ISSN (Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

Volume 3, Special Issue 3, March 2014

2014 International Conference on Innovations in Engineering and Technology (ICIET'14)
On 21st & 22nd March Organized by

K.L.N. College of Engineering, Madurai, Tamil Nadu, India

Bottled Biogas: A new Approach to Renewable Energy

Vinayak R. Gaikwad[#1], Dr.P.K.Katti[*2]

[#1]Department of Electrical Engineering, Dr.Babasaheb Ambedkar Technological University, Lonere, Maharashtra, India.

[*2]Department of Electrical Engineering, Dr.Babasaheb Ambedkar Technological University, Lonere, Maharashtra, India.

ABSTRACT— Due to scarcity of petroleum and coal it threatens supply of fuel throughout the world also problem of their combustion leds to research in different corners to get access to the new sources of energy, like renewable energy resources. Solar energy, wind energy, different thermal and hydro sources of energy, biogas are all renewable energy resources. But, biogas is distinct from other renewable energies because of its characteristics of using, controlling and collecting organic wastes and at the same time producing fertilizer and water for use in agricultural irrigation. Biogas does not have any geographical limitations nor does it require advanced technology for producing energy, also it is very simple to use and apply. Being site specific, it is not possible to transport and put in use to the extent it is required. This paper presents a proposal to bottle such a gas which can be carried out at the required site as a source of supply for heat and power**.**

KEYWORDS— Biogas compression, Bottling, scrubbing unit, Compressor, Manifold system.

I. INTRODUCTION

The ever increasing demand of the combined heat and power particularly electrical energy has stressed the Oil and power generation organizations thus, affecting the economics of country. Dependence on fossil fuels is thus detrimental to economics and environment. Different alternatives are available to address this issue. Biogas is one of the alternatives which would cater a considerable amount of alternative energy. Biogas is becoming an increasingly important source of energy for rural areas in developing countries and presently also in urban areas, as can be seen by the increased construction of bio digesters. Biogas has become an important fuel source because it is driven by readily available biomass. Biogas is a clean-burning, renewable fuel that is 60-70% methane and can be used to power household appliances and generate electricity [5]. But, it is not fully utilized up to its maximum extent Because of this, there is a need to increase the versatility and availability of this natural fuel source to accommodate increased use. The biogas produced by bio digesters are currently in place. At the moment there is no system available to store the gas that these digesters produce, so all the gas that is created must be used at the same rate that it is produced.

II.PROPOSED METHOD

The biogas compression and bottling process consists of different steps such as biogas purification, compression and bottling. Fig.1 represents the typical arrangement of biogas compression and bottling process.

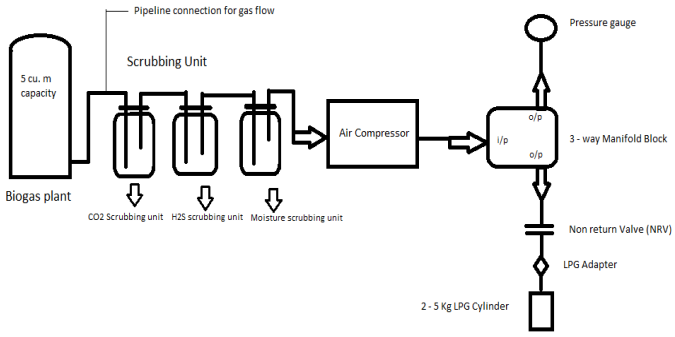

Fig. 1 Typical arrangement of biogas compression and bottling process.

The proposed method as depicted in figure 1 consists of,

1. Biogas digester
2. Scrubbing unit
3. Compressor unit
4. Storage unit

The raw biogas from the digester is first allowed to pass through a set of three scrubbing units for removal of impurities as shown in figure.1. The methane rich content

biogas is now allowed to compress by passing it through a compressor. The compressed gas is finally stored into small cylinders with the help of manifold system and adapter. The manifold system used in the prototype is of single input and double output. Gas cylinder is connected to one output port where as a pressure gauge is connected to the other output port. The reverse flow of the biogas is avoided by using ball valve and non return valve.

