CHAPTER 3
PLANT DESCRIPTION

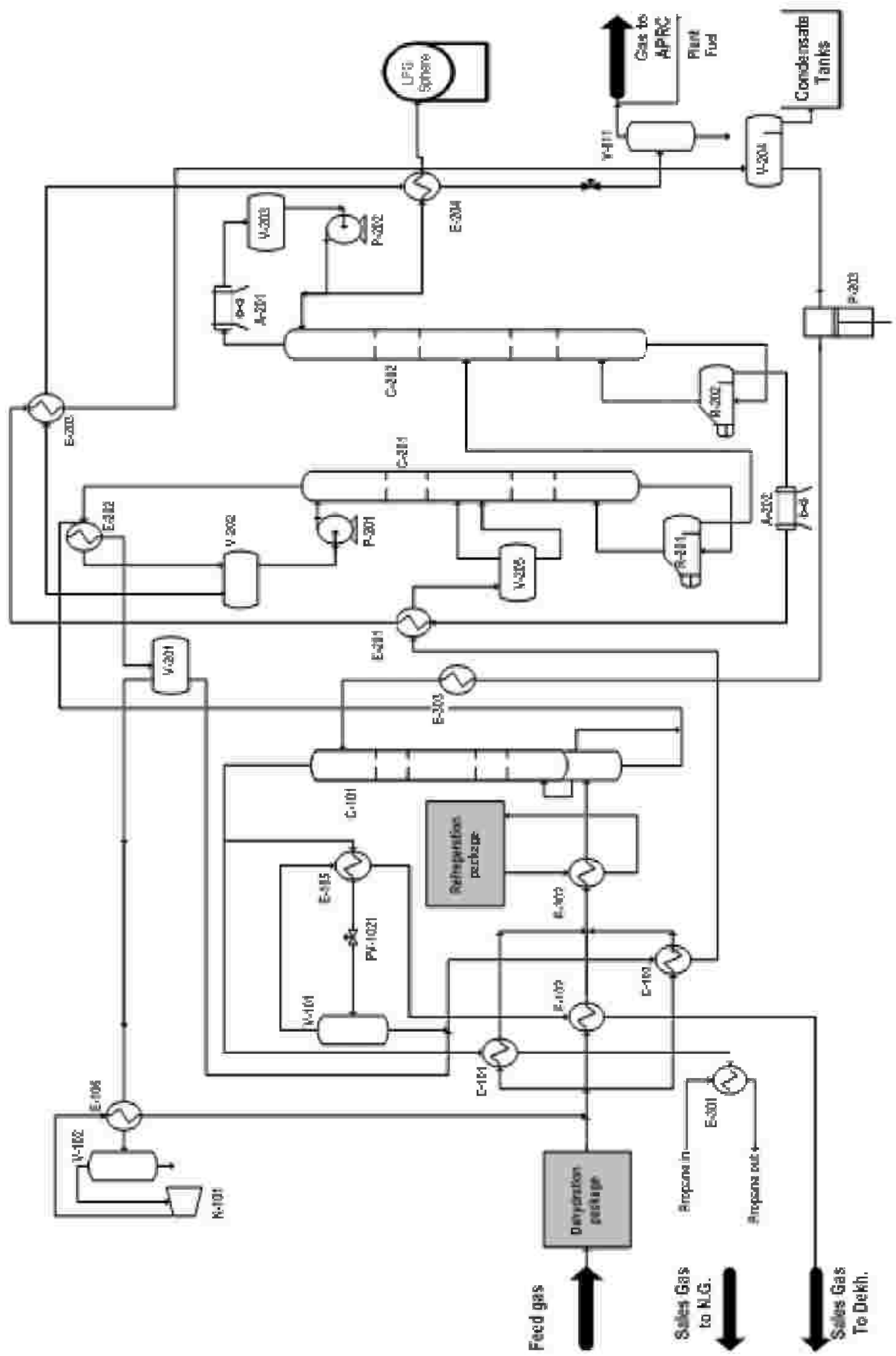

Figure 3.1 Amerya LPG plant

General Process Description

Amerya LPG Recovery plant is an extraction plant located at Amerya, Alexandria, Egypt.

