Performance and Emission Characteristics of Diesel Engine Fuels with Biogas and Neem Biodiesel Blends

Mr. Ankit N. Patel[1] D.C.Gosai[2] D.R.Shah[3]
[1]P.G.Student, [2,3]Associate Professor
[1, 2, 3] Mechanical Department
[1, 2] Shree S'ad Vidya Mandal Institute of Technology, Bharuch, Gujarat, India
[3] Government Engineering Collage, Ghandhinagar, Gujarat, India

Abstract--- This work presents the dual fuel measurements with Neem Biodiesel and Biogas using 7.5 kW Diesel engine. Tests are done with Neem Biodiesel and with Diesel to characterize the engine's total Fuel consumption, Brake Thermal Efficiency, Mechanical Efficiency versus Brake power. Dual fuel experiments, adding different quantity of Biodiesel at 15% and 25% blends with Biogas. The experimental results were better total Fuel consumption, Brake Thermal Efficiency, Mechanical Efficiency and Emission.

Keyword: Diesel engine, Performance, Emission, Biogas, Neem Biodiesel

I. INTRODUCTION

The crude oil and petroleum products, sometimes during the 21st century will become very scarce and costly to find and produce. At the same time, there will likely be an increase in the number of automobiles and other I.C. Engines. Although fuel economy of engines is greatly improved from the past and will probably continue to be improved, numbers only dictate that there will be great demand for fuel in the coming decades. Gasoline will become scarce and costly. Alternative fuel technology, availability, and use must and will become more common in the coming decades.

Diesel is a fossil fuel made from crude oil. The supply of diesel is limited. India is mainly dependent on Arab countries for their fuel supplies. India is largest cattle breeding country. There is abundance of raw material for producing biogas. Also municipal sewage can be used for this purpose. Biogas consists of approximately 55-65% of methane. Biogas can be produced by anaerobic digestion of organic matter. The raw materials for Biogas are cow dung, municipal waste and plants specially grown for this purpose such as water hyacinth, algae and certain type of grasses. The main advantage of Biogas is that it can be produced in rural areas from readily available materials.

Fuels derived from renewable biological resources for use in diesel engine are known as biodiesel. Biodiesel is environmentally friendly liquid fuel similar to petrol-diesel in combustion properties increasing environmental concern, diminishing petroleum reserves and agriculture based economy of our country are the driving force to promote biodiesel as an alternative fuel. Biodiesel operates in compression ignition engines like petroleum diesel thereby requiring no essential engine modifications.

A. BIOGAS

The biogas is generally produced from by dung from different beats as cow, buffalo, goats, sheep, horse, donkey and elephant. Biogas is produced by digestion, pyrolysis or hydrogasification. Digestion is a biological process that occurs in absence of oxygen and in the presence of anaerobic organism at ambient pressures and temperature of 35-70^{0}C. The container in which digestion takes place is known as the digester. Biogas plants have been built in various designs.

Biogas means social benefits for women in developing countries where every year a lot family tum away from the traditional fireplace and have a biogas plant installed to provide energy for cooking and lighting. In rural areas, where there is generally no electricity supply, the introduction of biogas has given women a sense of self-worth and time to engage in more activities outside the home. Dung is no longer stored in the home but is fed directly into the biogas plant, along with toilet waste. As a result, standards of hygiene have improved, and the vegetable patch has gained a top quality fertilizer that guarantees a better crop.

The importance of biogas in developing countries means a lot of benefits such as waste treatment benefits (natural waste treatment process, requires less land than aerobic composting or land filling, reduces disposed waste volume and weight to be land filled), energy benefits (net energy producing process, generate high quality renewable fuel, biogas proven in numerous end user applications), environmental benefits (significantly reduces carbon dioxide and methane emissions, eliminates odours, produces a sanitised compost and nutrient-rich liquid fertiliser, maximises recycling benefits), economic benefits (is more cost-effective than the other treatment options from a life-cycle perspective). But also social and environmental benefits, for this reason we believe biogas is a future energy in places where the conditions are suitable.

