Case Study on Bio Gas Plant Installed at Hingoniya Gaushala, Jaipur (Rajasthan), by Sai Nath Renewable Energy Pvt. Ltd.

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Abstract

India is a land of religions. There are multiple believes and description of cattle in society related with the religion as well as in agriculture. India has the largest number of Cattle/ cows in the world. Livestock in India is increasing every year with increasing awareness. Most part of the India the slaughtering of Cattle specially cow is ban. To protect the cows Animal welfare Board of India (AWBI) works for them and also the state government has established many Gaushalas (an affiliated shelter). Cow shelters (gaushalas) are unique traditional institutions in India, where aged, infertile, diseased, rescued, and abandoned cows are sheltered for the rest of their life, until they die of natural causes. These institutions owe their existence to the reverence for the cow as a holy mother goddess for Hindus, the majority religion in India. The other aspect of running a gaushala is not simple as day-to-day expense is required to overcome the demand of food / fodder for cows, medicine for the cows, the infrastructure, staff salary taking care of the cows, electricity expenses, etc. Gaushalas are getting some fund from central as well as state governments and also in our country many private/ individuals also provide fund to the gaushalas.

Keyword: Bio Gas Plant, KVIC model, Gaushala, Scrubber, Organic Manure

Introduction

India has the largest cattle population in the world, with more than 190 million cattle, used primarily for dairy and draft purposes. Most rural people own a few cows but have limited land for grazing, especially as the human population has encroached upon their traditional grazing lands, leading to cows roaming freely in the streets and causing traffic problems. In some states, crop raiding by street cattle has led to significant human-animal conflict, and there are many fatal road accidents involving cattle on the streets.

In most Indian states there are cow shelters or sanctuaries, termed ‘gaushalas’, or for more recent shelters ‘Go Sadans’ (hereafter, collectively termed ‘shelters’), where abandoned, infertile, and chronically ill cows are sheltered by philanthropists, animal protection organizations, religious organizations, and religious temple trusts. Shelters play a significant role in the management of stray cattle in India.

To study the Gaushala, I went to Hingoniya gaushala situated in Jaipur city (capital of Rajasthan also known as pink city of India). The Hingoniya gaushala is now under the care of Akshaya Patra and the fund is provided by the Jaipur Nagar Nigam, Jaipur. There in Gaushala I found a 240 cubic meter (cumtr) bio gas plant that was constructed in year 2003- 2004 but at that time it was not working.

We made some of the modification in the old bio gas plant and made it working and the bio gas generated from that plant is used in the kitchen of the Gaushala, to prepare cow feed and milk related products. The compost is used in the farms by near about.

Here in this I will discuss the complete set up of the bio gas plant and its maintenance so that the cow dung is brought in used instead of leaving open and the foul gases released from that dung becomes a cause of environment pollution.

Details of Bio gas Plant

The process of bio gas involves processing of organic waste in anaerobic condition, the fermentation of the organic waste is done in absence of the oxygen, the bacteria grow over the waste to break it in simpler form – separating CH_4, H_2O, H_2S, CO_2, CO leaving the fibre and water as the left over.

1. *The total capacity of the plant is 240 cumtr.* – The plant installed is based on the KVIC floating dome and daily it can produce 240 cumtr of bio gas which is equivalent to 120 kg of LPG (as 1 cumtr of bio gas = 0.465 kg of LPG)
2. *There are 4 nos. of digester having 60 cumtr capacity each* – there are four different digesters placed one after the other near by so that each plant can be feed separately and the gas from each plant is connected with the single pipe line.
3. *Gas from the Holder* – the gas from the holders travels through 3" GI pipe line to the compressor (low pressure compressor), one line from the compressor is attached to the scrubber, another line is directly attached with the kitchen. The filtered bio gas is supplied to the DG set through 2" CPVC pipe lines. The supply line of raw bio gas to kitchen is 2" CPVC. The Pipe lines are controlled by pressure valves/ ball valves.
4. Each digester is having an intake of 1500 kg of cow dung per day + 1500 ltr of water i.e. 3000 ltr of slurry. The HRT is 45 days (as per the old design)
5. The Plant is having 5 major parts
    a. Mixer / Agitator
    b. Digesters.
    c. Compressor.
    d. Bio gas Supply Line.
    e. Filters / Scrubbers.

