EXPERIMENTAL INVESTIGATION OF DIESEL ENGINE USING GOBAR GAS BLENDS

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Abstract

Vehicular exhaust fouling of the environment has already become a serious problem in the western countries and is growing menace in the developing countries like India. They are exhausting huge quantities of harmful pollutants in urban areas. Since the 1973 international oil crisis and the related increase in the price of fossil fuels, all countries of the world have been developing increased effort to open up a new energy source. An alternative approach of getting gas fuels is through an anaerobic fermentation of wet placental mammal waste to provide Gobar Gas (50 to 70% of CH4 and remaining CO2). This gas particular significant for India because of its large scale and best population. Production of Gobar Gas from supposedly worthless organic waste which is easily available and as yet unused source of energy. Recent advances in the storage and transportation of Gobar Gas had it made it now profitably use it as a fuel for C.I. Engines. It can be either carried as liquefied gas or stored in a compressed gas cylinder. The primary advantages of these gaseous fuels are its ability to operate the engine on a lean mixture, thereby reducing exhaust hydrocarbon and CO2 concentration in the effluent of the engine. It gives less deposit and shows clean burning characteristics and as compared to petrol and diesel oil. The ignition temperature of Gobar Gas is higher than many other fuels.

Keywords: *Gobar gas, fossil fuels, Specific fuel consumption, fermentation.*

1. Introduction

Gobar Gas is really a mixture of gases, sometimes dioxide and alkane series. It is made by a sort of microorganisms, sometimes once air or chemical element is absent. The Gobar Gas are not made by the cow themselves, however, by innumerable small organisms sleep in their organic process systems. Gobar Gas may be a sort of renewable energy, as a result of it's made with the assistance of flowering plants. Gobar Gas is a wonderful and economic fuel for each gasoline and diesel engines. But the facility obtained is a smaller amount than that obtained once the liquid fuel alone is employed. As engines mistreatment Gobar Gas become hotter than those on liquid fuel, their cooling has got to be unbroken in shape. Gasoline engines run 100% on Gobar Gas except that tiny gasoline is consumed for initiating.

Diesel engines square measure changed to dual-fuel engines that use each Gobar Gas and diesel. S.Siripornakarachai and T.Sucharitakul (2009) conducted experiments on turbo charged diesel engine of compression ratio 8:1, air fuel ratio 0.9 to 1.2 operating at 1500 rpm. They concluded that the booster pressure of 56 kpa has given highest efficiency when the ignition timing in between 500 to 600 before top dead center. Omid Razbani, Nirma Mirza mohammad and Mohsen Assadi (2011) made a detailed literature review

how to utilize biogas on spark ignitionengine to control the emission which obey the emission norms. Tjokorda G de Tirta Nindhia, I Wayan Surata, I Ketut Adi Atmika, Dewa Ngakan Ketut Putra Negara and Ari Wardana (2013) converted the small gasoline engine by automatic valve opening upto 9:1 compression ratio suck the biogas into the cylinder. It was very useful for running small electrical generators efficiently.
N.H.S.Ray, M.K.Mohanty and R.C.Mohanty (2013) made detailed literature survey of biogas as fuel for compression ignition engine and concluded that removal of carbon di oxide has given better thermal efficiency. N.H.S.Ray, M.K.Mohanty and R.C.Mohanty (2013) from the organic waste the biogas is derived as good alternative to petroleum fuels. Due to the better mixing ability with air and clean burning nature is used in compression ignition (CI) engines. Hitesh N Prajapati, Tushar M Patel and Gaurav P Rathod (2014) conducted experiments on CI engine and concluded that remarkable reduction in specific fuel consumption at higher and lower loads when biogas mixed with diesel as adual fuel. D.Deepa and T.Mythili (2014) performed experiments on CI engine of compression ratio 18.5:1 and concluded that more power generation was possible with less fuel consumption when biogas blends were utilized. D Muthu, C Venkatasubramanian, K Ramakrishnan and Jaladanki Sasidhar (2017) studied biogas generated from kitchen waste and cowdung run the engine generator of 30 kVAand 50 kVA to supply power to student hostel. Himsar Ambarita (2017) studied emission from biogas blended with diesel and concluded that the emission was lesser than diesel operated engines.
In this work an attempt has been made to run the diesel engine with diesel, B10, B20 blends of gobar gas. The observations on brake power, indicated power for different load conditions were made. These observations were applied to estimate brake thermal efficiency and indicated thermal efficiency for the blends.