1) Composition Of Biogas

CH_4	: 55-65 %
CO_2	: 30-40 %
H_2 and N_2	: 5-10 %
H_2S and O_2	: Trace
Octane rating without CO_2	: 130
Octane rating with CO_2	: 110

2) Properties Of Biogas

Specific Gravity	: 0.84
Density (kg/m^3)	: 1.19177
Calorific Value (KJ/kg)	: 22280
Octane Number	: 120
Stoichiometric A:F ratio	: 9.5:1 to 10:1

B. NEEM BIODIESEL

Neem (Mellia azadirachta) is of Meliaceae family. The other names of neem are margosn, Veppam, Vepun, Nimba and Vepa (Telugu) etc. It is one of the two species in the genus Azadirachta and is native to India and Burma, growing in tropical and semi tropical regions. Neem is a fast growing tree and can reach up to a height of 15-20 merrily to 35-40m. It bears an ovoid fruit, 2cm by 1cm and each seed contains one kernel. The seed kernals which weigh 0.2g constitute some 50-60% of the seed weight and 25% of the fruit. The fast content of the kernerls ranges from 33-45%. The fruit yield per tree is 37-55kg. Neem oil is used as Soaps, medicinal and insecticide.

Neem oil is a vegetable oil pressed from fruits and seeds of neem, an evergreen tree which is widespread to the Indian Subcontinent and in many tropical areas. Neem oil is Light to Dark Brown in colour, Bitter in taste and has a strong odour. It comprises of Triglyceride and Triterpenoid compounds. Neem Oil is Hydrophobic in nature and in order to emulsify it in water for application purpose. Neem oil is generally light to dark brown, bitter and has a rather strong odour that is said to combine the odour of peanut and garlic. It comprises mainly triglycerides and large amouns of triterpenoid compounds, which are responsible for the bitter tasted.

1) Properties Of Neem Biodiesel

Density (kg/m^3) : 0.86
Calorific Value (KJ/kg) : 37230
Kinematic Viscosity @ 25^{0}C : 7.9
Flash point (^{0}C) : 106
Cloud point (^{0}C) : 10.2
Pour Point (^{0}C) : 6

II. EXPERIMENTAL SETUP

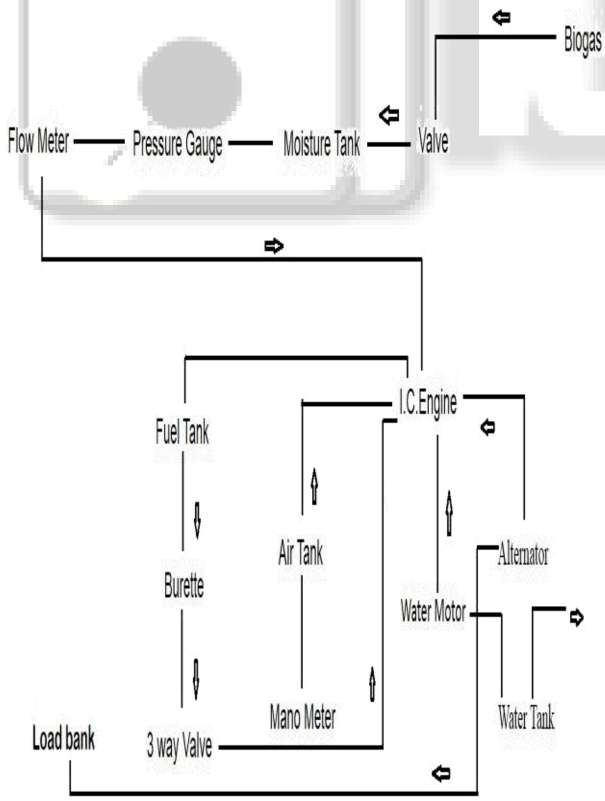

Fig. 1: Experimental setup

A. Engine Specification

Engine No. : 00405998
Bore : 127mm
Stroke : 139.7mm
Compression Ratio : 18:1
Break Power : 7.35kW
RPM : 1000RPM
Fuel : High Speed Diesel

