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Study, Analysis And Development Of Biogas Run Generator Of 50 KW Capacity At Pachane Taluka Mawal, District Pune.

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Abstract: This Study, Analysis and Development of a Biogas Run Generator of 50 KW capacity at Pachane Taluka Mawal, District Pune is done for the production of electricity from the Diesel Engine which is run on biogas. The engine has to be modified with the use of 4 spark plugs for the combustion chamber so that biogas can be used as the substitute fuel. The other modification required to be done is to reduce the compression ratio of 16:1 for the diesel engine to 8:1 for the biogas run engine. This reduction of the compression ratio is achieved by grooving the piston to increase the volume of the combustion chamber and reduce the compression ratio of the engine. We also need to filter the gas as the raw gas contains CO2 which is a non-combustive gas and NOx and Sulphur which causes a lot of corrosion in the combustion chamber and thus causes problems of knocking etc. Thus we have a filter installed in between and also we have a gas pump that pumps the gas after the filtration process is over and thus achieves continuous flow of the gas. This avoids the knocking effect on the engine. We have also studied that the major gas generated is methane which is around 67-70 % and the rest are other gasses like CO2, NOx, and SO2 etc. 1.72 KWH is the output recorded for the generator output for the biogas having 63% of methane.

1. *INTRODUCTION* :

Due to rising economic activities, population growth and upgrading living standards, by 2036, India's energy requirements market, which is among the fastest growing in the world, will account for the second-largest share of the global increase in energy demand. It will be responsible for roughly 18–20% of the increase in energy consumption that has occurred worldwide. As previously mentioned, given its expanding energy needs and finite supply of domestic fossil fuels, India has big plans to grow its nuclear and renewable energy sectors for clean and safe energy production. According to study data that is currently available, India's installed capacity for electricity needs related to the utility sector was 290.70 GW as of the end of March 2021. 30% of the total installed capacity was made up of renewable power plants, and the remaining 70% was made up of non-renewable power plants. In India, the total amount of electricity consumed between 2021 and 2022 was 1015 kWh per person. Out of which the highest electric energy consumption in agriculture was recorded (19.45%) in 2021-22 amongst all countries in the world.

Renewable energy sources are largely clean and non-exhaustible; they provide a solution to the sustainability issue that traditional fuels for power generation raise. For distant areas, Renewable Energy (RE) offers an affordable off-grid energy option. Even though India is presently the world's fifth-largest electricity generator, it is crucial to remember that India still has a power shortage. Since rising energy consumption and economic growth are strongly correlated, as the economy grows in the coming years, so too will the need for power. India has been working hard and consistently to increase the amount of energy it can produce. But while the energy demand has been steadily increasing, it is now more than supply. This has heavily strained the electricity distribution and also deteriorated the level of energy-related services throughout the country. This condition becomes still worse during periods of peak power consumption like summers etc where the domestic and the industrial demands increase. As per the estimates by the Base load energy deficit and peaking shortfall are projected by The Central Electricity Authority (CEA) to be 2.1% and 2.6%, respectively, for the 2021–22 fiscal year. (Central Electricity Authority, 2014) Currently, in India, the farmers are suffering due to the non-availability of electricity during the day time, due to which they have to be in the farms at night which is dangerous for human life as there can be snakes and other animals in the dark which they may not see and thus can harm them.

Renewable energy sources must be adopted due to the growing energy demand and environmental concerns. Biogas, produced through the anaerobic digestion of organic matter, presents an eco-friendly alternative to traditional fossil fuels. Also, there was less pollution due to this because diesel fuel was making high pollution and now in the BS VI norms we need to take care of nature. The load connected at this site was @ 40 KW and thus I selected a generator that will run for 50 KW and thus will have a spare capacity for further growth in the energy demand here.

In this area, no one has thought of the diesel generator to be run on biogas which I thought because there is a lot of fuel to generate the biogas and thus help to generate manure as the residual product. Also, the cost of diesel and petrol is rising and hence this can be a probable feasible solution. Another advantage is that the pollution is also minimized and thus helps the environmental balance is maintained. Hence I have chosen this topic and also worked on it.

Now in India, there is a power shortage against the demand of the country. There are abundant sources of electricity generation like Hydroelectricity, Thermal Electricity, Nuclear Power and lastly nonconventional energy sources like Wind Energy, Solar Energy etc. We have a deficit of Power which can be overcome by generating energy sources. Solar Energy and other nonconventional energy sources are abundantly available in India and thus can solve our problem of the energy deficit and thus make our country self-sufficient in the energy requirements.

