Effect of CNG Substitution on Performance and Emission of Diesel Piloted Dual Fuel Engine

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Abstract— CNG is well known for biggest alternative fuel. Main Aim of project is enable use of Natural gas at higher compression ratio. It can be achieved by Dual Fuel Engine. The research on Dual Fuel is carried out to reduce Dependence of CI engine on Diesel Fuel. Natural gas is used as main gaseous fuel and injected in inlet manifold and Diesel is used as pilot fuel to initiate combustion. According to literature survey, Performance and Emission of Dual Fuel engine varied according to the Amount of CNG. So the substitution is varied in order to achieve better performance and reduce emission. In this work, single cylinder 4 stroke CI engine is converted to run on duel Fuel mode and Effect of CNG substitution on Performance and Emission is studied and compared with conventional Diesel Engine.

Key words: Dual Fuel Engine, CNG

I. INTRODUCTION

A. *Dual Fuel Engine*

In some diesel engine [11], gaseous fuel is used for partial replacement of diesel. The engine using this technology is known as DUAL FUEL ENGINE. A dual fuel engine is based on a traditional diesel engine. During operation of dual fuel mode, gaseous fuel is introduced into the intake manifold. The air-to- gas mixture from the intake is drawn into the cylinder, same way as in a spark-ignited engine, but with a leaner air-to-fuel ratio. Just before the compression stroke, diesel fuel is injected, same way as in a traditional diesel engine. The diesel fuel gain its auto ignition temperature and combustion starts which causes the mixture to burn. A dual fuel engine can be operate either fully diesel fuel mode or the substitution mixture of diesel and Gaseous Fuel. Dual fuel engines have same performance of power density, torque curve and transient response as the base diesel engine does. This technology can be used for diesel-CNG dual fuel engines. Using natural gas in diesel engine provides both economic and environmental benefits because CNG costs 15%-40% less than gasoline or diesel[11].

B. *CNG*

Natural gas is a biggest alternative fuel to engine in the current and future, because it has the higher efficiency and lower emission. Besides as a clean burning fuel, natural gas has the other advantage such as large reserve. The reasons for higher efficiency and lower emission is, CNG has its main composition methane (CH4) for about 90%. Which is has been known that the higher H fraction in engine fuels and lower CO2, that cause the lower dangerous gas emissions from the combustion. Second, the density of CNG is lower than fresh air, therefore, in case of leakage both in the tank and in the fuel line system the CNG will evaporate to the top of the air quickly. Third, due to the CNG is in the form of gas, hence, it will not require to be evaporated first like gasoline before filled into the chamber. This can reduce the problem related to the cold start in the low temperature season and eliminate excessive emission caused by the rich air-fuel mixture when the engine is started.

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

The research engine used was 4stroke, single cylinder CI engine. Technical specification of engine is given in above table. Electrical dynamometer is used to measure power. It is a externally exited alternator. 440 V DC power supply is supplied through rectifier. 200 W bulbs are attached for electrical loading. Load on engine was varied by increasing the number of bulbs. Air box with manometer is used to measure air flow rate. K type thermocouple was used to measure various temperature such as Air Inlet temperature, Exhaust gas temperature, water inlet and outlet temperature. Burette is used to measure diesel consumption. Time was measured for consumption of 10ml Diesel. From that fuel flow rate can be measured. Tachometer is used for measurement of speed. DC Ammeter is used to measure current of dynamometer and DC voltmeter is used to measure voltage. 5 Gas analyzer was used to measure exhaust emission. By multiplication of current and voltage power produced can be measured. Using all this measurement instrument performance of Diesel engine was done.

III. MODIFICATION

A. CNG Pressure Reducer Unit

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

1) Solenoid Valve

Solenoid Valve is used to on or off the CNG fuel supply to the gas air mixer.. It works as locking device, it stop the fuel supply during shut down of engine. When solenoid valve is energized by 12 V it supply Natural gas to pressure reducer.

2) Pressure Reducer

It reduces the pressure of natural gas from 200 bar to about atmospheric pressure. Pressure is reduced in two stage.

3) CNG Mixture

CNG mixture is provided in intake manifold. Its construction is like a venture, from which Air is passed. This venture surrounded by CNG so that CNG can easily mixed with Air. This mixture is allowed to go in combustion Chamber.

Fig. 2: CNG Mixture

IV. RESULT AND DISCUSSION

– Effect Of Load On Brake Thermal Efficiency

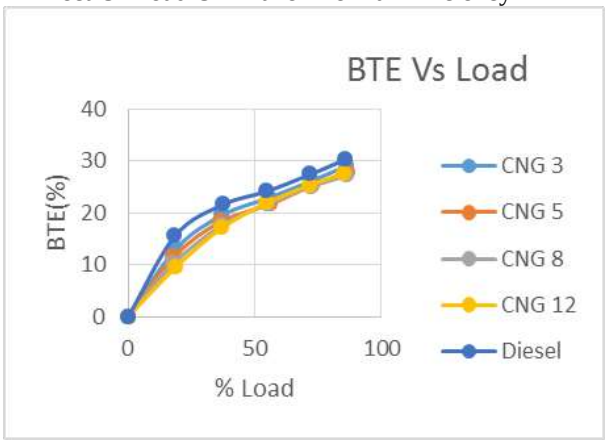

Fig. 3: BTE vs Load

In all case efficiency of engine increase with increase in load. Efficiency of dual fuel engine was observed lower than conventional diesel engine especially at lower load but at higher load efficiency is almost near to conventional diesel engine. Reason is incomplete combustion at lower load.