B. Experimental Procedure

- Fill up the sufficient fuel in Diesel tank and check oil level in the Engine.
- Fill up water in manometer up to half of the manometer height.
- If diesel tank is empty before filling the fuel, remove air bubbles in fuel pipe by opening the vent screw provided at the sides of the fuel pump.
- Lift up decompression lever present at the sides of the valve covers, put the handle over the starting shaft and rotate the shaft. As Engine picks up sufficient speed drop the decompression levers.
- Connect the pipe of biogas plant to scrubber system and extend it to passes through the moisture tank. Moisture tank pipe is connected to the biogas flow meter and then connects to engine and control the valves.
- As Engine picks up the speed, switch" ON" the main switch. Speed of engine is to be set at constant speed using tachometer for all load conditions.
- Now slowly apply load so that engine gets loaded. Open the valve at bottom of the burette. Take sufficient fuel in the burette, close the valves of tank line so that diesel in the burette passes to the engine. Note down the time required to consume 50 ml of fuel.
- Required parameter is note down.
- Repeat the procedure for different loads. After completion of test, remove all load by load banks. Switch OFF the main switch and put off the engine by pressing governor lever near to flywheel.

III. PERFORMANCE ANALYSIS

A. Fuel Consumption

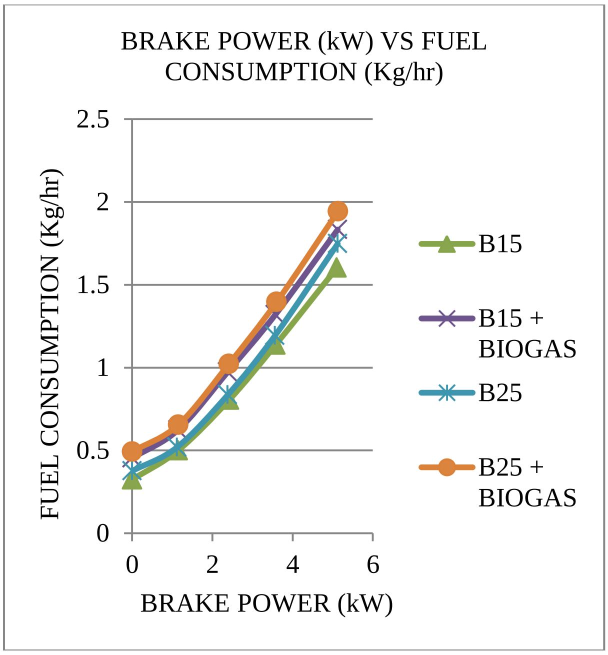

Fig. 2: BRAKE POWER (kW) Vs FUEL CONSUMPTION (Kg/hr)

From the graph of BP Vs FC as shown as fig. 2, it can be seen that as brake power increases Fuel Consumption also increases for all test fuels. It is found that for almost all value of BP, Fuel Consumption of B15 during test run is minimum and (B25 + Biogas) is maximum.

In general FC $_{B25+biogas}$ > FC $_{B15+biogas}$ > FC $_{B25}$ > FC $_{B15}$

B. *Brake Thermal Efficiency*

From the graph of BP Vs BTE as shown as fig. 3, it can be seen that as Brake Power increases Brake Thermal Efficiency (BTE) also increases for all test fuels excluding full load condition. At full load condition for almost test fuels it was found that Brake Thermal Efficiency decreases compared to that at 80% load. It is found that for almost all values of BP, Brake thermal Efficiency (BTE) of B15 during test run is maximum And (B25 + Biogas) is minimum compared to all other test fuels.

In general BTE $_{B25+biogas}$ < BTE $_{B25}$ < BTE $_{B15+biogas}$ < BTE $_{B15}$

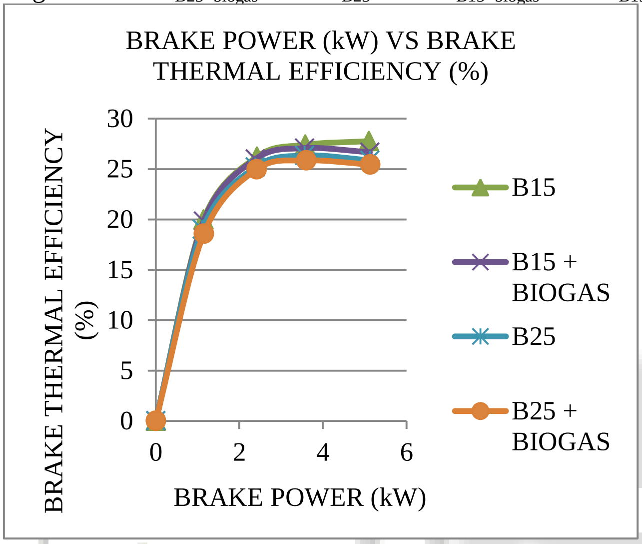

Fig. 3: BRAKE POWER (kW) Vs BRAKE THERMAL EFFICIENCY (%)

