Experimental Investigation on Emission from Petrol Engine Utilizing Biogas with Petrol

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Abstract

Biogas is clean and cheap source of energy. It was produced from anaerobic digestion from agricultural waste and cow dung. It contains 50-75% methane, 25-50% carbon dioxide, 0-10% nitrogen and 0-1% hydrogen. This work was focused on blends of biogas with gasoline which run the engine. It was observed for maximum load condition the emission of hydrocarbon, carbon dioxide and carbon monoxide has been considerably reduced. The increasing trend in nitrous oxide was measured from the emission of the engine.

Keywords: *Biogas, petrol engine, carbon dioxide, carbon monoxide and emission*

1. Introduction

Rapid growth of industrial sector and continual improvement of civilization needs more amount of energy consumption. This consumption of energy ends up with depletion of fuel resources. The demand in energy for the growth enforces to search for new fuels which are renewable in nature. Bio gas is one of the renewable sources meet the energy demand which is generated from anaerobic digestion of kitchen waste and cow dung. It consists of major percentage of methane and carbon dioxide and small percentage of hydrogen sulphide. This methane has energy content which is substitute for conventional fuels to meet the energy demand. An attempt has been made to run the spark ignition engine by utilizing biogas mix with petrol.

2. Literature review

Some of the literatures are discussed in detail in the field of engine run by biogas blends with petrol. Lee et al. (2010) conducted experiments on spark ignition engine found that for optimum spark timing maximum efficiency was obtained when the engine was run by biogas. Yadav et al. (2013) run the engine without purification of biogas found considerable reduction in HC and NOx emission compared to petrol. Porpatham et al. (2006) found the biogas with hydrogen run the engine had good brake thermal efficiency and brake power and reduction in hydrocarbon levels. Porpatham et al. (2013) found swirl action in spark ignition engine run by biogas improves burning rate and reduced HC and NOx significantly. Papagiannakis et al. (2013) run the turbo charged petrol engine with wood gas and came to the conclusion that increase in compression ratio improves the efficiency at the same time increases the NO emission. Porpatham et al. (2015) performed experiments on petrol engine using biogas with different compression ratios and concluded that the power output and brake thermal efficiency was improved at higher compression ratio. Eui-Chang Kwon et al. (2016) conducted the performance on small SI engines of 5kW for various control volumes and found improvement in brake thermal

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efficiency and brake power. Feroskhan et al (2017) discussed running engines with purified and enriched biogas. They found that the removal of non-combustible gas carbon dioxide from biogas utilized in engines improves its performance and better control on emission characteristics. William Cezar Nadaleti et al (2018) has done experiments on SI engine using hydrogen addition to improve combustion characters. They observed advanced ignition reduced emission of CO_2, NO_X and also the improvement in brake thermal efficiency.

In this work an attempt has been made experimentally on the spark ignition engine using the fuels petrol, B15 and B25 blends of biogas with petrol. The impact of load on the emissions of the engine were measured and discussed in the analysis of results.

3. Materials and Methods

3.1 Generation of biogas

Anaerobic digestion of kitchen waste and cow dung yielded the biogas which contains 60-70% of methane and remaining percentage of carbon dioxide. Lime water is used to remove the impurities from biogas. Carbon dioxide and hydrogen sulphide has been removed by the process scrubbing. Axial flow compressor is utilized to compress the gas in the cylinder which is used to run the spark ignition engine. Honda 188F engine is run by petrol and mix of petrol with biogas to study the emission at various load conditions.

3.2. Experimental Setup

The block diagram of experimental setup was shown in fig 1. The Honda engine runs at 1500 rpm was connected to the AVL five gas analyser. Carbon dioxide, carbon monoxide, hydrocarbon and NOX emissions were measured at different load conditions using AVL five Gas Analyser. In this arrangement gasoline in a tank and biogas in the cylinder are allowed to pass through the mixing chamber. Mixing chamber regulates the flow of fuel mixer to the engine. Engine was coupled with mechanical dynamometer and gas analyser for measurement.

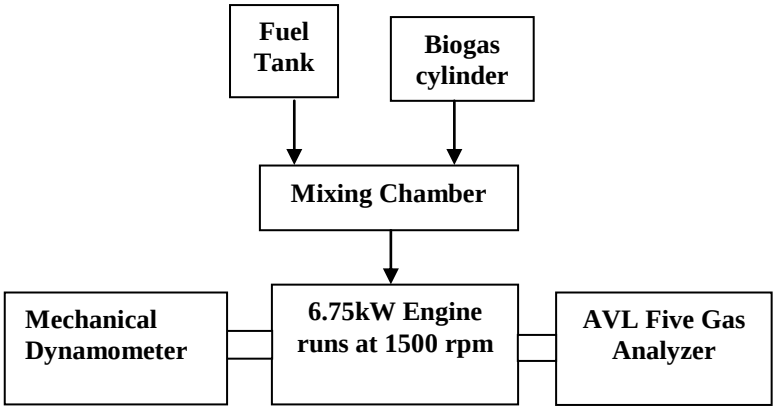

Fig 1 Schematic arrangement of experimental setup

4. Results and Discussion

4.1. Load versus Specific fuel consumption

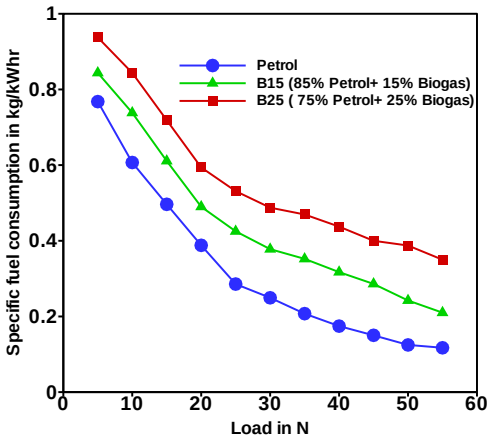

Fig 2 Load vs specific fuel consumption(sfc)

Figure 2 shows the impact of load applied on the engine on specific fuel consumption. It was found that decreasing trend for three fuels petrol, B15 (85% petrol and 15% biogas) and B25 (75% petrol and 25% biogas) from minimum to maximum loads. The percentage of biogas with petrol was increased the sfc was more observed experimentally. B25 mix consumes more fuel than other two fuels.

