

Bio-CNG plant

Spectrum Renewable Energy Limited, Kodoli, Kolhapur

Spectrum Renewable Energy Private Limited (SREL) developed a large scale biogas generation and bottling project at Kodoli near Kolhapur in the state of Maharashtra. It is a 100 TPD press mud to biogas and organic manure generation plant. This is first of its kind project, developed in partnership with a large farmers' co-operative society. SREL is purifying and enriching about 20,000 m³ of biogas produced from press mud as well as spent wash which generates around 8000 kg Bio-CNG which is CNG grade fuel also called as CBG (compressed biogas). This is a price-competitive renewable energy that can be used in vehicles as well as heating application in heat treatment facilities



replacing LPG (Liquefied Petroleum Gas), diesel or other fossil fuels. CBG can also be used for electrical power generation. SREL provides a close cycle of sugar cane crop i.e. sugar cane is harvested from the agricultural fields and sent to the factory for sugar recovery and press mud, press mud is further treated through process of biomethanation for gas generation and organic

manure. This organic manure goes back to the fields where sugar cane is cultivated. Hence, SREL project is a renewable energy and waste management project with triple bottom line impact: Environmental, Social and Financial.

Background:

India is the second largest producer of sugar cane in the world. The states of Uttar Pradesh, Maharashtra and Karnataka lead the nation in sugarcane production. About 202 sugar factories exist in Maharashtra alone. As a nation dominated by agricultural activities, India has massive potential for utilization of agricultural products and waste for energy generation.

India's sugar industry and farmers stand to benefited greatly from biomethanation, a technology with economic, social and environmental objectives. Biogas is produced by the biological breakdown of organic matter under anaerobic conditions. Biogas is advantageous because it can be used as a fuel substitute at local level for vehicles or as fuel to generate electrical and thermal energy.

Press-Mud, the waste by-product produced during sugar making from sugarcane is an ideal feedstock for biomethanation. The conversion of Press-Mud into biogas also produces high quality organic-fertilizer, which can be used as a soil enricher and nutrient in agriculture. Farmer members of the sugar factory, other agricultural farmers and manure merchants/dealers can be benefited immensely by the continuous and assured supply of organic manure all through the year from this plant.

Salient features of the plant:

- Plant operation: 80 % is mechanical and 20 % is manual.
- Three reactors made of concrete each with 8.5 m height to 24 m diameters in dimensions, having 9000 m³ of active culture volume.
- These are CSTR type reactor and operate at mesophilic temperatures. HRT is 35 to 40 days.
- Feed stock is stored and used during off season. Holding capacity of the storage yard is 18000 tons and consists of 6 open compartments made of concrete.
- Press mud is fed by a conveyer belt into feed tank.
- Feed tank is fitted with a mixer for making a uniform feed slurry and pumped (Wangen pump), into digesters through underground pipe line.
- Each digester is fitted with hot water pipes (14 rows) at about 3 meters height from the bottom. Hot water (60° C) from the generator is circulated through these pipes and digester temp. is maintained at about 38 ± 1°C.
- Each digester is provided with four agitators, whose direction is changed manually for mixing the digester contents.
- Each digester is also equipped with gas capturing system to hold about 950 m³ of biogas. It is of German make; air inflated double membrane type, to prevent the heat loss from the digester top portion. It is also weather resistant.
- All the digesters are interconnected through pipes at the upper gas storage area to have equal gas pressure.
- All the digesters are fitted with safety valve to prevent over and under pressure. Pressure and level sensors fitted to all the digesters and all of them are connected to PLC.
- Biogas generated is continuously sucked by a blower (9.3kW) and supplied to gas cleaning system.



Biogas cleaning process description (for H₂S and CO₂ removal)

The raw Biogas from distillery and press mud digester is taken to the gas header. Raw biogas parameters at the header are as below;

- Biogas Flow : 20000-22000 Nm³/ day
- Biogas pressure : 2500 mmWC
- Methane (CH₄) : 60 %
- Carbon Dioxide(CO₂) : 35 % (Max)
- Hydrogen Sulphide(H₂S) : 3 % (Max)

- The "**Bioskrubber**"TM process, consist of an aerobic reactor with an absorber and a sulphur recovery unit, which treats H₂S containing gases. The process leads to conversion of sulphide biologically to elemental sulphur.