Present Working of Bio Gas Plant done by SNRE

a. **Mixer / Agitator**

The capacity of the bio gas plant's digester already installed in gaushala was to treat 6000 kg of cow dung per day. Manual handling of such a huge quantity is not easy and time taken to complete the activity is also more. So overcome the time and the labour we introduce mechanical mixing system (to mix cow dung with water). The pits were already constructed, modification made.

The mixing area/ Platform is introduced with the ramp so that cow dung can be transported on the platform with tractor. The cow dung from the tractor is pulled manually by 2 labours on the metal platform / stand made of MS Channel and the water is added to the cow dung with the 2" pipe line at the side of the pit. After some time, the agitator motor is switched (7.5 HP motor each operating on 3 phase) on, the work of the agitator blades is to mix the cow dung with water, to have a homogenous slurry. The agitator is having 3 blades of 12 mm thick MS flat patti, attached with MS solid rod of 18 mm dia, with top Pully 9" dia and another pully on the motor of 3" dia. Both the pully are connected with 2 V type belts – number 103. The vertical rod is free to rotate when the motor is switched on, the vertical road is having bush with bearing at top at middle and with a brass bush at the bottom (floor). The agitator rotates at the 50 to 120 RPM (to reduce the speed of the mixer, no spilling at the time of mixing takes place). There are 4 outlets present in the pit (with gates) to feed each digester separately.

After the slurry get ready the gate no. 1 is open so that the slurry enters in the digester no (1) time taken (in emptying the tractor and mixing with agitator/ mixer and making the slurry) is around 45 to 55 minutes. Similarly, the process of mixing is repeated till feeding of the all the 4 digester is completed. Total time taken to complete the feeding of all the 4 plants will be take about 4 to 5 hours.


Picks of the missing pit with agitator placement and the metal platform

b. **Digesters**

There are total 4 digester. The depth of the digester is 15 ft from the top, the diameter is 13 ft, the construction of the digester is made of 12" RCC with water jacket on the top having width 9" and the depth is 3.5 ft. There is a buffer wall of 10" thickness at the centre of the digester, to the height 10 ft. The capacity of the digester is 1,35,000 ltrs. HRT is 45 days.

To the one side of the digester is a 12" dia RCC pipe incline at 45 degree from the top and is 5 ft away from the digester, top of the pipe is at 6" down from the level of the digester top and the bottom of the pipe if 2 ft up from the bottom of the digester/ floor of the digester this pipe is also called as ***Inlet pipe***. Opposite side of that pipe is another pipe placed same but the top of the pipe is kept 1.5 ft below the top of the digester and this pipe is also called as ***Outlet pipe***.

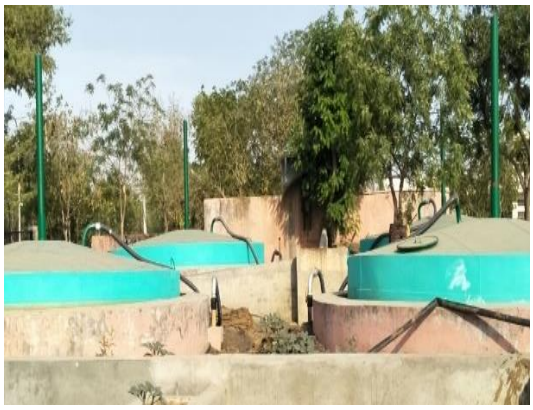
The Inlet pipe is attached to the feeding pipe attached to the Mixing / Agitator Pit.