2. Technology of Bio Gas

2.1 Principle

The Gobar Gas production may be a measurable method, a microbes concerned in Gobar Gas production grows within the absence of air. The foremost vital organisms area unit little microorganism. Totally different teams of microorganism touch advanced organic material within the absence of air to provide Gobar Gas wealthy in gas. The process involves the combined action of four groups of bacteria, in four stages the degradation of high molecular weight substances like cellulose, starch, proteins, etc. present in organic material into small molecular weight compounds like fatty acid, amino acids, carbon dioxide and hydrogen. This is brought by hydraulic groups of bacteria in the second stage, the end products of the first stage are converted into acetate and hydrogen by acetogens. In order to produce more acetate, a third stage is involved, in which microorganisms known as homo acetogens convert hydrogen and simple carbon compound product in the first and second stage in into acetate. The fourth stage is the conversion of acetate and some other simple compounds like format, carbon dioxide and hydrogen into methane. This is brought about by a unique group of organism known as methogens. Methane, being lighter than air, rises out of the system and can be collected and used for various purposes.

2.2 Raw Materials for Gobar gas and their Properties

Most forms of organic matter containing proteins, fats are carbon hydrate and cellulose can be microbiologically transformed into Gobar Gas. Three groups of organic material theoretically, used to different composite of methane and CO2.

Table 1. CH4&CO2 content in organic material

SUBSTRATE	Liter gas per kg	CH_4%	CO_2%
Protein	690	68	32
Fat	1175	65	35
Carbohydrate	780	49	51

2.3 Gobar Gas Properties

Gobar Gas is somewhat lighter than air and gas an ignition temperature of approximately 700°C. The temperature of the flame is 870°C. Gobar Gas consists of

50 to 65 % of CH4,
35 to 58 % of CO2,
30-160 g/m3 of water and
4-6 g/m3 of H2S

It has a calorific value of about 5.96kWh/m3 and a density of 0.94 kg/m3. The air requirement of its combustion if 5.7m3/m3 with a combustibles speed of 40cm/s.

2.4 Benefit of gobar gas

A Gobar Gas unit is an asset to a farming family. It produces good manure and clean fuel and improve sanitation. Gobar Gas may be a new supply of fuel mechanization of an agricultural and village industries. It is often used for running diesel and gasoline engines. Even electricity is often generated from it. Then value concerned in low that results in bigger acceptableness. Bio ICE area unit on the market at market.

As the consumption of Gobar Gas in internal-combustion engine is concerning 0.50m3 gas per hour per B.H.P or 0.65m3 gas per hour kW electricity. The Massive size Gobar Gas unit is needed to run the engine. The number of diesel fuel saved from mistreatment Gobar Gas made from completely different size of Gobar Gas unit.

3. Alternative Renewable Source of Energy

It is evident that no single supply of energy would be capable of substitution petroleum fully that has various applications. On the opposite hand, dependence on petroleum would need to be reduced at a quicker pace. Therefore on stretch its use for extended amount and in crucial sectors until any acceptable energy supply ideally renewable one square measure created to offer. Presently, the country is disbursed a fortune in imported crude oil which might be hardly be afforded for long on the face of development wants paraffin gas and a lot of popularity called Gobar Gas. One such alternate source of energy that has been known as a helpful hydrocarbon with flammable qualities as that of different organic compound. Through its hot worth isn't high as some product of crude oil and different energy sources, it will meet some of unit and farms. Following table would offer a concept of comparative heat values and thermal potency of usually employed in the unit and farms.

3.1 Comparison of Various Fuels

Table 2. Comparision of various fuels

Commonly used fuels	Calorific values in kilo calories	Thermal efficiency
GOBAR GAS	4715/m^3	59.5 %
Dung cake	2090/kg	12 %
Firewood	4975/kg	17.8 %
Diesel (HSD)	10545/kg	65.6 %
Kerosene	10848/kg	19 %
Petrol	11102/kg	38 %

These hot values or heat values indicate that theGobar Gas will perform works the same as crude oil in domestic change of state, lighting, etc., with higher potency relying upon the methane series content in it. The Gobar Gas has conjointly the potential to be used in burning engines used for pumping water, etc., that analysis and development works are current. Gobar Gas thus, includes a bright future has an associate in nursing alternate renewable supply of energy for domestic and farm use.

