International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 10, October 2017
www.ijarse.com
IJARSE
ISSN 2319 - 8354

Performance of Duel Fuel Engine Operated on Honge Oil Methyl Ester and Biogas Combination

Pavangouda B. Kundagol[1], Vijaykumar R. Shivannavar[2], V.S. Yaliwal[3]

[1, 2,3]Department of Mechanical Engineering

SDM College of Engineering and Technology, Dharwad, Karnataka (India)

Abstract

Present work highlights the experimental investigation on a single cylinder four stroke direct injection diesel engine operated in duel fuel mode using Honge oil methyl ester (HOME) and Organic waste derived Biogas. HOME is used as a pilot injected fuel which ignites the Biogas and air mixture when subjected to higher compression ratio. In order to study the effect of compression ratio on the performance of dual fuel engine, the compression ratio of the engine was varied from 15 to 17.5. Comparative measures of Break thermal efficiency, emission parameters were made to study the effect of compression ratio on the duel fuel engine performance. The results of investigations were compared with the base line operation. Results revealed that the higher compression ratio resulted in overall improved performance with reduced emission levels.

Keywords: Biodiesel, Honge oil methyl ester, Biogas, Emissions.

I.INTRODUCTION

World energy council, a multi non conventional organization opined that in the next 20 years, the global demand for energy will increase by 40% and two billion people may have no access to commercial energy.

In India due to the rapid industrialization, urbanization and increasing use of modern agricultural techniques have all led to an electricity demand growing at a rate of 7 percent per annum [1, 2]. The planning commission estimates, India's total commercial energy supply at about 4000 billion kwh. This is estimated to grow to 20,000 billion kwh. The fossil fuels are going to be exhausted in near future because of limited reserve and it is estimated that by 2050 the 80% of the reserve will be exhausted [3, 4]. Apart from this they have a problem of emission of various pollutant gases into the environment. Therefore, the rising demand with shortfall in supply has increased cost of energy. This significant power sector challenges offer a unique opportunity to shift our technology towards greater use of renewable energy resources. In view of this, among the renewable technologies biogas is the most mature technology. Economically also biogas technology has the lowest financial input per kwh energy [5]. Biogas can be produced by anaerobic digestion of biodegradable organic matter. The product of anaerobic digestion is a combustible gas with about 60% methane and 40% of CO_2. Biogas technology provides energy, fertilizer and better sanitation. This composition of biogas depends on the raw material used for the biogas generation and ingredients used. Some of the factors affecting the biogas generation are long hydrocarbon chains, liquid present in the slurry, reaction time, pressure, temperature and carbon-hydrogen ratio etc. Varying the parameters, biogas composition may change. Therefore it is an ecofriendly technology. Use of biogas for engine applications lowers the emission levels with accepted levels of thermal efficiency [4, 6]. This technology can mitigate shortage of electricity in rural villages and it suitably addresses both health and waste management and socio-economic issues as well. India has largest population of livestock over 300 million and about 980 million tones of cattle dung is available. If the entire quantity of dung available for biogas production, it can generate nearly 2000 million kwh of energy annually. It is also estimated that biogas produced from municipal urban and industrial wastes can generate 2,700 mw of power.

The main objective of the work is to investigate the performance of dual fueled diesel engine operated on dual fuel mode using Honge oil methyl ester (HOME) as an injected fuel and biogas as an inducted fuel. the results of investigation were compared with base line data.

II. FUEL PROPERTIES

Honge oil is also called Karanja oil. Its botanical name is Pongamia pinnata L., belonging to the family Leguminaceae or Papilionaceae. The HOME can be produced by conventional transesterification process. Properties of Honge oil, HOME and biogas are given Table 1.

Table 1. Properties of pilot liquid fuel and biogas composition

Sl. No	Properties	Pilot fuel properties		Biogas composition	
		Diesel	HOME	Mathane	52-71
1	Viscosity @ 40 ^{0}C (cSt)	3.6 -3.9	5.6	Carbon dioxide	28-41
2	Flash point, ^{0}C	56	163	Hydrogen sulphide	6-11
3	Calorific Value, kJ / kg	45000	36,010	Hydrogen	0.75-2
4	Specific gravity	0.830	0.870	Nitrogen	0.25
5	Density, Kg / m^3	830	890	Water vapour	remaining
6	Carbon content (%weight)	76-81	89.6	---	---
7	Oxygen content (% weight)	0.1	11	---	---

