperature for B20 to B100 varied between 198^0 C and 390^{0}C as compared to 206^{0}C and 386^{0}C for petro diesel indicating no much variation in exhaust gas temperature. This could be due to nearly the same quantity of fuel being consumed per hour for both diesel and biodiesel blends in each load setting of the engine. Since heat loss to the exhaust on per cent basis was approximately constant throughout the entire load range, hence, same quantity of fuel consumed means same heat was dejected, resulting in little variation in exhaust gas temperature. It is observed that as the load on the engine increased, the exhaust gas temperature also increased. This is mainly due to higher fuel consumption of the engine at higher loads. Similar trends of increase in temperature as the load increased was reported by Raheman and Phadatre (2004) for testing of 10 hp diesel engine using pongam biodiesel and its blends. They reported that for B20 to B100, the exhaust gas temperature varied between 260^{0}C to 336^{0}C as compared to 262^{0}C to 335^{0}C for diesel indicating no much variation in exhaust gas temperature.

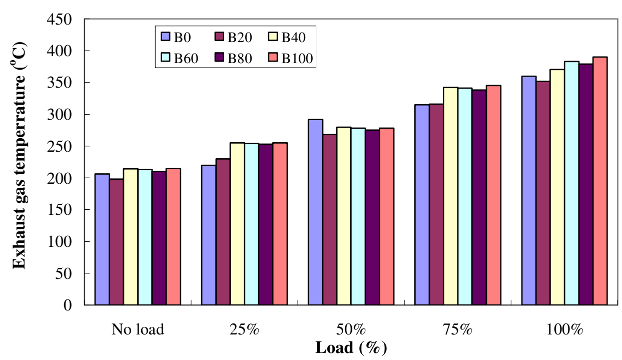

Fig. 1 : Variation of exhaust gas temperature with load for different blends tested

CO emission :

The variation in carbon monoxide emission with load for different blends of biodiesel tested is shown in Fig 2. From the figure it was observed that as the load increased, carbon monoxide emission decreased initially and further it increased as the load increased. At each load the amount of CO emitted was lower in case of biodiesel blends than that of petro diesel which may be due to less number of oxygen molecules present in the biodiesel compared to petro diesel. The addition of biodiesel to the petro diesel decreases the CO emission. The CO reduction by biodiesel varied from 10.24 to 17.84 per cent for B20 to B100. The similar results commensurate with Ramesh (2004) for Jatropha biodiesel and Chinna *et al.* (2005) for linseed, rice bran gobhi sarson (*Brassica napur*), sunflower and *Jatropha curcus* oil. They concluded that the combustible emissions for all bio-diesels were observed to be lower as compared to petro diesel.

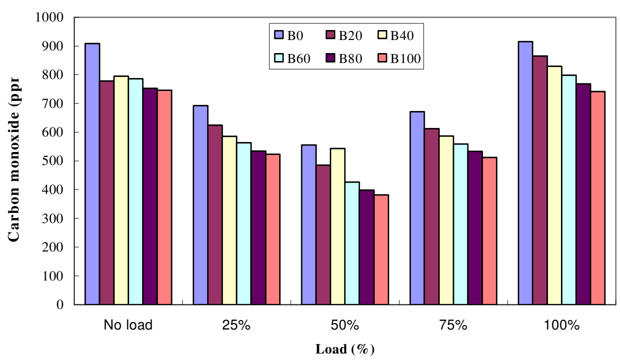

Fig. 2 : Carbon monoxide emmision of diesel engine at different loads using different blends

CO_2 emission :

Carbon dioxide emission at different loads using different blends of biodiesel tested is shown in Fig 3. It was observed that carbon dioxide emission increased with the increase in load for both petro diesel and biodiesel blends tested. The amount of CO_2 emission was lower in case of biodiesel blends compared to petro diesel. The CO_2 reduction by biodiesel varied from 6.89 to 27.58 per cent for B20 to B100. The similar results were reported by Anuraj (2008) for Jatropha biodiesel and its blends with petro diesel. The results inferred that the addition of biodiesel to the petro diesel decreased the CO_2 emission.

