IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 37-41

Biogas: Alternative Fuel and its purification Methods

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Abstract: *Most critical issue in the advancing world is energy. Crude oil prices are touching skies and sources getting depleting day by day. Thus it's a need to hunt for alternative energy sources. Out of many biogas is one of such alternative sources which hold much potential of changing today's world energy scenario. The problem with biogas is lower concentration of methane. Many methods have been developed for scrubbing biogas of H2S and CO2.But they are useful only on large scales and investment and complexities are also greater. In our project we tried to scrub biogas at lower cost using simple method, no doubt economically. The results we obtained are enthusiastic and will certainly promote use of method we developed on domestic as well as commercial scales.*

Keywords: - *Alternative fuel, Biogas, Scrubbers*

I. Introduction

Biogas as an Alternative Fuel:

Energy is one of the World's most critical issues in the 21st century. As fossil fuel resources are depleting rapidly, energy security has become more sensitive in international affairs. Continuing increase in crude oil price in recent years (over 145USD/barrel in July 2008) poses threats to the stability of the world's economy, caused by burning fossil fuel (coal, oil, and natural gas) have caused impacts on human beings and the environment for decades. Combustion product pollutants that are very harmful to human health such as carbon monoxide (CO), hydrocarbons (HC),nitrogen oxides (NOx), Sulphur dioxide(SO_2),soot etc. Especially carbon dioxide (CO_2), the main product of combustion, is a greenhouse effect gas that significantly contributes to global warming. A lot of international efforts and initiative has been made to reduce greenhouse effect gas emissions for controlling the phenomenon of climate change. ASIAN member countries have commitments to implementation of Kyoto Protocol under UN Framework convention on climate change and are already making steps towards emission reductions, particularly through Clean Development Mechanism. The utilization of sustainable and renewable energy is apparently an effective measure to achieve CO_2 emission reduction targets and combat with global warming. Research on using of renewable energy as an alternative source of energy has captured attention of scientists for decades, especially since the world's oil crisis in 1973. Biogas, a neutralizing CO2 fuel, has double interest: energy saving and environment protection. Biogas is a product of decomposing organic substance in anaerobic conditions. Organic substance can often be plants (trees, straws etc.) or animals (animal wastes, by-products from food processing…), and wastes from breeding. CO_2 generated by burning biogas will be absorbed by new plants; therefore CO_2 amount in atmosphere will be balanced . There are two main sources of biogas produced: one from biogas digesters (tanks) and the other from the organic substance fermentation under anaerobic conditions in landfills. Biogas contain mainly CH_4 (50-70%) and CO_2 (25-50%) and other impurities such as H_2S. If biogas is refined from impurities, we will have a fuel with the same properties as natural gas .Developed countries such as USA, France, Germany, and Denmark etc. use biogas from landfills to generate electricity. In developing, countries biogas production technology for household use has become popular, particularly in India, China and ASIAN countries. In the meantime, developing countries has also piloted or employed technologies of utilizing biogas from landfills for power generation.

Biogas can replace the conventional fuels and it has economical and it has economic and environmental advantages. It is generally accepted that biogas gives an average of 95% carbon dioxide reduction (well to wheel) in comparison to diesel, as well as 80% lower nitrous oxide emissions. Plus, it also has zero particulate emissions. Biogas is an alternative fuel for powering vehicles and a very real alternative to petrol and diesel. CO_2 emission of combustion gasoline fuel is 2.31kg/liter. The above 1kW generator gasoline engine runs 10h/day emits 11.55kg CO_2 per day or 3.5 tons CO_2 per year. Thus the production of 1kW/h electricity by biogas will contribute to the reduction of 1kg CO_2 emission. So, if the engine runs on biogas,1 we can reduce CO_2 emission about 3.5 ton per year. If we use 10,000 similar biogas engine groups, we can reduce 35,000 tons of CO_2 emission per year. The Diesel engine can be modified to run on biogas although it cannot run on biogas alone. The modification are easier than that of an Otto engine in that a gas mixing valve is the only thing that needs to be added to the intake of the Diesel engine, this valve serves to

mix the biogas with the air to have in essence an 'explosive' mixture. The gas needs to be regulated to an extent that the biogas burns with the diesel and more 'explosive' air, this can be easily determined by listening to the engine and when the motor wants to 'die' the amount of diesel is reduced to such a point that diesel ignition is not available.