Table 3.Comparision of various fuels in SI units

FUEL	CALORIFIC VALUE KJ	THERMAL EFFICIENCY %	EFFECTIVE HEAT KJ
Gobar Gas(m^3)	19733	55	10853
Kerosene(ltr)	38194	40	15278
Dung cakes(kg)	8759	10	876
Charcoal(kg)	29016	30	8765
Soft coke(kg)	26345	30	7904
LPG(kg)	45563	55	25509
Electricity (kWh)	3600	70	2520

The gas, thus produced by the above process in a Gobar Gas plant does not contain pure methane and has several impurities. A typical composition of such gas obtained from the process is as follows:

Table 4. Contents of Gobar gas

Methane	63%
Carbon dioxide	35%
Nitrogen	0.70%
Hydrogen	0.80%
Carbon-monoxide	0.19%
Oxygen	0.11%
Hydrogen sulphide	0.20%

The hot worth of methane series is 8400kcal/m3, which of higher than mixture is concerning 4173kcal/m3. However, the Gobar Gas provide a helpful heat of 3000kcal/m3. If similar heat value area unit to be obtained from an alternative supply of fuel, the equivalent quantities of these fuels need to be substantial. It's not the amount that is therefore vital, whereas Gobar Gas is renewable, others don't seem to be.

3.2 Appliances of Dual Fuel Engines

This is a recent appliance wherever modification of the air intake system helps carburetion Gobar Gas to run the diesel motor. It's well recognized that diesel motor has wide application in rural areas for irrigation to any stationary operations and these engines may be regenerated to twin fuel one's. This twin fuel engine is in an exceedingly position to create use of regarding seventieth Gobar Gas and half-hour diesel. The economy of running twin fuel engine with Gobar Gas is indisputable, however it's sure operational difficulties. The most drawback is that whereas Gobar Gas plants square measure settled close to the house, the running of the diesel pump sets is needed within the fields. As such it's in impractical and technically unsound to supply long gas pipes to attach the herb with the diesel engines within the field. Another side that prohibits the employment of Gobar Gas in diesel engines is that it needs larger gas plants a minimum of 8-10cum, thus on modifying a coffee 3HP ICE to run 4-5 hours each day and sometimes the users like the sizes of 2-4cum gas plants as a variety of cattle's aren't several. However, considering giant Gobar Gas plants hold the key to the economical operation of twin fuel engine, in the future one several see its wide unfold application once several such gas plants are available to existing.

3.3 Power Generation

Gobar Gas is a wonderful and economic fuel for each gasoline and diesel engines. However, the facility obtained is a smaller amount than that obtained once liquid fuel alone is employed. As engines mistreatment Gobar Gas become hotter than those on liquid fuels, their cooling must be unbroken in shape. The gasoline engine is running 100% on Gobar Gas except that small gasoline is consumed for setting out. Diesel engines area unit changed to dual-fuel engines that is each Gobar Gas and fuel.

Gobar Gas is introduced within the recess pipe when it passes through the air filters, gas recess devices are designed to suit totally different engine styles and recess pipes and so as to present the right Gobar Gas/air mixture. Injection of somewhat diesel fuel to ignite the gas mixture in every stroke is crucial to the traditional running of engines. This is often as a result of in diesel engines the temperature at the tip of compression stroke is typically not over 700° C, wherever, because the ignition temperature of the methane/air mixture in 814° C.

Dual-fuel engine square measure marketed as "Gobar gas engines". The capacities of such engines vary from 3 to 96 H.P(British horse power). The consumption of Gobar Gas in diesel engines is concerning $0.50m^3$ gas per hour per B.H.P., or $0.65m^3$ gas per hour per power unit electricity, massive size Gobar Gas units square measure needed to run engines. The amount of diesel fuel saved by exploitation Gobar Gas created from totally different sizes of Gobar Gas units.

3.4Gobar Gas-As Alternative Fuel For C.I. Engine

Since the 1973 international oil crisis and the related increase in the price of fossil fuels, all countries of the world have been devoting increased efforts to opening up new energy sources. Whereas the industrialized nations are aiming to protect existing energy supplies and implement economy measure in individual sectors to reduce consumption, the third world is concerned mainly with meeting the continuously increasing demand for fuels for basic needs such as cooking and light and with supplying

energy to its developing industry. As it is, these countries are particularly severely affected by the oil shortage and the resulting worldwide price increase. In addition to the chronic food shortage, the developing countries are suffering from a lack of fuel, which in most regions has led to ruthless exploitation of timber resources.

Production of Gobar Gas from supposedly worthless organic waste which is easily available and as yet unused source of energy. Recent advances in the storage and transportation of Gobar Gas (50 to 70 % CH_4 and remaining CO_2) have made it now possible to profitably use it as a fuel for C.I. Engines. It can either be carried as liquefied gas or stored in compressed gas cylinders.

