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Performance and Emission Characteristics Study of LPG and Olive Biodiesel in Dual Fuel Engine

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Abstract

Using renewable fuels for transportation and power generation is one of the approaches for sustainable energy solution for the future world. Our prospective of project is minimizing use of non renewable resources & to use renewable source of energy. Dual fuel approach is the one of the techniques. In this project, utilization of Liquefied Petroleum Gas (LPG) as a primary fuel and biodiesel from olive as a pilot fuel used in a compression ignition engine. The LPG-biodiesel dual fuel engine performance and emission characteristics were studied and the dual fuel engine results were compared with neat diesel operation. In this experimental work by varying the LPG mass flow rate to the inlet of engine cylinder, performance and emission characteristics of the engine were measured. The brake thermal efficiency slightly less, as well as increases brake specific energy consumption as compare to pure diesel fuel .The exhaust gas emission such as HC , CO ,smoke opacity and CO_2 were quiet decreased while comparing with the diesel fuel. The optimized NOx emission was obtained as compared with base fuel.

***Keywords**: Dual fuel operation, olive biodiesel and LPG*, *Emission and Performance Characteristics. Manifold injectio ;At different LPG mass flow rate.*

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1. Introduction

This work deals with the control of emission from CI engines. CI engines emit various kinds of pollutant such as NOx, CO2, CO,HC, particulate matter (PM), soot particles etc. Apart from engine parameters, the emission depends on combustion phenomenon and the chemistry of fuel used. By using bio diesel and gaseous fuel additives these emissions can be reduced significantly. This exhaust emission from CI engine is harmful for our respiratory system besides causing global warming. There are two ways for controlling emissions. The first method is to control the emission after the combustion, at the exit point using various equipment such as catalytic converter, thermal converter etc. The second method is to control the emissions during combustion. This can be done either by the changing the fuel injection timing or by injecting some additive from outside which may react inside combustion chamber and produces clean exhaust. This can be done by injecting LPG, hydrogen, or steam in combustion chamber. LPG is injected in combustion chamber during suction stroke through intake manifold with air. It forms a homogeneous combustible mixture. LPG however, doesn’t burn due to high auto ignition temperature. But when supplied with another fuel having low auto ignition temperature e.g. diesel then it is easily burned. Due to homogeneous combustion, unburned hydrocarbon, soot particles are reduced lowering pollutants in exhaust.

Diesel engine dates back to 1892 when Rudolf Diesel invented the compression-ignition engine. It is widely used in power generation, transportation and agricultural machinery sectors. As of today, diesel engine is playing a more and more dominant role due to its superior thermal efficiency and fuel economy. However, its exhaust emissions have become the major concerns due to their environmental impacts. As such, emission regulations have been made more and more stringent during the past few years, and this has posed serious challenges to the researchers and engine manufacturers. As advance technologies becoming available, researchers are looking into new strategies such as common rail fuel injection, multiple injections and low temperature combustions to reduce the harmful emissions and increase the engine efficiency. However, the rising oil prices and concerns on the depletion of fossil fuel reserves have forced researchers to not only look into engine optimization, but also find alternative resources to tackle the energy crisis. Biodiesel has gained a growing interest as one of the most promising solutions. Its primary advantages are biodegradable, renewable, carbon neutral and do not produce hazardous toxic gases among this, biodiesels have received increasing attention as an alternative fuel because they can be employed in diesel engines without needing modification. Furthermore, fuel properties of biodiesel are almost similar to diesel fuel.

1.2 Introduction of Fuel characterization:

LPG is supplied to the engine through intake manifold with air which is passing from air filter .biodiesel is use as olive as a pilot fuel. Table 3.4.1 and 3.4.2 shows properties of olive biodiesel and Diesel & LPG respectively.

Table 3.4.1 Olive biodiesel, diesel & LPG Properties

Properties	**LPG**	**Diesel**	**Biodiesel**
Density kg/m^3	1.8985	830	875
Kinematic viscosity CST	-	2.7	6
Flash point C	-	56	140
Fire point C	-	68	161
Water content mg/kg	-	-	60
Acid value KOH/gm	-	-	0.27
Calorific value KJ/kg	45100	42000	40395
Specific gravity	0.587	0.83	0.911

2 Experimental Setup

Figure show 2 the photograph of experimental setup. The experimental has been conducted by using pure diesel, pure olive biodiesel and LPG with olive biodiesel (Dual fuel mode) for variable load at constant speed of 1500 rpm. For dual fuel mode two set of reading were taken by supplying LPG at mass flow rate of 0.10kg/hr and 0.22kg/hr respectively. The conventional gas fumigation technique is use for mixing the LPG with the intake air through a cross flow mixing chamber added before the intake manifold

