Industrial Oxygen Generation Plant

Operation Process Description : (Ref: P-I Diagram)

Oxygen is generated from Compressed air by a separation process which uses the principle of selective adsorption. The air is passed through a bed of Zeolite Molecular Sieves (ZMS) which has a property of very high degree of affinity to nitrogen. The ZMS contains an infinite number of micropores and it retains the adsorbed nitrogen molecules in these pores.

Before this process is effected, the compressed air has to be purified by removing all contaminants i.e. solids, condensed liquids and oil & water vapors by passing it through Prefilter. Oil Removal Filter (not required if oil-free Compressor is used) and Air Dryer.

The dry & oil-free air from Air Dryer is stored in a Dry Air Receiver before it enters the PSA System. In this System, there are two adsorbers filled with ZMS, where nitrogen along with any traces of moisture are adsorbed and product gas (dry oxygen) comes out and passes to Oxygen Surge Vessel. In the PSA System, one adsorber is in production cycle while the other is regenerated (desorbed) by depressurization. The two adsorbers keep switching from adsorption to desorption automatically, through a sequence timer. The pressure in the adsorbers swings from atmospheric pressure to line pressure, which is why this process is known as Pressure Swing Adsorption (PSA).

Stage By Stage Equipment Description

A. AIR COMPRESSOR

Screw oil-free Air Compressor is used to provide feed air for the Oxygen Generator. See Annexure I for capacity & power requirements.

B. AFTERCOOLER WITH MOISTURE SEPARATOR

The After cooler is a vertical, shell & tube type where compressed air is cooled by plant cooling water. When the compressed air cools down, condensed liquids are separated by the in-built Moisture Separator. These condensates are drained out automatically by Auto Drain Valve.

C. WET AIR RECEIVER

This is a vertical pressure vessel provided with safety valve & pressure gauge in which some condensates accumulate. These are drained out automatically by Auto Drain Valve.

D. PREFILTER

Carried forward fine contaminants such as liquids, dust, rust, etc are filtered out up to a 5 micron level in the Prefilter. The separated contaminants are drained out automatically by Auto Drain Valve.

E. OIL REMOVAL FILTER

During compression of air, lubricating oil vaporizes due to heat of compression. This oil vapour is removed in the Oil Removal Filter. Separated oil is drained out automatically by Auto Drain Valve. This Filter is not provided when oil-free Air Compressor is used.

F. AIR DRYER

The filtered air now contains only water vapour and can be purified further only by an Air Dryer. Removal of moisture is essential since this will add unnecessary adsorption load on the

ZMS in the PSA System. Heatless type or Refrigeration type Air Dryer is used depending on dew point requirements.

G. DRY AIR RECEIVER

Dry & oil-free air coming from the Dryer is stored in the Dry Air Receiver, Some air is drawn out for operating the various valves of the Generator.

H. **PSA SYSTEM**

This System has got two adsorbers filled with ZMS and interlinked by valves required for different functions of the PSA System. Dry oxygen gas is generated by the processes of adsorption, desorption (by depressurization) and repressurization. These processes are carried out by operating the System valves at preset timings and are controlled by the sequence timer.

I. **OXYGEN SURGE VESSEL**

Since the PSA System operation is cyclic, the oxygen pressure & purity immediately at the outlet of the PSA System will have some variations in flow & purity, which are stabilized by the Oxygen Surge Vessel. It also provides oxygen required for fast repressurization.

J. **AFTERFILTER**

The Aftercooler traps any fine dust, rust & adsorbent particles from the nitrogen going into the Oxygen Vessel.

K. **OXYGEN VESSEL** :

This is a large capacity vertical vessel where the oxygen is drawn for use.

L. **MEASUREMENT & CONTROL DEVICES**

(1) **Oxygen Analyzer** – this periodically monitors the oxygen content of the gas in a program preset in factory.

(2) **Rotameter** – This monitors the flow of oxygen from the Generator. It can be set at a desired value by adjusting the valve provided at its entry.

(3) **Back Pressure Controller** – this ensures that the oxygen pressure in the Surge Vessel is maintained by closing whenever the pressure falls below set pressure and opening whenever the pressure rises back.

M. SAFETY INTERLOCKS

(1) **Pressure Switch (AR)**– Switches off O2 Generator when pressure in Air Receiver reaches lower set point & restarts it when pressure rises back to upper set point.

(2) **Temp Switch** - Gives audio-visual indication when temp. in Air Receiver reaches above set point.