C. *Mechanical Efficincy*

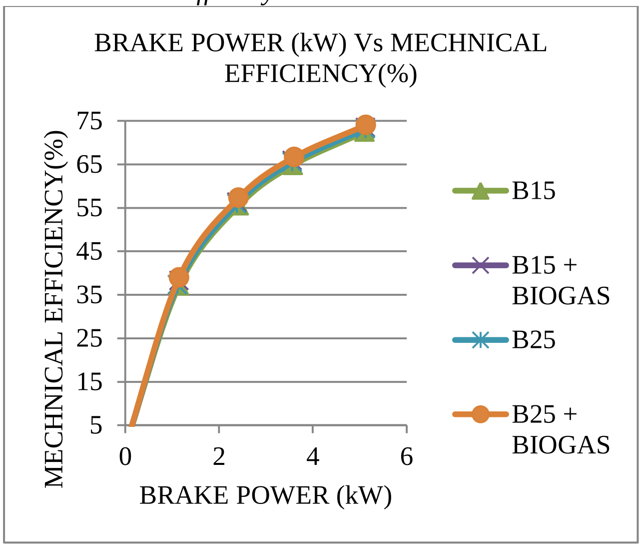

Fig. 4: BRAKE POWER (kW) Vs MECHANICAL EFFICIENCY (%)

From the graph of BP Vs ME as shown as fig. 4, it can be seen that as brake power increases Mechanical Efficiency also increases for all test fuels. It is found that for almost all values of BP, Mechanical Efficiency of All the fuel is almost same to all test fuel. Also, It is found that for almost all values of BP, Mechanical Efficiency of diesel during test run is minimum compared to all other test fuels and maximum (B25+ biogas).

IV. EMISSION CHARACTERSTICS

A. *Exhust Gas Temperature*

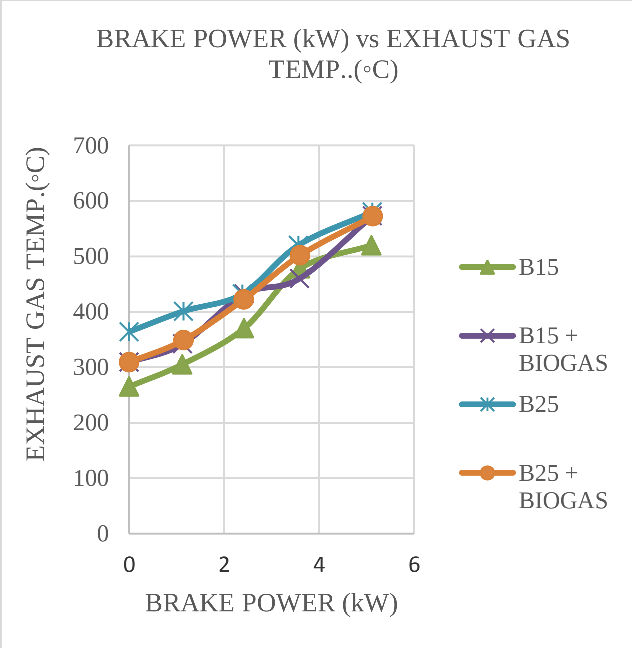

Fig. 5: Brake Power (kW) Vs Exhaust Gas Temp. (◦C)

From the graph of BP Vs EGT as shown as fig. 5, it can be inferred that with increase in Brake power, EGT also increases for all test fuels. For all different values of BP, EGT is Maximum of B25 and Minimum of B15.

B. *Co Emission*

From the graph of BP Vs CO as shown as fig. 6, it can be inferred that with increase in Brake power, CO % also increases for all test fuels. For all different values of BP, CO % is constant during 40% load and then after suddenly increases up to maximum load.