Fig 2 shows overall view of C.I. Engine Test Rig with dual fuel arrangement

3 Results and discussion

3.1 Performance and emission characteristics

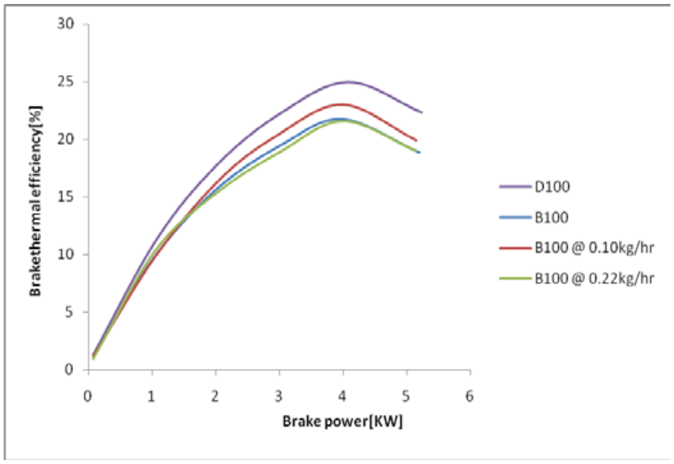

Figure 3.1 variation of brake thermal efficiency with brake power.

Figure 3.1 shows the variation brake thermal efficiency vs brake power for diesel and olive biodiesel. olive biodiesel-LPG dual fuel mode, at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr respectively. Brake thermal efficiency increase with increase BP for all fuel tested. The maximum BTE of duel fuel mode (olive biodiesel - LPG)is 23.04% against that of diesel 25% at 71% of load . In dual mode for LPG at mass flow rate of LPG 0.10kg/hr BTE is maximum . The maximum BTE for dual fuel mode at 0.10kg/hr is 23.04% against 21.73% neat biodiesel. This is due to the induction of LPG which results in better combustion of the fuel, which increases BTE in dual fuel mode. In dual fuel mode figure shows slight higher power output mainly because of higher heating value (CV) of fuel.

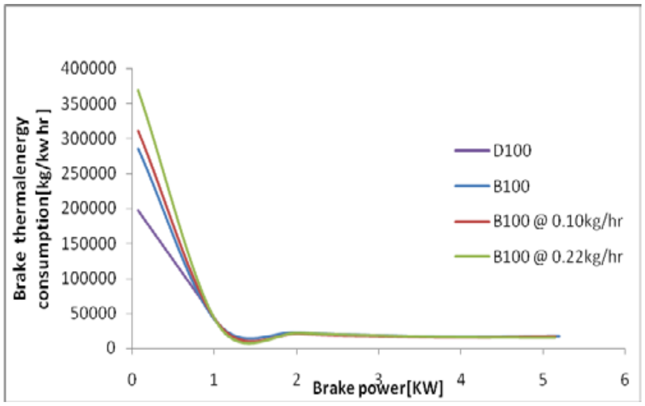

Fig 3.2 variation of brake specific energy consumption with brake power.

Figure3.2 shows the variation brake specific energy consumption vs brake power for diesel and olive biodiesel. olive biodiesel- LPG dual fuel mode, at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr respectively. Brake specific energy consumption decreases with increase BP for all fuel tested. This may due to improved utilization of fuels with increase in engine load. The brake specific energy consumption maximum lower load , however at higher load decreases with increases in percentage of lpg . The maximum brake specific energy consumption for 0.22kg/hr in dual fuel mode is 33565 kg/kw hr against 30827 kg /kw hr neat biodiesel.

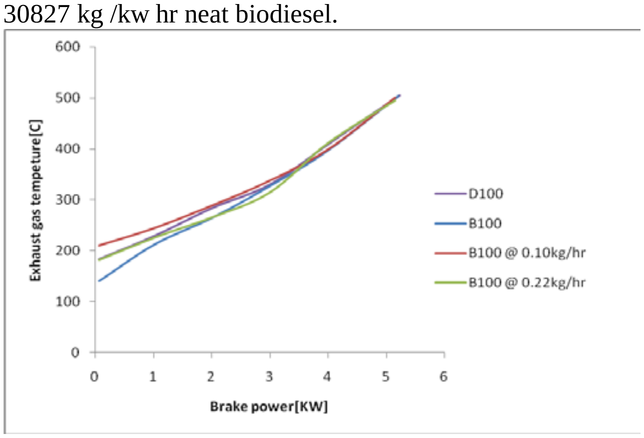

Fig 3.3 variation of exhaust gas temperature with brake power.

