International Journal of Advance Research in Science and Engineering
Volume No.06, Special Issue No.(02), December 2017
www.ijarse.com
IJARSE
ISSN: 2319-8354

Performance and emission analysis of a CI engine in Dual Mode with LPG and Jatropha Oil Methyl Ester

Pawan Kumar Singotia[1], Ashish Kumar Singh[1*], Ashish Kumar Mishra[1], Amardeep[2]

[1]*Mechanical Engineering Department, GLBITM, Gr. Noida, India*

[2]*Mechanical Engineering Department, IEC, Gr. Noida, India*

ABSTRACT

In the present study, a single cylinder four stroke dual fuel CI engine was tested to investigate the performance and emission characteristics of LPG and Jatropha oil methyl easter. The engine was tested in dual fuel mode using LPG and Jatropha oil methyl easter with a constant gas flow rate under different loading conditions. From the experimentation it was found that the dual fuel mode shows an improvement of 2% in brake thermal efficiency at full loads compared to diesel fuelled engine of operation, with no appreciable change at intermediate loads. HC and CO emissions are increased by 69% and 50% in the dual fuel mode of operation compared to Jatropha oil methyl ester fueled engine. The dual fuel operation improves the combustion. It shows higher peak heat release rate, compared to Jatropha oil methyl ester fuel operation. The peak pressures are higher in dual fuel operation in the entire load range when compared to Jatropha oil methyl ester fuel operation. In general assistance improves the part load performance in dual fuel engine with a significant reduction in emissions.

Keywords: LPG, Jatropha Oil Methyl Easter, Dual Fuel, Performance, Emission

1. INTRODUCTION

Use of vehicles is increasing day by day in India, due to which use of diesel and gasoline also increase rapidly. Diesel vehicles have high initial cost but good efficiency, diesel engine creates more pollution than gasoline engine. On other hand gasoline engines have less efficiency and also high rate of petrol in India. So it is very difficult use petrol vehicle in India. That's why the demand of LPG & CNG vehicles is increases rapidly because of economical and low-pollution vehicles. Dual fuel system in compression ignition (CI) engines has been proposed as one of the approaches to overcome the diesel engine emission issues such as particulate matter and NO_X[1].

The main benefits of converting diesel engines into LPG engines are both environmental and economic. In the dual fuel gas engines, the gaseous fuel is inducted along with the air, and this mixture of air and gas is compressed like in conventional diesel engines. A small amount of diesel or biodiesel, usually called the pilot, is sprayed near the end of the compression stroke to initiate the combustion of the inducted gas air mixture as in diesel engines [2]. With low load condition, the dual fuel engine gives significant reduction in oxides of nitrogen emission, smoke density, and also improves brake thermal efficiency. The combustion of pilot Jatropha oil methyl ester leads to flame propagation and combustion of the gaseous fuel. The engine can be run in the dual fuel mode without any major modification, but is usually associated with poor brake thermal efficiency and high HC & CO emissions at low loads [3].

The increase in pilot Jatropha oil methyl ester increases the brake thermal efficiency at low loads. At higher loads, it's efficiency reduced due to rapid combustion [4]. Low efficiency and poor emissions at light loads can be improved significantly by advancing injection timing of the pilot fuel [5-6]. Any measures that lower the effective lean flammability limit of charge and promote flame propagation will improve part load performance [7]. The gas concentration is low at lower loads, thus ignition delay period of pilot fuel increases, and some of the homogeneously dispersed gaseous fuel remains unburned which results in poor performance [7-8]. A concentrated ignition source is needed for combustion of the inducted fuel at low loads [9]. Poor combustion of the gaseous fuel at low loads results in higher emission of carbon monoxide and unburned hydrocarbons [10].

The hot surface assisted ignition concept is commonly applied to overcome the low temperature-starting problem in diesel engine. Introducing low cetane fuel such as alcohol and natural gas requires an extended application of the hot surface as continuous ignition assistance. The function of the hot surface is to provide favourable local ignition condition, followed by combustion propagating through the fuel air mixture to establish a stable diffusion flame [11].

