

# Investigations and Analysis of Performance Characteristics of IC Engines

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**ABSTRACT:** Day to day the non-renewable energy decrease in the world, in our project is alternate minimum of diesel and maximum biogas use to run I.C. engine. The majority of the world's energy is generated by burning non-renewable resources. These are naturally occurring substances that cannot be reproduced, grown, generated. The renewable energy from the sun, wind, wave, biomass and geothermal energies are based on renewable resources. Biogas from anaerobic digestion of organic waste is a potential alternative to the partial substitution of petroleum derived fuels because it is from renewable resources that are widely available. The effect on performance of engine using biogas and diesel dual fuel operation is presented in this paper and also find the level of mixing ratio of biogas and diesel to effectively run the I.C. engine. Biogas is easily made, the anaerobic digestion or fermentation of biodegradable materials such as biomass, manure, sewage, municipal waste, green waste, plant material and crops. Biogas can also be cleaned and upgraded to natural gas standards when it becomes bio methane. An overall evaluation of the results indicated that the biogas and diesel dual fuel operation could be substituted for diesel fuel in electricity generation possible to work satisfactorily under long term engine operation without any major troubles.

**KEYWORDS:** Biogas, dual fuel, performance test, renewable energy, compression ignition.

## I. INTRODUCTION

It is known that the world's main energy resources will be reduced within the next few decades. The world is shortly going to face with demand of fossil fuel shortage also environmental degradation as a direct impact of growth in population and industrialization [1]. The searching for alternatives to partially or total substitution of non-renewable fuels has, therefore, been intensified in the last decade. Among the many different types of alternative fuels, biogas from anaerobic digestion of animal manure appears to be one of the most promising options [2]. It is developed from the biodegradation of organic materials by bacteria under anaerobic condition and consists of mainly methane, hydrogen sulphide and carbon dioxide. This idea of biogas as a diesel fuel substitute is not new, but it is a very attractive and efficient alternative, especially in countries having work more on agricultural products and demand in petroleum resources. There have been continuing efforts in research work for alternative fuel source, development and demonstration to utilize biogas to provide heat and power agricultural engines in farms within the country for the past several decades [3]. Biogas can be used as an alternative to the partial or total substitution of gasoline and diesel fuels without requiring extensive engine adjustments or modifications [4]. To operate with gaseous fuels, diesel engines can be conveniently converted to a fumigated dual fuel engine which is the most practical and efficient method. Since biogas has a high octane number, it can be employed in a high compression ratio engine to maximize its conversion efficiency [5]. In dual fuel operation mode, biogas is mixed with air prior to entering the combustion chamber. At the end of compression stroke, a pilot amount of diesel fuel is injected to ignite the mixture, as long as proper spray penetration and evaporation are achieved. One advantage of this method is that the engine can be switched back to conventional diesel operation mode when the gaseous fuel supply is not available [6]. In this investigation testing of compression ignition engine is operating with biogas and diesel dual fuel were carried out and reported. The main

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objective is to evaluate performance characteristics of a small, naturally aspirated, agricultural, direct injection engine using dual fuel.

## II. BIOGAS PRODUCTION

Biogas is produced in many different environments, including in landfills, sewage sludge and during anaerobic degradation of organic material. Biogas is comprised of methane (CH<sub>4</sub>, about 45-75% by volume), carbon dioxide (CO<sub>2</sub>, 25-55%), and other compounds including hydrogen sulfide, water vapour, and other trace gas compounds. Methane is a powerful greenhouse gas if emitted into the atmosphere, but can also represent a valuable renewable energy source, with the potential to reduce GHG emissions when it is collected and substituted for fossil fuels.

Biogas can be used directly to generate power, but the large volume of CO<sub>2</sub> reduces the heating value of the gas, increasing compression and transportation costs and limiting economic feasibility to uses that occur at the point of production. Purification allows for a wider variety of uses, either for heat and electricity, or for vehicle fuels. For use as a fuel, purification to remove carbon dioxide (CO<sub>2</sub>) and hydrogen sulfide (H<sub>2</sub>S) is required, because H<sub>2</sub>S corrodes vital mechanical components within engine generator sets and vehicle engines if it is not removed.

## III. INVESTIGATIONAL EQUIPMENT SETUP

The particular type of engine used in this investigation is a single cylinder 5 Horse power diesel engine. Setup of the investigation engine is illustrated in Fig. 1 and its specifications are noted in the table 1. The engine is cooled by water cooling fitted in the engine itself. There is only one change in the engine was biogas and air are mixed in the one chamber like T joint near intake manifold. The investigating engine is attached to the mechanical loading arrangement. For measuring readings I have used instrument and gauges.