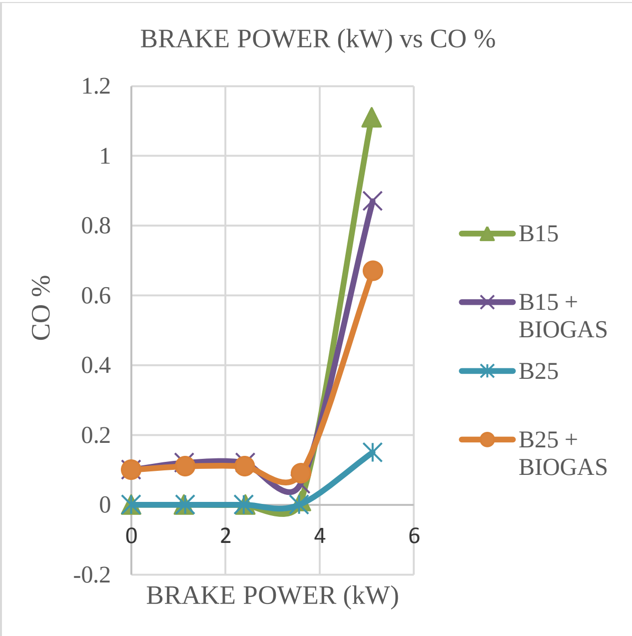

Fig. 6: Brake Power (kW) Vs CO %

C. Hc Emission

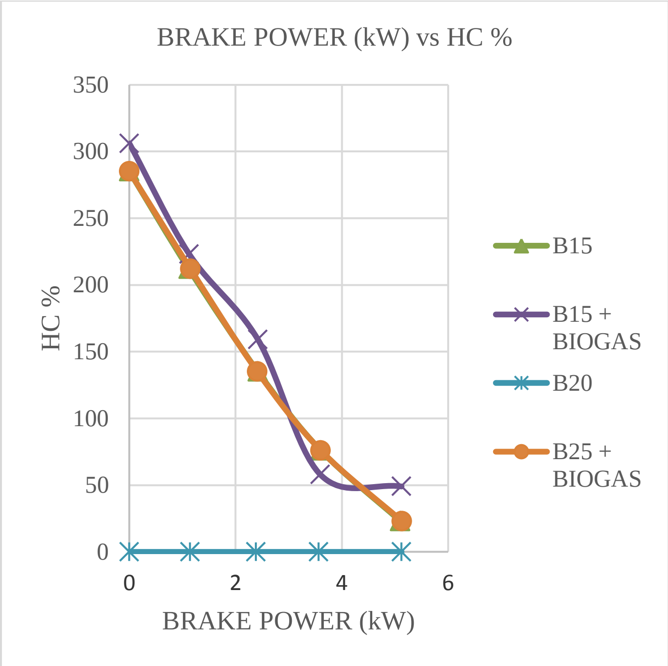

Fig. 7: Brake Power (kW) Vs HC %

From the graph of BP Vs HC as shown as fig. 7, it can be inferred that with increase in Brake power, HC also decreases for all test fuels. For all different values of BP, HC emission of B15, B25 are nearly up to Zero. Only effect of B15 + Biogas, B25 + Biogas test fuels, HC % can be decrease with Brake power.

V. CONCLUSION

Modification is required to run the engine when using biogas. (Biodiesel + Biogas) fuel consumption is more comparing to Biodiesel due to Lower Heating Value of Biogas so friction power is less compared to Biodiesel. Mechanical efficiency is almost same for Biodiesel and (Biodiesel + Biogas). In emission, CO and HC are more produced to use for biogas blend.

REFERENCES

[1] Venkata Ramesh Mamilla, V. Gopinath, C.V.Subba Rao, "Performance and Emission Characteristics of 4 Stroke Petrol Engine Fuelled with Biogas / L.P.G Blends", journal of International Journal of Advanced Engineering Technology, vol. no. 2, pp. 209-213, Jan-March 2011

[2] Seung Hyun Yoon , Chang Sik Lee, " experimental investigation on the combustion and exhaust emission characteristics of biogas-biodiesel dual-fuel combustion in a CI engine", journal of Fuel Processing Technology, vol. 92, pp. 992-1000, May 2011

[3] Ch.penchalayya, A.V.Sitarama Raju and Ravikumar puli, A.Swarna Kumari, "experimental investigation of diesel engine using neem oil", journal of engineering research and studies, vol. 2, pp. 44-47, October 2011