Also, the other factor is saving the Diesel Consumption over the Generator as it is a product that India buys from outside and thus we spend a lot of dollars on that purchase. This generator is most useful as a power backup and can be very cost-effective.

1.1 Objectives of Biogas to be used as an alternative fuel for Diesel Generator.

1. To study the utilization of the biogas in an effective way to generate electricity.
2. Analyze various parameters of Biogas to be used to run the generator.
3. To develop the generator by using Biogas as an alternative fuel to generate 50 KW power.
4. To give an additional conversion source for energy.

1.2 Methodology of the study of modification of Diesel generator to be used with Biogas as an alternate fuel.

1. Literature Study.

We first studied the available data and also visited the Biogas generation plants and studied the data regarding the quality of the gas produced.

2. Study and Data collection to generate Biogas.

In Pachane there are @35 no’s of cows, which give us the cow dung and also the organic waste, in addition to the cow dung and the urine and cattle feed waste. Every morning the cow dung and the other organic waste is poured into the Biogas digestor and then it undergoes the fermentation process and thus generates the various gasses. The maximum generated gas is methane which is @60-70 % and the Carbon Dioxide CO2, H2S Water vapour etc contribute the balance amount.

DIGESTOR OF BIOGAS PLANT.

3. Socio Economic Survey.

Biogas is an old technology that was earlier used for cooking gas and is still used as cooking gas in rural areas. I chose to do this as a project after doing the socioeconomic survey as there was a need for power in that area and also by learning from the literature available and also the availability of the diesel engine generator etc.

In Pachane there was this opportunity to do this project as there was an ample amount of bio waste and also the energy demand was there which was not completed by existing means. Also, there was less pollution due to Biogas as compared to the diesel fuel which was making high pollution. Also in addition to this now in the days of BS VI norms we need to take care of nature and the air quality index. The other major reason is also to reduce the use of diesel which is a costly fuel in economic terms.The survey of load connected at this site was done and found @ 40 KW and thus I selected a generator that will run for 50 KW and thus will have a spare capacity for further growth in the energy demand here.

4. Analyzing the benefits of this modification to work with Biogas

Around 30 cows give cow dung and cattle waste to feed the biogas generation fuel. The food waste and other organic waste are also poured into the feeder chamber of the biogas digestor. The bacteria thus are fermenting the cattle and organic waste and thus generates the biogas. During the biogas generation there are some unwanted gases such as Carbon dioxide, Hydrogen Sulphide etc aregenerated in the form of impurities due to which the combustion process is not done properly. These engines resemble gasoline engines greatly and use biogas as the operating fuel, which is at atmospheric pressure. Therefore, with a few simple modifications, gasoline engines can be effectively modified to use biogas. Here, the compression ratio is extremely low, the spark ignition engine runs at a very high speed, and there is a significant amount of derating while using biogas, which reduces power output in comparison to modified diesel engines. Diesel engines are easily modifiable and capable of producing the required power output. We need to do the installation of the spark ignition system and combustion chamber modification, both of which are doable locally. Thus, using biogas as fuel makes it very simple to modify the diesel engine and achieve the required output. With similar emission and combustion characteristics to other fuels, biogas is a good fuel.

5. Filteration of Biogas.

Now after the generation of the biogas, we have the major task of cleaning the gas by removing the unwanted elements from it. This is done because if we do not clean the gas the engine will produce knocking and will not be able to function properly. This filtration process is done by passing the gas through various processes. Co2 and H2S can be removed by scrubbing in water as CO2 is soluble in water and the H2S is also removed by the same process. The disadvantage of this process is that it requires a lot of water to be recycled and hence wastage of water also can happen.

The other process of removing the moisture is by passing the gas through the charcoal bed which removes the moisture and also CO2 by which we can get cleaner gas which will avoid the knocking and also corrosion of the inner parts of the engine and also the pipes and other equipment's.

Table 1:- Composition of Biogas

Sr No	Components	Amount Percentage%
1	Methane (CH_4)	50 – 70
2	Carbon Dioxide (CO_2)	30-40
3	Hydrogen (H_2)	05-10
4	Nitrogen (N_2)	1-2
5	Water Vapour (H_2O)	0.3
6	Hydrogen Sulphide (H_2S)	Traces

Chapter 4:- Modifications done to adapt biogas as the alternative fuel for the diesel engine generator.

Diesel engines use compression ignition to burn their fuel, so their higher compression ratio of 15 to 22 applies. Diesel and other less flammable fuels are appropriate for this mode of operation. These diesel engines compress the air before injecting the fuel into the combustion chamber, where it burns and produces power. We now need to make some changes to the current engine to convert these engines to run on biogas.

