Biogas Plant installed at KU to produce Pressurized and Purified Methane.

Presented at RECON organized WEBINAR by

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Problem in waste management (3
08 tonnes/day in Kath Valley)

Background Information

Solid Waste

Our Civilization - Riding Cars in the core area of Kathmandu city

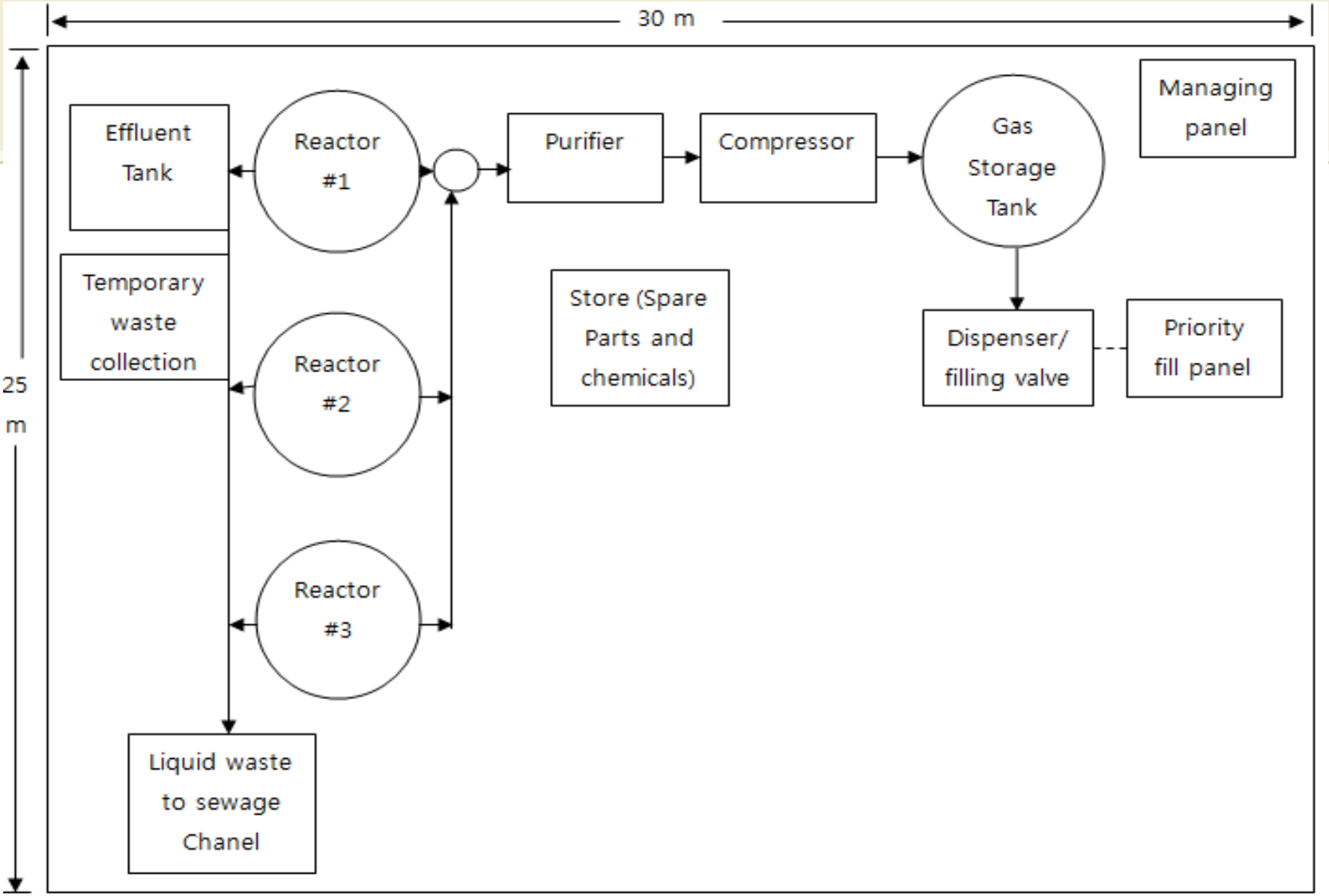
- A brief History of this Project

- Proposal submitted to South Korea/KEMCO on Oct 26, 2008
- Competitors 200+
- 18 proposals selected and one of them our proposal
- Project completion certified on December 23, 2009
- Project Cost around US $ 400k (out of this **equipment sent to Nepal worth MORE THAN US$300 K)**
- **Project partners: Ecosian (Korea), NSES (Nepal)**
- **Project Site: KU, Dhulikhel**
- **Project handed over to KU for continuesd R&D (?)**

Why this project?

- preventing the uncontrolled emissions of CH_4 to the atmosphere (21 times more powerful than CO_2) from landfill sites/other disposal places;
- beneficial use of biofertiliser, displacing mineral fertilisers;
- production of renewable energy (displacing fossil fuels);
- Bottling of purified methane for transportation ; and
- Helping in creating cleaner environment in urban areas.