Figure3.3 shows the variation exhaust gas temperature vs brake power for diesel and olive biodiesel. olive biodiesel- LPG dual fuel mode, at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr respectively. Exhaust gas temperature increase with increase BP for all fuel tested. Dual fuel operation exhibits low exhaust gas temperature as compare to diesel at all full loading. This may due to the lean air fuel mixture inside the combustion which absorbs heat due to higher specific capacity of the cylinder charge results in this behavior. At full load exhaust gas temperature is almost same for all tested fuel. In dual fuel mode exhaust gas temperature is higher at 0.10kg/hr then that of dual fuel mode at 0.22kg/hr . The maximum dual fuel mode at 0.10kg/hr is 500.6 c against 495.78 c dual fuel mode at 0.22kg/hr.

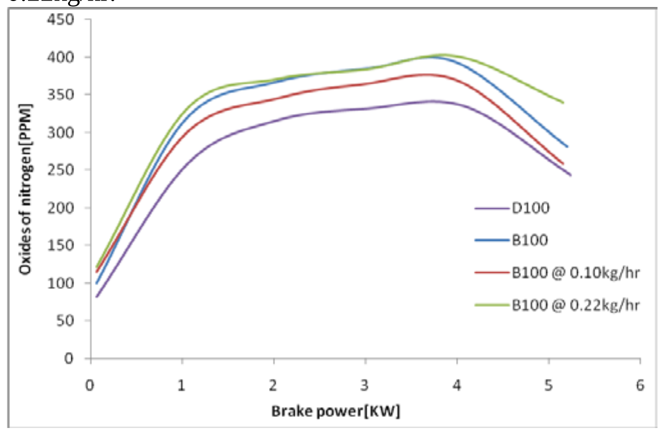

Fig 3.4 variation of oxides of nitrogen emissions with brake power.

Figure 3.4 shows the variation NO x emissions vs brake power for diesel and olive biodiesel. olive biodiesel- LPG dual fuel mode, at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr respectively. The NOx emission depends on the combustion temperature. If the combustion temperature of the fuel increases, then the NOx emission also increases. Even slow combustion of the fuel results in higher NOx emission .NO x emissions Increase with increase BP up to a certain load & gradually decreases for all fuel tested .The NO x emissions for biodiesel is higher than that of diesel . The maximum NO x emissions of neat biodiesel is 393ppm against that of diesel 335ppm. In dual fuel mode at full load the NO x emissions at0.10kg/hr with biodiesel is lower than that of dual fuel mode at 0.22kg/hr. The maximum NO x emissions for 0.10kg/hr in dual fuel mode is 370ppm against 401ppm dual fuel mode at 0.22kg/hr.

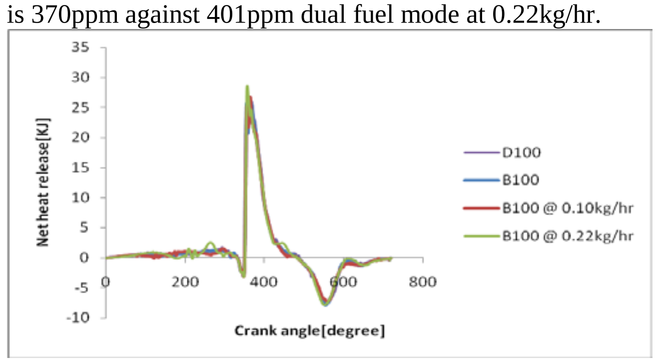

Fig 3.5 variation of net heat release rate with crank angle

Figure 3.5 shows the variation net heat release rate vs crank angle for diesel and olive biodiesel. Olive biodiesel- LPG dual fuel mode, at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr respectively. Higher net heat release rate is observed for dual fuel mode at 0.22kg/hr compare to neat biodiesel & dual fuel mode at 0.10kg/hr. The maximum net heat release rate for 0.22kg/hr dual fuel mode is 28.59KJ at 356 of crank angle against diesel at 26.11KJ at 367 of crank angle.

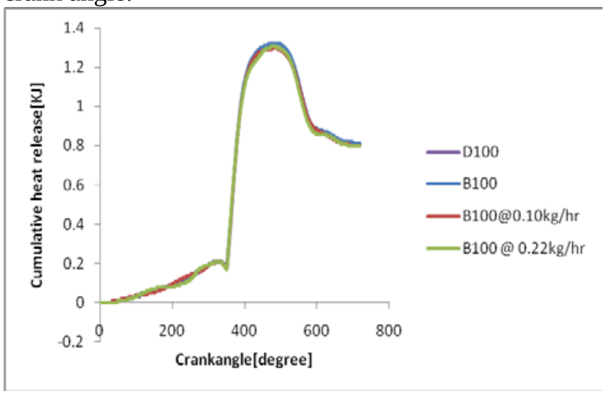

Fig 3.6 variation of cumulative heat release rate with crank angle.