The fuel pump and injectors must be removed, and the appropriate spark plug must be installed instead of the fuel injector after the required mechanical adjustments have been made.

There are two different ways to modify a diesel engine so that biogas serves as the primary fuel for lighting. The first technique, referred to as dedicated biogas conversion, involves using biogas exclusively in diesel engines. We exclusively use biogas as the burning fuel in this conversion. The second technique involves converting dual-fuel engines to use biogas and diesel fuel in the engine's combustion chamber to start the flame. The engine is powered by a mixture of diesel and biogas. The following adjustments will be made to the diesel engine to adapt it for use with biogas: the engine will now be tuned for the fuel type.

The first type of modification is mechanical, where we make the necessary adjustments to achieve the desired compression ratio.

Installing the ignition system comes in second since it will burn the compressed gas and provide the engine with power.

The piston head of the first method is typically milled to form a recessed bowl shape. Due to the potential for thermal stress to build up with small pistons with recessed bowls, it is typically suitable for large pistons both in the piston skirt and head.

The second strategy is to change the connecting rod's length to lessen the combustion chamber's compression ratio. However, this is a very expensive and precise job that calls for highly skilled labor and also involves a lot of process engineering. The engine will experience stress and vibration due to poor workmanship.

The third method is to grind the combustion chamber to a diameter of @0.5 mm and then increase the piston rings to match.

This is done to increase the engine's power while also lowering the compression ratio.

This approach can be used with the initial step where we create the grove on the piston head and expand the cylinder's diameter, changing the piston rings to match the altered cylinder size

The theoretical compression ratios for engines that use compression ignition (CI) and spark ignition (SI) are 16 to 24 and 5 to 10, respectively. Since the engine we modified uses spark ignition, the necessary compression ratio and octane number are displayed in the table below. Gases have octane ratings between 85 and 125. Because biogas is made up of a variety of combustible gases, its octane number is nearly 120. The following formula can be used to estimate theoretical compression based on octane number: Maximum practical compression ratio without pre-ignition (octane number = 10)

Lastly, the octane quantity of 120 The producer gas engine has a 12:1 compression ratio, but even for brief runs, this results in a knocking effect and a high engine heat load. This indicates that the heat generated for a brief period is too high, which shortens the spark plug's life and hinders its performance. According to the experimental results of our diesel engine running on biogas fuel, an 8:1 compression ratio yields the best operating conditions.

The type of mixer used in this particular project is a burner mixer. The primary inlet of the mixer allowed air to enter, and the throat of the mixer allowed biogas to enter through tiny encircling holes mixer. The mixing of the air-fuel mixture is examined in this modeling using the number of 30 holes.

(a)Piston of diesel engine (b) Piston of converted biogas engine

Fig 7:- Piston of diesel and converted biogas engine (Reference Biogas Production and Engine Conversion from Diesel Engine to Biogas Engine for Lighting in Rural Area (Seint Thandar Tun)

Table:-3 Difference between Diesel Engine and Biogas Engine.

Sr No	Diesel Engine	Biogas Engine
1)	It works as Compression Ignition Engine	It works as Spark ignition Engine
2)	This engine draws only air in the combustion chamber during one stroke.	This engine draws the mixture of air and biogas
3)	These engines need stronger construction due to high compression ratio.	These engines need relatively lighter construction as the cooling system is increased because the medium working temperature is increased.
4)	This engine requires fuel injectors, fuel pumps to inject the diesel in the combustion chamber.	This engine requires spark plugs and air fuel mixture equipment's.
5)	The engine cost is slightly high	The engine cost is lower than the diesel engine.

Improvement in Compression Ratio:-

The compression ratio of the diesel engine can be varied by making the combustion chamber volume bigger by boring and also with the use of a spacer. The spacer is designed and fabricated for the cylinder head to bring the compression ratio down from 25:1 to 8:1 for proper spark ignition operation. The cylinder head is also modified to accommodate a set of spark plugs in place of the fuel injection nozzle. The modified cylinder is shown in Figure B.