– Effect of load and CNG flow rate on volumetric efficiency

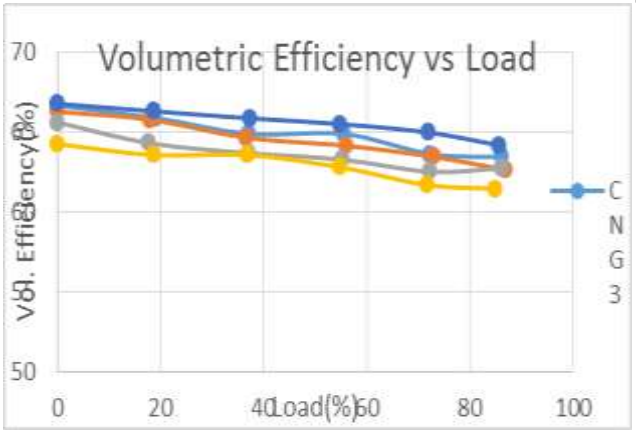

Fig. 4: Volumetric Efficiency vs Load

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

– Effect of load and CNG flow rate on HC emission

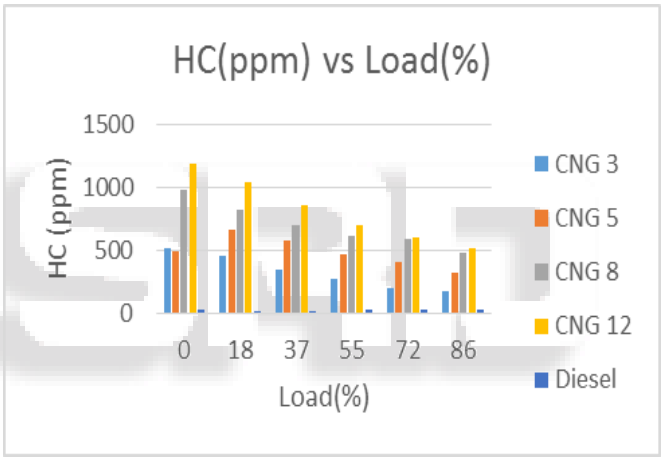

Fig. 5: HC (PPM) vs Load (%)

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

– Effect of load and CNG flow rate on CO2 emission

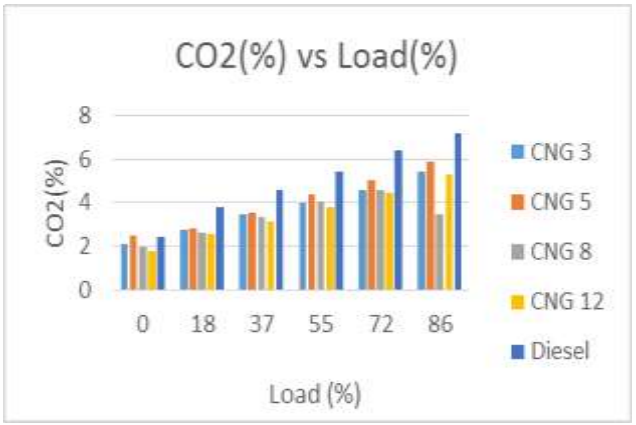

Fig. 6: CO2 (%) vs Load (%)

CO2 emission of dual fuel engine is lower than diesel engine. Because carbon content of natural gas is less than diesel so CO2 produced is less and hence CO2 emission is less.

– Effect of load and CNG flow rate on NOx emission

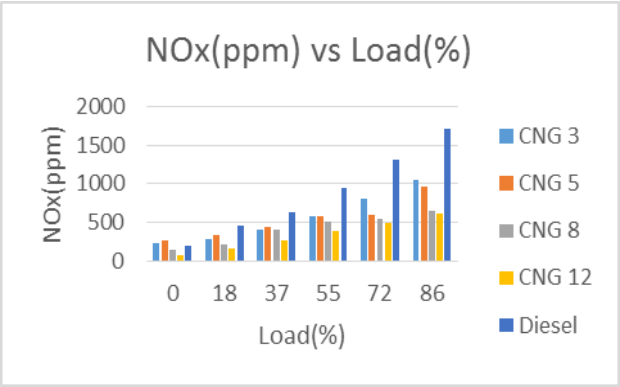

Fig. 7: NOx (PPM) vs Load (%)

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

V. Conclusion

- Lower flow rate of Natural gas is not advisable because it cause incomplete combustion and hence lower efficiency and higher emission.
- Dual fuel engine give good performance for emission of CO2 and NOx.
- Duel fuel engine face a problem of higher CO and HC emission which can be reduced with help of catalyst.

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