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Performance Analysis of a Twin Cylinder C.I. Engine with Diesel-Biogas Blend as Fuel

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***Abstract*—Enormous growth in industries and increase in population are the main reason for heavy depletion of fossil fuel. In recent years, the desire of energy independence, foreseen depletion of non-renewable fuel sources, fluctuating petroleum fuel costs, the necessity of stimulating agriculture based economy, and the reality of climate change have created an interest in the development of bio fuels. Though large amount of biomass is available they are not properly utilized for the energy conversion. Keeping this in mind the tapping of energy from various biomass sources is essential. Biogas technology is one which can be adopted for heat and power generation. Biogas produced by the anaerobic digestion from various organic substances offers low cost and low emissions than any other secondary fuels. The exhaust emissions from biogas-fuelled vehicles are relatively low in particulates and nitrogen oxides and hence contribute to improve local air and climate quality. This project provides an insight on the potential of biogas production and its application, as a gaseous fuel in Internal Combustion (IC) engines especially in CI engines without alterations in the engine.**

Keywords*— Biogas, Alternative fuels, Biogas-Diesel Combination, Stationary I.C Engine

I. INTRODUCTION

Current energy situation throughout the world and the fact that main resources of energy such as crude oil, natural gas, coal and nuclear fuel are not renewable give importance to other alternative sources of energy, like hydro energy, solar energy, wind energy, biodiesel, tidal energy, geothermal energy and biogas. Biogas is particularly significant because of possibility of use in internal combustion engines, without alterations in the engine, which are the main power source for transport vehicles and also commonly used for powering of generators of electrical energy. This possibility of use is justified by biogas' properties, which make it convenient for stationary IC engines.

Biogas is the product of fermentation of biological waste products when bacteria degrade biological material in the absence of oxygen, in a process known as anaerobic digestion. Since biogas is a mixture of methane (also known as marsh gas or natural gas) and carbon dioxide it is a renewable fuel produced from waste treatment.

Biogas contains 50% to 70% of CH4, 2 % of H2 and up to 30% of CO2. After being cleaned of carbon dioxide, this gas becomes a fairly homogeneous fuel containing up to 80 % of methane with the calorific capacity of over 25 MJ/m3. The most important component of biogas, from the calorific point of view, is methane, CH4. The other components are not involved in combustion process, and rather absorb energy from combustion of CH4 as they leave the process at higher temperature than the one they had before the process.

Thermodynamic properties of CH4 at 273 K and 101325 Pa are:

- Specific heat Cp = 2,165 kJ/kg K
- Molar mass M = 16.04 kg/k mol
- Density ρ = 0.72 kg/m3
- Individual gas constant R = 0,518 kJ/kg K
- Lower calorific value Hu = 50000 kJ/kg,

Biogas will not self-ignite in a diesel engine. Therefore, it is necessary to use a little diesel to ignite the fuel. The biogas enters the engine via the air inlet system, after the air filter. This needs a small modification to the air intake system. This option also allows for the engine to be operated fully on diesel fuel alone in periods when there is insufficient biogas.

Advantages of Biogas: -

1) It is light fuel gas.
2) It mixes easily with the air.
3) It is highly knocked resistant.
4) Due to uniform distribution thermal efficiency is higher.
5) Biogas has a high octane number.
6) It reduces pollution.
7) Higher compression ratio can be used with biogas.
8) Plants capital cost is low.
9) Domestic fuels for burners used in kitchen.
10) Non toxic to skin.

Biogas produced by the anaerobic digestion from various organic substances offers low cost and low emissions than any other secondary fuels and also the exhaust emissions from biogas-fuelled vehicles are relatively low in particulates and nitrogen oxides.

