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Research paper

Comparative Assessment of Performance and Emission Characteristics of a C.I. Engine Using Biodiesel and Gtl (Gas to Liquid) Fuel

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Abstract

Today we are worry due to hiking the prize of diesel fuel. Fossil fuels are main cause of environmental problem like air pollution, global warming and health related problem. Therefore, in this paper our main concerned about to study the performance parameter on CI engine by using diesel fuel, jatropha biodiesel (B20), Gas to liquid (GTL) diesel. Experimental study shows that GTL fuel produce lower amount of unburned hydrocarbon, carbon monoxide, carbon dioxide, smoke etc compared with the diesel fuel. We have also observed that brake specific fuel consumption is low in GTL engine as compared with the conventional diesel engine even the nitrogen oxide formation is also low compared with jatropha biodiesel (B20).

Keywords*- Gas to Liquid (GTL), Jatropha Biodiesel (B20), performance parameter, Diesel Fuel, Hydro Carbon Emission.*

1. Introduction

Ahmed Hassaneen et. al. (2012) investigate the exhaust emission characteristics, fuel economy of two alternative fuel RME (Rapessed Methyl Ester) and GTL (gas to liquid) fuel with the diesel fuel. Experimental set were made and test were done on ESC-13 model. The particulate Matter (PM) magnitude is determined by scanning mobility particle seizer. Experimental results shows biofuels(RME) produce 70% less co, 50% less HC, and 60% less PM. Ralph Sims and Michael Taylor (2008)investigate the 1st and 2nd generation biofuel requirement due to increase price of fossil fuel, production of green house gases emission and low cost like ethanol. They also show the drawback of using the vegetable oil like linseed oil, peanut oil therefore lot of hope will be concentrated over 2nd generation of biofuel. 2nd generation fuels are nothing but these are wastage of crop and forest that is used for energy production. H. Sajjad et. al. (2014) compared the combustion characteristics parameter, level of hydrocarbon in exhaust gas with conventional diesel fuel and bio-diesels at different level of blending of GTL and diesel fuel. Finally they concluded that GTL fuel performance was better than conventional fuel and biodiesel. Magin Lapureta et. al.(2008) give the effect of biodiesel on engine power, fuel economy and efficiency of engine. They also concentrate over the investigation of hydrocarbon emission like Co, HC, Nox and the composition of particulate emission as well as its size. Deepak Agarwal et. al. (2006) investigate how to reduce the amount of NOx emission in exhaust gases by using exhaust gas recycling method but by using this method the amount of particulate matter produced should be increased that will hampered the performance of compression ignition engine. In last decade research paper it was found that by using biodiesel fuel the level of CO, HC would reduced but the amount of NOx emission would increased. For above aforesaid purpose we are using two cylinder air cooled CI engine and investigate the amount of HCs, CO, NOx, opacity in exhaust gas emission. Soo-Young No(2011) give a review paper on seven vegetable oil like jatropha, karanja, mahua, linseed, rubber seed, cottonseed and neem oils. From this review paper we can see that by using the biofuels the level of NOx emission is increased and the amount of HCs, Co, PM will reduced as compared with diesel fuel. If the amount of blending is 20% biofuels and 80% diesel than it will not harmful for the engine as well as parts. Paul C. Smith et. al. (2010) investigates the effect of biodiesel on the performance of engine and exhaust gas emission. In bio fuel some amount of fatty element present that will reduce the ignition quality of the fuel. L. M. Dass et. al.(2001) investigate the effect of different amount of blending in bio fuels on the fuel properties like viscosity, density, flash point, cetane number, calorific value etc. Magin Lapuerta et. al.(2010) test the Gas to liquid(GTL) fuel on automatic euro-4 engine compared with biodiesel and diesel fuel with its emission characteristics. They concluded that due to blending of biofuel in different proportion with diesel the HCs, CO, PM emission will reduced in significant amount not much affecting Nox emission. Tao Wu et. al. (2007) investigate the physical and chemical properties of Gas to Liquid(GTL) fuel after mixing with conventional diesel fuel. They conduct the experimentation on six cylinder turbo-charged direct injection compression ignition (DICI) engine for calculating performance parameter, combustion characteristics at different, speed and pump timing. It also concluded that the cetane number, heating value, emission of HCs, CO, Nox, PM will reduced by good proportion of mixing of GTL fuel with conventional diesel. Octavio Armas et. al. (2010) concentrated on experimental comparison of three fuels on diesel engine. These fuels are ultra low sulfur diesel fuel(BP15), a pure soyabean methyl-ester biodiesel fuel(B100), and a synthetic Fischer-Tropch fuel(FT). The experiments were carried out on the 2.2L turbo diesel engine at 2400 rpm and 64 Nm torque. Finally it is concluded that diodiesel emission reduce the particle size as compared with BP15. The PM emission will high in B100 fuel as compared with biodiesel. Kuen Yehliu et. al. (2010) compared the combustion characteristics, emission quality by using three different fuels like ultra low sulphur diesel fuel(BP15), a pure soyabean methyl ester(B100), sulphur free aromatic compound, Fischer Tropch(FT) produced Gas To Liquid fuel.