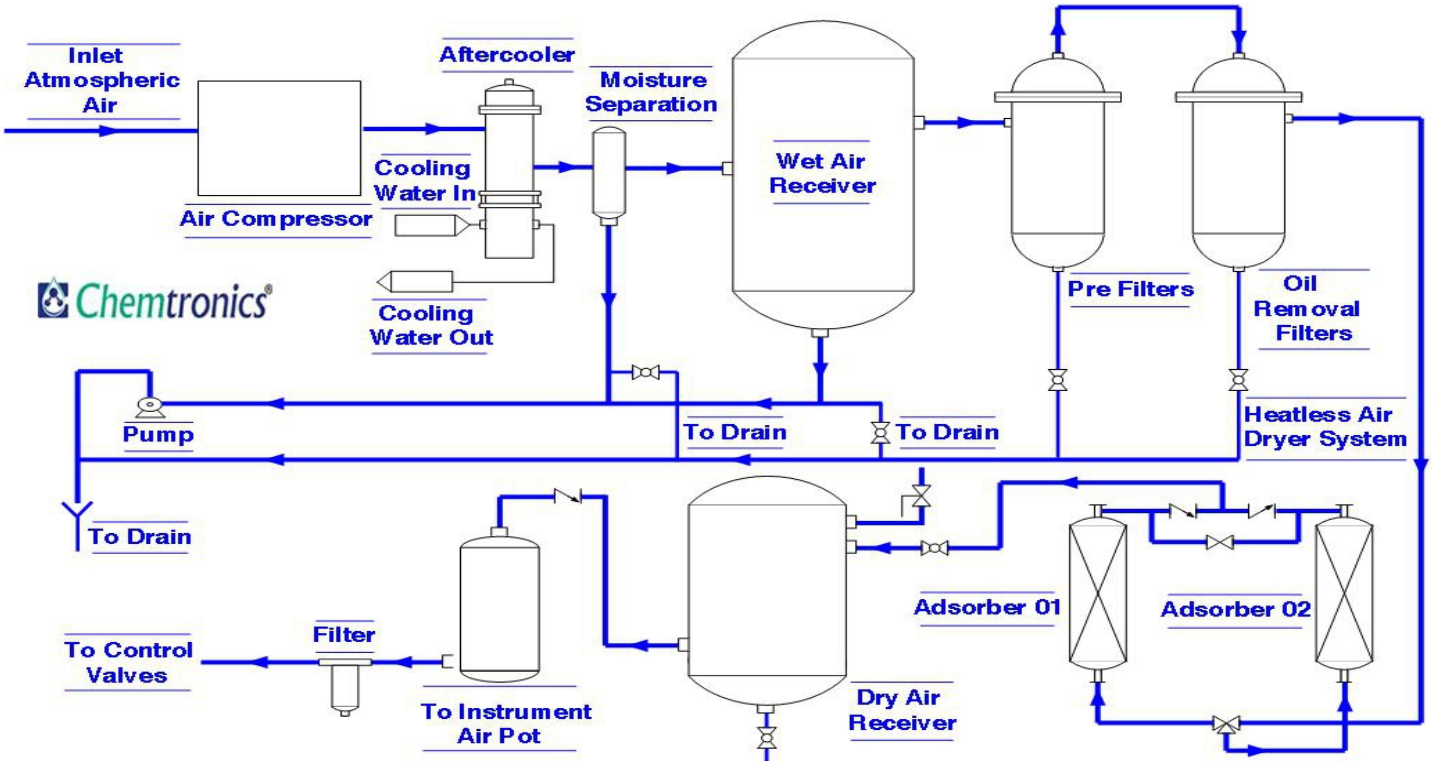
(3) **Vent Valve** – Operated by Operator whenever O2 content of gas is observed to be below preset value. It vents out the impure gas into atmosphere and is closed after O2 content is brought within range.

(4) **Pressure Switch (OV) :** Switches off O2 Generator when pressure in Oxygen Vessel reaches upper set point and restarts it when pressure falls to lower set point.

Air Preparation & Purification

1. **Oil Free Screw Compressor**
2. **After Cooler / Heat Exchanger**
3. **Moisture Separator**
4. **Wet Air Receiver**
5. **Pre Filter & Oil Removal Filter**
6. **Refrigerant Air Dryer / Heatless Air Dryer**
7. **Dry Air Receiver**