The MS hollow pipe of 4" dia of height 10 ft is attached at the centre of the Buffer wall with help of MS placed on the top of the wall to hold the pipe straight, this pipe will help the Floating dome to move in up and down straight without touching walls of the digester.

The Floating dome is made of MS Angles 60 mm x 60mm x 6mm and 3 mm MS sheet with centre MS hollow pipe of 6". The dome is made of angle skeleton and then it is covered with MS plate the welding is done in such a way so that there is no leakage of gas. On the top of the dome a 3" MS Elbow is welded for the outlet of the bio gas produced and stored in the dome for further use. One more round cut-out is made on the top of the dome of 2ft dia and is covered by a lit, so can be used as the service trap door.

As the fermentation starts the formation of the gas forces the dome to be lift by its own and comes down when the gas is used. The weight of the dome is 3500 kg app which pressures the gas to flow in the bio gas pipe line when the valves are set open.

For the best performance of the digester the dome is to be rotate manually on its axis 300 degree clock wise and anti-clock wise. This rotation removes the top scum that appears on the top (inside) of the digester due to fermentation process. This also helps the dome up and down functionality properly.



Picks of the Digester with dome over it with fitments

c. Compressor

The compressor is used to suck the raw bio gas from the dome and compress it. The compressed bio gas is stored in the MS tank. The compressor is attached with 5 hp motor (Crompton make) of 3 phase. The motor runs clockwise, attached with the compressor with help of the Pully and fan belt

(for durability 2 no of belts – the belt no is B65). The motor starts and rotates the compressor clock wise, the compressor with 2 piston sucks the raw bio gas and compress it (single stage compressor) and sent the compressed bio gas in the attached MS storage tank.

The MS storage tank is made of 5mm thick plate with FRP lining inside. The tank is equipped with

1. Pressure meter to show the pressure inside the tank.
2. Pressure switch is also attached in the tank that will switch off and, on the motor, depending on the pressure inside the tank (when pressure of the tank reaches 3 bar switches activated and it on the motor and when pressure reached 10 bar the switch deactivates and switch off the motor).
3. Safety valve is attached with the tank, for safety. If pressure exceed the valve breaks and releases the excess pressure.
4. A bottom drain valve is also provided, for draining of the moisture or water sucked from the raw bio gas. With in the interval of 3 to 7 days the water / moisture present in the MS Bio gas storage tank is to be removed by opening of the ball valve.

Picks of the Compressor

Bio Gas Flame in Kitchen with fitments

d. Bio gas Supply Line

The different type of pipes lines installed for various purpose –

1. The PVC 9" (blue colour) pipe line is used to feed No 1 and No 2 digester from the mixing tank.
2. The Flexible 3" PVC pipe is attached with the MS floating dome to supply the bio gas to the main line.

3. The 3" GI pipe is used to collect the gas from all 4 digester and bring it to the compressor. The line is coated with rubber coat to make it rust free, also the line is placed inside the ground. Ball valves is also used to control the out flow from each digester.
4. The 2" CPVC pipe line is used to supply the gas inside the kitchen area with Ball Valves and the.
5. The 2" CPVC line is used to supply the gas to the DG set.
6. The 1" composite pipe line (black colour) is from Compressor to the Hospital.

Picks of point no 1 Line

Picks of point no 2 Line

e. Filters / Scrubbers

The Filtration / purification of the raw bio gas in the plant is done on the basis of PSA technology (Pressure Swing Adsorption) as now a days it is one of the most used purification systems in the bio gas plants. The space required is less as compared to other Bio Gas purification system.