A flow sheet diagram for LPG plant is shown in Figure 3.1. The plant comprises facilities for recovery of liquefied petroleum gas (LPG) and condensate form 300 MMSCFD of feed gas delivered by pipeline originating from Abu-Sannan recovery plant and BED-3 facilities in the western desert. The feed gas is delivered to the plant battery limit at Amerya via a tie-in facility already provided prior to the gas entering the existing BAPETCO metering station.

The treated lean gas, after LPG and condensate recovery, is delivered to Dekheila Iron & steel company and National consumers.

Table 3.1: Tag no. description of the plant equipment

S/N	Tag No.	Description
1	A-201	Depropanizer over head condenser
2	A-202	Condensate air cooler
3	A-151	Regeneration gas air cooler
4	C- 101	High pressure absorption tower
5	C-201	Depropanizer tower
6	C-202	Debutanizer tower
7	D-151	Mol Sieve Bed
8	E- 101	First gas/gas exchanger
9	E- 102	Second gas/gas exchanger
10	E- 103	Third gas/liquid exchanger
11	E- I 05A	Dekheila gas/gas exchanger
12	E- 106	Compressor suction/discharge exchanger
13	E-201	Depropanizer feed preheater
14	E-202	Depropanizer over head condenser
15	E-203	First condensate sub-cooler
16	E-204	LPG cooler
17	E-30l	Liquid propane sub-cooler
18	E-302	Propane chiller

19	E-303	Second condensate sub-cooler
20	K- 101	Depropanizer feed drum gases compressor
21	K- 151	Regeneration gas compressor
22	K-301	Refrigerant compressor
23	FL-151	Dry gas filter
24	H-151	Regeneration gas filter
25	V-101	Dekheila feed drum
26	V-102	Compressor Suction knock-oil drum
27	V-151	Feed high efficiency separator
28	V-152	Regeneration gas knock out vessel
29	V-201	Depropanizer feed high pressure flash drum
30	V-202	Depropanizer over head accumulator
33	V-204	Condensate holding drum
34	V-205	Depropanizer feed low pressure flash drum
35	SDV	ON/OF valve

3.1.1. Dehydration package

Untreated feed gas is dehydrated by molecular sieve dehydration package to reduce its water content to the required level for further processing, in order to avoid the formation of hydrates within the plant.

3.1.2. Feed gas chilling

Dry gas is mixed with a recycle gas stream from Depropanizer feed drum gases compressor (K- 101), then it is chilled in two identical heat exchanger trains. Each train has three parallel legs, namely first gas/gas exchanger,E-101, second gas/gas exchanger, E- 102 & and third gas/liquid exchanger, E- 103. Flow control valves are used to balance the splitting between the three legs in each train to achieve the lowest possible gas chilling temperature prior being fed to the propane chillers, E-302.

3.1.3. Feed gas Refrigeration

Propane refrigeration is used to deep chill the feed gas downstream the chilling exchangers to -37 °C in the propane chiller, E-302, where cooling is provided by vaporization of the propane refrigerant. Two electric motor driven refrigeration compressors are used.

table (3.4) Refrigerant composition:

Component	wt%
Cl	Nil
C2	0.16 to 1.42
C3	99.6 to 98.0
C4	0.24 to 0.68

3.1.4 Absorption

In order to attain the desired butane recovery, 90% (minimum), without going to deep chilling (-65 °C) operation level, absorption is used. Chilled gases from E-302 , at -37 °C, are introduced to the bottom of a 25 tray high pressure absorption tower, C-101, where it is contacted with sub-cooled, fresh solvent (light condensate) ,which is fed to the top tray.

- Overhead gases from C-101 are split into two streams, Dekhila conditioned (lowerC5+) sales gas and National Grid sales gas.

