Emission Study on Spark Ignition Engine by Using Biogas Mix with Petrol

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Abstract

Depletion and rapid use of conventional resources like petrol and diesel enforces mankind to search for new alternative resources. One of the best renewable sources is biogas from the waste of kitchen and cow dung which is used in spark ignition engine with petrol. This study exhibits the emission of SI engine utilises petrol, B15, B25 mix with petrol. The specific fuel consumption has been reduced from petrol to B25 mix when continuous increment in brake power. The findings are brake thermal efficiency is low for B25 and vice versa for petrol, but the emission of CO and appraisable.

Keywords: *SI Engine, Specific fuel consumption, petrol, emission, brake power, biogas*

1. Introduction

The huge amount of necessity of energy demand consumes conventional fuel which turns the mankind towards the alternative fuels to meet this demand. One of the resources is biogas produced from kitchen wastes and cow dung. It is best supplement for conventional fuel. It has been generated from the process anaerobic digestion which yielded major percentage of methane and carbon dioxide. It has good characteristics of low hydrocarbon emission when mixes with petrol for the same power generation in comparison with pure petrol engines.

2. Literature review

Rapid consumption of convention fuel enforces the mankind towards the alternative energy sources to meet this demand. One of sources is biogas from animal waste which contains 65-75% of methane. Though it has low flame velocity it enhances the quality emission by reducing CO, NOx. Nadaleti et al. (2018) conducted experiments on petrol engine runs at 1500 rpm with biofuels of 60% and 90% methane and concluded that SFC reduction at high load due to complete combustion. Kwon et al. (2017) observed the performance of small SI engines and found enhancement of brake power, brake thermal efficiency. Singh (2016) studied the effect of biogas mixed with petrol on a commercial four-stroke SI engine. They found at maximum load brake thermal efficiency was improved and reduction in emission of HC and CO. Awogbemi et al. (2015) performed experiments on a Honda GX 140 SI engine using 20% biogas reduces SFC, HC, CO emission. Porpatham, Ramesh, and Nagalingam (2015) conducted experiments on a biogas-fuelled single-cylinder spark ignition engine for different compression ratios for maximum throttle and found at high compression ratio thermal efficiency was improved. Ji and Wang (2009) performed experiments on a 1.6 L SI engine running at 1400 rpm with biogas and found a decrease in CO and HC emission and increase in HC emission under a full load condition. Yadav et al. (2013) performed experiments on SI engine of

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7.5 hp for various speeds ranging from 2000 rpm to 6000 rpm at the interval of 1000 rpm. They concluded that engine runs at excess oxygen with biogas and petrol yielded less emission of CO and NOx at 6000rpm. Porpatham et al (2013) conducted experiments on SI engine and found that increasing swirl action at full load condition reduced HC emission and raise in NOx emission. Papagiannakis et al.(2013) done experiments on heavy duty turbocharged engine at high compression ratio and came to the conclusion that high compression increases NOx emission but improves the ignition timings. Chen et al. (2012) conducted experiments on SI engine with biogas in addition to hydrogen and found that carbon dioxide reduced the temperature and yielded less NOx emission. Chung et al. (2012) performed experiments on engine with hydrogen and biogas enhances heat release rate reduce the elements of emission. Park et al. (2011) had done experiments on SI engine using biogas with hydrogen. They found the reduction in emission of NOx and improvement in thermal efficiency. In this study the experiments were conducted on SI engine at various load condition and their effects on emission for blends of petrol with biogas was studied.

3. Materials and Methods

3.1 Generation of biogas

Biogas is generated from the process anaerobic digestion of kitchen and animal waste which contains methane and carbon dioxide. The impurities were removed when it passes through the lime water. The process scrubbing removed carbon dioxide and sulphides of hydrogen which makes corrosion on the pipeline and inner surface of engines. The biogas which contains major percentage of methane was compressed into the cylinder with the help of axial flow compressor. The compressed biogas and petrol from fuel tank passes through the mixing chamber and then to the engine to generate power.