The objective of the present work is to improve part load efficiency, which is the main drawback in dual fuel operation. In the present experimental work, the effect of introducing glow plug inside combustion chamber, which was not attempted earlier in the dual fuel operation, was studied. Pilot fuel quantity of 8.5 mg/cycle was introduced. It preheats the gas air mixture; and reduces the delay period of the pilot Jatropha oil methyl ester [10-11]. This results in improvement in the performance and in reduced emissions at low loads.

II EXPERIMENTAL SETUP

The base engine for this work is kirloskar four stroke, single cylinder, direct injection stationary diesel engine. The modification is being done in intake manifold to run engine on dual fuel mode. The engine intake system is modified via the installation of a specially designed venturi-type gas mixer that allows the introduction of liquefied petroleum gas, and mix with the fresh air. The mixture is allowed to preheat then induced to the cylinder as a result of engine suction. The liquefied petroleum gas is supplied through high-pressure (200 bar) commercial LPG bottles; typical to those used in vehicular applications. A multi stage pressure regulator is used to reduce LPG pressure to sub atmospheric level for suction of engine. An electrical dynamometer coupled to the engine was used as a loading device. The load can be assorted on the dynamometer and there by engine by switching on or off the load resistances. The technical specifications of engine and dynamometer are listed below in Table1.

Fuel consumption was measured with the help of a digital stopwatch and burette for JOME whereas mass flow rate of gaseous fuel is measured using a specially-designed Pitot-tube connected to a low pressure transducer having a maximum range of one inch of water. The pressure transducer converts the measured pressure to an analogue electrical signal, which is further manipulated via digital multi meter with computational functions, to be presented in the units of mass flow rate. The gaseous fuel, before entering the engine cylinder, passes through a small tank to damp the pressure fluctuation resulting from the engine suction.

AVL Di gas analyzer is used to record engine emission parameters like HC, NOx, CO etc. AVL smoke meter is used for measurement of engine smoke. All the instruments used in the test rig were of standard quality and the error within the permissible range. Detailed specification of test rig is mentioned in table 2. The engine trial was conducted as specified in IS: 10,000 and engine operated at no load, 20, 40, 60, 80 and 100% load condition.

Table 1 Technical specification of the engine and the alternator

Engine Specification	
Make	Kirloskar oil Engine Ltd., India
Model	DAF 8
Rated Brake Power (bhp/kW)	8/5.9
Rated Speed (rpm)	1500
Number of Cylinder	One
Bore X Stroke (mm)	95 X 110
Compression Ratio	17.5 : 1
Cooling System	Air Cooled (Radial Cooled)
Lubrication System	Forced Feed
Cubic Capacity	0.78 L
Starting	Hand Start with cranking handle
Dynamometer Specification	
Manufacturer	Kirloskar Electric Co. Ltd., India
Dynamometer Type	Single phase, 50 Hz, AC alternator
Rated Output	5 KVA @ 1500 rpm
Rated Voltage	230 V
Rated Current	32.6 A

International Journal of Advance Research in Science and Engineering
Volume No.06, Special Issue No.(02), December 2017
www.ijarse.com
IJARSE
ISSN: 2319-8354