- Absorber bottom liquid from C-101 is heated by exchanging heat with the depropanizer overhead vapors in the depropanizer overhead.

3.1.5 Fractionation

❖ **Depropanizer section**

A 36 tray depropanizer column, C-20l, is used to remove excess light components from the recovered absorbed gas to meet the LPG specification. Cold rich solvent from absorption tower, C-101 bottom provides the required cooling duty in the depropanizer overhead condenser, E-202. In order to ensure steady and stable flow to the depropanizer, the preheated stream from E-201 is flashed in a pre-flash vessel. V-205 Re-boiling in the depropanizer bottom is achieved by circulating heating oil medium, DOWTHERM G, in the depropanizer reboiler, R-201 Depropanizer overhead vapor is the source for plant fuel gas after being partially condensed in E-202 and flashed in the depropanizer overhead accumulator, V-202. Flashed liquid from V-202 is totally refluxed to C-201.

❖ **Debutanizer section**

A 40 tray debutanizer, C-202, fractionates the depropanizer bottom liquid into LPG and condensate. Bottom condensate product is cooled successively in both condensate air cooler A-202, depropanizer feed preheater E-201, and condensate sub-cooler, E-203, prior to splitting in the condensate holding vessel V-204 into condensate product and condensate recirculated to C-101 (lean fresh absorbent). Reboiling in the debutanizer bottom is achieved by heating oil medium circulation in the debutanizer reboiler, R-202. Debutanizer overhead vapor is the source of LPG after being totally condensed in the debutanizer overhead condenser A-201, and flashed in the debutanizer overhead accumulator, V-203. Condensed LPG from V-203 is partially refluxed to C-

202. The remaining LPG is transferred to the spherical tanks after being cooled in the LPG cooler, E-204.

3.1.6 Storage

- **LPG**

The LPG storage system comprises two spherical tanks for on-spec. LPG and one. "Cigar: vessel for off-spec LPG.

- **Condensate**

Condensate produced from the debutanizer reboiler, R-202, is utilized mainly as absorbent to recover natural gas liquefied (NGL) from feed gases in the absorber tower. The product condensate is slightly lighter, higher in RVP values, than stabilized condensate from conventional LPG plants due to the lower content of C_{5+} fraction in the feed gases.
Surplus condensate will be directed to the condensate storage tanks.
The condensate storage system comprises two floating roof tanks,

3.2 Dehydration Package

- **General**

Untreated feed gas with up to 90 ppmv of water content is dehydrated by molecular sieve dehydration package to reduce its water content to maximum level of 0.1 ppm_v as required for further processing.

- **Package description**

A flow sheet for dehydration package is shown in fig. (17), the inlet gas is first passed into the feed high efficiency separator (V-151) designed to separate all liquid droplets up to 10 microns size, and is then filtered by the coalescing wire mesh include where 99% of droplets with diameter greater than 5 micron are removed. Therefore, the gas is dried by the molecular sieves beds in the dries (D-151A/B/C) before being passed into the dry gas filters where all solid particles with diameter greater than 2 micron, and 99% of sold particle with diameter greater than 1 micron, are retained.

- **Molecular sieves beds operation**

Three Mol. Sieve beds are installed. Each of them is designed to dry 150 MMSCFD of gas, two are in operation (water adsorption) while the third is in regeneration.

3.3 Molecular Sieves Beds Regeneration

i. **Bed heating**

Part of the dry gas is used as regeneration gas. A controlled stream of gas is compressed by a centrifugal compressor (K-151A/B) (one operating – one out standby) and then heated up to 260^{o}C in the directed fired heater (H-151A/B) (

one operating – one out standby). When the molecular sieve beds, the regeneration gas is filtered in the regeneration gas filter (FL-152A/B) and cooled down to 45 ^{o}C on passing through the air cooler (A-151). The condensed water is separated from gas in the regeneration gas

knock out vessel (V-152). The regeneration gas is then mixed with the raw gas at the inlet of the high efficiency separator (V-151).

ii. **Beds cooling**

When the water adsorbed by the molecular sieve bed is completely removed, the bed is cooled down using the same dry gas from the dehydration unit outlet. The dry gas is compressed by (K-151A/B) and sent to the molecular sieve bed for cooling. The gas is then cooled in the air cooler (A-151), passes into the regeneration gas knock out vessel and is mixed with raw inlet gas.