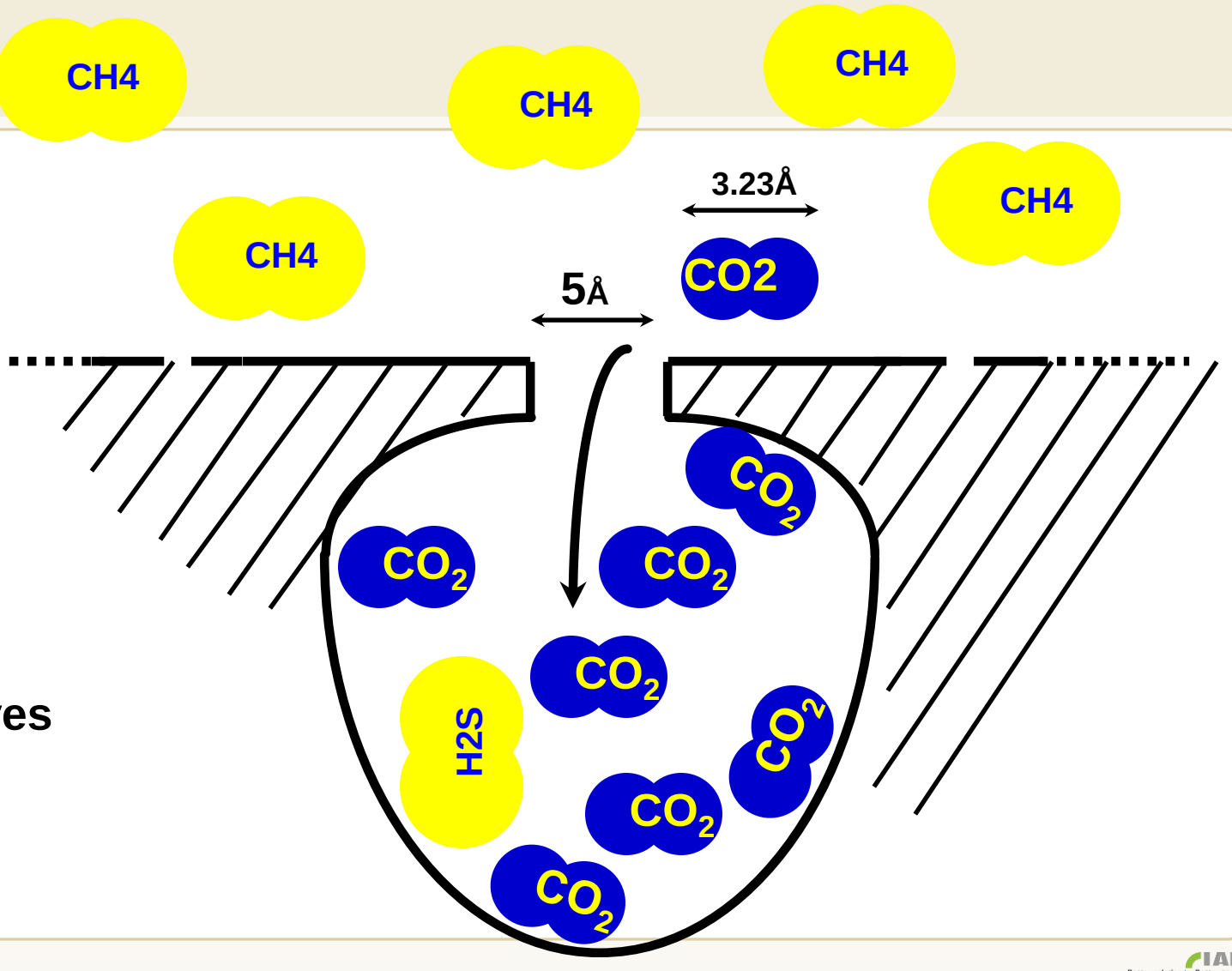
Basic idea of the project



KU Officials approving the Project


Three Bio digesters of 30 m3 each at KU
(18 m3 of biogas is generated per day)
Slurry Outlet
Gas Outlet
Waste Feed

Molecular Sieves (MS) (Source: PSA Nitrogen Ltd)