III. NEED OF SCRUBBING

Unlike commercially available Natural gas, Biogas contains a large proportion of impurities as shown in table 1, which are insignificant for practical purposes. Because of hydrogen sulphide and carbon dioxide, biogas needs to be pre-processed in an operation called Scrubbing [2]. The main purpose of scrubbing is to remove as much as practicable of the corrosive gases which combine with water vapour to form acids and hence corrode all metal parts of the gas system to get rid off the incombustible carbon dioxide that simply takes up space for no useful return. In addition to this, biogas forms an explosive mixture with air and oxygen.

IV. SCRUBBING UNIT

To compress and bottle biogas it needs to be purified by removing impurities as they come along from the digester as shown in table 1.These impurities, if allowed to pass through either the flare for heat production or IC engine port would harm the operation and leads to the reduction of life and efficiency. The table 1 depicts the detailed composition of biogas. [3]

TABLE 1: DETAILED COMPOSITION OF BIOGAS

Substances	Biogas %
Methane (CH_4)	50-60
Carbon Dioxide (CO_2)	34-38
Nitrogen (N_2)	0-5
Oxygen (O_2)	0-1
Water Vapour (H_2O)	6
Hydrogen Sulphide (H_2S)	Trace

The purification of biogas is carried out in the scrubber unit which consists of the following sub units;

1. CO_2 separation unit.
2. H_2S separation unit.
3. Moisture separation unit.

The function of each unit is as follows,

A.CO_2 separation Unit - The raw biogas is first passed through a CO_2 separation unit. Limestone crystals are used to remove carbon dioxide. Limestone reacts with carbon dioxide to form calcium carbonate. The chemical reaction is as follows; [5]

$$CaO + CO_2 \rightarrow CaCO_3$$

B.H_2S separation Unit – After CO_2 removal, the biogas is passed through a H_2S separation unit. Hydrogen sulphide is removed by using catalyst iron oxide in the form of oxidised steel wool or iron turning from any workshop. Once biogas comes in contact with this wool, iron oxide is converted into elemental sulphur. The chemical equations are as follows; [5]

$$2Fe_2O_3 + 6H_2S \rightarrow 2Fe_2S_3 + 6H_2O$$

$$2Fe_2S_3 + 3O_2 \rightarrow 2Fe_2O_3 + 6S$$

C.Moisture separation Unit – Finally the biogas is passed through a moisture separation unit. Here silica gel crystals are proposed to separate moisture. Silica gel crystals should be replaced after a specific time according to the rate of purification. The capacities of the scrubbing units are decided according to the size of the biogas plant. Now the out coming biogas from the scrubbing unit is 98% pure. Further, if the purification is required the multiple number of scrubbing units can be used.

Fig. 2 depicts the actual assembly of one of the biogas scrubbing unit [5]

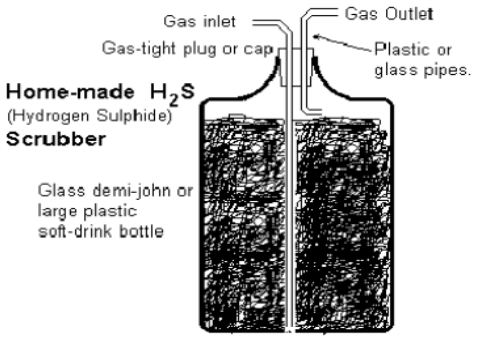

Fig. 2 Scrubbing Schematics

It consists of one inlet for raw biogas to enter the unit and one outlet for clean biogas. The glass jar is tightly closed with a lid and hose attachment in order to prevent gas leakage. Likewise two more scrubbing units are connected in series for carbon dioxide and moisture separation. Finally the clean biogas from scrubbing unit is allowed to pass through a compressor.