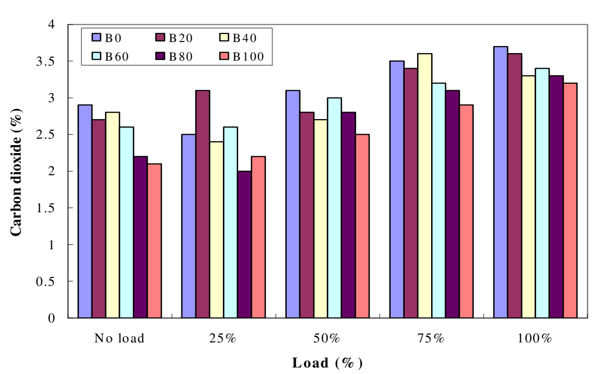

Fig. 3 : Carbon dioxide emmision of the engine at different loads using different loads

NOx emission :

The NOx emission from the engine at different loads using various blends of biodiesel is shown in Fig. 4. It was observed that NOx emission for different blends increased from average value of 75 ppm to 385 ppm as the load increased. Further the NOx emission for all the blends was more than that of petro diesel at higher loads. These results are in agreement with the finding of Anuraj (2008) for testing of power tiller engine using jatropha biodiesel and its blends with petro diesel.

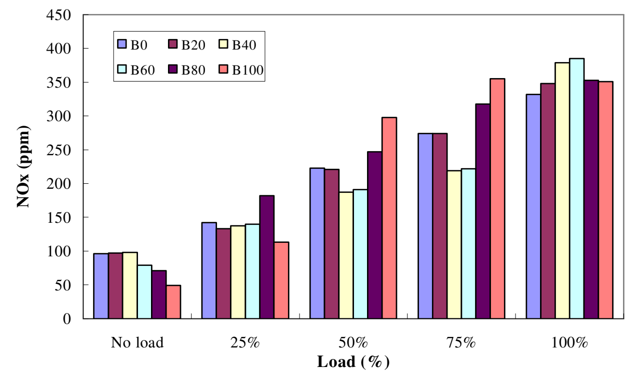

Fig. 4 : NOx emmision of the engine at different loads for different blends of biodiesel

Emission characteristics of the engine during water pumping:

Exhaust gas temperature :

The variation of exhaust gas temperature is presented in Table 2 and depicted in Fig 5. The exhaust gas temperature of the engine during pumping operation varied between 306 to 332^{0}C for B20 to B 80 as compared to 310^{0}C for petro diesel indicating no much variation in exhaust gas temperature. This could be due to nearly the same quantity of fuel being consumed per hour for both diesel and biodiesel blends. These trends are similar to the findings during the load test of the engine as explained earlier.

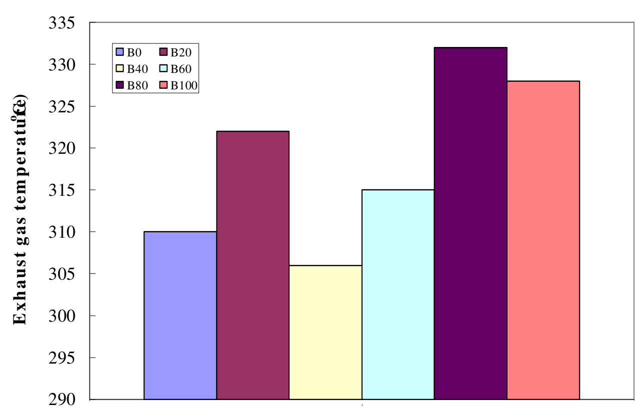

Fig. 5 : Exhaust gas temperature of the engine during pumping operation using different blends of biodiesel

CO emission :

The variation in carbon monoxide emission for different blends of biodiesel tested is shown in Fig 6. From the figure it was observed that the amount of CO emitted was lower in case of biodiesel blends than that of petro diesel owing to less number of oxygen molecules present in the biodiesel compared to petro diesel. The addition of biodiesel to the petro diesel decreased the CO emission. The CO reduction by biodiesel varied from 7.93 to 22.9 per cent for B20 to B100. The present results are in conformity with Ramesh (2004) for Jatropha biodiesel and Chinna *et al*. (2005) for linseed, rice bran gobhi sarson (*Brassica napur*), sunflower and *Jatropha curcus* oil. They concluded that the combustible emissions for all bio-diesels were observed to be lower as compared to petro diesel.

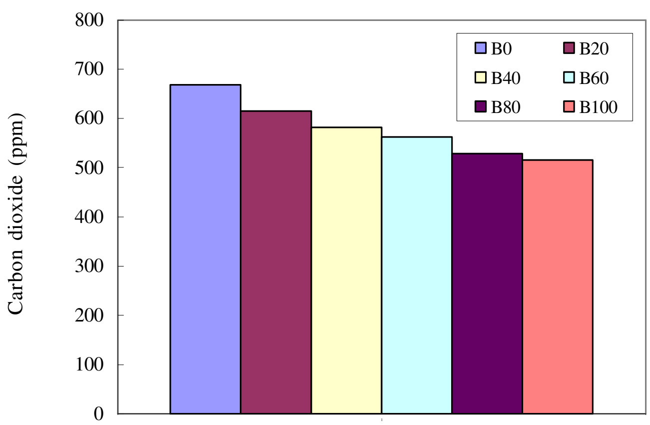

Fig. 6 : Carbon monoxide emmision from the engine during pumping operation using different blends of biodiesel