Magnified View of Molecular Sieves

Energy Balance

Bio-digester

H2S Remover

- 0.374 kWh

CNG Low compressor

CNG Buffer Drum

- 0.525 kWh

PSA System

- 0.034 kWh

PLC System

Vacuum pump

CNG Buffer Drum

- 4.289 kWh

Gas compressor

CNG Storage Tank

212.408 kWh

Dispenser

- 0.5 kWh

PLC System

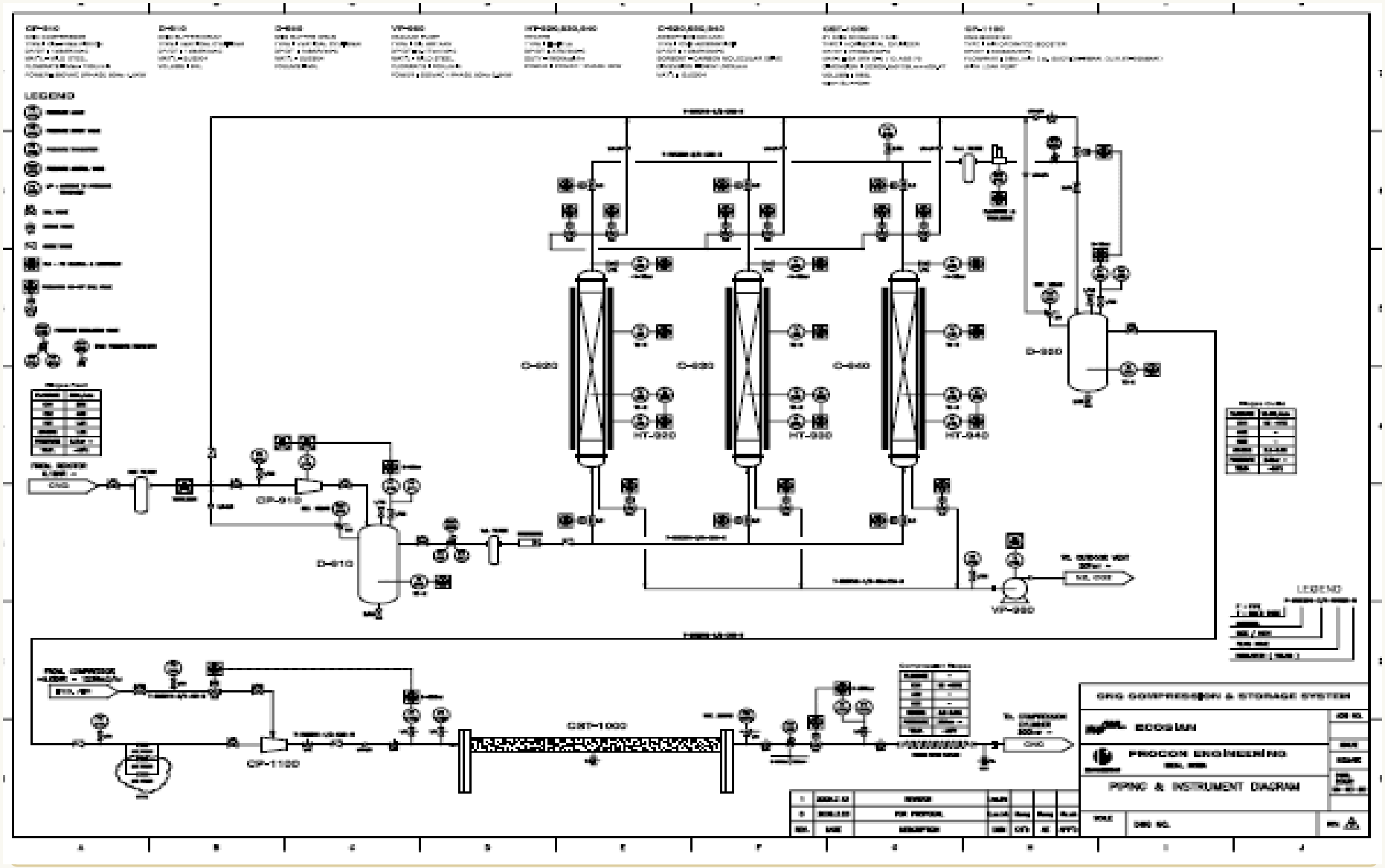
Sub-Total Energy Input = - 5.722
Total energy required for one Cycle = - 5.722* 145.646 kWh
= - 833.38 kWh
Energy Balance = Output Energy – Input Energy
= 1212.408 kWh – 833.38 kWh
= 379.066 kWh

AUTOMOTIVE CAR AND THREE WHEELER RUNNING ON ENRICHED BIOGAS

Biomethane Volvo – 0.5m^3 manure or 60kg of kitchen waste per 100km

Waste to energy (Cow to Car)

Piping & Equipment Diagram



Description of equipment

H2S Remover

1. It consists of changeable filter

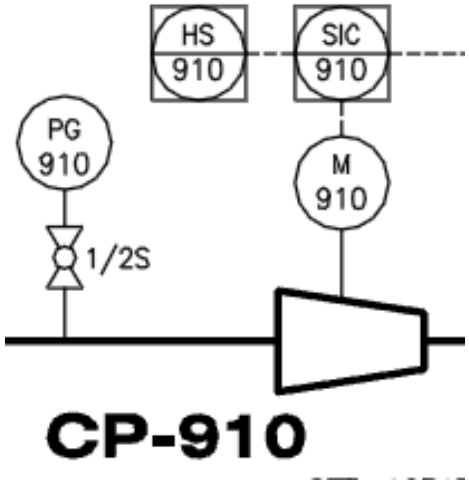
2. While the amount of H2S attached to the filter increases, the pressure shown in the pressure gauge also increases

3. Once filter is fully saturated, it needs to be changed

4. H2S should remove completely as it cause corrosion of other vessels.

Description of equipment

Small biogas compressor



Specification

Type: Oil-free piston
Design Pressure: 15 bar
Design temp: 50 degree centigrade
Material: Mild Steel
Flow rate: 100L/min
Power 380VAC 3 phase 50Hz (0.374kWh)

Function: To compress the biogas coming out of H2S remover and create the pressure around 2~3 bar which is required for easy storage of biogas in buffer drum.