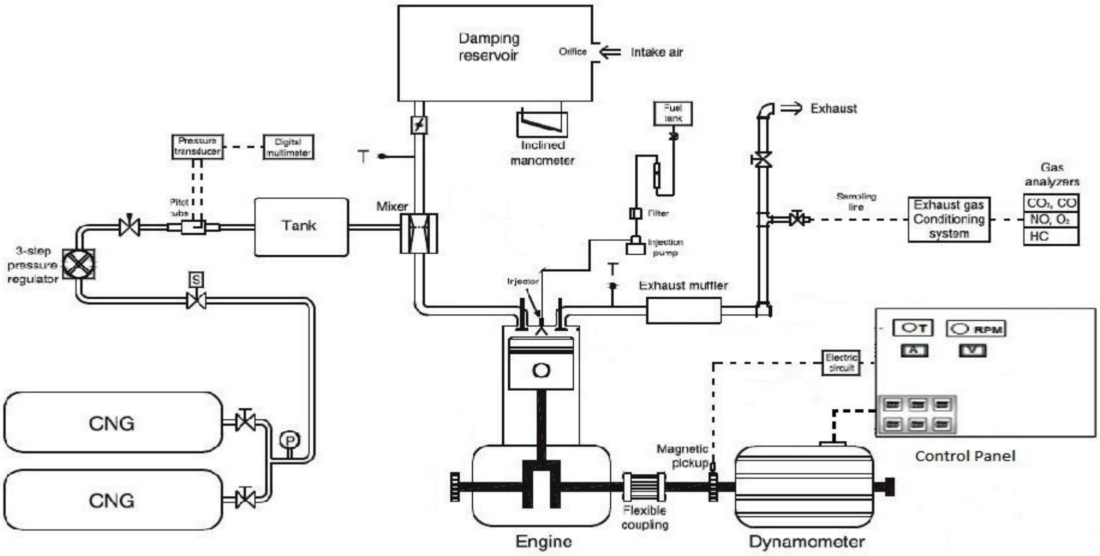

Figure 1 Schematic diagram of experimental test rig setup.

Table 2 Test rig specification

AVL Di Gas Analyser					
S.No.	Instrument Name	Measurement Range	Resolution	Measurement Technique	Percent Uncertainty
1	Carbon Monoxide	0 – 10 % volume	0.01 % Volume	Non dispersive infra-red sensor	0.2 %
2	Hydrocarbons	0 – 20,000 ppm Volume	1 ppm	Flame ionization detector - FID	0.2 %
3	Oxides of Nitrogen	0 – 5,000 ppm Volume	1 ppm	Chemi – luminescence principle, electro chemical sensor	0.2 %
4	AVL SMOKE METER	0 – 100 %	± 1 % Volume	Hatridge principle	0.1 %

III RESULTS AND DISCUSSION

The results obtained in the dual fuel operation are compared to Jatropha oil methyl ester; and are presented.

3.1. Brake Thermal Efficiency

The variation of brake thermal efficiency against load is shown in Figure 2. The dual fuel mode of operation improves the efficiency by 2% up to full load. Brake thermal efficiency ranges from 14.6 % to 34.7% in the case of dual fuel mode of operation. This may be reduction in delay period of pilot diesel and an increase in the mixture temperature. The brake thermal efficiency for Jatropha oil methyl ester varies from 16.1 % to 32.3 %.

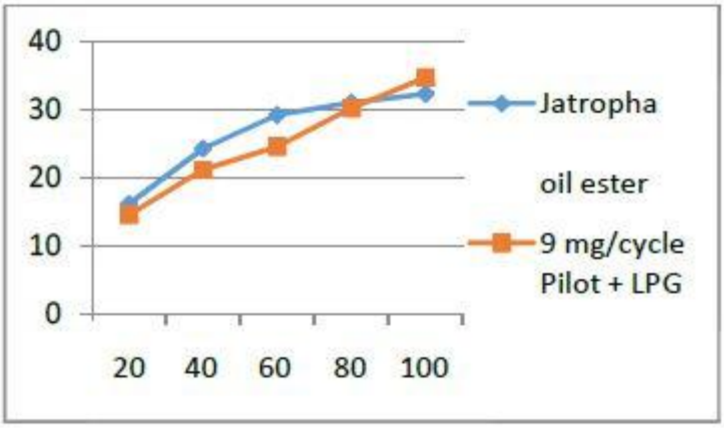

Figure 2 .Variation of brake thermal efficiency with load

3.2. HC and CO Emissions

Figure 3 shows the variation of hydrocarbon emission against load. The dual fuel mode of operation, it ranges from 11.9 g/kWh to 1.9 g/kWh, and for h.