- **Adsorbent Bed:** Biogas from "Bioskrubber" is passed through the adsorbent bed where H₂S is reduced from 200 ppm to 5 ppm. Online H₂S analyzers are provided to measure the H₂S concentration.



The parameters after the adsorbent bed are as follows;

- Biogas Flow : 19800 Nm³/ day
 - Biogas pressure : 1000 mmWC
 - Methane (CH₄) : 65 - 67 %
 - Carbon Dioxide(CO₂) : 30 - 32 %
 - Hydrogen Sulphide(H₂S) : less than 5 ppm
 - Moisture (H₂O) : 2 - 3 %
- **CO₂ scrubber:** For CO₂ removal from biogas a packed column is used. Soft water is used as solvent at high pressure (7.5 kg/cm²). CO₂ concentration is reduced to less than 5%.
- **Dryer Unit:** From CO₂ removal system biogas is passed through drying system. Dryer is two vessel molecular sieve type and heatless. Here the moisture is removed to ppm level. It is equipped with timer logic for regeneration and PRV. Purge gas is taken to the clean gas holder.

BIO-CNG composition:

- Biogas Flow : 11960 Nm³/ day
- Biogas pressure : 6-7 kg/cm²
- Methane (CH₄) : minimum 95 to 95.5 %
- Carbon Dioxide(CO₂) : maximum 4.0 to 4.5 %
- Hydrogen Sulphide(H₂S) : less than 5 ppm
- Water vapour : Nil
- Oxygen : Nil
- Hydrogen : 0.2 to 0.5%
- Methanol/Glycerol : Absent

Online analyzers and flow meters are provided to measure the above parameters.

- **Buffer Vessel:** From the drying unit biogas is sent to the buffer vessel at pressure 6 to 7 kg/cm². It is equipped with pressure control system and PRV connected in close loop to recycle gas header.
- Gas from this buffer vessel is taken to the high pressure compressor.



All above units are operated through PLC installed at control room.

GAS COMPRESSING SYSTEM

- Two Burckhardt make compressors are installed for compressing the purified biogas from 7 bar to 200 bar pressure and bottled into a cascade of cylinders.

BIOGAS STORAGE CASCADES

- The CBG stored in cylinders (cascades) is transported to the client place and used instead of diesel, LPG and furnace oil through PRV's.



Flare unit

- Excess Biogas released during plant breakdown or in any other case of emergency is burned by flare unit.

BIOGAS BASED POWER GENERATOR

- Gas Generator of 340 kW capacity is installed at the site which operates 100% on H₂S free Biogas.
- It generates power for fulfilling plant auxiliary consumption.
- The generator generates approx. 2.5 units per m³ of gas.
- Heat recovery system, extracts heat from engine jacket water, lubricating oil and exhaust gas is used to maintain required temperature inside the digesters.

Advantages and Benefits of Biogas

1. Biogas is eco-friendly fuel. Provides a non-Polluting and renewable source of energy.
2. Has a calorific value of around 6kWh/m³—this is equivalent to half a liter of diesel.
3. Larger biogas plants generate and feed electricity into mainstream power grids.
4. Efficient way of energy conversion.
5. Saves women and children from drudgery of collection and carrying of firewood, exposure to smoke in the kitchen, and time consumed for cooking and cleaning of utensils.
6. The digested sludge is high quality organic manure, completely natural and free from harmful synthetic chemicals. It can supplement or even replace chemical fertilizers.
7. Leads to improvement in the environment, sanitation and hygiene.
8. Provides a source for decentralized power generation.
9. Leads to employment generation in the rural areas.
10. Household wastes and bio-wastes can be disposed of usefully and in a healthy manner.
11. The technology is cheaper and much simpler than those for other bio-fuels.
12. Dilute organic waste materials (2-10% solids) can be used as feed materials.
13. Any biodegradable matter can be used as substrate.
14. Anaerobic digestion inactivates pathogens and parasites, and is quite effective in reducing the incidence of water borne diseases.
15. Environmental benefits on a global scale: Biogas plant significantly lowers the Greenhouse effects on the earth's atmosphere. The plant lowers methane emissions by entrapping and using it as fuel.