II. Benefits of Biogas

Biogas originates from bacteria in the process of bio-degradation of organic material under anaerobic (without air) conditions. In the absence of oxygen, anaerobic bacteria decompose organic matter and produce a gas mainly composed of methane (60%) and carbon dioxide called biogas. This gas can be compared to natural gas which is 99%methane. When we use biogas as an alternative fuel, we get following advantages.

i. Production of energy (heat, light)
ii. Health benefits of biogas
iii. Environmental advantages through protection forests, soil, water and air
iv. Global Environmental Benefits of Biogas Technology

III. Objective

Impure biogas contains CO_2, H_2S & H_2O which hamper calorific value of biogas compared to LPG and CNG and creates many problems like Hydrogen sulfide in a 2.8% concentration is hell on internal combustion engine valves, rings,pistons and cylinders so corrosive the engine will wear out in a couple hundred hours and CO_2 mainly responsible for lowering the calorific value of biogas as it is present in very large amount and it is noncombustible. Therefore there is a need of biogas purification but if we used some conventional methods it having limitation. So in present work we are trying to overcome all the limitations in traditional methods.
Our main objective of our project is to prepare domestic size scrubber, which is as easiest manufacturing as possible with low cost.

IV. Method Selection

There are many methods available for biogas purification, some are listed below Hydrogen Sulfide Removal Strategies

i. Iron Salts
ii. Scavenger Systems
iii. Alkaline scrubbing
iv. Claus Technology
v. Regenerable Oxidation-Reduction
vi. Iron Wool Method
vii. Solid State Scavenging System
viii. Biological desulphurization
ix. Activated carbon
x. Membrane Separation

Carbon dioxide removal strategies

i. Polyethylene glycol scrubbing
ii. MEA method
iii. KOH method
iv. Carbon molecular sieves
v. In-situ methane enrichment

Methods of removing moisture

i. Mechanical separator
ii. Grain drier
iii. Refrigeration
iv. Using drying agent
v. Using hygroscopic salts

V. Construction and Working

Fig 1 – Setup for biogas purification process

It is design to remove H_2S is present in the biogas so that we could get rid of its corrosive effect and bad odor.

Fig 2 – H2S Scrubber

It consists of PVC pipe of 2.5 inch diameter and five feet in length reducers of 2.5"to 1.5" are glued on both the sides of pipe. Another reducer of 1.5" to 0.5" is also glued on both the side. 0.5" side has internal thread. The hose nozzle of size from 8 mm to 12.7 mm (0.50") are fitted on both side having external thread on 8 mm diameter side.

CO2 Scrubber

Carbon dioxide is strongly absorbed by aqueous KOH solution.

$2KOH + CO_2 \rightarrow K_2CO_3 + H2O$

A 10kg LPG scarp cylinder is too used to make the CO_2 scrubber. Handling ring is cut by welding. A half inch circular hole is drilled at the top and a one half inch collar is welded at this hole. One and half inch plug is fastened to this threaded collar and the joint made water tight. This is a blow of cock. Half inch collar (PVC) with 2 feet length pipe dipped in the cylinder. Half inch collar is used as entrance for reactant that is aqueous solution. This can be closed by plug. The other hole is used as entrance of biogas. A 1/2" to 1/4" hose nozzle is fastened by using thread tape for biogas pipe fitment.

