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BIOGAS PURIFICATION AND COMPRESSION SYSTEM

Biogas is comprised of Methane (CH4, about 45-75% by volume), Carbon Dioxide (CO2, 25-55%), and other compounds including hydrogen sulfide (H2S, present in concentrations from several hundred to a couple of thousand parts per million), water, and other trace gas compounds. Methane, if extracted from the biogas would be used as replacement of CNG or LPG.

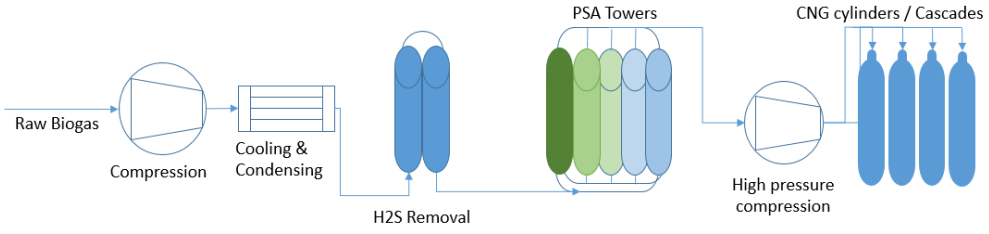
Various methods are available for Methane extraction from the biogas are water scrubbing, chemical absorption, Membrane separation, Bio-filter, cryogenic separation and Pressure swing absorption. The method proposed here is Pressure Swing Adsorption technology.

Pressure Swing Adsorption

Pressure Swing Adsorption (PSA) is a technology used to separate some gas species from a mixture of gases under pressure according to the species' molecular characteristics and affinity for an adsorbent material. Special adsorptive materials (e.g., zeolites and active carbon) are used as a molecular sieve, preferentially adsorbing the target gas species at high pressure. The process then swings to low pressure to desorb the adsorbent material.

The PSA process relies on the fact that under pressure, gases tend to be attracted to solid surfaces, or "adsorbed". The higher the pressure, the more gas is adsorbed; when the pressure is reduced, the gas is released, or desorbed. PSA processes can separate gases in a mixture because different gases tend to be attracted to different solid surfaces more or less strongly. Since the material is continuously used and regenerated, there comes a point where the process achieves a “cyclic steady state” (CSS)

However, during biogas purification, the adsorption material adsorbs H2S irreversibly and thus is poisoned by H_2S. For this reason a preliminary H2S removing step is often included in the PSA process.



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PSA using zeolites or activated carbon at different pressure levels is an effective method for the separation of CO2 from methane. Activated carbon impregnated with potassium iodide can catalytically react with oxygen and H2S to form water and sulfur. The activated carbon beds also need regeneration or replacement when saturated. The advantages of PSA technology are more than 92-95% CH4 enrichment, low power demand, and low emission and removal of nitrogen and oxygen.

Design basis

Raw Bioogas inlet flow : 20-250 m3/hr

Bio GAS inlet Pressure by Blower : 0.4 kg/cm2g.

Outlet gas flow (Purified Bio Gas) : 10-130 m3/hr,

Outlet gas Pressure : 0.3 kg/cm2g

INLET GAS SPECIFICATION:-

CH_4	: 55 - 62 %
CO_2	: 30 - 35 %
H_2S	: <1000 ppm
H_20	: 2 %
Air	: 2 %

OUTLET GAS COMPOSITION:-

CH_4	: 92-95%
H_2S	: < 10 PPM
CO_2	: < 5 – 6%
H_20	: < 30 PPM
Air	: 2.6 %

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Process description

The system can be designed to intake 20 -250 cum/hr raw biogas. The special adsorptive materials absorbs CO2 molecules from the biogas. The resultant gas is free from CO2 and H2S. The absorbed CO2 is released to regenerate the material.

The biogas is fed into PSA System with the help of BIO-GAS BLOWER via Fe2O3 based de-sulpherizer tower. The de-sulpherizer tower absorbs the H2S content from biogas. The reaction takes place as follows.

$$Fe2O3 + 3\ H2S \rightarrow Fe2S3 + 3\ H2O$$

The Blower is a single stage, roots type, oil free, water cooled, double seal, Nickel coated blower of suitable capacity.

Blower outlet gas is routed through a vertical tower filled with Fe2O3 where 90+% of the H2S is removed.

H2S free gas is then passed through shell and tube type heat exchanger and Alumina-filled biogas dryer of suitable capacity and as per specifications given in the bid document.

H2S and moisture free gas is routed into a PSA tower 1 with 0.5-0.7 Bar g pressure. While tower 1 is purifying the gas, the tower 2 is taken for regeneration which is achieved by depressurization of the tower, creating partial vacuum in the tower with the help of vacuum pump and providing small purge of pure gas in the reverse direction in the tower. The changeover from one tower to another is fully automatic and accordingly continuous supply of purified gas is available at the outlet of the system.

H2S, moisture and CO2 free refind biogas is then sent to a surge vessel. The pressure in the surge vessel is maintained at around 0.5 bar by controlling the speed of the VFD on the blower.

Before pressurizing the gas, the gas undergoes through a vessel filled with Zinc Oxide for removing traces of H2S.

GAS COMPRESSION

The purified gas is fed into a high pressure compressor. The reciprocating compressor is capable to compress the gas upto 250 bar pressure. Capacity of the compressor can be selected based upon requirement. Purified compressed gas is filled into cylinder cascades. The size and capacity of cascade can be adjusted as per consumption pattern.

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Gas storage cylinders

To store purified Biogas –Bio-CNG or CBG seamless cylinders are used. The gas is tore at 250 bar pressure. The cylinders are available in various size and capacity.