The study was carried out in multipoint direct fuel injection system in common rail turbo engine without exhaust gas recycling process (EGR). Xinling and Zhen H (2010) have been carried out their study to find the combustion characteristics, emission characteristics parameter (HCs, CO, NOx and smoke) on turbocharged diesel engine fueled with gas to liquid (GTL) and diemethyl ether (DME). Finally he concluded that GTL fuel performed similar to diesel fuel but its fuel economy is better than diesel fuel. Nabi M. et. al. (2009) concentrated on the experimental investigation of Fischer-Tropch(FT) and Bio Diesel(BD) in which they consider the FT fuel is the reference fuel due to good emission and performance characteristics. The experimental results shows for the carbon monoxide(CO), unburned hydrocarbon(HCs), Oxides of nitrogen(NOx), particulate emission(PM), smoke and they found that emission of these elements is less for FT fuel compared with DF fuel. Han Hao et. al.(2010) in his paper comparison done between the GTL and diesel fuel on the basis of performance parameter and green house emission(GHG). On the basis of results they concluded that as the efficiency of GTL fuel improved upto 75% the green house emission is also reduced to same amount as compared to the diesel fuel. David A. Wood et. al. concluded in their reviewed research paper how that Gas to liquid fuel used in the vehicle will improved the economy of the country and shift the country in the different paradigm. In this paper they show how the GTL industry today faces the challenges in the world, and on what parameter they get success in the world.

2. Experimental Setup

Experiments were carried out on a single cylinder **KIRLOSKAR DENKI** AC GENERATOR GD10050. The engine was a four-stroke, single cylinder, CI engine. Bore and stroke are 87.5 mm and 110mm respectively. Compression ratio of the engine is 17.5:1. The rated power of the engine is 4.41 KW at 1500 rpm. Emission data were taken using an exhaust gas analyzer Data of exhaust gases were recorded which included the concentration of NOx, hydrocarbons (HC), CO, and CO2.

2.1. The experimental test set-up comprises following major component

1- Fuel supply and measuring system.
2- Engine.
3- Load control panel and measuring system.
4- Fuel tank.
5- Smoke meter

2.2. Fuel supply and measuring unit

Fuel supply measured by burette which is installed on controlled panel by which fuel flow Measurement is taken.

2.3. Engine

A KIRLOSKAR DENKI AC GENERATOR GD10050 Engine was used. The engine Specification is listed in appendix (Table 1).

Table1: The specifications of engines

Engine type	Single cylinder 4 Stroke CI engine
Bore	87.5 mm
Stroke	110 mm
Capacity	0.662 Litres
Max Power	4.41 kW @ 1500 RPM

2.4. Load control panel and measuring system

For loading and measurement of engine power, a load control panel was used which was
Connected to be the engine dynamometer whose specification is given in appendix (Table 2).