Bubbler

This is 0.50" P.V.C. pipe, 10 hole of 5 mm diameter have been drilled it. To reduce size of bubbler so that surface area to volume ratio of bubbler increases, we covered these holes with plastic tape and pin holed it. The biogas enters from H_2S scrubber, which is slightly more than atmospheric pressure, enters into the CO_2 scrubber. First, because of its high pressure it forces out the aqueous KOH presents and then due to high pressures it starts bubbling small hole.

Dryer

Solid state $CaCl_2$ absorbs water vapor contents because it has strong affinity toward water reaction is $CaCl_2+2H_2O \rightarrow Ca(OH)_2+2HCL$

This HCL formed also has strong affinity towards water vapor and while absorbs water vapor. Thus we get double advantage. It is a PVC pipe of 1 inch diameter on both sides is reduce to 1/2 inch so that we can fit gas nozzles to threaded reducer. To this reducer gas pipes are fitted. The biogas has about 3-4%moisture content in it and also when it comes from CO_2 scrubber it carries some moisture in it. The biogas coming out of CO_2scrubber is passed through dryer. The $CaCl_2$ present in dryer has greater affinity for moisture and it absorbs moisture from the coming biogas.

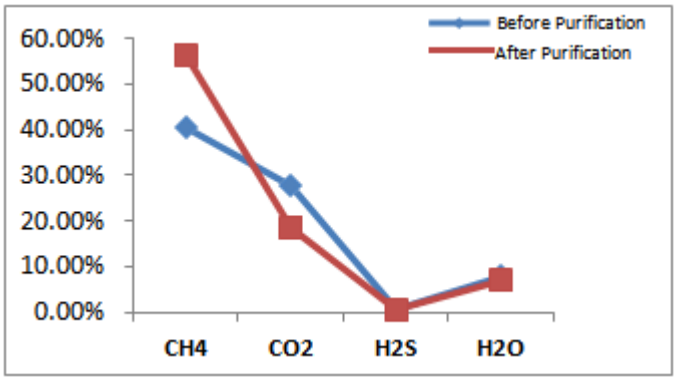
VI. Results and Discussion

Test is performed to check the change % of contents in biogass before and after purification in Nikhil Analytical & research Pvt.Ltd, Sangali, Maharashtra. It is found that % of CH4 increases while the % of H2S,CO2 and Moisture is decreases.

TABLE 1. Technical Specification

Sr. no.	Component	Material	Dimensions (mm)
1	Biogas plant	C.I.	D=2400 H=100
2	H_2S Scrubber	P.V.C	D=63.5 L=1524
3	Cylindrical Tank	C.I.	D=240 H=450 t=5
4	Dryer	P.V.C	D=25.4 H=304.8
5	Pipe	Rubber	D=10
6	Reducer	P.V.C	75*40 32*20

Graph –Change in % Vs Contents of Biogas



VII. Conclusion

As renewable energy is the need of hour, as biogas cane made available in large quantity, so it is the renewable energy which can used in future at very less cost on large scale. But due to some reasons like low calorific nature of gas due to presence of H_2S and also less compressibility it's use is limited. In our, we have tried to eliminate the gases having deteriorating effect to maximum extent and we have succeeded in eliminating these gases to maximum extent near about the composition of CNG. The purified biogas has near about 90% CH_4. Therefore this method will certainly prove beneficial for scrubbing biogas on small scale and large scales. Government is planning you make compulsory the use of CNG for transport vehicles in big cities. But main roadblock is of shortage of CNG. If purified biogas is available at lower cost with qualities matching with CNG, fuel problem can be easily solved. Thus we feel satisfied with of our project and we are hopeful about its use on domestic as well as commercial levels.

VIII. Future Scope

The limitation on the use of biogas as fuel in vehicles is also due the presence of H_2S and moisture. As both having the corroding effect on iron and increase the chances of corroding the engine cylinders. In industries also it can be used for generating the power. In some industries where boilers are used for generation of steam, like sugar factories where burning of solid fuel creates the problem of ash and also these fuels have lower efficiencies. So purified biogas can replace these fuels as it had no ash problem and it has high calorific value.

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