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II. EXPERIMENTAL SETUP AND PROCEDURE

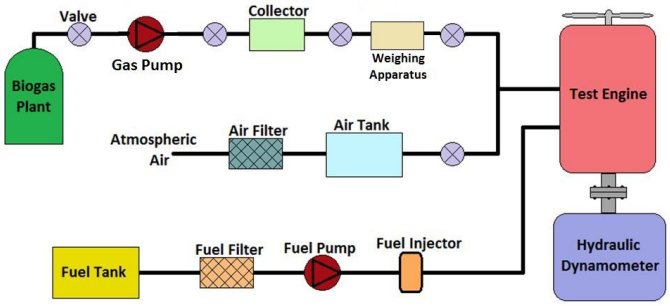

Fig 1: Experimental Setup

The experimental setup shown above can be broadly divided into five systems:

1. Biogas Supply System
2. Air Supply System
3. Diesel Supply System
4. Test Engine
5. Dynamometer

Fig 2: Experimental Arrangement with biogas storage in rubber tube

Biogas was produced by the fermentation of cow dung inside the biogas plant. The gas produced was transferred to a collector, which was an automobile tire tube using simple foot pump in which the inlet is connected to the biogas plant and the outlet is connected to a collector. As a result, on pumping, the biogas will get stored in the collector at a high pressure.

The outlet of biogas collector was connected to air tank, which was connected to engine cylinder head. This was done to ensure that a mixture of biogas and air were introduced for combustion.

The collector tube was placed on weighing apparatus for quantifying mass flow rate of biogas. The weighing apparatus consisted of an electronic weighing machine and a provision for holding the collector correctly so as to get accurate readings. The weighing machine was having a precision up to three decimal places.

The diesel supply system consisted of fuel tank, fuel filter, diesel pump and diesel injector.

Fig 3: Twin cylinder Kirloskar Engine

The engine used for conducting the experiment (test engine) was a 4-stroke twin cylinder diesel engine, popularly known as Twin Cylinder Kirloskar Engine. It was a self governed 10 H.P engine with a speed of 1500 rpm and was self-governed.

Fig 4: Hydraulic Dynamometer

The Hydraulic Dynamometer was used for loading the engine variably so as to study its performance characteristics.

While engine was running, for a particular mass flow rate of biogas, time for 10cm3 diesel consumption was noted. Simultaneously, air pressure and load on dynamometer were also noted.

The experiment was done at different loads and different biogas flow rates.