III. EXPERIMENTAL SET UP:

In this present work, Kirloskar TV1 type, four stroke, single cylinder; water-cooled diesel engine test rig was used. Figure 1 shows photographic views of mixing chamber and experimental set up for duel fuel engine. Figure 2 shows the gas flow diagram for duel fuel engine. The specification of the compression ignition (CI) engine and biogas digester is given in Table 1 and 2. Electrical loading was used for engine loading. Exhaustive experiments on the diesel engine has been conducted at varying loads and operated at constant speed of 1500 rev/min. Biogas was generated by anaerobic digestion of organic material using a digester and is directly admitted into the combustion chamber during suction of the engine. The flow rate air and gas was measured using a calibrated single tube manometer and gas flow meter respectively. The biogas flow was not restricted and mixed with air using suitable mixing chamber shown in Figure 1. To prevent flow disturbance of biogas and air mixture, a suitable mixing chamber was used. Ability to maintain the required air-fuel ratio with varying load and pulsating gas flow conditions is taken care and ensured smooth operation. Fuel consumption during dual fuel operation has been measured on volumetric basis. The speed of the engine was maintained constant in both the versions of the injected fuels (diesel/HOME) operation by adjusting the governor speed. In the present work, pilot fuel injection timing, injection pressure and compression ratio were kept constant at 27^0 bTDC, 205 bar and 17.5 respectively. The exhaust gas analyzer and smoke meter were switched on and allowed to stabilize before the measurements, and these instruments were periodically calibrated. The temperature of cooling water at exit was maintained at 70^0C.

IV. RESULTS AND DISCUSSIONS:

This section presents the results and discussions on the performance of HOME- Biogas dual fueled engine.

Performance Characteristics

The variation of brake thermal efficiency (BTE) with a brake power is shown in Figure 3. BTE was found to higher for increased compression ratio (CR) due to decreased auto-ignition temperature of the fuel combination. Increase in CR increases flame temperature leading to better combustion with decreased residual gases [7-9]. BTE was lower for HOME-Biogas operation compare Diesel–Biogas operation. This could be due to incomplete combustion of the fuel combination due to effect of calorific value, lower higher viscosity and lower volatility of HOME. Increase in load produces more power due to the fact that governor acts automatically on fuel pump and reduces the pilot fuel supply and bring down the speed of the engine to the actual speed and maintains speed constant.

Figure 4 shows variation of fuel substitution with brake power. Maximum fuel substitution is most important in dual fuel mode of operation. Fuel substitution values were higher for increased CR due to improved BTE and decreased specific fuel consumption. It is observed that lower pilot fuel was consumed for higher CR. More Biogas burning was taken place at higher CR.

Table 2 shows specification of experimental test rig

Sl No	Parameters	Specification
1	**Machine Supplier**	**Apex Innovations Pvt Ltd, Sangli. Maharastra State.**
2	**Engine Type**	**Single cylinder four stroke water cooled direct injection TV1 CI engine with a displacement volume of 661 cc, compression ratio of 17.5:1, developing 3.7 kW at 1500**

		rev/min (Kirolsker make)
3	**Software used**	**Engine Soft**
4	**Nozzle opening pressure**	**200 – 225 bar (20 -22.5 MPa)**
5	**Cylinder diameter (Bore)**	**0.0875 m**
6	**Stroke length**	**0.11 m**
7	**Piston bowl dimension**	**52 mm diameter,**
8	**Clearance/length**	**40.1 cc at CR 17.5.**
9	**Connecting rod length**	**234 mm**
10	**Eddy current dynamometer:**	**Model :AG – 10, 7.5 KW at 1500 to 3000 RPM**