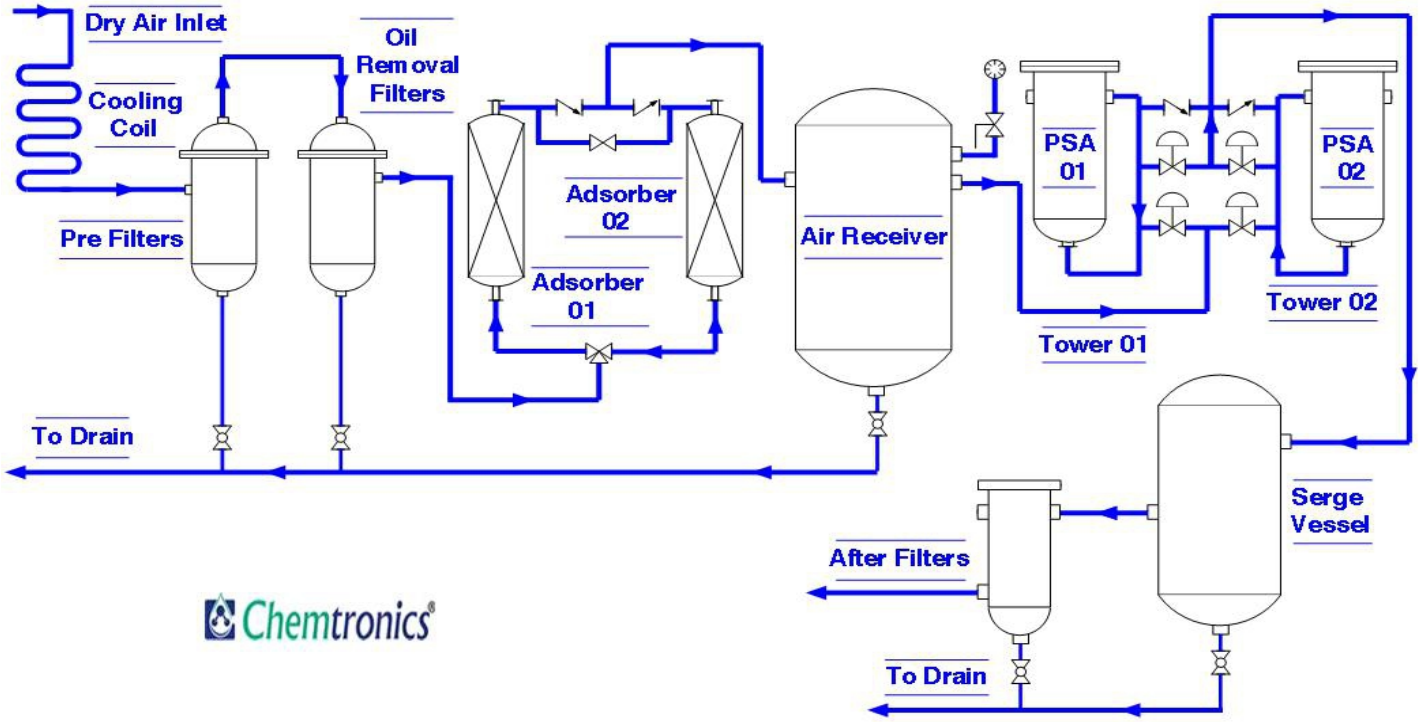
Flow Diagram – Air Preparation & Purification



Oxygen Concentrator

1. **Pre Filter + Oil Filter + Air Dryer – With Auto Drain**
2. **Pressure Swing Adsorption [PSA] Oxygen Concentrator**
3. **High Pressure Zeolite Molecular Sieves [ZMS] - - 6 – 8 bar**
4. **High Strength, Friction & Abrasive Resistant ZMS**
5. **Longer Operation Life - - - - - 4 – 6 years**
6. **Serge Tank for Stabilization & Purity**
7. **PLC Bases Operation - Precise Timing Control**
8. **Pneumatically Operating High Speed Solenoid**

Flow Diagram – Industrial Oxygen Generation



Chemtronics®

Techno-Commercial Comparisons Of

Industrial Oxygen Plant & Medical Oxygen Concentrator

Points of Comparison	Industrial Oxygen Plant	Medical/Commercial Oxygen Generator
Technology	Industrial ✓✓	Medical/Commercial
Suitable / Recommended For	Above 2.0 Nm3/hr [30 LPM] ✓	Up to 1.2 Nm3/hr [20]
Operation	Continues 24 x 7 x 365 ✓✓✓	Moderate
Oxygen Purity	not less than 93 % ✓✓✓	85 - 90 %
Oxygen Feed Pressure	1.2 - 1.5 Kg/cm2 ✓✓✓	0.5 Kg/cm2
Operation Controlled	Programmable Logic Control [PLC] ✓	Digital Circuit
Oxygen Consistency	All the time ✓✓✓✓	Gradually Reduces
Oxygen Purity Monitoring, Display & Control	Online continuous Monitoring & Display ✓✓✓	No monitoring & Display
Life of consumables [Molecular Sieves]	3 - 5 years ✓✓✓	1 - 2 years
Life cycle of the plant	20 - 25 years ✓✓✓	3 - 4 years
Operational Cost [Power]	18 - 20 kW ✓✓	20 – 22 kW
Repair & Maintenance	Economical & Less nos. ✓✓	Expensive & Huge Nos.
No. of Plant/Units	02 no. of 6 Nm3/hr	40 units of 0.3 Nm3/hr OR 20 units of 0.6 Nm3/hr
Total Capital Cost [Add tax]	28 – 30 lakh ✓✓	30 – 32 Lakh