V. NEED OF COMPRESSION & BOTTLING

India has a huge population of humans and cattle's. One fifth of the population of Earth as well as millions of cattle reside in India [1]. So biological waste is available in abundance. Unfortunately no conscientious efforts, expect the traditional use of animal waste as manure, has been made to some extent. No efforts have been made to use this waste for the purpose of production of energy to run power plants and vehicles. Several years back a half hearted effort was made to use this biogas as a source of

cooking with the help of bio digesters. Due to smaller size of the plants and improper handling the output of the gas was limited and irregular. It has always been considered only as a stand by alternative arrangement. Therefore, a Technology has been proposed, enabling the use of this gas from bio digesters. Gober gas is purified of all impurities and moisture. Pure methane is then compressed and stored in small cylinders or bottles which make it easy to transport at the point of application.

VI. Different Types Of Compressors

For the purpose of biogas compression two types of compressors are suggested;

1. Automatic Biogas Compressor.
2. Manual OR Hand Compressor.

Automatic biogas compressors are readily available in the local market. They are available in the pressure range of 2.5 bars up to 200 bars. So depending on the capacity of biogas plant and storage systems appropriate compressor should be chosen. On the other hand if the capacity of biogas plant & storage systems is small a suitable hand compressor can be used. The hand compressor works on the principle of suction and compression similar to that of a bicycle pump. The hand compressor consists of one inlet for biogas to enter in and one outlet for compressed biogas [4]. The hand compressor consists of specific valve at its base which consists of two ports, one port for suction and other for compression. Fig 4. depicts the specific valve of the hand compressor [7].

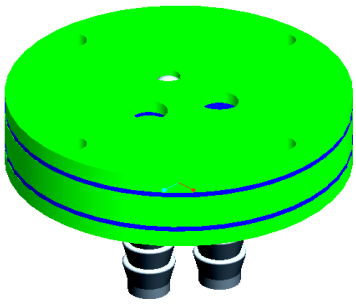

Fig. 3 Hand compressor valve.

Fig. 3 depicts the actual design of the biogas hand compressor. The compression of biogas occurs within this system, the gas inflow and outflow being regulated by the valve system. A sufficiently large stroke and small diameter is to be designed to reduce the compression force, while maximizing the swept volume. This reduces the number of pumps required to fill a cylinder.

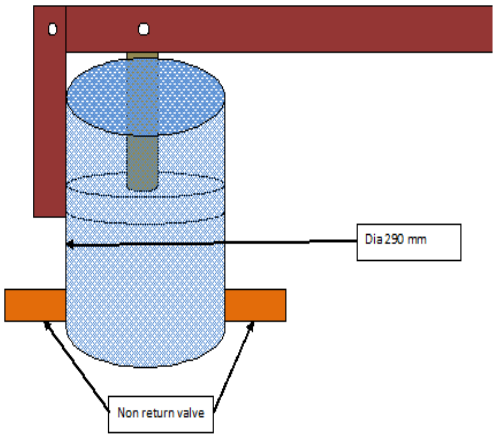

Fig. 4 Biogas hand compressor.

The details of the hand compressor are tabulated in the table 2. [4]

TABLE 2: Details Of Hand Compressor

Parameters	Actual valve
Diameter of cylinder	290mm
Stroke length	200mm
Thickness of cylinder	5.2mm
Compressibility	5-6 bars

VII. Biogas Connections And Fixings

The proposed method of Biogas compression and bottling consists of different connections and fittings such as manifold block, Ball valve, Non-return valve, Hose nozzle, LPG adapter, Gas flow meter and LPG cylinder. These are the secondary components required to enhance the flow of biogas. The manifold block used is a three way block which consists of one inlet and two outlets. One of the outlet is connected to pressure gauge whereas the other outlet is connected to a small cylinder through an adapter. Ball valve and non return valves are used to prevent the backward flow of biogas. Depending on the requirement the manifold block specifications can be changed that is more number of outlets can be connected. Different manifold blocks with different configurations are readily available in the local markets. Fig 5. depicts a manifold block [7]

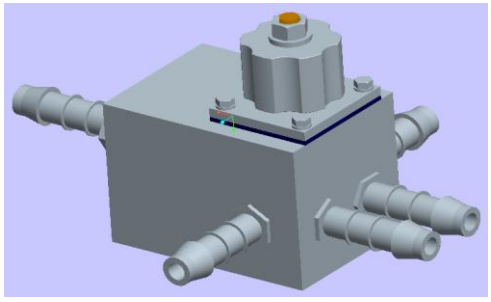

Fig. 5 Manifold block.