Description of equipment

CNG buffer drum

Specification:

Type: Vertical Cylinder
DP/DT: 15 bar/ 50 degree C
Volume: 30 L

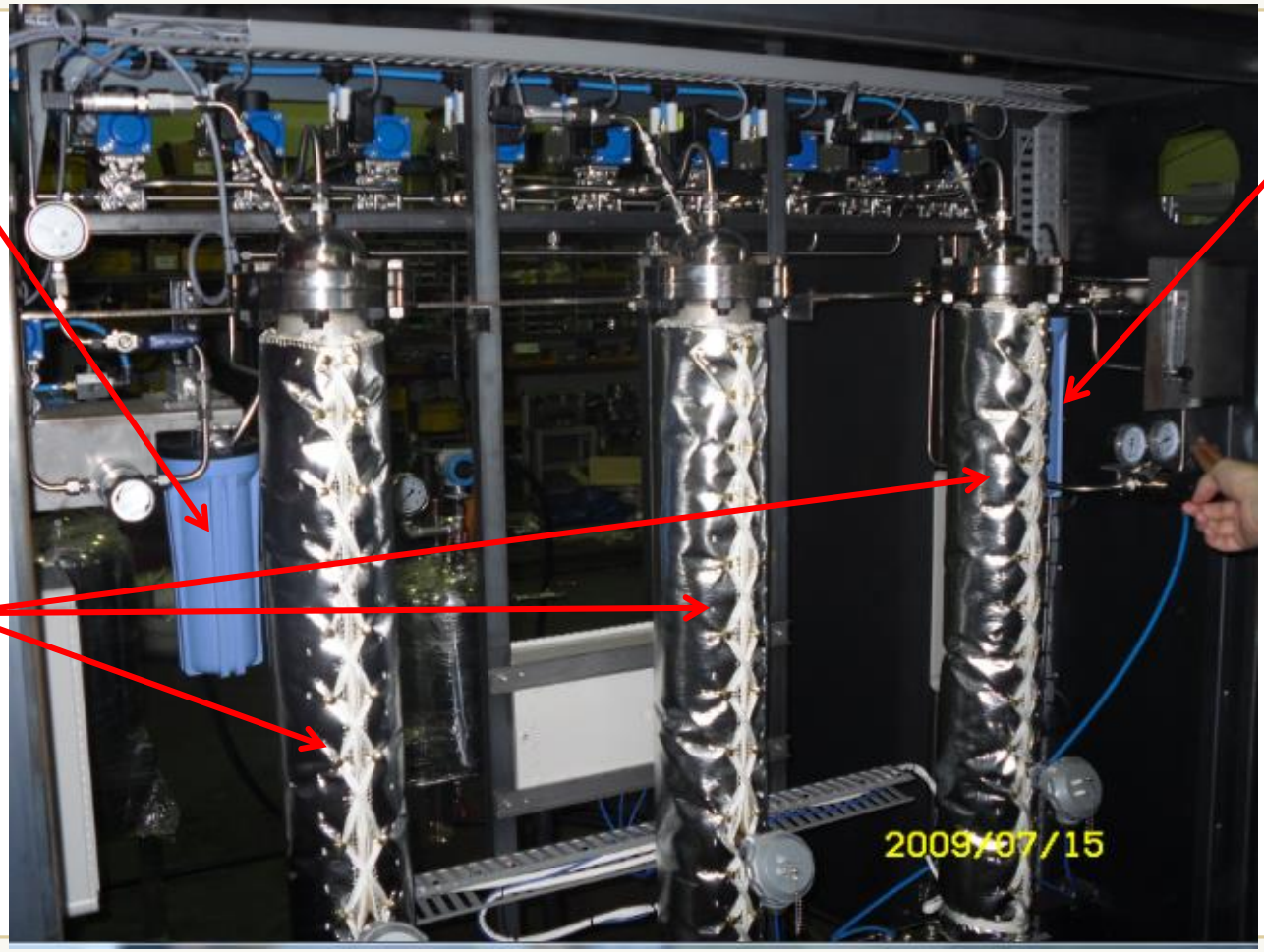
Function: Collect slightly compressed gas before sending to the purifier (PSA)

It maintain continuous flow of gas to the purifier

It prevents from popping and irregular strike of bio gas to purifier.

