International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)
doi : https://doi.org/10.32628/IJSRSET

Impact of CNG Replacement on Diesel Piloted Dual Fuel Engine Performance and Emissions

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ARTICLEINFO

Article History:

Accepted: 10 April 2017
Published: 30 April 2017

Publication Issue
Volume 3, Issue 2
March-April-2017

Page Number
1003-1007

ABSTRACT

The most popular alternative fuel is CNG. The primary goal of the work is to make natural gas usable at higher compression ratios. An engine with dual fuel can accomplish that. The goal of dual fuel research is to lessen the reliance of CI engines on diesel fuel. Diesel is used as a pilot fuel to start combustion, and natural gas is used as the primary gaseous fuel and is injected into the inlet manifold. A review of the literature revealed that the amount of CNG used affected the dual fuel engine's performance and emissions. Therefore, different substitutions are used to improve performance and lower emissions. This project converts a 4-stroke, single-cylinder CI engine to run on dual fuel. It also studies and compares the effects of switching to compressed natural gas (CNG) on emissions and performance to those of conventional diesel engines.
Keywords : Dual Fuel Engine, CNG

I. INTRODUCTION

A. Dual Fuel Engine

Gaseous fuel is used to partially replace diesel in certain diesel engines [11]. This technology is employed by an engine referred to as a DUAL FUEL ENGINE. The foundation of a dual fuel engine is a conventional diesel engine. Gaseous fuel is injected into the intake manifold when the dual fuel mode is operating. Similar to a spark-ignited engine, but with a lower air-to-fuel ratio, the air-to-gas mixture from the intake is drawn into the cylinder. Similar to a conventional diesel engine, diesel fuel is injected just prior to the compression stroke. Burning occurs when the mixture ignites because the diesel fuel reaches its auto ignition temperature and begins to burn. An engine that runs on two fuels can run entirely on diesel or run on a combination of diesel and gaseous fuel. The power density, torque curve, and transient response of dual fuel engines are identical to those of the base diesel engine. Dual fuel engines that run on both diesel and CNG can use this technology. Because natural gas (CNG) is 15%–40% less expensive than gasoline or diesel, using it in diesel engines has advantages for the environment as well as the economy[11].

B. CNG

Because natural gas has lower emissions and is more efficient than other fuels, it is expected to become the most popular alternative fuel for engines in the future.

Natural gas has additional benefits in addition to being a clean-burning fuel, like a big reserve. Methane (CH4) makes up roughly 90% of the main composition of CNG, which accounts for its higher efficiency and lower emission levels. It is well known that lower CO2 and a higher H fraction in engine fuels result in less harmful gas emissions during combustion. Second, because CNG has a lower density than fresh air, it will quickly evaporate to the top of the atmosphere in the event of a leak in the fuel line system or tank. Third, unlike gasoline, which must first be evaporated before being poured into the chamber, CNG does not need to be in the form of gas. In addition to removing excessive emissions brought on by the rich air-fuel mixture when the engine is started, this can lessen the issue with cold starts during the colder months.

II. EXPERIMENTAL SETUP

Fig. 1: Test Setup

Parameter	Specification
Engine bore(mm)	85
Engine stroke(mm)	110
Swept volume(CC)	624
No. of Cylinder	1
Power	6.5hp
Compression Ratio	17.5

Table 1: Specification of Engine

A 4-stroke, single-cylinder CI engine was used in the research engine. The engine's technical specifications are listed in the table above. A power meter is an electrical dynamometer. It's an alternator with an external exit. A rectifier is used to supply a 440 V DC power supply. There are 200 W bulbs attached for power consumption. The number of bulbs was increased to change the engine's load. Air flow rate is measured using an air box equipped with a manometer. A K type thermocouple was utilized to measure a variety of temperatures, including those of the water inlet and outlet, exhaust gas, and air inlet. Diesel consumption is measured with a burette. A 10-milliliter diesel consumption time was recorded. Fuel flow rate can be calculated from there. The tachometer is used to measure velocity. The dynamometer's current is measured with a DC ammeter, and its voltage is measured with a DC voltmeter. 5 Exhaust emission was measured using a gas analyzer. Power produced can be measured by multiplying the current and voltage. All of these measuring tools were used to complete the diesel engine's performance.

MODIFICATION

A. CNG Pressure Reducer Unit

Pressure of CNG is reduced from 200 bar to about 0.5 bar which is done in three steps:

1) Solenoid Valve
   To turn on or off the CNG fuel supply to the gas air mixer, utilize a solenoid valve. It functions as a locking mechanism, cutting off the fuel supply when the engine is shut off. A solenoid valve that supplies natural gas to a pressure reducer is activated by 12 volts.
2) Pressure Reducer
   It reduces the pressure of natural gas from 200 bar to about atmospheric pressure. Pressure is reduced in two stages.
3) CNG Mixture
   The intake manifold has a CNG mixture. Its construction resembles an undertaking that Air passes through. This project is surrounded by CNG, making it simple to combine CNG and air. The combustion chamber is allowed to contain this mixture.

Fig. 2: CNG Mixture

III. RESULT AND DISCUSSION

– **Effect Of Load On Brake Thermal Efficiency**

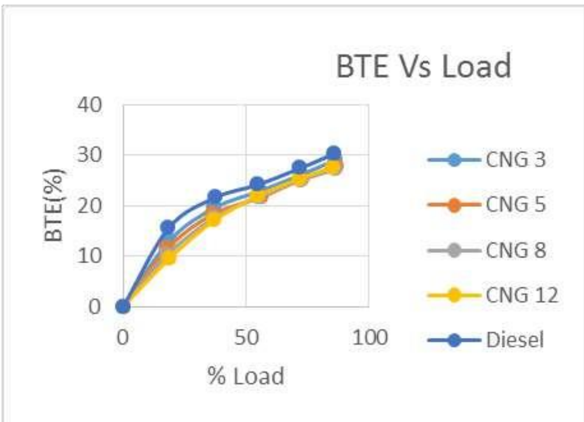

Fig. 3: BTE vs Load

Engine efficiency always rises with increasing load. The efficiency of the dual fuel engine was found to be lower than that of the conventional diesel engine, especially under lighter loads; under heavier loads, however, it was almost equal to the conventional diesel engine. The reason is incomplete combustion at reduced load.