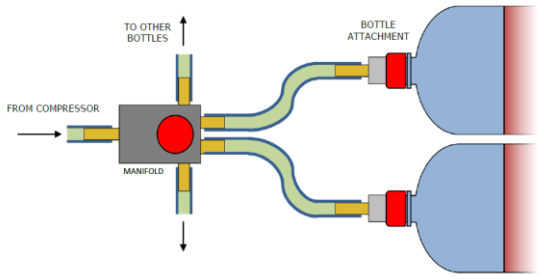

Fig. 6 one input, four output Manifold block.

The overall dimensions of the connections and fittings are surveyed in the local market and are tabulated as follows.

TABLE 3: DETAILS OF BIOGAS CONNECTIONS AND FITTINGS

Sr. No	Items	Dimensions
1	Tube	12.7 mm OD
2	3-Way Manifold block	Ht 60 x Width 62
3	1/2'' Ball valve (BV)	Length 42.7 mm
4	1/2'' Non return valve (NRV)	Length 42.7 mm
5	1/4'' Hose	1 meter

VIII. COMPRESSED AND STORED BIOGAS APPLICATIONS

The compressed and stored biogas in cylinders can be used for various purposes. The main application of stored biogas is to generate electricity which will help in bridging the supply and demand gap. It can also replace household LPG useful for cooking purposes [8]. CNG cylinders can be replaced by BIO CNG cylinders which will act as an environmental friendly fuel. This will help in achieving carbon credits. [4][5].

IX. CONCLUSION

On the studies carried out, it is clearly seen that the renewable and alternating energy sources need to be tapped on the background of scarce fossil fuels and climate change issues. Biogas is seen to be one of the best alternatives as depicted in this paper. The proposed method of bottling the biogas would definitely led to enhanced use of biogas from very site specific utility. The bottled biogas facilitates to be transported at the point of application which can be used for heat or power generation from different mechanism. Therefore, the bottling of biogas commercialization finds a huge scope in the years to come.

REFERENCES

[1] Syed Zafar Ilyas, "*A case study to bottle the biogas in cylinders as source of power for rural industries development in Pakistan*". Group of renewable energy and environment, Department of Balochistan, Quetta, 87300, Pakistan.

[2] S.S Kapdi, V.K. Vijay, S.K. Rajesh, Rajendra Prasad*," Biogas scrubbing, compression and storage: perspective and prospectus in Indian context*". Centre for rural development and technology, Indian Institute of Technology, New Delhi 110 016, India.

[3] Vinayak R. Gaikwad, Dr. P. K. Katti, *" Bottled biogas; A future source of renewable energy"*, Department of Electrical engineering, Dr BATU, Lonere, Maharashtra.

[4] Vinayak R. Gaikwad, Dr. P. K. Katti, *" Biogas compression and bottling"*, Department of Electrical engineering, Dr BATU, Lonere, Maharashtra.

[5] Virendra K. vijay, Ram Chandra, Parchuri M. V. subbarao and shyam S. kapdi, "*Biogas purification and bottling into CNG cylinders: producing bio CNG from biomass for rural automotive applications"*. Mechanical Engineering department, Indian Institute of Technology, Delhi, Hauz khas, New Delhi- 110 016, India.

[6] Piyapong Singbua and Ratchaphon suntivarakorn, "*Development of Biogas compression system for using in household*", Department of Mechanical Engineering, Faculty of Engineering, khon Kaen Uni, Maung, Khon Kaen 40002, Thailand.

[7] Michael, Jason, Peter and James Faupel, *"Design and Development of a Biogas compression and storage system capable of implementing in the developing world*", Department of Mechanical, Materials and manufacturing Engineering

[8] Biogas support program,"*A study report on efficiency measurement of biogas, kerosene and LPG stoves*"