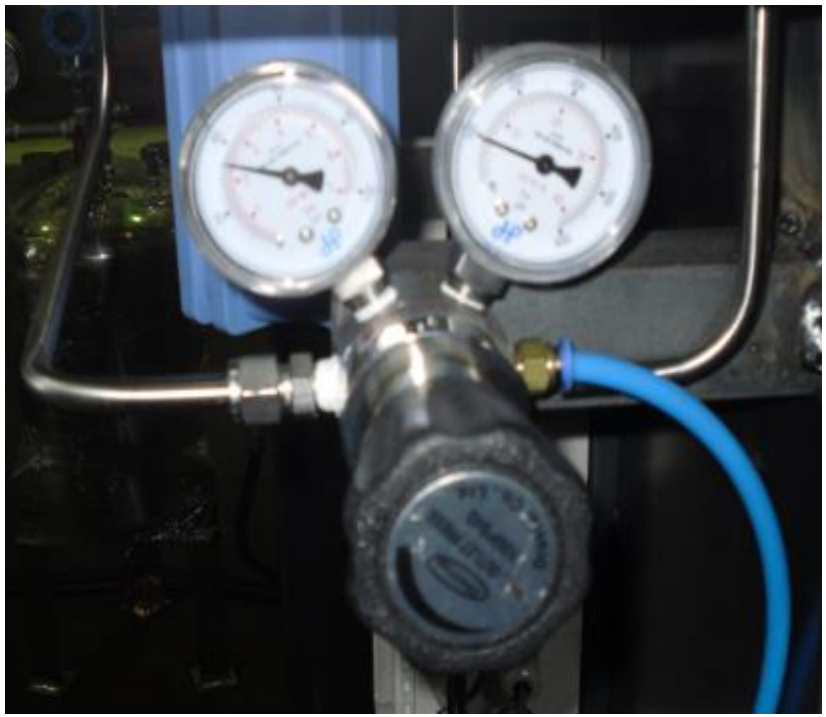
Description of equipment

Scrubber (Pressure Swine Adsorption Type)



Description of Equipment

CNG regulator fitted in adsorption column



It maintains the pressure and flow rate of gas in adsorption column

Functioning condition and data can be seen in the graphic board of control panel.

Simultaneous falling and increasing of pressure and flow rate occurs during alternating cycles namely adsorption, regeneration and pressure build-up

Description of Equipment

Vacuum pump

Specification:

Type: Oil rotary
Flow rate: 200L/min
Power: 220VAC 1 phase 50Hz
0.034kWh
Material: Mild Steel

Function: to pump out CO2 and N2 from adsorption columns and maintain the pressure

PSA system linking with PLC

Electric circuit and signal transfer

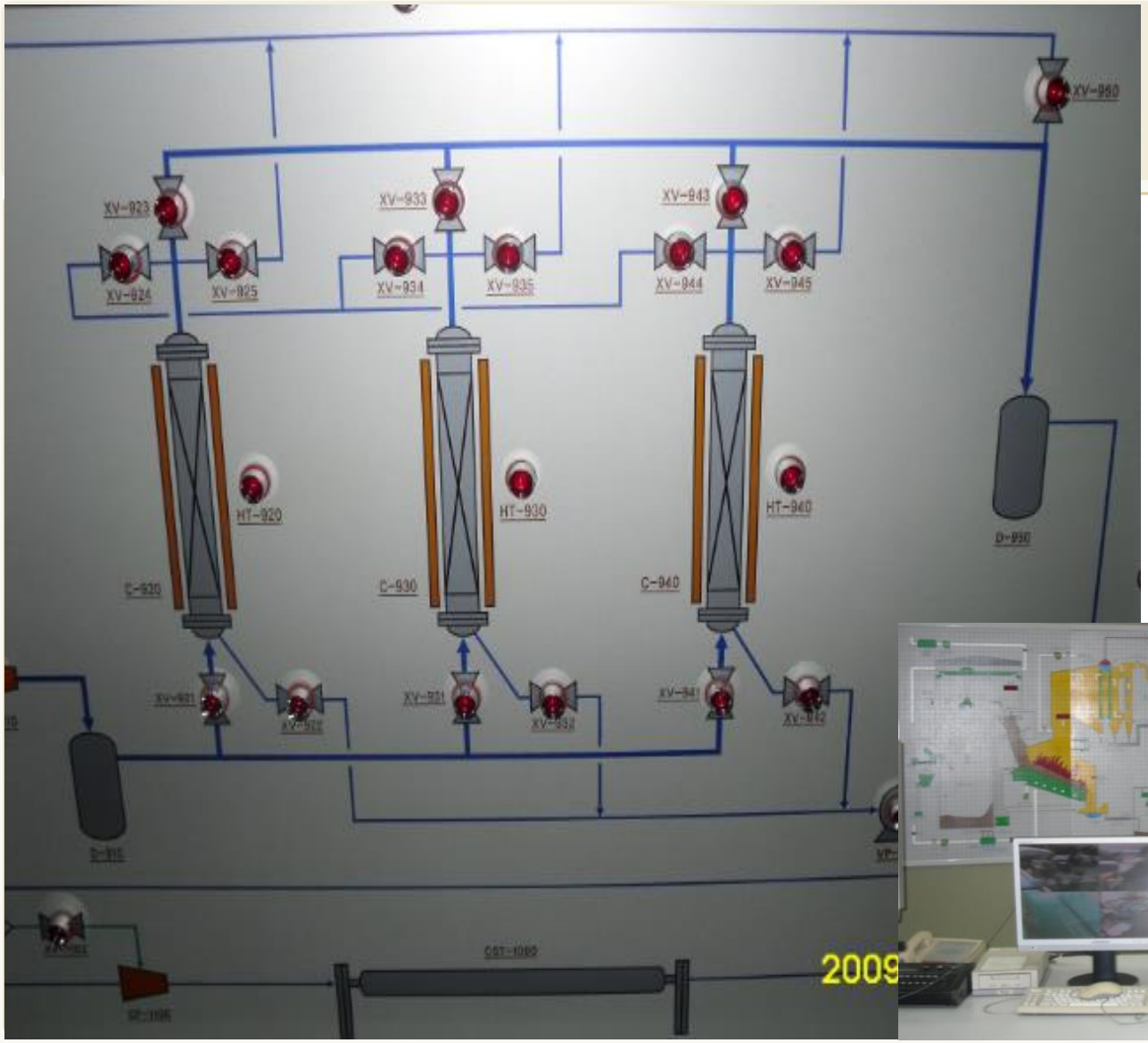
It receive signals from all devices of purifier and transfer it to the control panel.