– **Effect of load and CNG flow rate on volumetric efficiency**

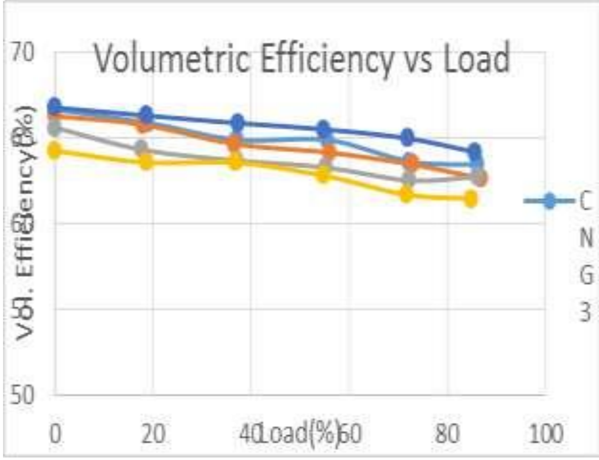

Fig. 4: Volumetric Efficiency vs Load

Volumetric efficiency decreases with load and also decrease with increase in CNG flow rate because admission ofnatural gas in intake manifold will replace the air.

– **Effect of load and CNG flow rate on HC emission**

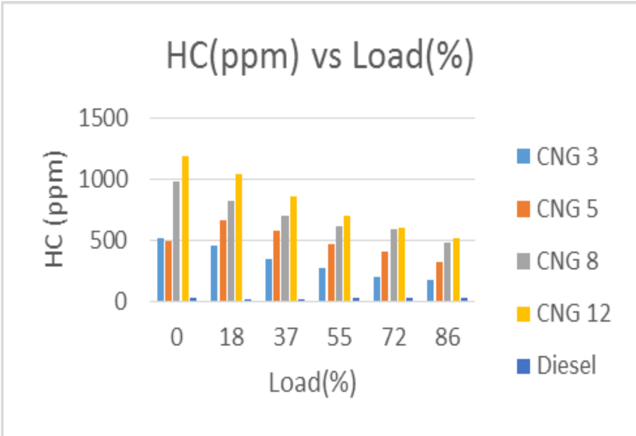

Fig. 5: HC (PPM) vs Load (%)

HC emission of dual fuel engine is much higher than convention diesel engine because of improper mixing and incomplete combustion.

– **Effect of load and CNG flow rate on CO2 emission**

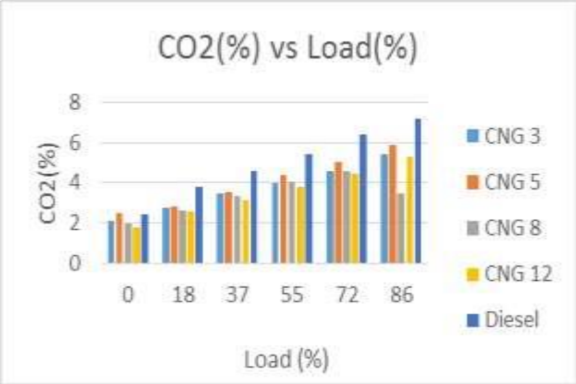

Fig. 6: CO_2 (%) vs Load (%)

CO_2 emission of dual fuel engine is lower than diesel engine. Because carbon content of natural gas is less than diesel so CO_2 produced is less and hence CO_2 emissionis less.

– **Effect of load and CNG flow rate on NOx emission**

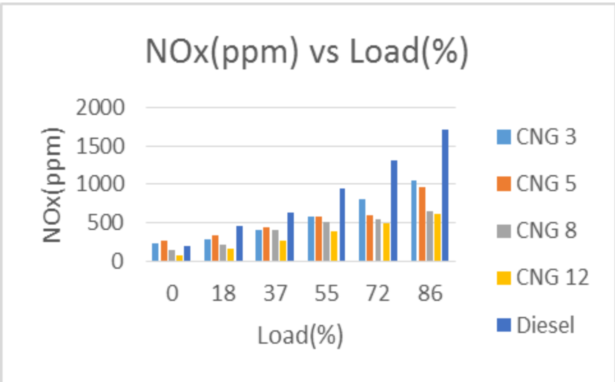

Fig. 7: NOx (PPM) vs Load (%)

NOx emission of dual fuel engine is quite lower than convention diesel engine. It is due to lower temperature of combustion chamber.

IV. CONCLUSION

– Lower flow rate of Natural gas is not advisable because it cause incomplete combustion and hence lowerefficiency and higher emission.

– Dual fuel engine gives good performance for emission ofCO_2 and NOx.

– Dual fuel engine faces a problem of higher CO and HC emission which can be reduced with help of catalyst.

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Cite this article as :

Prof. P. C. Sheth, Prof. P.V. Jotaniya, Prof. H. M. Ravat, Vijay N. Pithiya, "Impact of CNG Replacement on Diesel Piloted Dual Fuel Engine Performance and Emissions", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 3 Issue 2, pp. 1003-1007, March-April 2017.

Journal URL : https://ijsrset.com/IJSRSET2310536