3.2. Experimental Setup

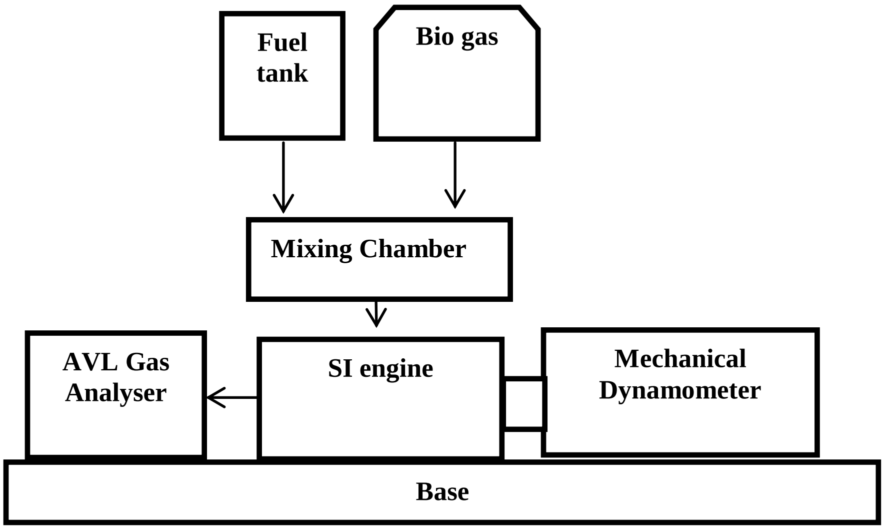

Fig 1 Schematic arrangement of experimental setup

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.

4. Results and Discussion

4.1. Brake power versus Specific fuel consumption

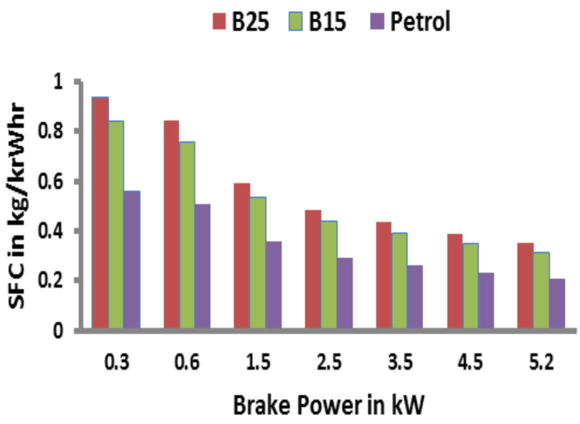

Fig 2 Brake Power vs SFC

Fig 2 depicts the representation of specific fuel consumption for petrol, B15 and B25 blends with petrol. Specific fuel consumption (SFC) decreases when the power reaches rated power in all three cases. It was observed minimum SFC for brake power generated and the same increased for B15 and B25 blend. The same trend was observed for all brake power. The reason was the blend has less calorific value than petrol so the fuel consumption was more when the percentage of gas mix was increased.

4.2. Brake Power versus Brake thermal efficiency

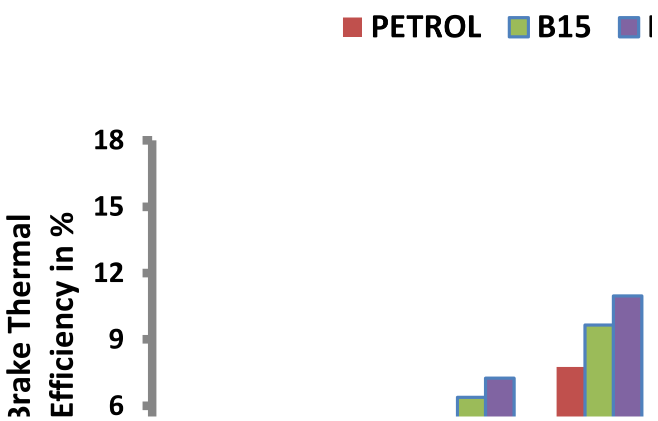

Fig 3 Brake Power vs Brake thermal efficiency

Fig 3 shows the relationship between the brake power generated by the engine of the to the brake thermal efficiency. It was found from the observation brake thermal efficiency for petrol was more. This is due to less conservation of mass to produce same power generation compared to the blends B15 and B25.

4.3.Brake power vs Hydrocarbon emission

Fig 4 shows hydrocarbon emission from petrol, B15 and B25 blends. The replacement in the mass of petrol by biogas reduces the HC emission. This is the reason for minimum HC emission when B25 blend used to run the engine. Another reason is complete combustion of fuel due to the increase in biogas percentage. This is optimum for more brake power generated by the engine.