Digital signals can be seen in PLC system and operation system can be observed by the notification of LED (light) in the graphic board.

Some equipment during testing

Inner circuit of control panel

Graphic Board



Operation of each equipment can be seen by the red light adjacent to drawing of equipment as well as monitor of PLC system.

Adsorption in brief

Adsorption is the process that happens when a gas or liquid solute gets accumulated on the surface of a solid or, sometimes, a liquid (adsorbent), forming in the process a molecular or atomic film (known as adsorbate).

The term adsorption refers and encompasses both processes, while the reverse process is known as desorption.

Separation of CO2 from CH4 is generally done by adsorption/desorption of carbon dioxide on beds of activated carbon (in our case) or zeolites at different levels of pressure.

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.

Application of Activated Carbon in PSA

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.

Lange number of gases are separated using activated carbon as the adsorbent material.

Slightly above the atmospheric pressure, the activated carbon preferentially adsorbs the impurities like non-methane.

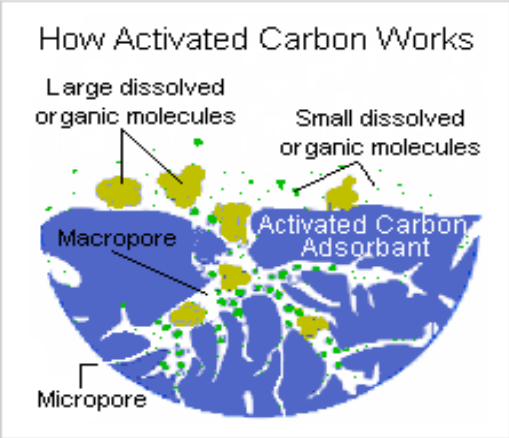


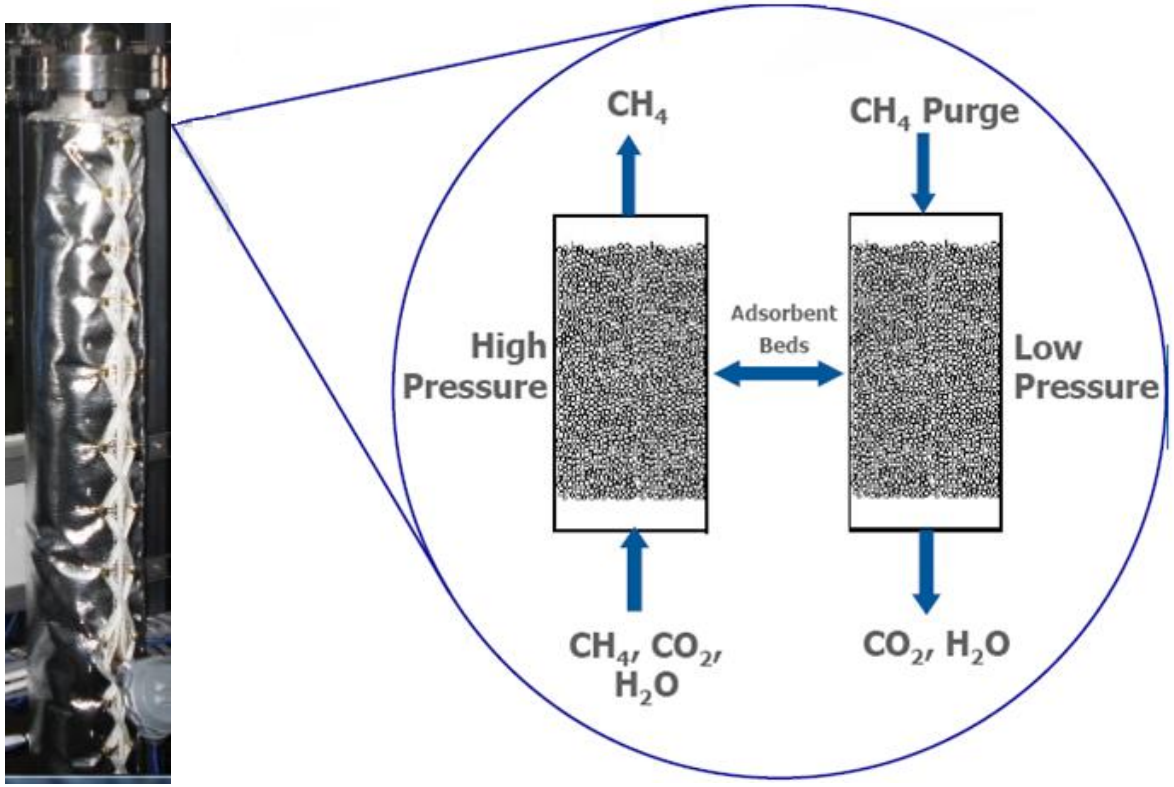
Figure illustrating the working of Activated carbon