[4] S.K.Mohapatra, K Kundu, S.S.ragit, "performance and emission evaluation of diesel engine fueled with methyl ester of neem oil and filtered neem oil", journal of science and industrial research, vol. 69, pp.62-66, January 2010

[5] G.prabhakar Rao and K.Hema Chandra Reddy, T.Venkateswara Rao, "experimental investigation of pongamia, jatropha and neem methyl esters as biodiesel on C.I. Engine", journal of jordan journal of mechanical and industrial engineering, vol. 2, pp. 117-122, June 2008

[6] K. Anbumani and Ajit Pal singh, "performance of mustard and neem oil blends with diesel fuel with C.I. Engine", ARPN Journal of engineering and applied science, vol.5, pp.1-4, April 2010

[7] D.K.Das, S.C.Pradhan and N.Sahoo, M.K.Ghosal, "performance study of diesel engine by using Mahua methyl ester (biodiesel) and its blends with diesel fuel", Agricultural engineering International: the CIGR journal, vol. 10, pp. 1-10, October 2008

[8] R. Ballesteros, J.J. Herna, L.L. Lyons, B. Caban, A. Tapia, "Speciation of the semi volatile hydrocarbon engine emissions from sunflower biodiesel", journal of Fuel, vol.87, pp. 1835–1843, dec.2007

[9] Magín Lapuerta, José M. Herreros, Lisbeth L. Lyons, Reyes García-Contreras, Yolanda Briceño, "Effect of the alcohol type used in the production of waste cooking oil biodiesel on diesel performance and emissions", journal of Fuel, vol.87, pp. 3161–3169, June 2008

[10] S-ehmus Altuna, H.samettin Bulutb, Cengiznerc, "The comparison of engine performance and exhaust emission characteristics of sesame oil–diesel fuel mixture with diesel fuel in a direct injection diesel engine", journal of Renewable Energy, vol.33, pp.1791–1795, Jan 2008

[11] Man Kee Lam, Keat Teong Lee, Abdul Rahman Mohamed, "Homogeneous, heterogeneous and enzymatic catalysis for Transesterification of high free fatty acid oil (waste cooking oil) to biodiesel: A review", journal of Biotechnology Advances, vol. 28, pp. 500–518, March 2010

[12] S. Bajpai, P.K. Sahoo, L.M. Das, "Feasibility of blending karanja vegetable oil in petro-diesel and utilization in a direct injection diesel engine", journal of Fuel, pp. 1-7, Oct. 2008

[13] Peyman Salehian, Keikhosro Karimi, Hamid Zilouei, Azam Jeihanipour, "Improvement of biogas production from pine wood by alkali pre-treatment", journal of Fuel, vol. 106, pp. 484–489, Jan 2013

[14] P. Venkateswara Rao, Saroj S. Baral , Ranjan Dey, Srikanth Mutnuri, "Biogas generation potential by anaerobic digestion for sustainable energy development in India", journal of Renewable and Sustainable Energy Reviews, vol.14, pp. 2086–2094, March 2010

[15] Yadvika a, Santosh, T.R. Sreekrishnan, Sangeeta Kohli, Vineet Rana, "Enhancement of biogas production from solid substrates using different techniques—a review" journal of Bio resource Technology, vol. 95, pp.1–10, March 2004

[16] R. Chandra, V.K. Vijay, P.M.V. Subbarao, T.K. Khura, "Performance evaluation of a constant speed IC engine on CNG, methane enriched biogas and biogas", journal of Applied Energy, vol. 88, pp. 3969–3977, May 2011

[17] Saija Rasi, B. Arhoun, A. Bakkali, "Biogas production from pear residues using sludge from a wastewater treatment plant digester. Influence of the feed delivery

procedure", journal of Bio resource Technology, vol. 127, pp. 242-247, May 2013

[18] E. Porpatham , A. Ramesh , B. Nagalingam , "Effect of compression ratio on the performance and combustion of a biogas fuelled spark ignition engine", journal of Fuel, vol. 95, pp. 247–256,Nov 2011

[19] C.C.M. Luijten , E.kerkhof , "Jatropha oil and biogas in a dual fuel CI engine for rural electrification", journal of Energy conservation and management, vol. 52, pp.1426-1438, Feb 2011