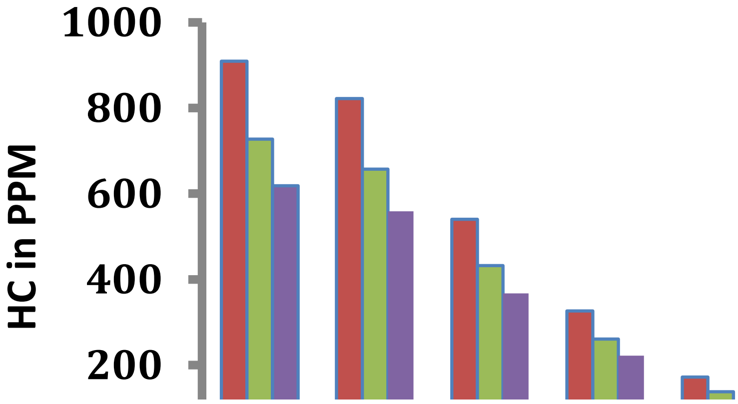

Fig 4 Brake Power vs HC emission

4.4. Brake power vs Carbon monoxide emission

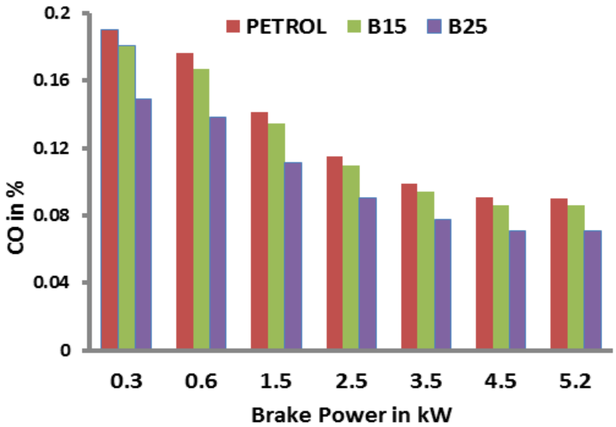

Fig 4 Brake Power vs CO Emission

Fig 5 shows CO emission gradually reduced for all three fuels. The complete combustion occurred in more percentage of blends with petrol. This is the reason of reduction in CO emission when the engine runs at higher loads.
cases.

4.6. Brake power vs CO_2 emission

The complete combustion of B25 blend yielded more percentage of CO2 to the environment compared to other fuels. The same trend has been established upto maximum brake power generated by the engine as shown in fig 6

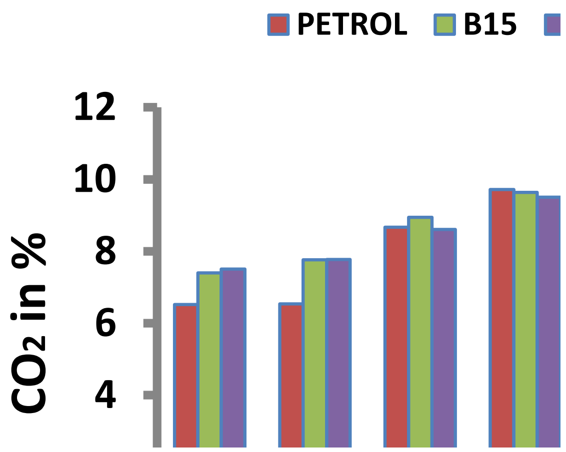

Fig 5 Brake Power vs CO_2 Emission

4.6. Brake power vs NO_X emission

At higher temperatures oxygen reacts with Nitrogen inside the engine emits more NOX. Air contains oxygen which is root case of more NOX emission in case of B25 Blend compared to other two fuels B15 and Petrol observed from the experimental results depicted from the figure 7.

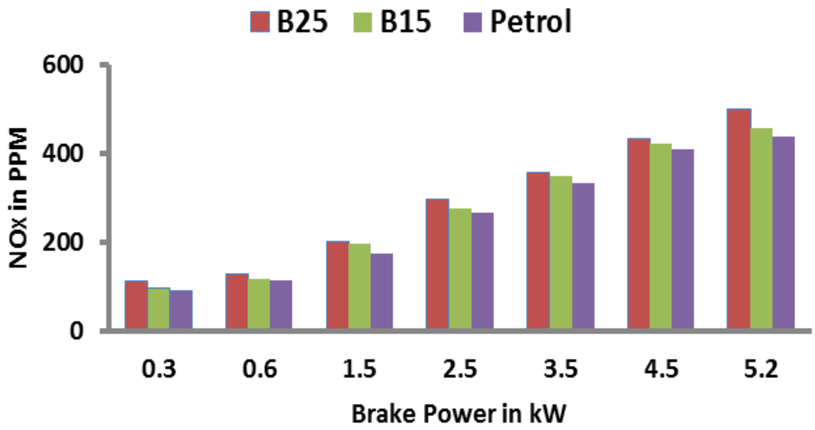

Fig.7 Brake power vs NOX emission

5. Conclusions

The output of experiments conducted on petrol engine with petrol, B15 and B25 indicates B25 mix emitted less CO, HC and NOx for the same Power generation. It has better thermal efficiency than other two fuels at all load conditions. The CO2 emission was more in case of B25 fuel indicated complete combustion in all load condition. Due to the less calorific value of the fuel the specific fuel consumption of B25 fuel was more than other two fuels for the same power generation.

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