Fig. 1. Mixing chamber and experimental set up for duel fuel engine

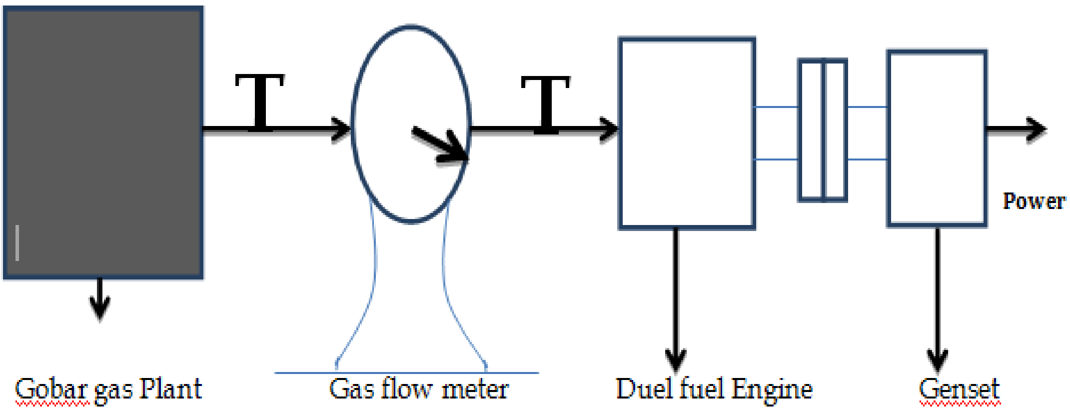


Fig.2 Gas flow diagram for duel fuel engine

V. EMISSION CHARACTERISTICS

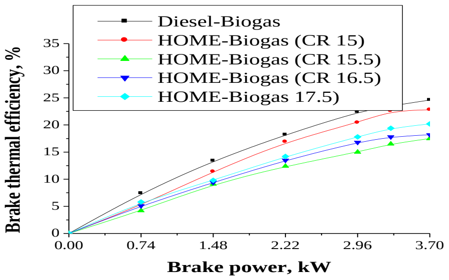
The emission from the engine indicates the combustion quality taking place inside the engine. The different emission levels during the dual fuel mode operation are discussed below.

Figure 5 shows variation of smoke opacity with CR. Results showed lower smoke levels with increasing CR due to increased combustion temperature and pressure. Increase in CR increases the flame temperature due to better burning of fuels [8]. Therefore lower smoke emission levels were obtained at higher CR with dual fuel operation. For the same CR, Diesel–Biogas operation resulted in lower smoke levels compared to HOME–Biogas operation. Increased smoke levels resulted from the HOME-Biogas operation due to heavier molecular structure and higher viscosity and density and poor atomization of HOME leading to incomplete combustion.

The variations of hydrocarbon (HC) and carbon monoxide (CO) emissions for diesel – Biogas and HOME – Biogas operation with respect to various CRs are shown in Figure 5 and 6. Increasing CR lowers both HC and CO emissions due to increased combustion temperature and pressures leading to improved combustion. Increased flame propagation caused by the increased CR, helps to burn the entire fuel mixture leading to burn complete fuel combination [7-9].

Dual fuel operation leads to slightly higher HC and CO emission levels at lower loads. This is because Biogas containing CO_2 and also the Biogas burns incompletely at lower loads due to lower combustion temperature. Further at higher loads higher CO was found to occur due to increase in fuel consumption. This Biogas and HOME mixture results in to incomplete combustion. This in turn leads to amplified CO and HC emission levels in the exhaust. However, dual fuel operation with HOME leads to higher HC and CO levels because HOME has higher viscosity and density, leading to relatively poor atomization.

The variation of NOx emission with brake power is shown in Figure 7 and 8. The NOx emission levels with HOME- Biogas resulted in lower NOx levels compared to Diesel-Biogas operation. This is because the combustion temperature inside the engine cylinder is lower with HOME-Producer gas combination and also it has lower calorific value.



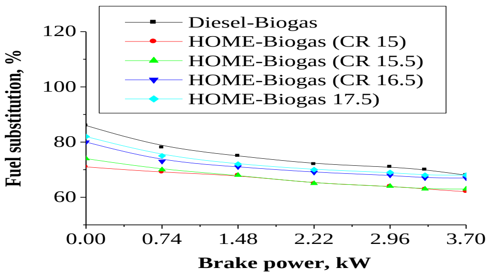


Fig.3. Variation of BTE with brake power **Fig.4.Variation of fuel substitution with brake power**

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 10, October 2017
www.ijarse.com
IJARSE
ISSN 2319 - 8354