Table-2: Loading Panel specifications

S.No.	Components	Specification
1	Lamp Bulbs	10 in numbers, 500 W each
2	Ammeter	0-75 Amp
3	Volt-meter	0-300 V
4	Voltmeter frequency	50 Hz
5	Load Switch	10 in numbers, 15 Amp
6	Fuel measuring tube	1 in number
7	Main supply switch	32 Amp 240 V

Fig1: Experimental Setup Test Ring

Fig 2: Electric loading panel

3. Result and discussions

In this paper, the results of the experiments which are carried out on above aforesaid engine specification. Here, the effects on performance parameter and exhaust gas emission of the CI engine using diesel, jatropha B20 and GTL fuels, at different loading conditions are discussed. For performance estimation, the graph of Brake Thermal Efficiency (BTE) & Brake Specific Energy Consumption (BSEC) has been drawn with different loading conditions whereas for Emissions estimation, the graph of CO, HC, CO2, Smoke and NOx are drawn with different loading conditions.

3.1. Variation of BTE with load

Figure 3 shows the effect of loading on brake thermal efficiency for diesel, B20 and GTL fuels. The efficiency of the B20 fuel was found slightly higher that for diesel, GTL fuels. And the efficiency for GTL fuel was found slightly less than that for diesel fuel and the possible reason may be that the without modified test engine may not be favorable for special properties of GTL fuel like higher cetane number, low viscosity and density which may hamper the efficiency of engine. While BTE is highest for B20 at all loading conditions. This is due to the improved combustion which is caused by greater oxygen content of biodiesel and also B20 has relatively higher kinematic viscosity which helps in reducing frictional losses and that reflects in terms of increased BTE for it.

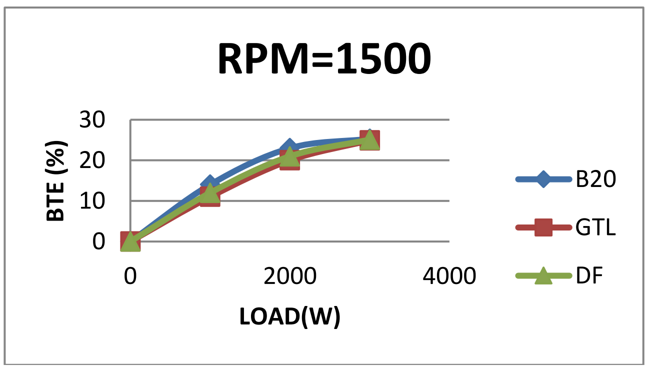

Fig: 3: Variation of BTE with load

3.2. Brake specific fuel consumption

Fig 4 shows the graph of BSFC with loading for above said fuel. We can easily see from figure the BSFC will reduce by increasing the load due to incensement in temperature and pressure. It could be seen by graph that B20 fuel economy is better than other two fuels. While B20 has relatively lesser heating value due to biodiesel blending and hence more amount of fuel required for getting the better efficiency.

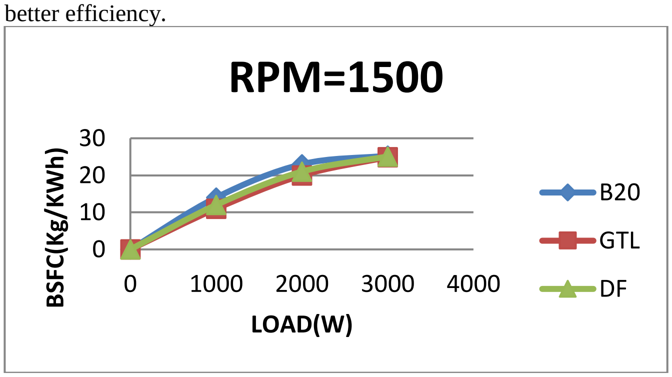

Fig: 4: Variation of BSFC with Load

3.3. Carbonmonoxide Emissions

Figures 5 show the variation of CO emissions with load for different fuels and it show that carbon monoxide emission for GTL are lower than that of diesel fuel and also that B20 has the least carbon monoxide emission. The reason for B20 producing least CO emission is the increased cetane number, the additional oxygen content in the fuel which enhances a complete combustion of the fuel, thus reducing CO emissions. GTL fuels exhibited lower CO emission compared to diesel irrespective of loading conditions.