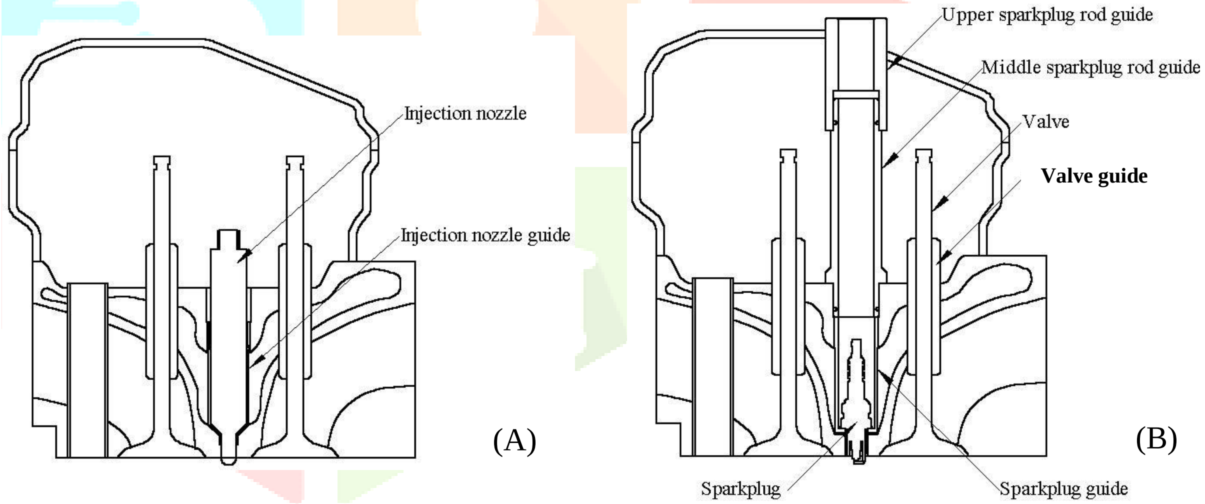

Fig:- 10 Cutaway view of the modified cylinder head: (A) Before modification, (B) After modification (Reference MODIFICATION OF DIESEL ENGINE FOR ELECTRICITY PRODUCTION FUELED BY BIOGAS by S. Sirpornakarachi Thailand and T. Sucharitakul Thailand)

Conclusions and suggestions for further improvement-

Primary and secondary data from the Pachane Generator were gathered for the study. After focus group discussions and a thorough, stratified survey, the primary data were gathered. The multidisciplinary team traveled to villages, held meetings with farmers, and then went on field trips to gather firsthand knowledge about general agriculture, productivity-related crops, surface and groundwater resources, and socioeconomic data. This data was gathered using pre-tested questionnaires to interview farmers, and about 20% of the households/farmers were chosen using a stratified random sampling technique. Through in-person interviews with farmers, the data were gathered. However, farmers were informed of the study's goals before the survey was conducted. The implementing agencies' reports, among other sources, provided the secondary data that were gathered. The project implementing agency provided financial information regarding the different activities as well. Topographic surveys were carried out as needed to augment the available data. Utilizing statistical methods like regression, correlation, and coefficient variance analysis, the data were examined.

Results and Discussions:-

Cost analysis and optimization of the generated model above. Increased electricity accessibility, decreased rural poverty, and improved livelihood security are the main objectives of the Biogas Generator, along with environmental preservation and improved natural resource sustainability. The Biogas Generator Pachane served as a case study for evaluating the effects of different procedures put in place to promote sustainable agricultural development on the ground. Nitrogen oxides, power output, and engine efficiency are plotted against the turbocharger pressure. The waste gate was adjusted to vary the turbocharger boost, and the compression ratio was fixed at 8:1. It was discovered that when the boost is increased from 40 to 52 kPa, the engine's efficiency rises and that NOX and CO levels slightly rise as well. The engine's efficiency starts to decline and the amount of pollution increases as the boost is raised from 52 kPa to 60 kPa. In this turbocharger boost range, there is also a noticeable increase in engine vibration.

The assessment of electrical potential was performed under the assumption that 1 m3 of methane and 1 m3 of biogas had respective calorific values of 36 and 22 MJ. Assuming a 35% electrical conversion efficiency, 1 m3 of biogas and 1 m3 of methane will respectively produce 2.14 and 10 kWh of power. The graph indicates that when high temperatures and pressures are present during combustion, NOX levels are high, and when the mixture is too rich or too lean, NOX levels are low.

CONCLUSION

The engine settings vary from 0.9 to 1.2 while the system is running at 1500 rpm, the ignition timing from 50 to 70 before the top dead center, and the turbocharger pressure setting from 40 to 70 kPa. In these operating conditions, the system will generate 90–120 kW of electricity. Test results indicate that running the engine with a rich air/fuel ratio and a high turbocharger boost will result in greater power being produced. Although boosting the boost pressure over 52 kPa may result in excessive pollutant emissions and engine vibration, which will likely decrease the engine life, higher engine production will result in a quicker payback period for the investment. Fine-tuning for maximum engine efficiency, minimum pollution, and shortest payback period will be performed in future research.

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