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Research Article

Emission Study of CNG Substituted Diesel Engine under Dual Fuel Mode

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Abstract: An experimental investigation was carried out on a single cylinder compression ignition engine to find out the emissions variation with change in amount substitution of Compressed Natural gas under duel fuel mode with diesel as pilot fuel. The emissions such as CO, NO_x, CO_2 & UBHC values were compared with that of normal diesel and at various substitutions of CNG. CNG was sent into the engine through induction in various percentages such as 2.5, 5,7.5,9 lpms.

Keywords: CNG, Emmisions, Internal Combustion Engine

INTRODUCTION

Many internal combustion engines, usually converted from commercial compression or spark ignition engines, have been fueled with various alternative gaseous fuels, such as natural gas, liquefied petroleum gas and less frequently biogases, for use in power generation, transportation and other applications [1–5]. Certainly, one of the main objectives for improving the combustion process of conventional internal combustion engines is to find effective ways to reduce exhaust emissions, without making significant modifications on their mechanical structure [6–9]. Various solutions have been proposed, and among them the use of natural gas as a supplement to the conventional liquid fuel possesses a dominant place, owing to its inherent clean nature of combustion [4,5,10–13]. Natural gas produces practically no particulates since it contains few dissolved impurities (e.g. sulphur compounds). Moreover, natural gas can be used in compression ignition engines (dual fuel diesel–natural gas engines) since the auto-ignition temperature of the gaseous fuel is higher compared to the one of conventional liquid diesel fuel [4,5,10–13]. Dual fuel diesel–natural gas engines feature essentially a homogeneous natural gas–air mixture compressed rapidly below its auto-ignition conditions and ignited by the injection of an amount of liquid diesel fuel around top dead center position. Natural gas is fumigated into the intake air and premixed with it during the induction stroke. At constant engine speed, the fumigated gaseous fuel replaces an equal amount of the inducted combustion air (on a volume basis) since the total amount of the inducted mixture has to be kept constant.

Furthermore, under fumigated dual fuel operating mode, the desired engine power output (i.e. brake mean effective pressure) is controlled by changing the amounts of the fuels used. Thus, at a given combination of engine speed and load, the change of the liquid fuel ‘‘supplementary ratio” leads to a change of the inhaled combustion air, thus resulting to the alteration of the total relative air–fuel ratio.

EXPERIMENTAL SETUP AND EXPERIMENTATION

In the present study, experiment has been conducted on a single cylinder, diesel engine. The flow of air which is sent to the inlet manifold along with the flow of CNG is calculated through CNG flow meter of rotameter type provided to the system. The flow rate of CNG was varied at different loads. In this experiment, by varying the load from 0.5KW to 3KW, emissions of the engine CO, CO_2, HC, NO_x were measured by using exhaust gas analyzer.

The exhaust gas analyzer used is MN-05 multi gas analyzer(4 gas version) is based on infrared spectroscopy technology with signal inputs from an electrochemical cell. Non-dispersive infrared measurement techniques uses for CO, CO_2, and HC gases. Each individual gas absorbs infrared radiation absorbed can be used to calculate the concentration of sample gas.

Analyzer uses an electrochemical cell to measure oxygen concentration. It consist of two electrodes separated by an electrically conducted liquid or cell. The cell is mounted behind a polytetrafluorethene membrane through which oxygen can diffuse. The Device therefore measures oxygen partial pressure. If a polarizing voltage is applied between the electrodes the resultant current is proportional to the oxygen partial pressure.

The engine used in the present study is a Kirloskar AV-1, single cylinder direct injection, water cooled diesel engine with the specifications given in Table 1. Diesel injected with a nozzle hole of size 0.15mm.the engine is coupled to a dc dynamometer. Engine exhaust emission is measured. Load was varied from 1 kilo watt to 2 kilo watts. The amount of exhaust gas sent to the inlet of the engine is varied. At each cycle, the engine was operated at varying load and the efficiency of the engine has been calculated simultaneously. The experiment is carried out by keeping the compression ratio constant i.e., 16.09:1.

Table-1: The entire specifications of the engine that has been used for the experimental purpose

Type	**Four- stroke, single cylinder, Compression ignition engine, with variable compression ratio.**
Make	Kirloskar AV-1
Rated power	3.7 KW, 1500 RPM
Bore and stroke	80mm×110mm
Compression ratio	16.09:1, variable from 13.51 to 19.69
Cylinder capacity	553cc
Dynamometer	Electrical-AC Alternator
Orifice diameter	20 mm
Fuel	Diesel
Calorimeter	Exhaust gar calorimeter
EGR	Exhaust Gas Recirculation provided
Cooling	Water cooled engine
Starting	Hand cranking and auto start also provided

RESULTS & DISCUSSIONS

Significant results were obtained from at various percentage substitution of hydrogen at different loads. The percentage CNG substitution varied continuously from 2.5lpm to 9lpm.

