PVSA Oxygen Generation System

1)Introduction :

BHEL, a Maharatna Public Sector Undertaking (PSU) under the Ministry of Heavy Industries, Govt. of India, is one of the largest engineering and manufacturing companies of its kind in India engaged in design, engineering, construction, testing, commissioning and servicing of a wide range of products and services with over 180 product offerings to meet the ever-growing needs of the core sectors of economy since its incorporation in 1964. BHEL has R&D Expenditure (>2.5% of Turnover) –one of the highest in Indian engineering field and Filing patent / copyright applications regularly –total 4,849 filings. BHEL has presence in over 84 countries for various products.

BHEL has supplemented the Nation's efforts of battling the Covid-19 pandemic saving lives through supply of critically required Medical Oxygen. BHEL stands firm in its resolve to contribute wholeheartedly in meeting the national requirements.

2)BHEL PVSA Oxygen Generation System

BHEL in association with CSIR -IIP-(Dehradun) is manufacturing Oxygen generation system. CSIR-IIP is a constituent laboratory of the Council of Scientific and Industrial Research, an Autonomous Body under the Ministry of Science and Technology, Government of India. In this system, Pressure Vacuum Swing Adsorption (PVSA) technology is being adopted, as this technology is an increasingly popular and meeting this demand.

3) Advantages of PVSA vs traditional PSA Oxygen Generation systems

The PVSA (Pressure Vacuum Swing Adsorption) system technology by BHEL is having various advantages over cheaper traditional PSA (Pressure Swing Adsorption)systems and is also more suited for medical systems

i) Importance of Pressure Vacuum Swing Adsorption (PVSA)

Pressure Vacuum Swing Adsorption technology ensures that each sieve bed is perfectly rejuvenated every cycle. This results in clean sieve beds, so they can produce high oxygen purity for a long period of time. This technology not only ensures the highest oxygen purity, but also decreases the need to frequently replace sieve beds, reducing the overall cost of ownership.

ii) Superiority of Pressure Vacuum Swing Adsorption (PVSA) over Pressure Swing Adsorption (PSA)

Vacuum is the most efficient way to desorb nitrogen from sieve material while delivering the highest purity of oxygen. This vacuum pressure swing adsorption process leaves sieve material as good as it can possibly be at the start of each sieve bed cycle.

Other PSA systems leave sieve beds with residual nitrogen and moisture, causing sieve bed to degrade, lower oxygen purity and ultimately frequent sieve bed replacements. This is averted in PVSA Technology.

iii) Advantages of PVSA system:

a. PVSA eliminates any residual nitrogen

b. PVSA eliminates any residual water vapour

c. No wasted oxygen

d. More energy efficient

e. **Longer service life** : Longer life for sieve bed and higher oxygen purity over a longer period of time (min. 5 years) PVSA whereas PSA vessels commonly require repacking of sieve material approx. 3-5 years. Thus PVSA system has a lower operating cost.

f. **More suited for medical systems**: Use of an oil-free blower, thus avoiding any oil carry-over that is common with oil-lubricated compressors.

4) Collaboration Agreement

BHEL has signed an agreement with the Council of Scientific and Industrial Research–Indian Institute of Petroleum (CSIR-IIP) on 03.05.21 for transfer of technology for Medical Oxygen Plants of 500 LPM and higher using Pressure Vacuum Swing Adsorption (PVSA) technology. The agreement entails development and deployment of 500 LPM medical oxygen plants and design upscaling to 1000 LPM and more.

The first prototype was completed by BHEL's Hyderabad unit on 11.06.21 in record time of less than 40 days from the date of signing of the agreement. The company was able to successfully complete absorption of technology, procurement of materials and manufacture of the equipment in this short time.

Notably, BHEL has already received commercial orders for supply of both 500 LPM and 1000 LPM PVSA plants to state hospitals.

5) Areas of Applications

It can be installed at Hospital premises with bare minimum footprints and supply the oxygen on demand.

6) Range of Products

BHEL manufactures technologically **superior** PVSA Oxygen systems of various sizes starting from min 500 LPM/1000 LPM systems and beyond. As indicated above, there are advantages of PVSA over traditional cheaper PSA Oxygen Generation systems that should be considered while procurement of Oxygen generation systems.

