Solid Works Approach to Biogas Compression and Bottling Systems

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ABSTRACT
The ever increasing demand of the combined heat and power particularly electrical energy is in greater demand due to enhanced industrialization and urbanization in last few decades has led to higher pressure on fossil fuels and need for alternatives like renewable energy sources. Biogas being site specific, it is not possible to transport and put in use to the extent it is required. This paper presents a working model to bottle such a gas which can be carried out at the required site as a source of supply for heat and power and Solid work Simulation of the working model with various cut plots for temperature & pressures.

Keywords
Solid works, Biogas compression, Bottling, scrubbing unit, Compressor, Manifold system.

1. INTRODUCTION
Energy is the key input for the socio-economic development of any nation. Industrialization, urbanization and mechanized agricultural techniques have generated a high demand of energy in all forms i.e. thermal, mechanical and electrical .To meet this ever-increasing demand, fossil fuels such as coal, oil and natural gas have been exploited in an unsustainable manner. This exploitation has been posing serious environmental problems such as global warming and climate change [7]. While we have shortage of energy and are dependent on imports in case of petroleum, we are blessed with plenty of natural sources of energy such as solar, wind, biomass and hydro. Biogas is a clean burning fuel which consists of about 50-60% methane [1]. It has the potential for leveraging sustainable livelihood development as well as tackling local and global land, air and water pollution. Biogas can be used for various applications namely, cooking, heating, space cooling / refrigeration, electricity generation and gaseous fuel for vehicular application [7]. At present it is not possible to transport biogas over long distances and to put in use to the extent where it is required. Biogas is becoming an increasingly important source of energy for rural areas in developing countries, 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. Because of this, there is a need to increase the versatility and availability of this natural fuel source to accommodate increased use. This biogas is produced by bio digesters that 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.

2. WORKING MODEL
The biogas compression and bottling process consist of different steps such as biogas purification, compression and bottling. Figure. 1 represents the typical arrangement of biogas compression and bottling process.

Fig1. Typical arrangement of biogas compression and bottling process

The proposed method as depicted in figure 1 has;

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 fig.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 upto a pressure of 4 bars. 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.

3. EXPERIMENTAL RESULTS
Raw biogas is purified, compressed and is filled into small Cylinder. 2 kg cylinder was used for filling purified biogas. The results obtained during biogas compression and bottling are tabulated as follows,

Table 2. Experimental readings

1.	Weight of Empty cylinder	2.840 Kg
2.	Weight of cylinder after filling biogas	3.936 Kg
3.	Total purified biogas in cylinder 1	3.963 Kg - 2.840 Kg = 1.096 Kg
4.	Time required to fill cylinder	15 Minutes
5.	Flow of biogas	7 liters per minute

4. ABOUT SOLID WORKS

The modelling of the proposed prototype can be done by using SOLID WORKS software. To start with the modelling of the prototype, it is first necessary to fix the basic dimensions of every component in the prototype. It is also necessary to finalize the entire assembly of the prototype. The solid work software is a mechanical design automation application that takes advantage of the Microsoft windows graphical user interface. It is 64 Bit software. The complete simulations are done in **SOLID WORKS 2013**. This software makes it possible for the designers to quickly sketch out ideas, experiment with features and dimensions and to produce models & detailed drawings. In solid works, you can sketch ideas and experiment with different designs to create 3D models. It consists of two sections

a. Parts.

b. Assembly.

5. SOLID WORKS MODEL

With the help of **SOLID WORKS 2013** software, a 3-D model of the proposed prototype is created which is depicted in figure below. It consists of biogas digester, 3 units of scrubbing system, a ball valve, compressor unit and finally a manifold block. The detailed dimensions of each and every block can also be seen from the software.

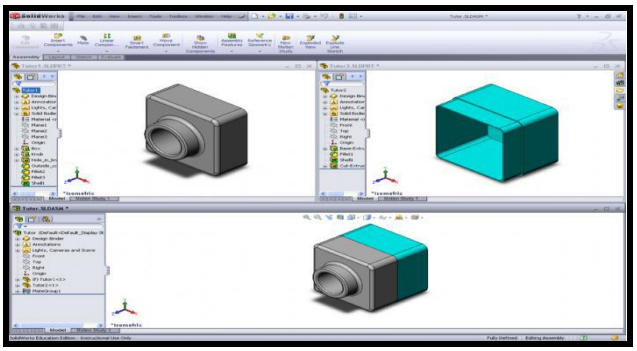

Fig 2. Solid works Model

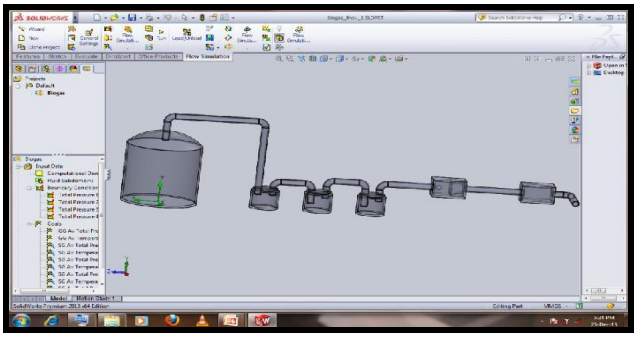

Fig3. Prototype 3D Model

Fig.5 & 6 throws a light on how actually a Ball valve operates during the flow of biogas. Different colours indicate different values of pressures and temperatures which can be taken from the counters. It may happen that in some areas two different colours might appears together which may lead to human error. In order to overcome this problem a facility of probe is provided, which will directly give the reading at any desired point.