4.2. Load versus Brake thermal efficiency

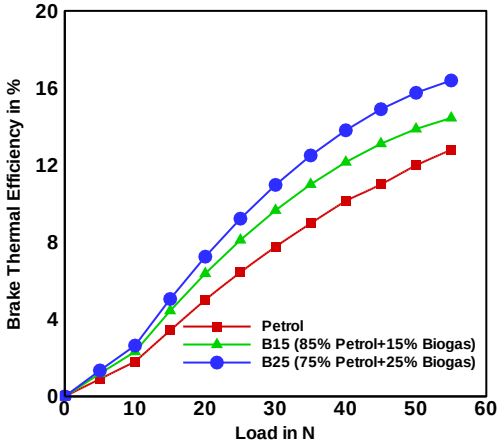

Fig 3 Load vs Brake thermal efficiency

Figure 3 shows the impact of load applied on the engine on brake thermal efficiency. It was found that increasing trend for three fuels petrol, B15 (85% petrol and 15% biogas) and B25 (75% petrol and 25% biogas) from minimum to maximum loads. The percentage of biogas with petrol was increased the brake thermal efficiency was more observed experimentally. B25 yielded better result than other two fuels.

4.3. Load versus Carbon dioxide emission

The different loads were applied on the engine from minimum to maximum while the engine was ran by fuels petrol, B15 (85% petrol and 15% biogas) and B25 (75% petrol and 25% biogas). Carbon dioxide emission from the engine run by petrol was more than

other two fuels depicted from fig 4. B25 mix has given low carbon dioxide emission at all load conditions.

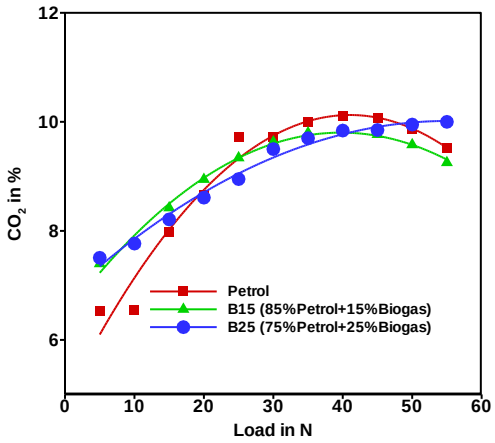

Fig 4 Load vs CO_2 Emission

4.5. Load versus Carbon monoxide emission

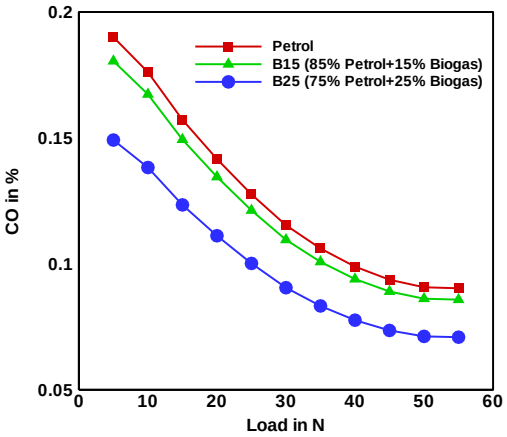

Fig 4 Load vs CO Emission

Figure 4 exhibited load versus CO emission for petrol, B15 and B25 mix. B25 emitted less amount of carbon monoxide at all load conditions. The inference from observed results was that complete combustion reduced CO emission in all three cases.

4.6. Load versus Hydrocarbon emission

Figure 5 exhibited load versus HC emission for petrol, B15 and B25 mix. B25 emitted less amount of HC at all load conditions. The inference from observed results was that complete combustion reduced HC emission in all three cases.

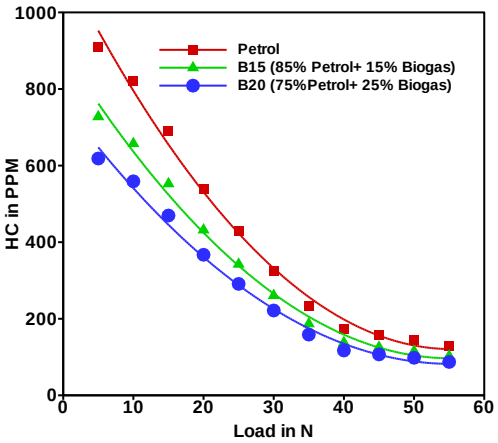

Fig 5 Load vs HC Emission

5. Conclusions

The emission characteristics of petrol engine were studied for petrol, B15 and B25 mix. In all parameters specific fuel consumption, Brake thermal efficiency, CO2, CO and HC emission B25 mix has yielded better results than B15 and petrol for all load conditions. The emission measured was low for B25 mix.

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