NO_X Emissions

The NO_X emissions as shown in figure 1 at different brake powers. As shown the NO_x emissions decreases with increase in the CNG substitution in the diesel. At peak load the decrease in the NO_x was detected as 15.2%. The trend of emission

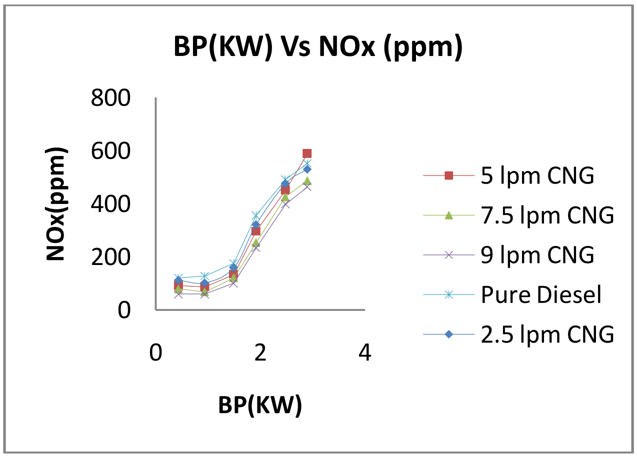

Fig-1:Effect of CNG substitution on NO_X

HC Emissions:

The HC emissions increases with decrease in the CNG substitution in the diesel. At peak load the in the HC was detected as 12.2%.

CO Emissions

The CO emissions as shown in figure 2 at different brake powers. As shown the CO emissions with in the CNG substitution in the diesel. At peak load the in the CO was detected as 20%.

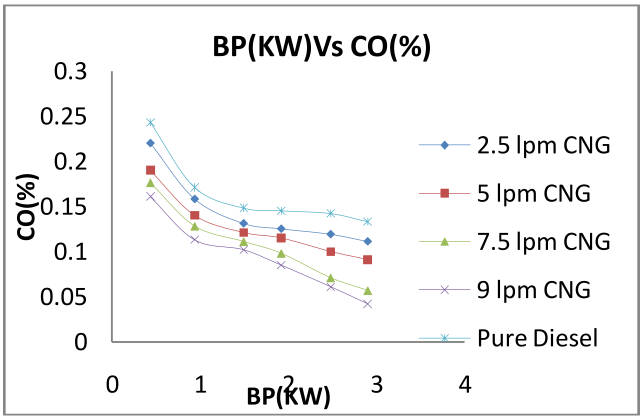

Fig-2: Effect of CNG substitution on CO

Volumetric efficiency:

As shown in figure 3 the volumetric efficiency is been decreasing with increasing substitution of CNG. This is because of the lower density gas is obstructing the air inflow.

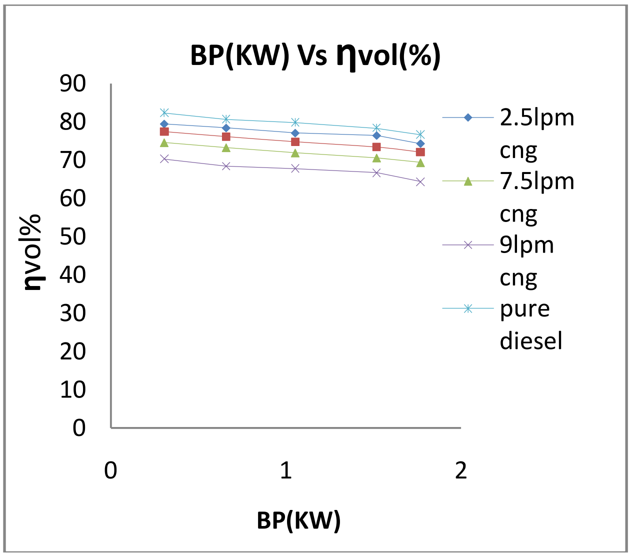

Fig-3: Effect of CNG substitution on volumetric efficiency

CONCLUSION

The NO_X emissions at different brake powers. As shown the NO_x emissions decreases with increase in the CNG substitution in the diesel. At peak load the decrease in the NO_x was detected as 15.2%. The trend of emission The HC emissions at different brake powers. As shown the HC emissions increases with decrease in the CNG substitution in the diesel. At peak load the in the HC was detected as 12.2%. The CO emissions at different brake powers. As shown the CO emissions with in the CNG substitution in the diesel. At peak load the in the CO was detected as 20%. The volumetric efficiency is been decreasing with increasing substitution of CNG. This is because of the lower density gas is obstructing the air inflow.

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