In a normal operation each adsorber operates in the following alternating cycles namely adsorption, regeneration and pressure build-up.

PSA for Biogas Upgrading

While passing through the adsorber vessel, carbon dioxide, oxygen and nitrogen gets adsorbed on to the surface of the adsorbent material.

The gas that exits from the top of the adsorber vessel has around 97% of Methane.



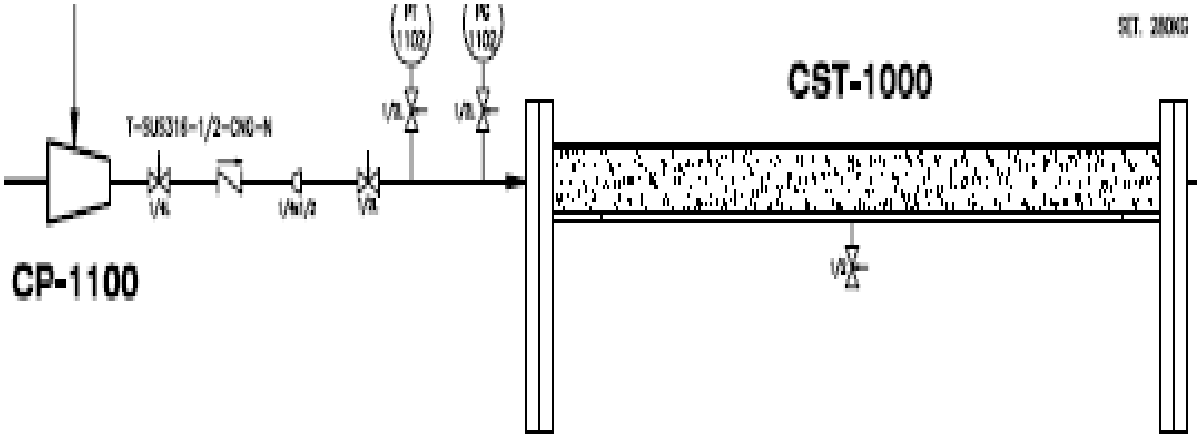
Compressor and storage tank

Function of Compressor:

To compress the gas after scrubbing
Pure methane is first collected in Buffer Drum to make the continuous supply without popping.

Function of Storage tank:

It is the heaviest among all equipment.
It collects compressed gas of pressure230 bar and its size is 585L.



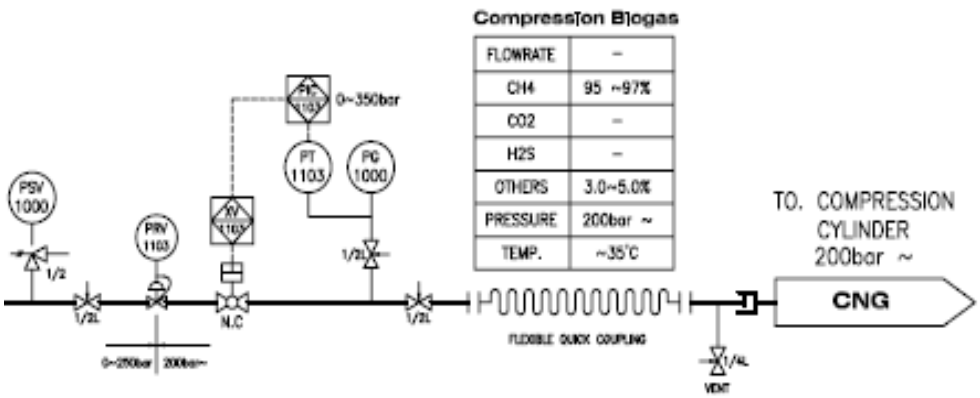
Dispenser

Gas contain in high pressure in the storage tank should be filled in CNG cylinders.

There will be three types of cylinders of different size.

One is of vehicular use (64L) and other are of commercial purpose (46.7L and 40.2L).

