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Case Study of Compressed Bio Gas Plant Installed at Hingoniya Gaushala, Jaipur, Rajasthan, India

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Abstract - *Nowadays countries are researching and using more and more renewable sources of energy to overcome the energy needs for electricity generation, driving vehicles, and burning fuel to meet the needs of human beings. Similarly, they are also making energy from biodegradable waste, which helps the environment in two ways i.e. by decreasing the emission of CO2 in the environment and fuel for electricity generation/vehicles/cooking. India is also moving forward to generate fuel from bio-degradable waste; GOI has initiated many Schemes to generate biogas from biodegradable so that fuel can be generated from the waste and that can resolve the fuel need of the country; schemes like SATAT, NBFM, NBMMP, GOBARdhan, and other sorts of subsidy schemes on installing domestic biogas plants, etc. In the SATAT scheme, GOI asked the private entrepreneur to generate Compressed Bio Gas and sell it to the PSUs (like BPCL, IOCL, HPCL, etc.). IOCL has started to set up 100-ton biogas plants at different locations of the country, CSR funds are being used to set up these CBG plants, and these CBG plants are being set up in the Gaushala (state government gaushala). As the cow dung is easily available in the Gaushala and in large quantities as more than 10000 nos of cows are there in the gaushalas utilizing locally available resources and promoting sustainable practices for environmental and economic benefits.*

Key Words: Biogas Plant, Cow Dung, Compressed Biogas (CBG), Organic Manure, Gaushala

1. INTRODUCTION

IOCL has set up a biogas plant with their CSR fund in the Hingoniya Gaushala, Jaipur, Rajasthan. The capacity of the biogas plant is 100 ton i.e. to produce biogas, compress it at high pressure, and store it in a cylinder that can be easily transported to the fuel stores where these bottled CBG and be used in vehicles. Also, the fuel can be used for cooking in the kitchen of the Akshay Patra. Akshay Patra maintains the hingoniya gaushala and takes care of the cows of the gaushala, also the maintenance of the biogas plant is under the Aksay Patra. In short the plant is set up by the IOCL fund on the government land (Gaushala Land) and the running and maintenance is under the Sri Krishna Balaram Seva trust (Akshay Patra). The gas right now produced in the plant is used in the kitchen of the Akshay Patra to prepare the meals of 150000 students every day (as they run mid-day meal program).

1.1 Plan of Location

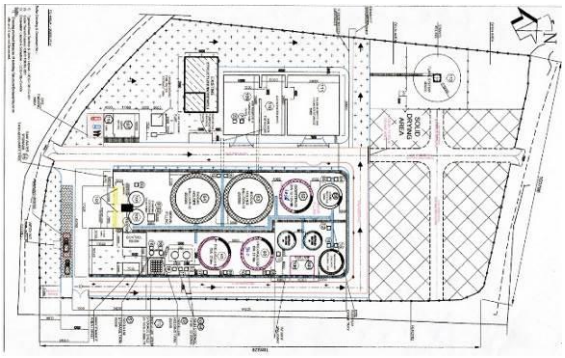


Figure 1 -- Plan of Plant

As we entered, we found that the complete plant site is covered by the boundary with an entry gate and a nice road network is there inside the site.

1.2 Components of the plant

1. Mixing tank – 2 nos

2. Water storage tank

3. Pumping station

4. Main digester (overhead) **Predigester**– 2 nos.

5. Neutralizing tank – 1nos.

6. Biogas Holder Balloon – 2nos

7. Inoculum drums – 2 nos.

8. Filtration unit

9. High Pressure compressor – 2 nos

10. Cascade on trolley (60 cylinders of 15 kg capacity)– 4 nos.

11. Vacuum Pump – 2 nos

12. Screw Press

13. Panne Room

Prabh of Akshya Patra is looking after the operation and maintenance of the biogas plant.

2. About the Plant

2.1 As previously discussed the Hingoniya Gaushala is maintained by Shri Krishna Balram Seva Trust, a subsidiary of Akshay Patra, the hingoniya gaushala is located in Jaipur City (outskirts). The hingoniya gaushala belongs to Jaipur municipality; under an MOU the gaushala is given to Akshya Patra for 15 years under maintenance.

Table 1-- composition of cow dung

Composition	Percentage by weight
Water	75%
Organic matter	20-25%
Nitrogen (N)	0.5-1.5%
Phosphorus (P)	0.2-0.5%
Potassium (K)	0.5-1.5%
Calcium (Ca)	0.5-1.5%
Magnesium (Mg)	0.2-0.5%
Sulfur (S)	0.1-0.2%
Microorganisms	Varied

2.2 So the staff and Prabhu looks after the gaushala and feeding of the cows, as the maintenance of gaushala (cleaning, collecting the left out, cow dung, cleaning of the roads, etc.), the collected cow dung is been used to make organic manure through vermin composting and selling it to the farmers. In 2015 / 2016 IOCL visited the gaushala and proposed to set up a bio gas bottling unit (Compressed Bio Gas). So IOCL from their CSR set up a 100ton compressed bio gas plant and handed over the plant to Akshay Patra for operation and maintenance.