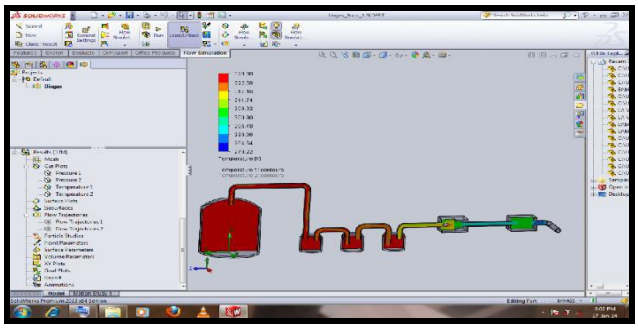

Fig4. Prototype 3D Model with temperature & Pressure Cut plots

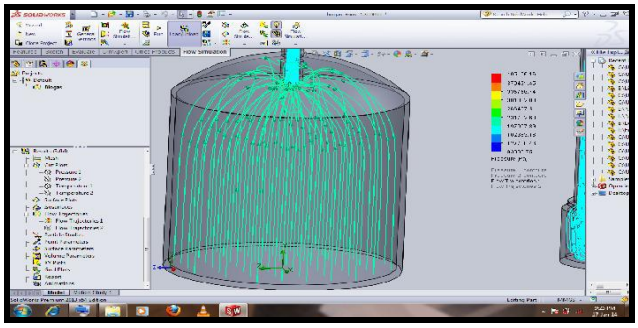

Fig5. Prototype 3D Model with Flow trajectory in digester

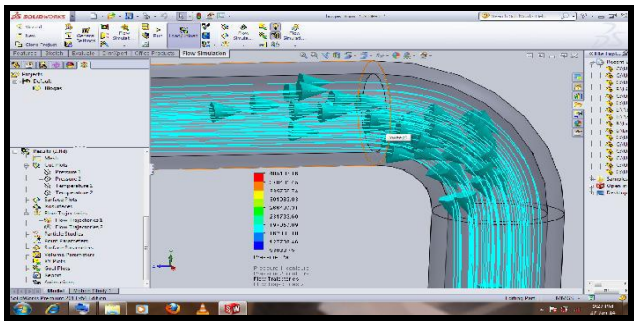

Fig6. Prototype 3D Model with Flow trajectory in gas pipes

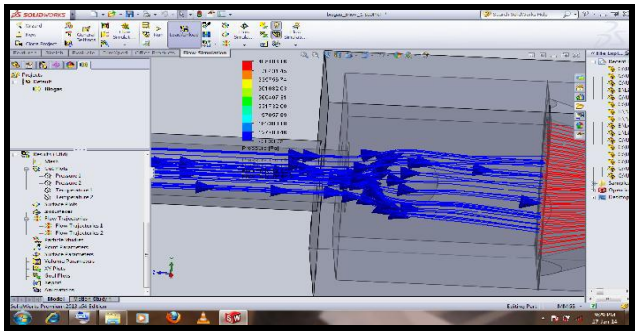

Fig7. Prototype 3D Model showing Ball valve flow trajectory

The cut plots are divided into 4 sections mentioned as below;

Cut Plot- Pressure 1.

Cut Plot- Pressure 2.

Cut Plot- Temperature 1.

Cut Plot- Temperature 2.

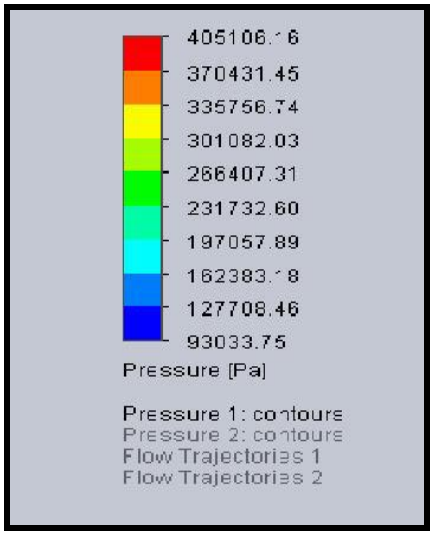

Fig8. Cut plot for pressure 1 & 2

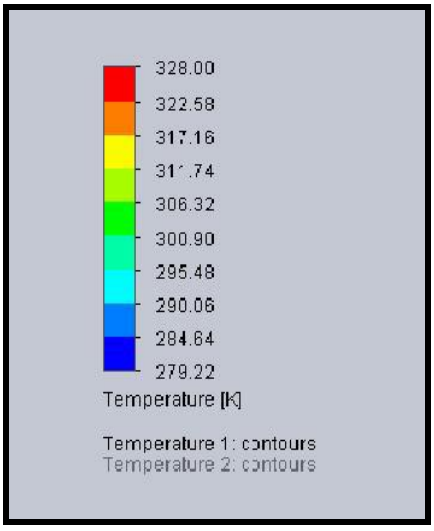

Fig9. Cut plot for Temperature 1 & 2

Depending on the colour counters Temperature & Pressure readings can be taken out. It is concluded from the simulations that the pressure of biogas goes on decreasing from digester to Compressor unit. Once it reaches compressor, biogas gets compressed at 4 bar pressure and further it again decreases till it reaches output point i.e. storage systems (cylinder). The same is true in case of temperature. The software also provides the results in the form of animations which clearly visualize the idea of gas flow right from digester up to the storage systems.

6. 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. It is observed that compressed biogas could hold successfully in the measuring cylinder after purification. Various temperature and pressure plots are obtained with the help of SOLID WORKS software which gives an idea about the changing values of temperature & pressure from starting point till the purified and compressed biogas is being bottled. Different colours help the observer to find out different values of temperature and pressure contours. Based on the simulated values it becomes easier to construct and model biogas compression & bottling system.

7. REFERENCES

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