Figure 3.6 shows the variation Cumulative heat release rate vs crank angle for diesel and olive biodiesel. olive biodiesel- LPG dual fuel mode, at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr respectively. The Cumulative heat release rate is observed for neat biodiesel & diesel is almost same. The maximum Cumulative heat release rate for neat biodiesel is 1.32KJat 466 crank angle against 0.10kg/hr in dual fuel mode is 1.29KJ at 450 crank angle, 1.31KJ at 473 crank angle at 0.22kg/hr dual fuel mode & 1.34KJ at 469 crank angle for diesel.

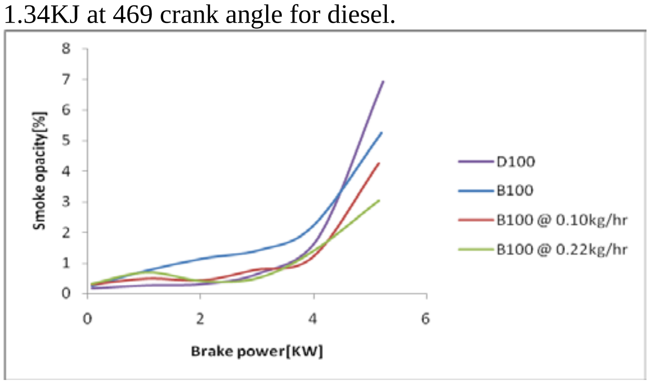

Figure 3.7 variation of smoke opacity with brake power.

Figure3.7 shows the variation smoke opacity vs brake power for diesel and olive biodiesel. olive biodiesel- LPG dual fuel mode, at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr respectively. The smoke opacity of biodiesel is lower than that of diesel but trend for both of them remain same .There is a sharp increase in smoke emission at full load. The maximum smoke emission of biodiesel is 5.26% against 6.92% of that diesel. However in dual fuel mode increase in lpg flow rate reduce the smoke. The maximum smoke emission emitted for 4.25% & 3.05% at dual fuel mode at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr respectively. From the figure, it is observed that, as the LPG energy share increases, the smoke emission of dual fuel mode decreases. This is due to the simpler structure with low carbon content of the LPG which results in reduction of smoke emission drastically.

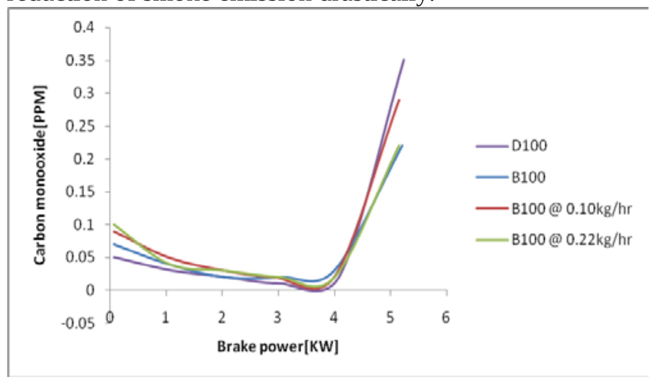

Fig 3.8 variation of CO emission with brake power.

Figure 3.8 shows the variation CO emission vs brake power for diesel and olive biodiesel. Olive biodiesel- LPG dual fuel mode, at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr respectively. CO emission increases with the increases in BP, This is due to partial oxidation of the inducted LPG during the compression and also during the combustion. At part load CO emission remain same for dual fuel mode at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr . CO emission is higher for diesel than that of biodiesel. The maximum CO emission of biodiesel is 0.22% against that of diesel 0.35% at full load. In dual fuel mode at full load the CO emission at 0.10kg/hr is higher than dual fuel mode at 0.22kg/hr mass flow rate of LPG .The maximum CO emission for mass flow rate 0.10kg/hr in dual fuel mode is 0.22% against 0.35% of diesel.