2.3 Clean and neat road network, proper piping with different color codes and the flow lines over it, the wiring/cables are properly placed in the tray, all plant part and the machineries are properly numbered with proper name over them, makes your visit more educative.

3. Working of Plant

→ At present, the collected cow dung is being transferred from the gaushala to the plant by the tractor trolly of the gaushala.

3.1. The cow dung from the trolly is directly empty in the mixing tank, water is added from the water storage tank shown in **photo no 2.** and the agitators are used to mix the cow dung with water and a homogeneous slurry is prepared, the slurry is pumped to the main digester first in digester no1 and after feeding the digester no2.

As per the plant design

Raw material = 100ton cow dung (per day)

Water required = 100000 ltr per mixing

100000 kg + 100000 ltr = 200000 ltr per day

3.2. The slurry is pumped to the **Main digester tank**, as shown in the above photo no **1**.

Characteristics of the main digester --erected over the ground with 3 mtr. foundation of RCC, and the walls are made of the MS steel plate 8mm thick riveted and welded to each other. The thermostatic is done by coating the complete tank with fiber wool and from the outer the SS sheet is covered. Stairs are also fixed from the bottom to the top of the tank. A blue color pipe (100 mm dia.) is fixed in the tank with a 2 hp pump which will take slurry from the bottom of the tank and throw it on the top of the tank this will help in agitating the slurry 2 nos. on the tank both sides. 4 nos. of 12" dia pipes are also attached required to empty the tank, also, 2 nos. thermostatic readers are connected to take the inside temperature of the slurry. The temp of the slurry is been read at three stages i.e. on the top, middle, and at the bottom of the tanks. The temperature reading is directly connected to the panel rooms, also the operation for the agitation of the slurry is been controlled from the Panel Room.

The inoculum is been added to the tank in a fixed proportion to decrease the HRT and make the methane fast.

now the capacity of the digester depends on the HRT the IOCL has taken the HRT as 10 days.

capacity of one digester = 10,00,000 ltr.

capacity of another digester = 10,00,000 ltr.

so total capacity of the digester = 20,00,000 ltr.

First the slurry of

day 1 is poured in digester 1 = 200000 ltr, similar

day 2 is poured in digester 1 = 400000 ltr, similarly

day 3 is poured in digester 1 = 600000 ltr, similarly

day 4 is poured in digester 1 = 800000 ltr, similarly

day 5 is poured in digester 1 = 10,00,000 ltr, now

day 6 is poured in digester 2 = 200000 ltr, and will Conti.

day 7 is poured in digester 2 = 400000 ltr, similarly

day 8 is poured in digester 2 = 600000 ltr,

day 9 is poured in digester 2 = 800000 ltr,

day 10 is poured in digester 2 = 10,00,000 ltr,

now both the digesters are filled and the first day feed is now 10 days old.

The inoculum technology is been created by the R&D section of the IOCL itself and they are confident that this will decrease the HRT time (which means the generation of the methane will be more and in fewer days). A separate tank and the dose chamber have been designed for this the inoculum is

transported in gunny bags from the IOCL and on site a paste is formed at a particular temp and pressure in 1000 ltr 2 nos. tanks. The 2 overhead black color tanks of 1000 liters capacity are been equipped with temperature sensors, pressure switches, motors, etc. The operation and maintenance is under IOCL of this part only they have guided how to feed the inoculum in the digesters and how to prepare the inoculum by adding water.

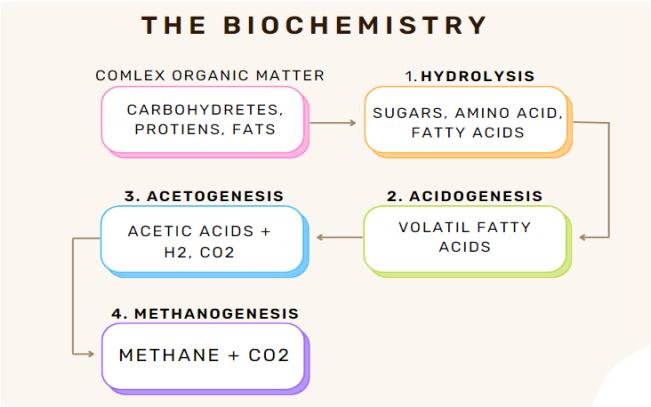


Figure 2 -- Bio-Chemistry of Biodegradable matter

Generally, 40 days HRT is considered for the degradation of cow dung but IOCL has introduced inoculum to decrease the HRT. Also, it helps in producing more methane.