CO_2 emission :

Carbon dioxide emission using different blends of biodiesel tested during water pumping operation is shown in Fig 7. It was observed that the amount of CO_2 emission was lower in case of biodiesel blends compared to petro diesel. The CO_2 reduction by biodiesel varied from 2.94 to 14.71 per cent for B20 to B100. The similar results were reported by Anuraj (2008) for testing of power tiller engine using Jatropha bio diesel and its blends with diesel. The results inferred that the addition of biodiesel to the petro diesel decreased the CO_2 emission.

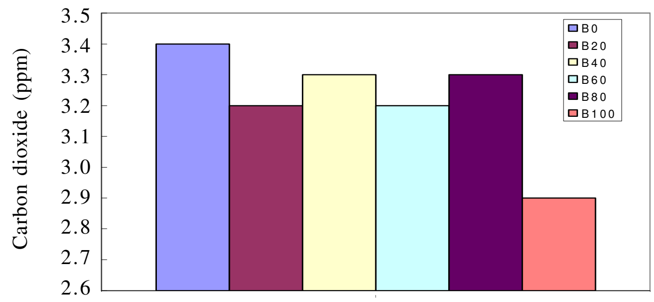

Fig. 7: Carbon dioxide emmision of the engine during pumping operation using different blends of biodiesel tested

NOx emission :

The emission of NOx from the engine during pumping operation using various blends of biodiesel tested is shown in Fig. 8. It was observed that NOx emission for different blends increased from 265 ppm to 356 ppm. Further the NOx emission observed was more for all the blends than that of petro diesel. These results are in agreement with the findings of Anuraj (2008) for testing of power tiller engine using Jatropha bio diesel and its blends with diesel.

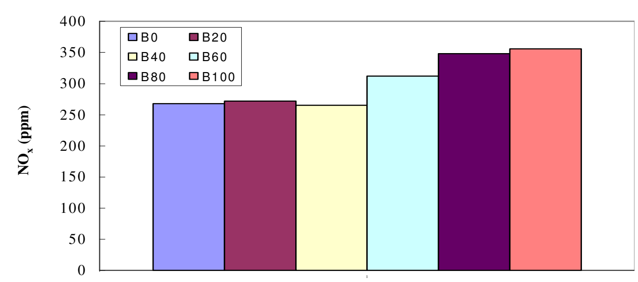

Fig. 8: NOx emmision of the engine during pumping operation using different blends of biodiesel

Based on the results of the present study it could be concluded that, the exhaust ga temperature of engine using pongamia biodiesel blends (B20 and B40) varied less with less amount of CO and CO_2 emission and more NOx emission compared to use of petro diesel in the engine. The exhaust gas profile of the engine for water lifting using a centrifugal pump was similar to that of load test indicating usage of pongamia biodiesel blends of B20 and B40 as an alternative to petro diesel being eco friendly and non health hazardous.

REFERENCES

Anuraj (2008). Performance evaluation of biodiesel in power tiller engine. Ph.D. Thesis, Department of Farm machinery, AEC&RI, Tamil Nadu Agricultural University, Coimbatore (T.N.) INDIA.

Economic Survey (2004-05). Indian agriculture, Ministry of Agriculture, pp.183-184.

Joshi, R.C. (2005). Biodiesel – Alternative energy source. *Employment News,* **30** (17): 1-2.

Ramadas, A.S., Muraleedharan, C. and Jayaraj, S. (2005). Performance and emission evaluation of a diesel engine fuel with methyl esters of rubber seed oil. *Renewable energy,* **30**:1789-1800.

Ramesh, D. (2004). Study on production of biodiesel from selected oil bearing nuts and utilization in engine, Ph.D. Thesis, Department of Farm machinery, AEC&RI, Tamil Nadu Agricultural University, Coimbatore (T.N.) INDIA.

Raheman, H. and Phadatare, A.G. (2004). Diesel engine emission and performance from blends of Karanja methyl ester and diesel. *Biomass & Bio energy,* **27** : 393-397.

Ravinder, Chhina, Verma, S.R. and Ajaysharda (2005). Exhaust emission characteristic of an un modified diesel engine operated on bio diesel fuels. *J. Agric. Engg*., **42** (1): 38-43.

****