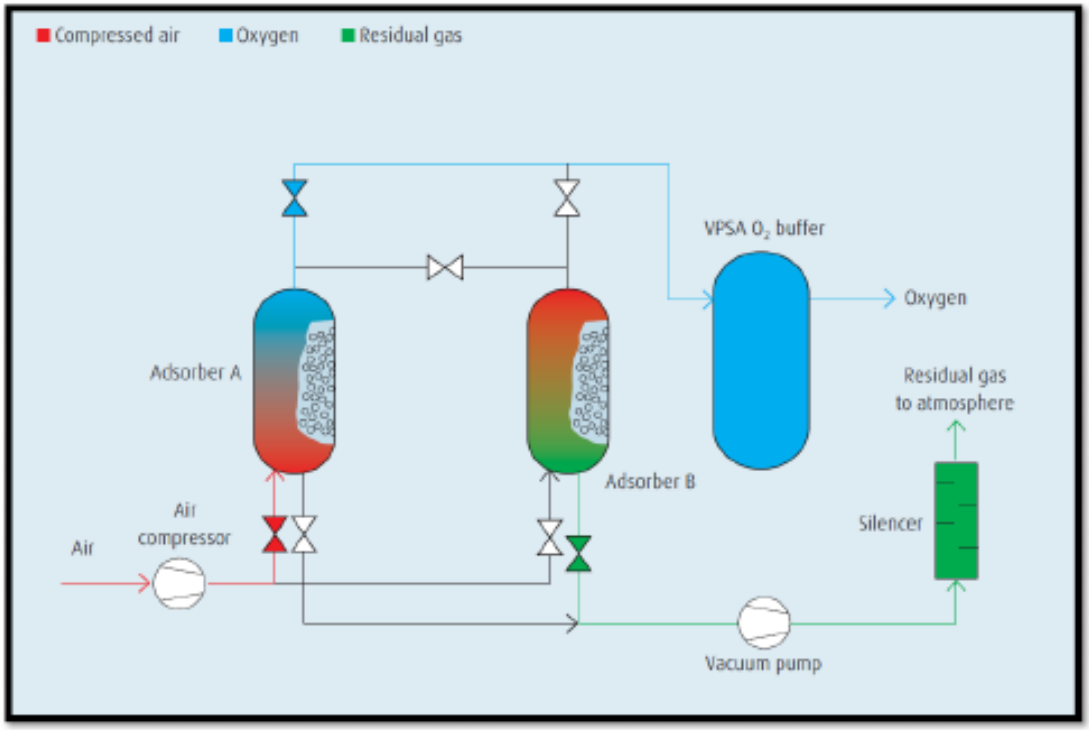
7) Design Feature

PVSA involves separating air into its constituent components by means of adsorption. In other words, the gas molecules bind with adsorbent material at different rates depending on the pressure. This allows operators to single out one particular gas from air. The growth in demand for PVSA technology is largely attributable to its simplicity, reliability and low operating costs.

The oxygen generator operates in Pressure Vacuum Swing Adsorption Process (PVSA) with zeolite and activated alumina. By means of the PVSA- process the oxygen content of the environmental air is concentrated up to a **purity of 93 ± 3% oxygen** and operating pressure of 1.8 to 5 kg/cm2, the remaining gases are mainly argon and nitrogen.

PVSA Oxygen Generation System

Typical process flow diagram of PVSA (Pressure Vacuum Swing Adsorption) Oxygen system