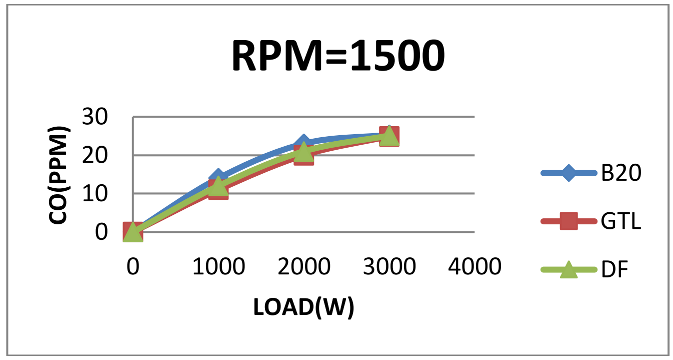

Fig: 5: Variation of CO with Load

3.4. Hydrocarbon Emissions

Figure 6 show the variation of HC emission with loading for diesel, GTL and B20 fuels and it shows that there is decrease in hydrocarbon emission with loading on engine because as the loading increases the temperature also increase which gives in high rate of combustion and reaction and hence HC emission decreases. HC emissions were found lowest for B20 and highest for diesel fuel. Reason for lowest HC emissions for B20 could be the oxygen content in the biodiesel molecule, which leads to a more complete and cleaner combustion and also the higher cetane number of biodiesel reduces the combustion delay which helps in reducing HC emissions. Alike CO emission reduction in HC emissions for GTL fuel can be explained regarding the fuel properties and combustion phenomena of GTL. Higher CN of GTL fuel shortens the ignition delay which prevents formation of over-lean regions hence reducing HC emissions.

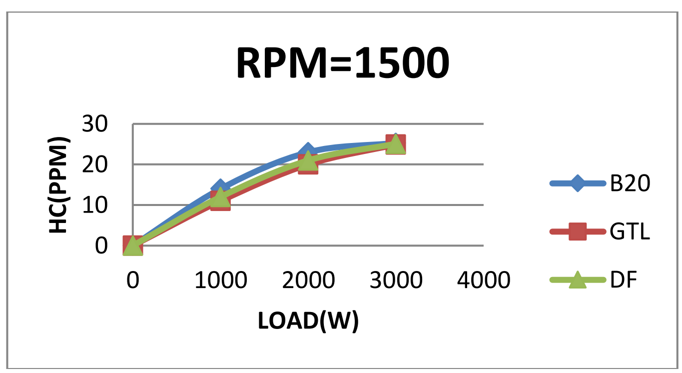

Fig: 6: Variation of HCs with Load

3.5. NOX Emissions

Figures 7 show the variation of NOx with loading for B20, diesel and GTL fuels and it shows that on increasing the load the NOx emission increases. NOx emissions were found higher for B20 compared to diesel and GTL fuels.

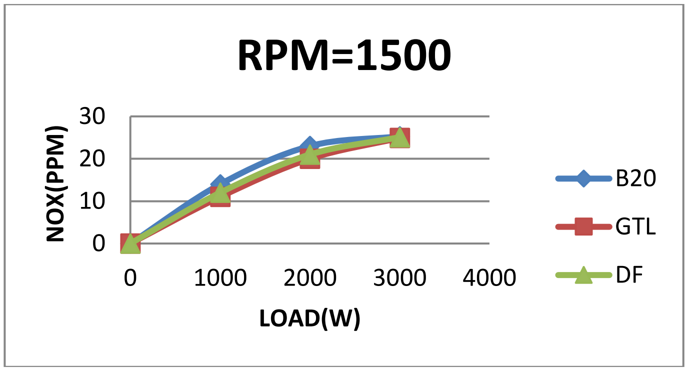

Fig: 7: Variation of NOx with Load

3.6. Carbon Dioxide Emissions

Figures 8 show the variation of CO2 emission with load for B20, diesel and GTL fuels. B20 emitted lower amount of CO2 compare to GTL and diesel fuel. This is attributed to the fact that B20 is a low carbon fuel and has lower elemental carbon to hydrogen ratio than diesel and GTL fuels. Alike CO and HC emission reduction, CO2 emission reduction can be explained regarding the fuel properties and combustion phenomena of GTL.