The primary advantages of this gaseous fuel are its ability to operate the engine on a lean mixture, thereby reducing exhaust hydrocarbon and CO_2 concentration in the effluent of the engine. It gives fewer deposits and shows clean burning characteristics as compared to petrol and diesel oil. Several characteristics of this gas make it an inherently safe fuel. Being lighter than air in case of a leak, it will rise and dissipate harmlessly into the atmosphere. The ignition temperature of Gobar Gas is higher than that of many other fuels.

3.5 Gobar Gas System

An alternative way of obtaining gaseous fuel is through an anaerobic fermentation of wet livestock waste to produce Gobar Gas (45-70% CH_4 and remaining CO_2). This gas has particular significance for India because of its large scale, beast population. The Gobar Gas is generally produced by dung from different beasts as cow, buffalo, goat, sheep, horse, donkey and elephant. India has 175 million cattle yielding about 70 million tons of dung every year. If this process the Gobar Gas plants would generate 40 billion m^3 of gas, which is equivalent to 20 million tons of oil. In addition to this, the N_2 content in the sludge after generating the gas will be 2 million tons per year.

Presently, the Gobar Gas plants are available in the capacity of 2 to 150 m^3/day. As per the data of 1985, the Gobar Gas plants available in India are 80,000 in numbers. In the first stage, the organic substances in the waste are acted upon by certain kinds of bacteria called acid formers and are broken into simple acids. In the second stage, the formed acids are acted upon by another kind of bacteria which produces CH_4 and CO_2.The C.V of the gas ranges from 16000 KJ to 25000 KJ/m. It is excellent fuel for cooking as well as for C.I. Engine when blended with diesel oil.

3.6 Use of Gobar Gas in C.I. Engine

The Gobar Gas can be in C.I Engine as a fuel and improves engine performance. The Gobar Gas can be introduced in the engine with air during induction stove and small quantity of diesel oil (15-20 %) is injected towards the end of compression, to initiate the combustion of the gas-air mixture power would be brought up to full rating by the introduction of gaseous fuel into the intake air.

When Gobar Gas is used as fuel, external means are required to initiate combustion, as the diesel engine compression ratio will not be sufficient to ignite the mixture because of high ignition temperature of Gobar Gas. Therefore, this is achieved by retaining the diesel injection equipment on the engine and Gobar Gas is admitted into the engine along with air during the compression stroke, diesel is injected which initiates combustion of Gobar Gas.

3.7 Engine Modification

When C.I. Engine works withdual-fuel system and the necessary modifications include provision for the entry of Gobar Gas with intake air, advancing the injection timing and a provision to reduce diesel supply. For mixing air and Gobar Gas, a mixing

chamber is provided with an injection of diesel in the cycle is required to be advanced for smooth and efficient running of engine on dual fuel. A suitable system to reduce the diesel supply by actuating the fuel control rack needs to be incorporated.

3.8 Advantages

The advantages of using Gobar Gas as fuel in C.I. Engine are listed below:

- ✓ The gas-air mixture provides a uniform mixture in multi-cylinder engines at all times.
- ✓ There is virtually no CO-emission in exhaust due to lean operation of the engine
- ✓ NOx emission is reduced by about 60% when Gobar Gas is used as a fuel.
- ✓ In case of C.I. Engines, soot is virtually eliminated and exhaust is found to have less pungent order than that obtained while operating the engine as diesel oil.

4. Testing And Result

Fig. 1 depicts the impact of load on specific fuel consumption (SFC). The specific fuel consumption reduced steeply at low loads and gradually decreased upto the maximum load for diesel, B10 and B20 blends. The inference from the graphical representation indicates more gobar gas addition, reduced specific fuel consumption at higher loads. This was unwritten explained when load reached nearer to maximum SFC marches towards the minimum. B20 has better results than B10 and diesel.

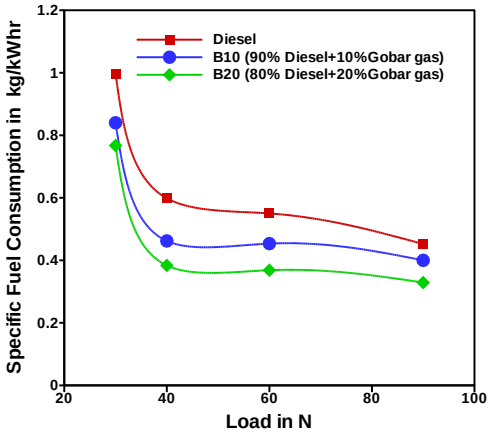

Figure 1. Load vs SFC

Load vs brake power depicted in fig. 2.exhibits load on the engine increases with brake power. B20 has lower values of brake power in comparison with B10 and diesel. The reason was a reduction in the calorific value of mixed fuel blended with gobar gas.