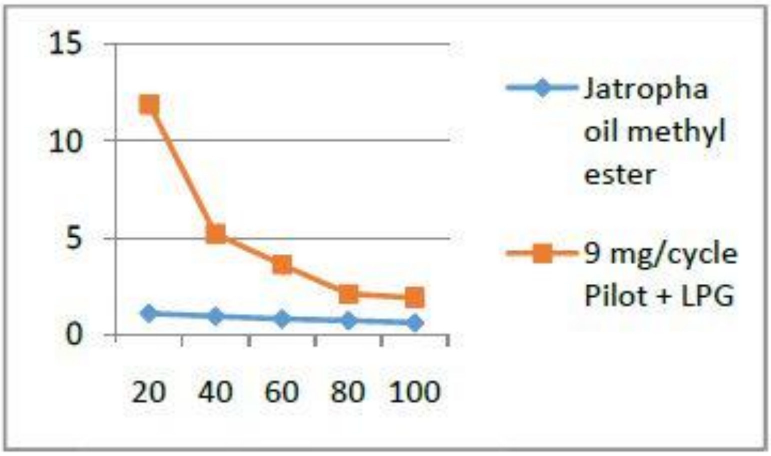

Figure 3. Variation of HC with load

Reduction in delay period of pilot Jatropha oil methyl ester, increase in pre flame reaction near the injector due to high temperature of gas air mixture which cause the increase in HC.

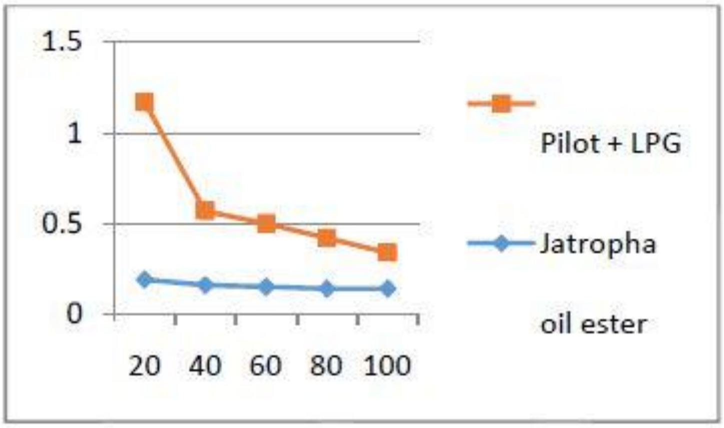

Figure 4 .Variation of CO with load

The variation of CO emissions against load is shown in Figure 4. The CO emission is increased throughout the engine operation in the dual fuel mode in comparison to simple biodiesel fuel mode of operation. It ranges from 0.98 g/kWh to 0.2 g/kWh whereas in the case of Jatropha oil methyl ester fuel mode of operation, it ranges from 0.19 g/kWh to 0.14 g/kWh. The reason for higher emission is the increased mixture temperature, which creates local turbulence and increase in flame velocity.

3.3. NOx Emission

The variation of NOx emission with load is shown in Figure 5. It increases marginally in the case dual fuel mode in comparison to Jatropha oil methyl ester fuel mode of operation. It ranges from 3.1 g/kW h to 2.7 g/kW h, whereas in the case of Jatropha oil methyl ester fuel mode of operation, it varies from 7.4 g/kW h to 5.8 g/kWh. The primary fuel forms a homogeneous mixture, and it leads to complete combustion and rise in the peak pressure resulting in high temperature inside the engine during combustion, and it increases the possibility of NOx formation.