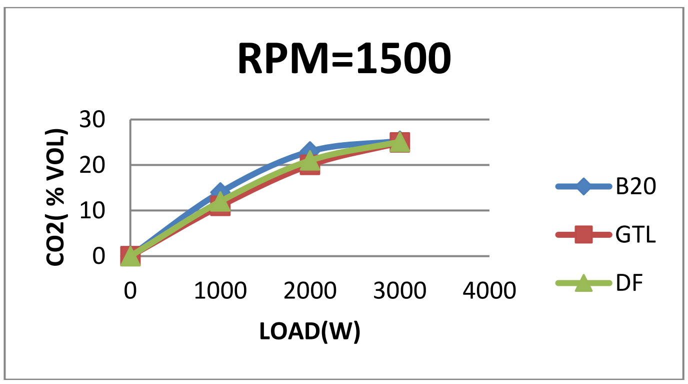

Fig: 8: Variation of CO2 with Load

3.7. Smoke emissions

Figures 9 show the variation of smoke emission with load for B20, diesel and GTL fuels. B20 showed fewer smoke emissions than that for GTL and diesel fuels; however they were very close to GTL fuel. This is due to the higher oxygen content of the biodiesel molecule, which enables more complete combustion and also absence of aromatics, nil sulfur content of biodiesel fuels, which prevents sulfate formation in biodiesel fuels.

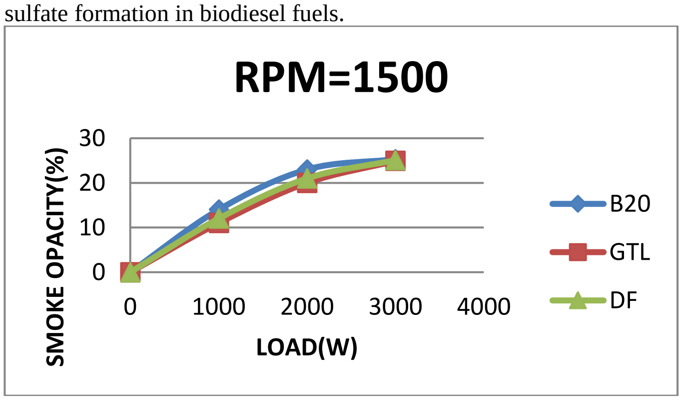

Fig: 9: Variation of Smoke with Load

4. Conclusion

The following conclusions are drawn based on the experimental results. The results for B20 and
GTL fuels are compared with conventional petroleum diesel.
Brake thermal efficiency increases with load as a result of increased in-cylinder temperature and pressure and it was found highest 29% for B20 followed by 28.4% for diesel fuel and 28.1% for GTL fuel at full load. The difference in BTE values are attributed to the fuel properties which help in better combustion of fuels.
The brake specific energy consumption decreases with increase in load and it is least at higher load. It was found highest 0.25 kg/kW-hr for B20 followed by 0.242 kg/kW-hr for diesel fuel and 0.23 kg/kW-hr for GTL fuel at full load. The reason for the same is attributed to the values of heating values of the fuels on gravitational basis.
CO emissions decreased with load and were found least for B20 followed by that for GTL and then that for diesel fuel. Reason for the same are attributed to fuel properties like cetane number, HCs ratios and higher oxygen content of B20.
HC emissions decreased with load due to higher rate of combustion at increased load. HC emissions are found highest 20ppm for diesel fuel followed by18ppm for GTL fuel and 17ppm for B20 at full load.
NOx emission increased with load. NOx emissions are found highest 760 ppm for B20 followed by 740 ppm for diesel fuel and 725 ppm for GTL fuel at full load. Reason for the same is attributed to fuel properties and higher oxygen content of B20 which helps in obtaining high temperature inside the cylinder and hence higher NOx formation for B20.
Smoke emissions also increased with load and they were found highest 5% opacity for diesel fuel followed by 4.4% opacity for GTL fuel and 4% opacity for B20 at full load. Reasons for the same are attributed to the fuel properties