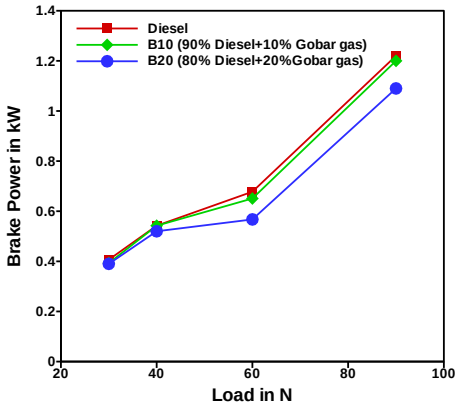

Figure 2. Load vs Brake Power

The friction Power was estimated as 0.14 kW. The same trend was observed from load vs indicated power shown in fig.3.

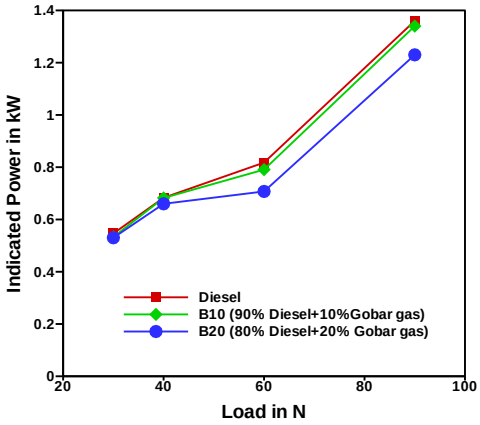

Figure 3. Load vs Indicated Power

The brake thermal efficiency was observed from fig.4. The efficiency ranges from 4 to 8% for diesel from low load to maximum load. The reduction in efficiency value observed for B10 blend 2 to 8% and for B20 blend lower than 2 to 5.2% from a minimum load to peak load condition.

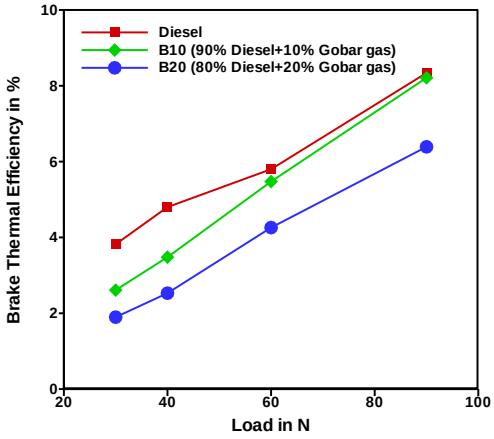

Figure 4. Load vs Brake Thermal Efficiency

The inclusion of frictional power raises the indicated thermal efficiency ranges from 5.9% to 10% for diesel, 3.9 to 8% for B10 blend and 3% to 6% for B20 blend mixed with

biogas obtained from the experiment and plotted on the graph shown in fig.5.load vs indicated thermal efficiency.

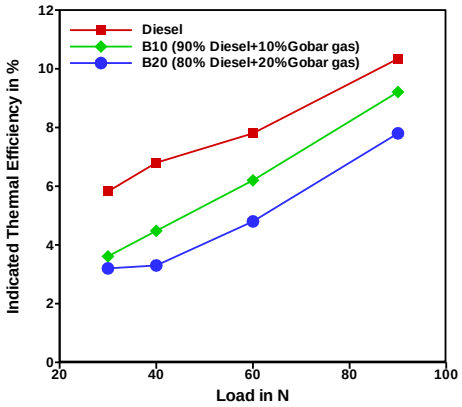

Figure 5. Load vs Indicated Thermal Efficiency

5. Conclusion

Gobar Gas, being a clean fuel, does not cause air pollution. It is considered a better fuel than natural gas and liquefied petroleum gas, because it does not contain sulphur. Sulphur, on burning gets converted into sulphur dioxide, which is responsible for lung diseases. The danger of explosion of Gobar Gas is less as it contains carbon dioxide, which act as a fire extinguisher. Gobar Gas is a new source of fuel for the mechanization of agricultural and village industries. From this project we have learned a lot such as the precautionary measure related with gas fuels handling fabricating the kit required for this purpose, engine testing conditions and variables etc.,

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