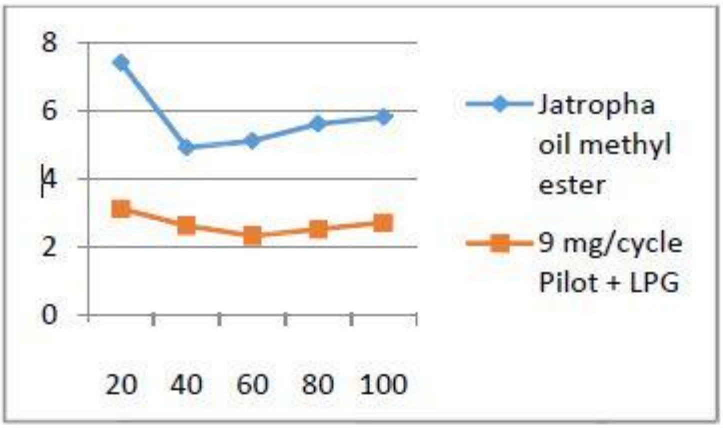

Figure 5. Variation of NOx with load

IV CONCLUSIONS

The following conclusions are drawn based on the experimental investigation:

- The dual fuel mode shows an improvement of 2% in brake thermal efficiency at full loads compared to diesel fuelled engine of operation, with no appreciable change at intermediate loads.
- HC and CO emissions are increased by 69% and 50% in the dual fuel mode of operation compared to Jatropha oil methyl ester fuelled engine.
- The dual fuel operation improves the combustion. It shows higher peak heat release rate, compared to Jatropha oil methyl ester fuel operation.
- The peak pressures are higher in dual fuel operation in the entire load range when compared to Jatropha oil methyl ester fuel operation.
- In general assistance improves the part load performance in dual fuel engine with a significant reduction in emissions

REFERENCES

[1] BB, Sahoo N, Saha UK., Effect of engine parameters and type of gaseous fuel on the performance of dual-fuel Sahoo gas diesel engines—a critical review, Renew Sustain Energy Rev 2009, 13,1151–84.

[2] D.T. Hountalas, R.G. Papagiannakis, Development of a simulation model for direct injuction dual fuel Diesel-natural gas engine, SAE Transactions, 2000-01-0286, 2000.

[3] Saleh HE, Effect of variation in LPG composition on emissions and performance in a dual fuel diesel engine, Fuel 2008; 87(13–14):3031–9.

[4] Korakianitis T, Namasivayam AM, Crookes RJ, Hydrogen dual-fuelling of compression ignition engines with emulsified biodiesel as pilot fuel, Int J Hydrogen Energy 2010, 35 (24):13329-44.

[6] G.H. AbdAlla, H.A. Soliman, O.A. Badr, M.F. Abd Rabbo, Effect of injection timing on the performance of a dual fuel engine, Energy Conversion and Management, Vol. 43, No.2, 2002, 269-277.

[7] G.H. AbdAlla, H.A. Soliman, O.A. Badr, M.F. Abd Rabbo, Effect of pilot fuel quantity on the performance of a dual fuel engine, Energy Conversion and Manageement, Vol. 41, No.6, 2000, 559-572.

[8] H. Raheman, A.G. Phadatare, Diesel Engine Emissions and Performance from Blends of Jatropha Methyl Ester and Diesel, Biomass and Bioenergy 2004.. 27:393-397.

[9] Gvidonas Labeckas, The Effect of Rapeseed Oil Methyl Ester on Direct Injection Diesel Engine Performance and Exhaust, Energy conversion and Management, 47, 2006, 1954-1967.

[10] N.K. Miller, G. Nagarajan, S. Renganarayanan, LPG fueled diesel engine using diethyl ether with exhaust gas recirculation, International Journal of Thermal sciences, Vol. 47, No. 4, 2008, 450 - 457.

[11] M.P. Poonia, Experimental investigation of the factors affecting the performance of a LPG-Diesel dual fuel mode, SAE Transactions, 1999-01-1123, 1999.

[12]Yamane K, Ueta A, Shimamoto Y. Influence of physical and chemical properties of biodiesel fuels on injection, combustion and exhaust emission characteristics in a direct injection compression ignition engine. Int J Eng Res , 2(4),2001,249–61