References

[1] Hassneen A., Munack A., Ruschel Y., Schroeder O., Krahl J., “Fuel economy and emission characteristics of GTL and RME as alternative fuels for diesel engine;” Fuel, vol.97, pp. 125- 130,(2012).
[2] “From 1st generation to 2nd generation biofuel technology;” International Energy Agency,http://www.iea.org/(2008).
[3] Sajjad H., Masguki H.H., Varman M., Kalam M. A., Arbab M.I., Imtenan S., Ashrafur Rahman S.M.,“ Engine combustion, performance and emission characteristics of GTL fuels and its blends with diesel and biodiesel;” Renewable And Sustainable Energy Reviews, vol.30, pp. 961-986,(2014).
[4] Lapuerta M, Armas O, Rodrıguez-Fernandez J, “Effect of biodiesel fuels on diesel engine emissions.” Progress in Energy and Combustion Science, vol.34, pp.198-223, (2008).
[5] Agarwal D, Sinha S, Agarwal AK, “Experimental investigation of control of NOx emissions in biodiesel-fueled compression ignition engine.” Environmental Engineering And Management Renewable Energy, vol.31, pp. 2356-69,(2006).
[6] No S., “Inedible vegetable oils and their derivatives for alternative diesel fuels in CI engines: a review.” Renewable and Sustainable Energy Reviews, vol.15, pp.131-149 (2011).
[7] Smith PC, Ngothai Y, Nguyen QD, O’Neill BK., “Improving the low-temperature properties of biodiesel: methods and consequences.” Renewable Energy, vol.35, pp.1145-51(2010).
[8] Das LM., Agarwal AK, “Biodiesel development and characterization for use as a fuel in compression ignition engines.” Transaction of the ASME Journal of Engineering for Gas Turbine and Power, vol.123, pp.440-447 (2001).
[9] Lapuerta M, Armas O, Rodrıguez-Fernandez J, Tsolakis A., “Potential for reducing emissions in a diesel engine by fuelling with conventional biodiesel and Fischer–Tropsch diesel.” Fuel, vol.89, pp.3106-13 (2010).

[10] Wu T., Haung Z., Zhang W.-g, Fang J-h, Yin Q. , "Physical and chemical properties of GTL-Diesel fuel blends and their effects on performance and emissions of a multicylinder DI compression ignition engine," Energy Fuels, vol.21, pp.1908-14 (2008).

[11] Armas O, Y yehliu K, Boehman A, "Effect of alternative fuels on exhaust emissions during diesel engine operation with matched combustion phasing." Fuel, vol.89, pp. 438-56 (2010).

[12] Yehliu K., Boehman AL, Armas O , "Emission from different alternative diesel fuel operating with single and split fuel injection;" Fuel, vol.89, pp. 423-437 (2010).

[13] Xinling L., Zhen H. , "Emission reduction potential of using gas to liquid and DME fuels on a turbo charged diesel engine;" Sci Total Environ, vol.407, pp 2234-44 (2009).

[14] Kitano K, Sakata I, Clark R, "Effects of GTL fuel properties on DI diesel combustion." SAE international paper. 01-3763 (2005).

[15] Nabi M., Kannan D., Hustad J, "Experimental investigation of diesel combustion and exhaust emissions fuelled with Fischer–Tropsch biodiesel blends: Part-I." SAE technical paper, 01-2721 (2009).

[16] Hao H., Wang H., Song N., Li X, Ouyang M , "Energy consumption and GHG emissions of GTL fuels by LCA : results from eight demonstration transit buses in Beijing;" Applied Energy, vol. 87, pp. 3212-17 (2010).

[17] David A.Wood, Chikezie Nwaoha, Brian F. Towler, "Gas to Liquid (GTL): A review of an industry offering several routes for monetizing natural gas;" Natural gas science and engineering vol. 9, pp.196-208 (2012).