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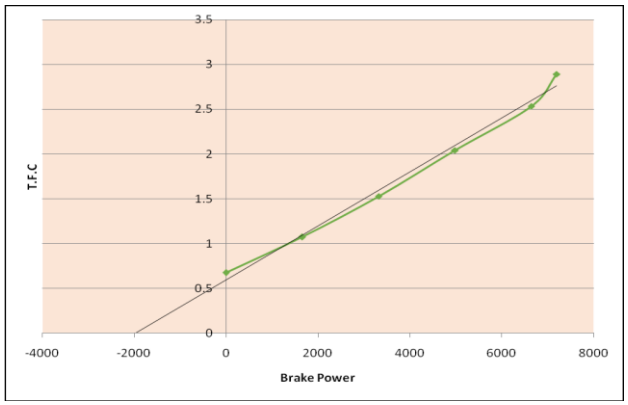
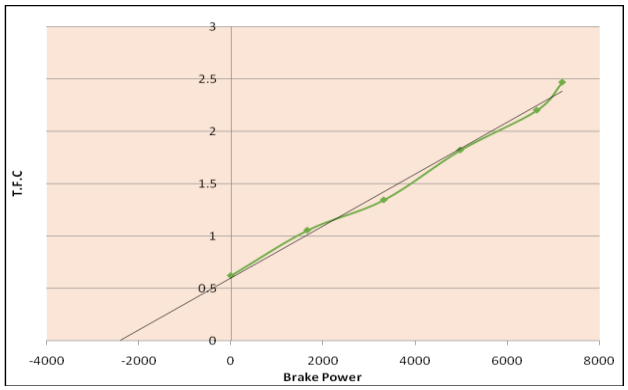
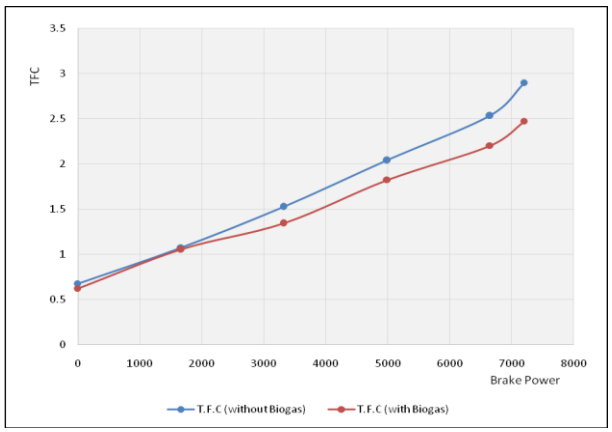
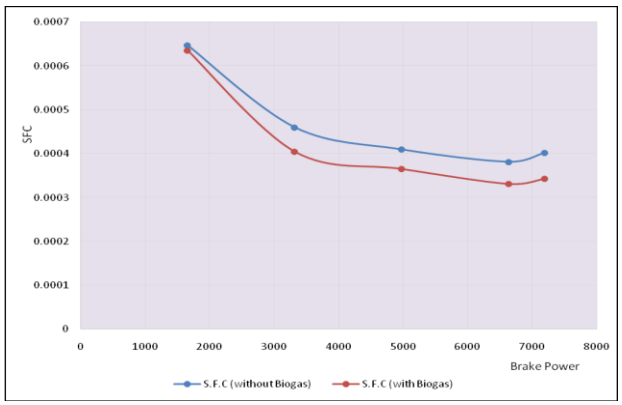
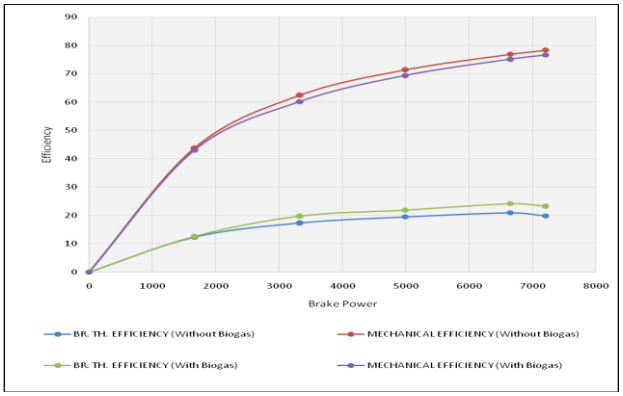
III. RESULTS AND DISCUSSIONS

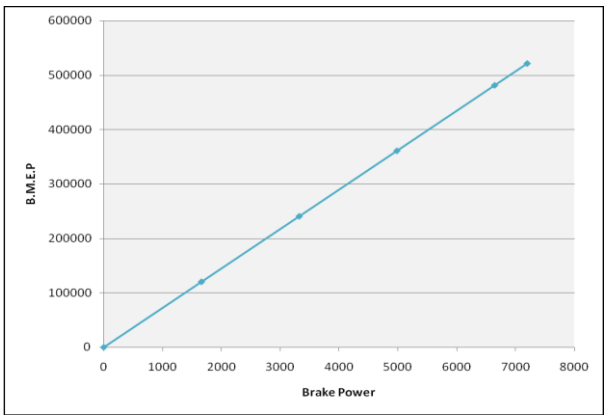












IV. CONCLUSION

Through this experiment the effect of biogas mixture in a twin cylinder direct injection diesel engine was investigated.

It was found that the maximum brake thermal efficiency was found to be increased by 3% by using Biogas-Diesel mixture.

The indicated thermal efficiency was also found to be increased by 4%. But, the mechanical efficiency was found to be decreased by approximately 2%. This is due to the increase in frictional power from 2000 watts to 2200 watts, which may be due to more heating value during combustion as biogas was introduced along with normal diesel fuel.

By this, we can conclude that, it is possible to use the Biogas-Diesel Mixture as fuel in I.C engines so as to reduce the fuel consumption by increasing the engine performance.

As we know we are in the verge of fuel crises and waste handling problem, it is the right time to implement and encourage the usage of non-conventional energy/fuel sources in all possible extend. So this Biogas-diesel combination can also be considered as an alternative fuel source for stationary or agriculture purpose internal combustion engines.

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