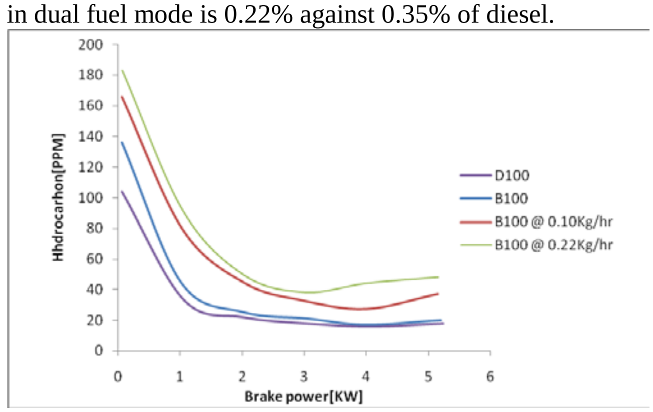

Figure 3.9 variation of unburned hydrocarbon emission with brake power.

Figure 3.9 shows the variation HC emission vs brake power for diesel and olive biodiesel. olive biodiesel- LPG dual fuel mode, at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr respectively. At full load HC emission remain almost same for all fuel tested .In dual fuel mode at 0.22kg/hr maximum unburned HC emission is 228ppm & dual fuel mode at 0.10kg/hr is 968ppm at no load condition. As the load increases unburned HC emission considerably reduces

4 .CONCLUSION

In this project experiment is carried out on a single cylinder water cooled, naturally aspirated Kirloskar make 5.2 KW at1500rpm .the engine is operated on a dual fuel mode with LPG & biodiesel as fuel .The experiment were conducted for neat biodiesel at mass flow rate of LPG 0.10kg/hr and 0.22kg/hr result are compared with that of pure diesel .Performance , emission characteristics of these fuel are evaluated & present .from this work the following conclusions are drawn. .

- ✓ Olive biodiesel is collected & characterization is carried out. Density , viscosity are higher & calorific value is lower for this biodiesel compare to diesel because of inbuilt oxygen content olive biodiesel .
- ✓ From above result we conclude that at mass flow rate of 0.1kg/hr in dual fuel mode preferable.
- ✓ Unbent hydrocarbon is higher at lower & decreases as the load increases in dual fuel mode .
- ✓ CO emission and Smoke emission reduces with increase in quantity of LPG in dual fuel mode.
- ✓ NOx emission is higher for neat biodiesel & is the order of 591 ppm, increases in percentage of LPG reduces the NOx considerably.
- ✓ At mass flow rate 0.10kg/hr of LPG in dual fuel mode has lower emission such as smoke opacity and unburned hydrocarbon and little improvement in brake thermal efficiency.

REFERENCES

1. P. Vijayabalan and G. Nagarajan, “Performance, Emission and Combustion of LPG diesel dual fuel engine using glow plug”, Jordan Journal of Mechanical and Industrial Engineering, Vol. 3, No. 2, June 2009.
2. G.A. Rao, A.V.S. Raju, K. Govinda Rajulu and C.V. Mohan Rao, “Performance Evaluation of a Dual Fuel Engine (LPG+Diesel)”, Indian Journal of Science and Technology, Vol. 3, No. 3, March 2010.
3. M.P. Poonia, A. Bhardwaj, A.S. Jethoo and U. Pandel, “Experimental Investigations on Engine Performance and Exhaust Emissions in an LPG Diesel Dual Fuel Engine”, International Journal of Environmental Science and Development, Vol: 2, No. 6, December 2011
4. Emad elnajjar, Mohamed Y.E. Selim and Farag Omar, “Comparison Study Of Dual Fuel Engine Performance And Overall Generated Noise Under Different Dual Fuel Types And Engine Parameters”, International Journal of Basic and Applied Sciences IJBAS-IJENS Vol: 11 No. 03, June 2011.
5. **Gupta, H. N.** Fundamentals of Internal Combustion Engines. Delhi : PHI Learning Private Limited, 2013.
6. **Heywood, John B.** Internal Combustion Engine Fundamentals. New York : Tata McGraw-Hill, 1988.
7. Wikipedia. [Online] 2016. http://en.wikipedia.org/wiki/Biogas.
8. Effects of mixing system and pilot fuel quality on diesel-biogas dual fuel engine performance. **Bedoya, Iván Darío, Arrieta, Andrés Amell and Cadavid, Francisco Javier.** 2009, Bioresource Technology, pp. 6624-6629.
9. Effect of compression ratio on performance, combustion and emission characteristics of a dual fuel diesel engine run on raw biogas. **Bhaskor J. Bora,Ujjwal K. Saha, Soumya Chatterjee and Vijay Veerb.** 2014, Energy Conversion and Management, pp. 1000–1009.
10. C. Gunea, M.R.M. Razavi and G.A. Karim, “The effects of pilot fuel quantity on dual-fuel engine ignition delay”. SAE Paper No 982453, 1998.

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