The PSA system comprises of 3 to 4 vessels. The PSA system installed at Hingoniya Gaushala 3 vessels are used to separate CO_2, H_2O, H_2S. The particles like Carbon monoxide, Water, and Sulphur are adsorbed on the surface area of the media used inside the vessels. The pressure is build inside the vessels by sending raw bio gas from one side of the vessel at 3 to 6 bar, the movement of the raw bio gas flows in such a way that the first CO_2, is adsorbed in the first vessel and gas is passed from the top of the vessel and enter inside the second vessel from the bottom the adsorption of the H_2O take place and the gas is left from the top of the second vessel and then it enters from the bottom of the third vessel adsorbing the H_2S and leaving the purified bio gas i.e. CH_4 at 90% to 92%.

The purification % depends on the media or the chemicals used for the adsorption also on the size / sieve / surface area of the adsorption material / media. The PSA also depends on the pressure built in, adsorption, depressurization and regeneration.

Scrubber installed based on PSA technology

Point to consider for Maintenance of Different parts

To get the best output from the bio gas plant following maintenance point be consider –

1. Every day the feeding must be done in each digester, other wise chocking of the digester will take place. Also it affects the regularity of the bio gas production, per day.
2. Rotating of the floating dome on its axis clockwise and anti-clock wise must be done at the interval of 7 to 10 days.
3. The gas pipe line must be clean by back pressure at an interval of 20 to 30 days, so that the removal of debris and water collected in the pipe line due to the moisture. But before doing this the valve present on the dome must be closed first and the pipe is to remove from the dome.
4. The belt of the mixing / agitator must be check periodically with interval of 150 to 200 days.
5. The belt of the Motor to the Compressor must be check periodically with interval of 50 to 80 days.
6. The ball valves of the pipe line must also be check periodically for any sort of gas leakages / loose connections due to weathering.
7. The bio gas MS tank moisture/ water must be also drain at interval of 4 to 6 days.
8. Compressor oil must also be checked periodically, without compressor oil starting of the compressor is not allowed (without oil compressor will damage).

9. Pressure gauge and auto control switch of the compressor mounted on the top of the MS bio gas storage tank must be also checked – they are working properly and they are helping the compressor in maintaining the pressure.
10. The scrubber chemicals to be check on the basis of quantity of raw bio gas Passed from it. The raw bio gas passed from the scrubber vessels (for purification) constant pressure should be maintained.

Practice of Bio gas plant in Gaushala and its usefulness

The best way to reduce the pollution caused by the cow dung left in open ground. In this study we have study the improvement of the old and existing non-working bio gas plant. various techniques to convert the organic waste into compost. This study will help the Gaushala operating trust, Gopalan vidhags and central as well as state government to select the bio gas as the treating method of the cow dung. That will also help the Gaushala in generating Income source by selling the Bio Gas and compost (organic manure). This study will also help the environment, to get rid from the toxic gas generated by the cow dung left open in the ground.

Suggestion and Recommendations

The suggestions given by the researcher based on the present study are given below:

- Bio Gas is one of the best ways to treat the cow dung and convert it in useful product – Bio gas and Organic Compost.
- The waste Generators can select the techniques depending in their requirements.
- The Government and NGO's should also help in spreading the awareness about the Bio gas plant.
- The Ngo's and Government bodies to come forward and educate for the techniques of Bio gas Plant.
- Gopalan vibhag, Ngo's and Government bodies to fund or provide subsidy on the bio gas plant that can help the gaushalas.
- Ngo's, CSR's and Government bodies to build the Community Bio gas Plants, so that near area gaushala can accumulate the cow dung at a single place.
- There should be meeting to educate the Gaushala owners or their trust members to build and maintain the bio gas plant to trat the cow dung.
- There should be the provision of loan by banks to build the bio gas plant.

Conclusion

This study will help Gaushalas to treat their available cow dung into the useful products like bio gas

and organic manure. Also Gaushala can have a wide know how on bio gas plant they can design according to their available Cow dung. This will help to protect the environment. The direct emission of foul gases can be prevented. This will help the Country and the world to treat the Bio Degradable waste / cow dung into compost – reducing the waste and enhancing the soil fertility.

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