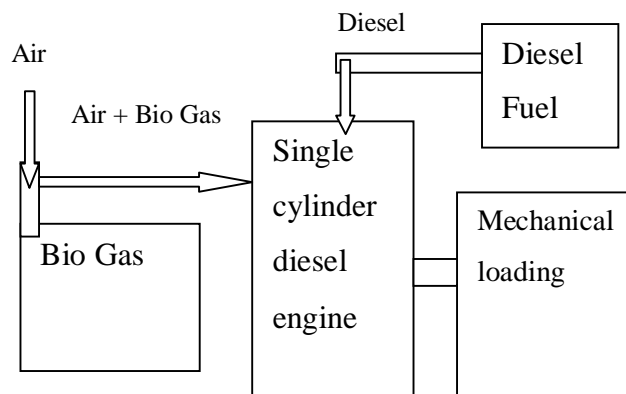


Table 1. Engine Specifications

Engine	Kirloskar
Type	Water cooled
B H P	5
Number of Cylinders	1
Bore	87.5 mm
Stroke	110 mm
Rated speed	1500 RPM
Combustion	Compression Ignition

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Biogas used in the tests was supplied from a near poultry waste biogas plant. It was stored and compressed in a collapsible rubber dome from where it was fed to the engine intake port. Before to enter the engine, biogas was passed through water for remove foreign particles and reduces CO<sub>2</sub> and some amount of sulfur in the gas was removed by this treatment. Its compositions were 66% CH<sub>4</sub>, 26% CO<sub>2</sub>, 6% N<sub>2</sub>, 2% O<sub>2</sub> with some traces of H<sub>2</sub>S. The biogas was also compared along with diesel for the properties obtained from a local commercial retailer. These are shown in Table 2.

## IV. ENGINE TEST PROCEDURE

Before to taking the performance test readings we need to maintain the engine running conditions. The engine was run at the idling condition for certain period for better running of the engine. The engine properly fitted with the mechanical loading arrangement for better result values after running the engine with this condition for certain time.

Property	Biogas	Diesel
Cetane number	-	50
Heating Value (MJ/Kg)	24.50	45.91
Viscosity @ 40°c (cSt)	-	3.34
Specific gravity @ 15°c	0.001	0.830
Sulfur content (% wt.)	0.12	0.037

Table 2. Property of diesel and biogas

First engine run with diesel fuel while engine running the fuel level was gradually reduced. Initially the reading taken for different load conditions performance test was carried out with same test set up and then engine run with dual fuel of biogas is mixed with the air send through intake manifold and then while in the power stroke the fuel is injected in the fuel injector in this condition engine was run in the idle condition and the test results of values taken and calculate performance of the engine.

## V. RESULTS AND DISCUSSION

In this test we have used unmodified diesel engine with the condition of diesel and biogas dual fuel operation was found that engine run safely with any change of running conditions.

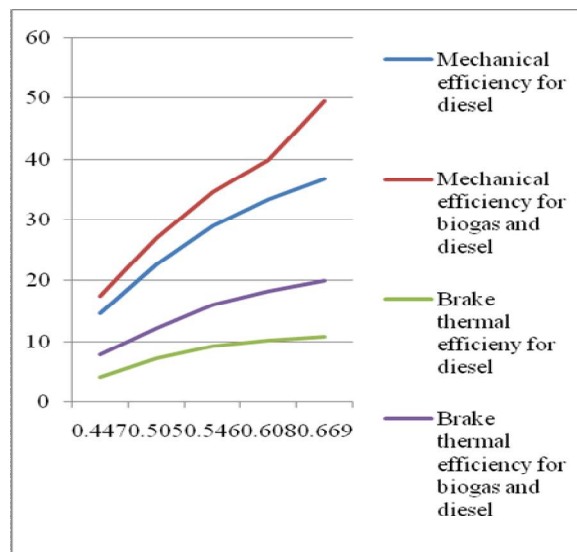
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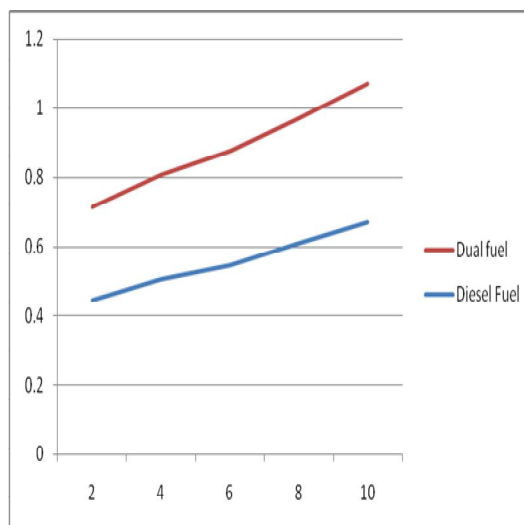
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**a) MECHANICAL EFFICIENCY COMPARISON**



Initially engine run with the diesel fuel in unmodified diesel engine attached mechanical loading arrangement. After some time engine run with dual fuel operation and take the report of the readings at different loading condition. If the engine run with diesel and dual fuel the comparison of mechanical efficiency while load increasing at same efficiency of 20% fuel consumption of diesel is low in dual fuel operation at around 30% efficiency and above that difference of total fuel consumption comparison is gradually increasing that means fuel consumption level is reduced at high load and higher efficiency and brake thermal efficiency also fuel consumption difference is higher.

**b) COMPARISON OF FUEL CONSUMPTION WITH DIFFERENT LOADING.**



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Diesel consumption of the engine with different loading arrangement initially difference diesel consumption level is equal upto 30% of the engine loading and further loading upto 55 % diesel consumption difference is reduced and after that percentage of loading the engine diesel consumption difference is increase upto 10% level.

## V. CONCLUSION

In this research study, Investigation of engine performance test operating on biogas/diesel dual fuel in a small Diesel injection engine at constant speed and different load condition has been carried out. The results were investigated in terms of performance. The following conclusions may be drawn from the present study.

- 1) Diesel consumption by this small diesel engine at different loading arrangement is around 50% diesel we can save by using biogas/diesel as a fuel in that engine.
- 2) Efficiency of the engine 20% is increased by using dual fuel arrangement.

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