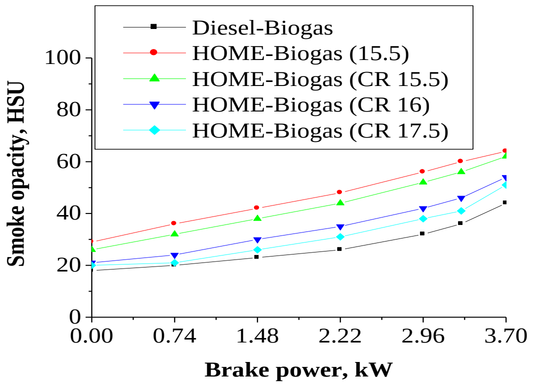


Fig.5. Variation of smoke opacity with brake power

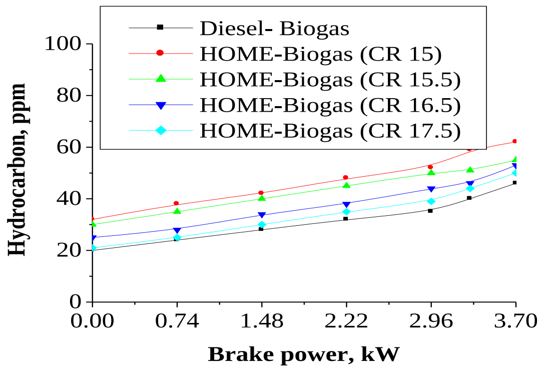


Fig.6. Variation of HC with brake power

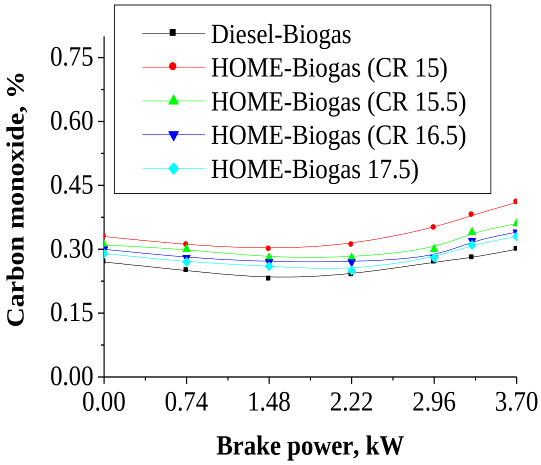


Fig.7. Variation of CO with brake power

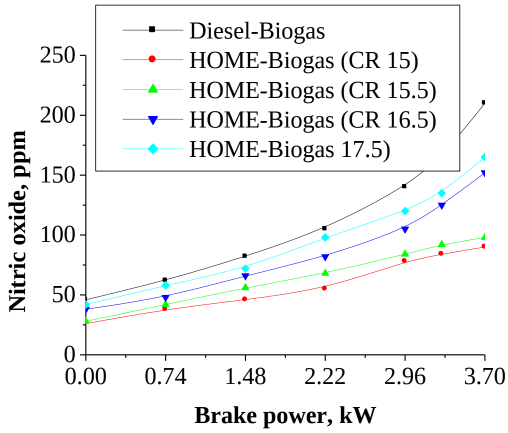


Fig.8. Variation of NOx with brake power

VII. CONCLUSION

Some important findings on the engine performance and environmental aspects in dual fuel mode of operation while using Biogas derived from organic waste and HOME as injected fuel with varying CR were made from the present study.

1. Among the renewable energy technologies biogas is the most mature technology and eco-friendly and engine can be operated with minor engine modifications.

2. Keeping all the facts in view performance of “duel fuel engine” was under taken. Results are encouraging. Liquid fuel saving in duel fuel engine is 88.0% and 76% for diesel and HOME based dual fuel operation respectively at 80% load.

3. Based on results of performance and emission levels, duel fuel engine is on far with the diesel engine and can be used to generate electricity.

REFERENCES:

1. Banapurmath, N.R., Tewari, P.G., Hosmath, R.S. Experimental investigations of a four-stroke single cylinder direct injection diesel engine operated on dual fuel mode with producer gas as inducted fuel and Honge oil and its methyl ester (HOME) as injected fuels. *Renewable Energy.* 2008, Vol.33, pp 2007–2018.
2. Banapurmath ,N.R., Tewari, P.G., Yaliwal, V.S., Satish Kambalimath, Basavarajappa, Y.H.,. Combustion characteristics of a 4-stroke CI engine operated on Honge oil,Neem and Rice Bran oils when directly injected and dual fuelled with producer gas induction. *Renewable Energy*. 2009, Vol. 34, pp 1877–1884.
3. http://mnre.gov.in/schemes/offgrid/biogas-2/
4. Saiful Bari, Effect of carbon dioxide on the performance of biogas/diesel duel-fuel engine, Renewable Energy, Vol. 9, Issue 1–4, 1996, pp 1007-1010
5. Dubey S. K. and S.K. Bhargava. Nonconventional Energy Resources, 2009, pp. 186.
6. Himsar Ambarita, Performance and emission characteristics of a small diesel engine run in dual-fuel (diesel-biogas) mode, Case Studies in Thermal Engineering, Vol. 10, 2017, pp 179-191.
7. Cenk Sayin, Metin Gumus,. Impact of compression ratio and injection parameters on the performance and emissions of a DI diesel engine fueled with biodiesel-blended diesel fuel." *Applied Thermal Engineering.* 2011, Vol. 31, pp 3182-3188.
8. Muralidharan K., Vasudevan D.,. Performance, emission and combustion characteristics of a variable compression ratio engine using methyl esters of waste cooking oil and diesel blends." Applied Energy. 2011, Vol. 88, Issue 11, pp 3959-3968.
9. Raheman, H., Ghadge, S.V., 2008. "Performance of diesel engine with biodiesel at varying compression ratio and ignition timing". Agricultural and Food Engineering Department. *Fuel.* Vol. 87, pp 2659–2666.