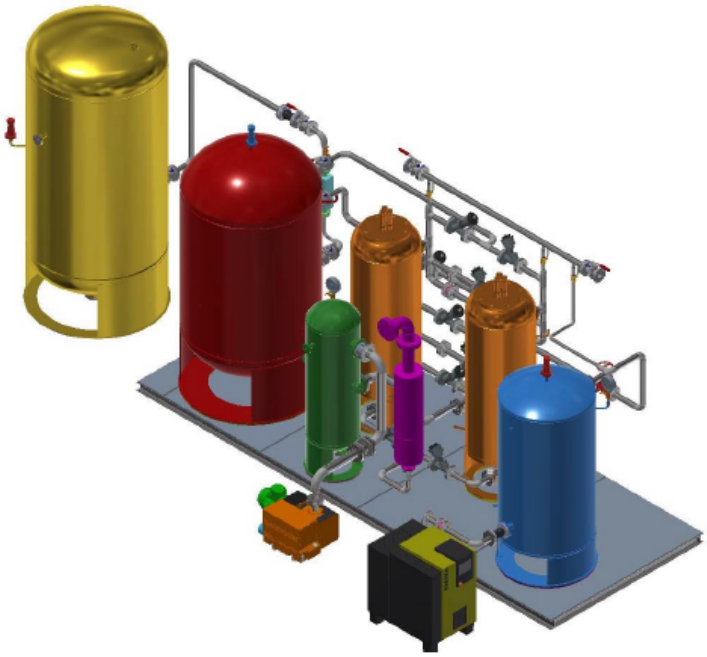
The feed air system comprises of screw type air compressor, motor, fan type air cooler, starter and control system etc. The screw compressor has integrated / built in Refrigerated type dryer so as to reduce the moisture load on the desiccant and the condensed water is drained out through a timer operated auto drain valve. To further reduce oil contents from the air, an additional activated carbon is provided. The carbon filter element should be replaced after its normal working life of 3 to 6 months. Micron air filter is provided before oil filter to remove any particulate matters. Thus, clean oil free air is available for continuous usage in the system. Air is then passed through a twin tower unit filled with special grade of desiccant wherein moisture & nitrogen are selectively adsorbed.

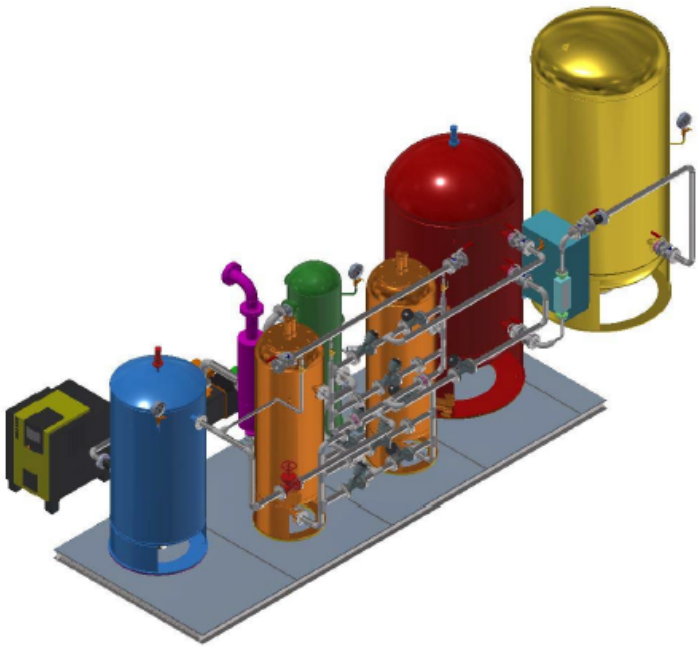
At a time, one set of adsorber remains in cycle (adsorption) supplying dry oxygen at the outlet while other goes under regeneration by depressurization followed by gas purging. For high degree of regeneration to achieve maximum performance from Molecular Sieves, vacuum is applied as a pulling force to make the regeneration complete in all respect.

To avoid any surges because of changeover from one tower to another, a suitable surge tank is provided. For the automatic changeover of adsorbers from one to another a suitable sequence timer/PLC and changeover valves with interconnecting piping are provided, thus making dry oxygen continuously available at the outlet through rotameter.

Total cycle time for adsorption/regeneration is of 2 x 45 to 2 x 90 seconds depending upon type of operating pressure, output pressure and required purities. The unit is selected with a time cycle of 70+70 seconds. All the above equipment's are complete with interconnecting piping and mounted on a common base frame as a skid.

8)Typical 3D view of 500 LPM PVSA (Vacuum Pressure Swing Adsorption) Oxygen system





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