3.3. The Semi digested organic matter (cow dung) from the main digester is sent through the screw press and the liquid is sent to the neutralization tank for further fermentation. This a very special technology that will reduce the size of the digesters and also decrease the fermentation time as well as the production of methane.

The matter passed from the screw press divides itself into two parts one is solid i.e. known or termed as manure and can be used as a soil conditioner, and the other part i.e. liquid is again sent to the neutralizing tank where the liquid is kept for some days that generated biogas.

In this technology, the biogas is generated from two tanks,

i) from the digester tank
ii) from the neutralizing tank which contains only liquid.

The biogas generated in these tanks are been stored in the raw biogas balloon, there are 2 biogas balloons with the capacity of 5000 cumtr each = 10,000 cumtr of raw biogas can be stored at a single time. The raw biogas is then passed to the filtration unit to separate CH_4 and remove other gases and can be used as fuel.

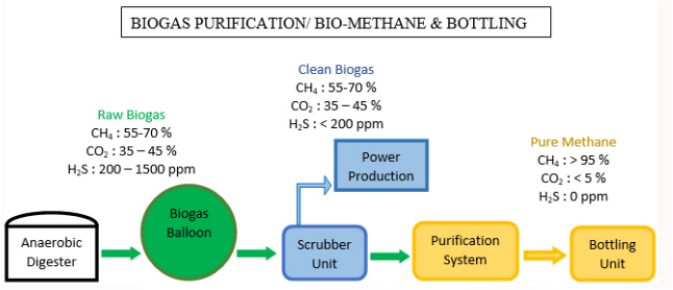
3.4. The filtration technology is also somewhat different, first, the biogas has been sucked by vacuum pumps to the filtration chambers, and during the suction process, the gas is cooled by the water cooling unit. The gas sucked from the balloon is passed from the cool water to reduce the gas temperature (as the gas travels from the pipes in the process of vacuuming the gas temp increases to reduce it and to control the gas expansion the cooling of gas is done) and then

i) biogas passes through the vortex flow – this will separate the water content from the biogas

ii) then the gas will be passed in the VPSA tanks to separate the CO_2 from the biogas.

iii) it passed to the H_2O filter and the pure biogas now known as methane is stored in a metal vessel at a pressure of 6 bar.

iii) the left-out gas from the VPSA process is been stored in a small metal vessel and then it is again mixed to the raw bio gas balloon, (to prevent the loss of gas and also to extract more methane from the VPSA rejected gas)



iv) the whole process of purification of biogas is automatic and controlled from the control room, the quality of gas coming/collected after the purification is been continuously checked with the help of analyzers (an online analyzer monitoring system is present there).

V) the composition of the gas coming after the filtration has a composition of CH_4 more than 92%, other gas like CO_2, H_2O, H_2S is in very less quantity depending on the CH4 content in the main gas.

3.5. The pure biogas / Methane is been compressed by use of heavy compressor and gas is been transferred/stored in the MS cylinders of (50-liter water capacity at normal temp.), There are 2 nos of compressor pumps, they are attached to the pure biogas storage tank, these pumps can compress @ 200 to 300 bar, as they are 5-stage compressors with self gas cooling system.

i) the gas is compressed and sent to the cascades already present in the plant, the cascade is a trolly having 60 cylinders of 50 ltr capacity, a cascade/trolly can have = 60*15 = 700 kg of pure methane@ pressure of 250 bar in each cylinder or of a cascade.

ii) cascade can be easily moved with the help of the tractors and can be transported from the plant to the kitchen/filling stations.

4. Present operation of the plant

→ many problems have been faced in operation earlier but now many modifications have been made for the proper and easy running of the plant.

→ nowadays they are feeding 40 to 50 tons of cow dung daily and the same is the water ratio, but some days they have to add more water due to non-working of the mud pump (sucks the slurry from the mixing tank and through it to the main digesters).

→ the gas produced is been bottled by the compressors and is used in Akshay Patra's kitchen, the pressure they are maintaining is 160 bar max.

→ they are also in search of private/gov purchaser of their CBG so that they can increase the production.

5. CONCLUSIONS

The production of biogas from biodegradable waste will help a lot to the environment and will also help in fulfilling the need for fuel. The best part of biogas fuel is that it can be used in the vehicles, for cooking, also to generate the electricity. The bio gas is a green fuel i.e. it is free from harmful gases. The bio gas can easily be compressed and can be transported from one place to another by bottling it.

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