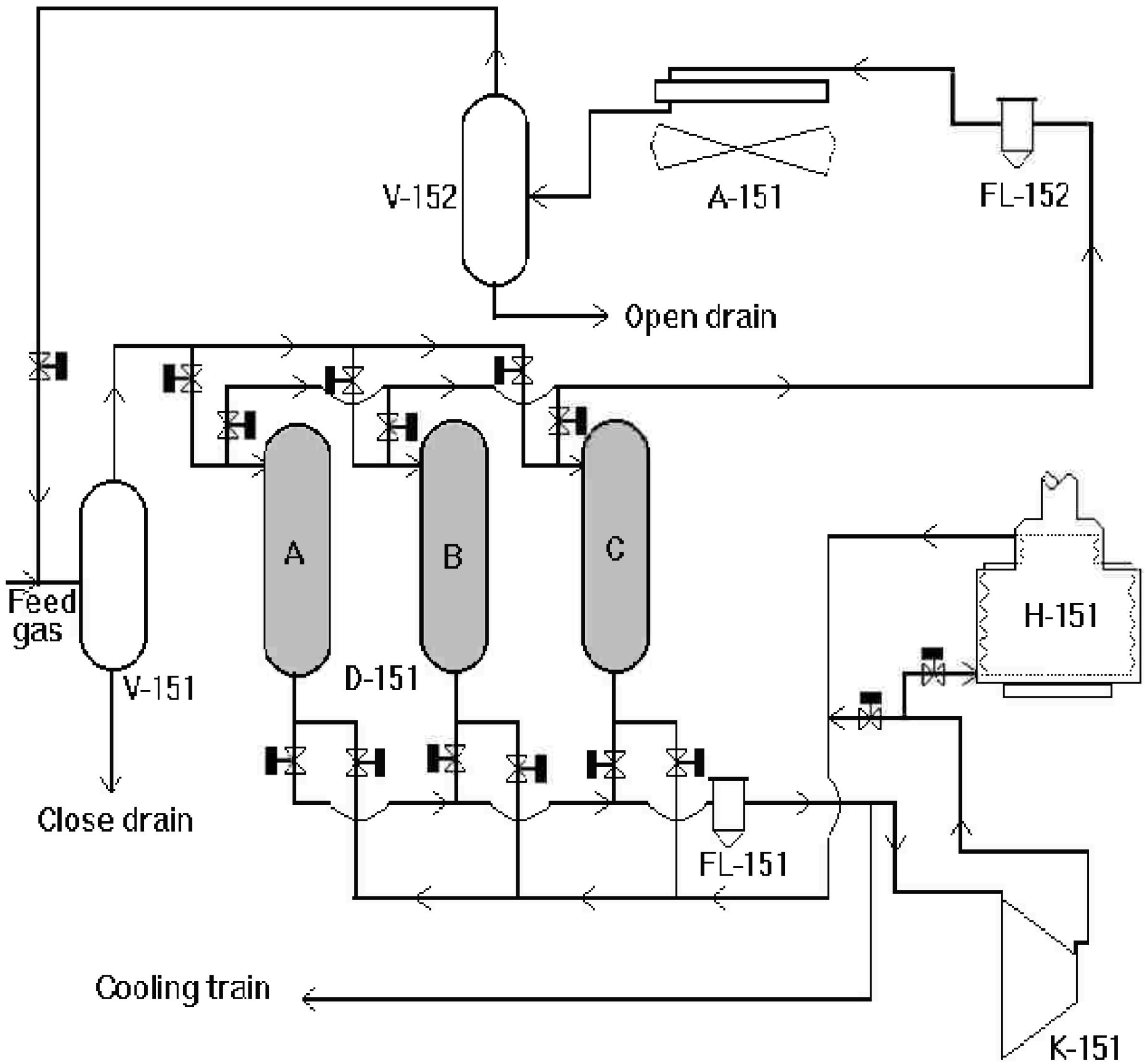

Figure 3.2 Molecular Sieves Dehydration Package

3.4 Pressure Swing Adsorption Package (PSA)

3.4.1 Theory of operation

N_2 production from air using PSA technology is based on the capability of a special adsorbent, named Carbon Molecular Sieve (CMS), to adsorb O_2 at a higher rate than N_2 or other gases. If air is send through a CMS bed and is kept in contact with CMS only for short period the difference in adsorption rate will result in a significant removal of O_2 from air and will allow collecting high purity nitrogen from outlet side.

After this period, the CMS will start to significantly adsorb also N_2 and therefore it will no longer remove O_2 from air. Consequently, it is necessary to stop flow through the adsorbent bed before reaching this point in order to regenerate the bed.
Bed regeneration is accomplished by depressurization to low pressure system, i.e. to atmospheric pressure. In order to obtain a continuous production of high purity N_2, two adsorbers that operate cyclically and alternatively between adsorption and regeneration and a N_2 buffer drum are required.

Production capacity and purity are dependent on feed flow rate, pressure, temperature and on selected cycle. High pressure and low temperature may result in higher purity and higher product capacity. Higher temperatures or low feed pressure would have a negative impact on product specifications.