There are alternative system and safety measures to fill two type of cylinders



Brief information on PLC

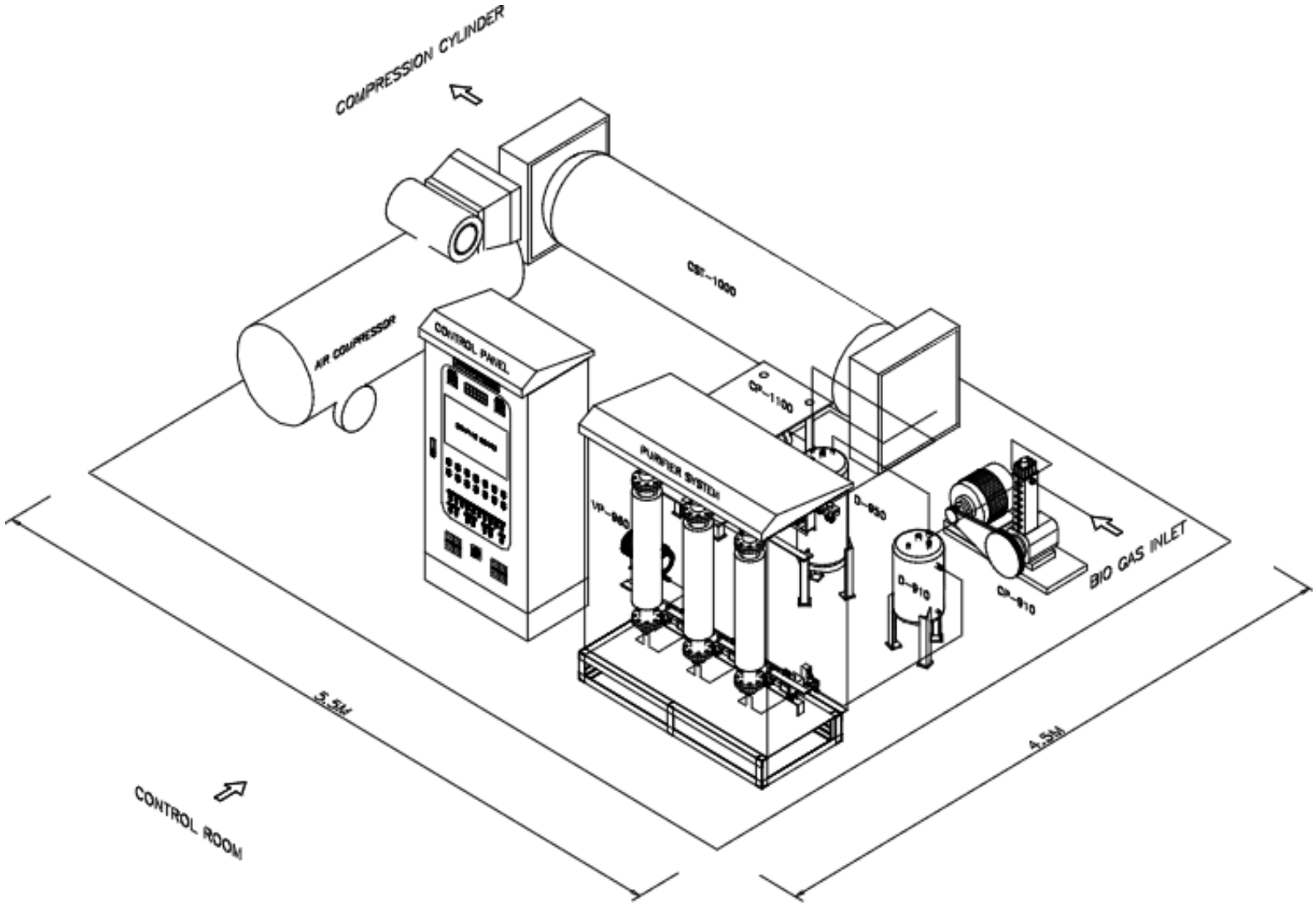
PLC: P**rogrammable logic controller** is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or lighting fixtures.

Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact.

A PLC is an example of a real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result.

PLC & Input Output arrangement

Equipment layout



Biogas Purification, Compression & Storage Plant @ KU

Main Point:

Why this pilot plant Could not be operated?

- Three municipalities near Kathmandu University initially promised to deliver biod egradable waste to the site but later on when they came to know that from this w aste CNG like gas is going to be produced which will be used to run vehicles, the se municipalities verbally asked to pay Rs. 2.50 per kg of biodegradable waste. T his is beyond the objective of the project.
- Concerned teachers of KU were extremely busy in conventional teaching/learnin g process and they did not have enough time to take care of this project.
- It seems municipalities are still not aware of the environmental benefits from this type of project which can help in reducing trade deficit of Nepal to some extent.

Suggestion:

The state of the art equipment installed at KU almost 10 years ago, I believe, is still intact and so these equipment be transferred to Kotre near Pokhara where Bioagas Plant is being operated by Gandaki Urja Limited. In this place research on different issues related to bioagas can be investigated. With this adsorption based related set of equipment many students studying in universities of Nepal will have more opportunity to continue research work at Kotre.

I am sure organisations like MoEWRI/AEPC will help in relocating this very important set of equipment there where intensive research can be conducted with a view to enable private sector to work actively in producing pure methane when pressurized CNG like fuel can be produced to run vehicles.