3.4.2 <u>Analytical description of the PSA operation cycle</u>

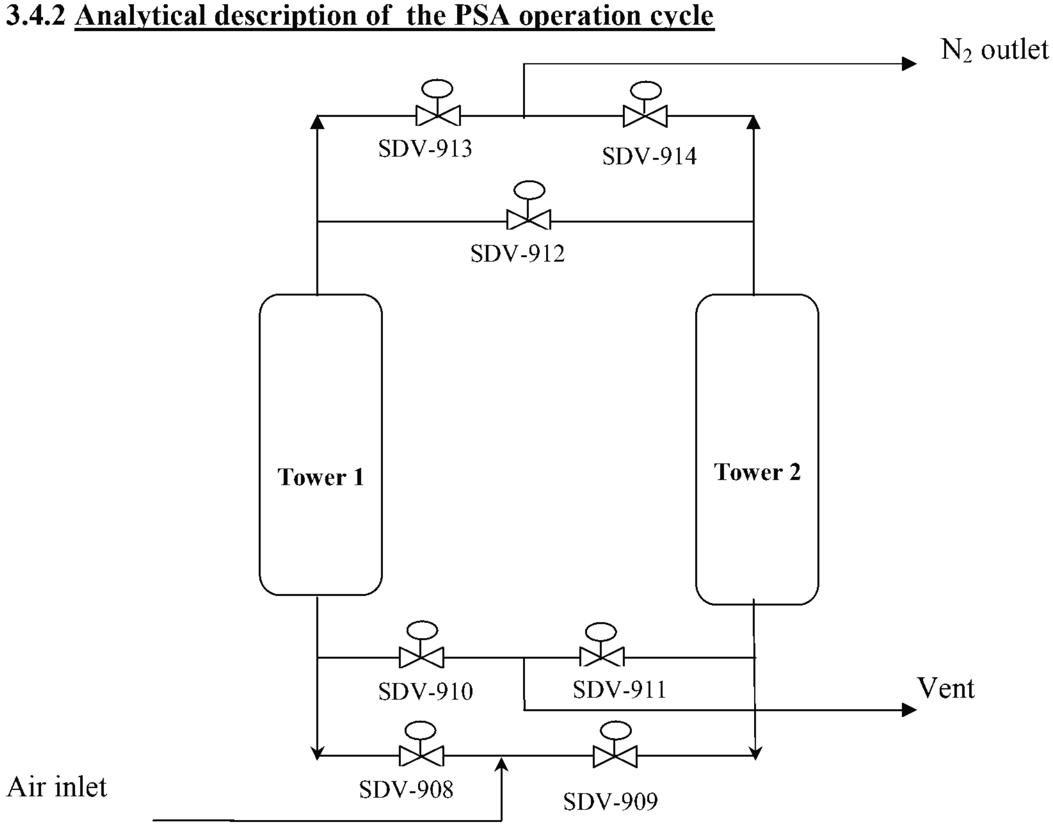

Figure 3.3 Nitrogen generation Package

Table 3.3: Operating cycle of PSA

Phase	Tower 2	Tower 1	Duration
1	Generation	Depressurization	30 sec
2	Generation	Purge	30 sec
3	Generation	Pressurization	30 sec
4	Generation	Equalization	30 sec
5	Depressurization	Generation	30 sec
6	Purge	Generation	30 sec
7	Pressurization	Generation	30 sec
8	Equalization	Generation	30 sec

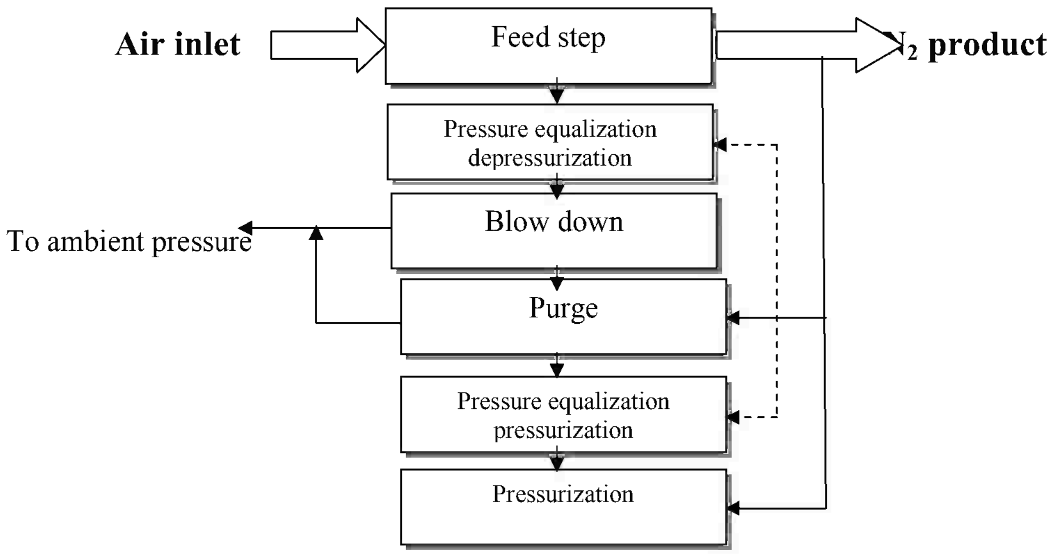

Figure 3.4 Flow sheet of PSA system

3.4.3 Description of the cycle

Tower 1 is in the adsorption phase, while tower 2 is regeneration.
Inlet air enters in tower 1 through valve SDV-908, it passes through CMS bed, leaving oxygen, and exit as nitrogen through valve SDV-913.
Tower 2 is depressurized opening valve SDV-911, to strip oxygen by CMS and vent it in atmosphere.
After complete depressurizing, a small flow of nitrogen is taken from generator outlet, by valve SDV-912, it is expanded at atmospheric pressure inside tower 2, it is runs in counter current inside tower 2 and it is vented to atmosphere, to remove all oxygen retained inside CMS.
Afterward, valve SDV-911 is closed and tower 2 is pressurized.
Before change-over, valve SDV-909 and SDV-914 are open to complete the pressurization and let both towers work in parallel.

3.5. Collection and Treatment of Data

- The dew point of water content in natural gas is measured by moisture online analyzer transmitter which is installed before and after dehydration unit.
- Orifice meters were used to measure the flow rate of plant feed gas (MMSCFD), and regeneration gas (m^3/h).