Zeolite oxygen concentrators

By IASToppers | 2021-10-16 17:10:00

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The extended 2- or 3-dimensional structures from linking together molecular units were created just as was done for polymers.

[Ref: The Hindu]

About 2- or 3-dimensional structures of molecule:

- This complex arrangement of atoms, such molecular networks are called **frameworks.**
- The basic units go on fitting together to form large networks, like a **wire mesh fence**.
- The network is **constructed by repeated additions of a molecule with symmetry**. A few such networked sheets, when stacked one over another, form a **functional 2-D entity.**
- Uses for these Covalent Organic Frameworks (COFs) take advantage of their stability, large surface area, controlled pore sizes, and tunable chemical environments.

Features:

- The frameworks can be designed to act as sieves in separating out molecules of a specified size.
- The smallest whiff of a toxic gas could be sensed - in an industrial environment, or in airline baggage.
- They are also **suitable for both storing energy (as capacitors) and for conducting it** (along membranes in fuel cells).
- Metal Organic frameworks (MOFs) are **structured like COFs** but have metals in complexes with organic entities.
- The choice of metals is wide, from **Beryllium to Zinc**, though relatively abundant metals are

preferred for economic and environmental reasons.

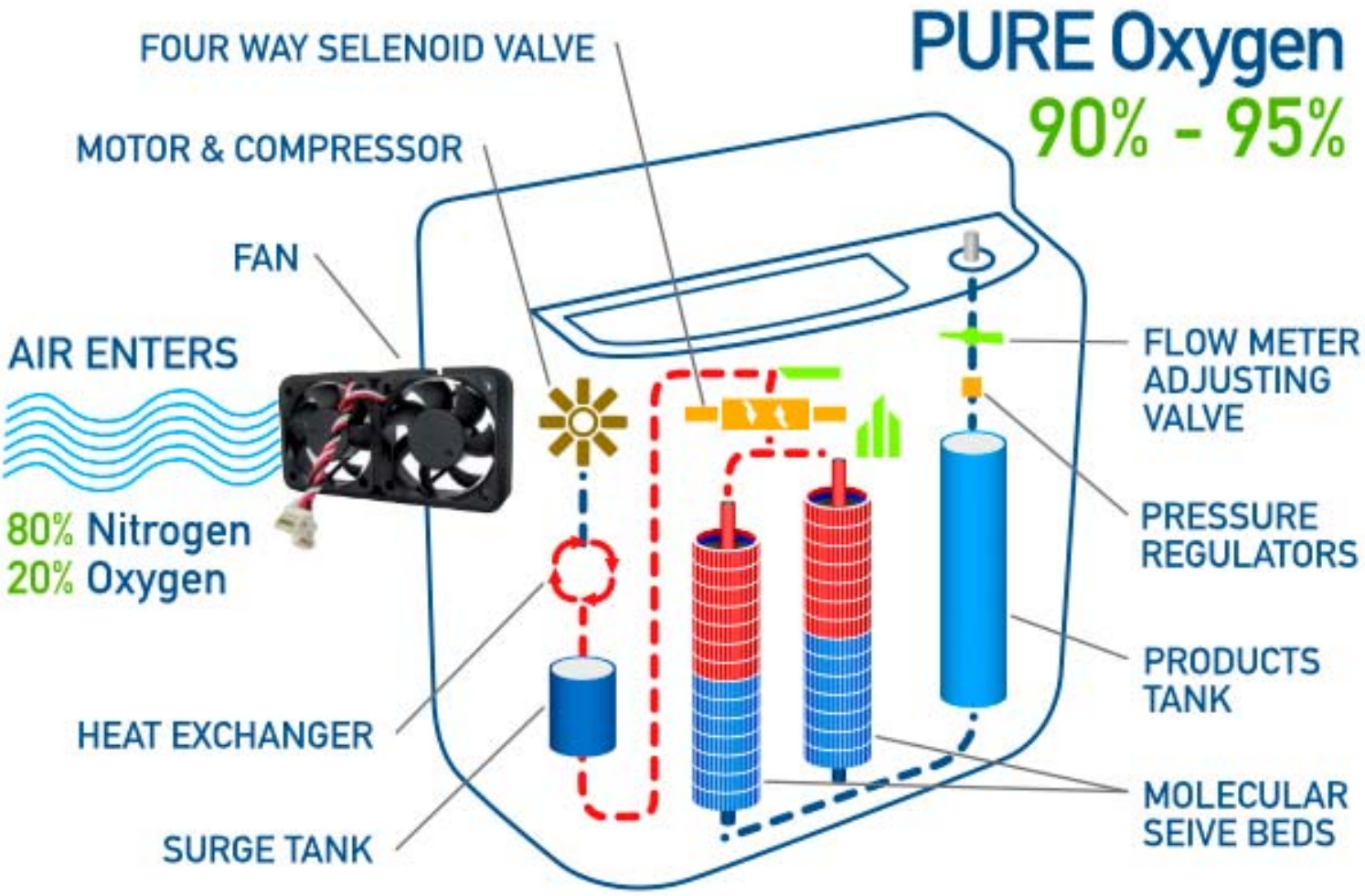
Advantages:

- **For gas storage**, as in the case of hydrogen storage in fuel cells;
- **In catalysis,** where they replace very expensive metals;
- In sensors; and **in drug-delivery** – anti-cancer and other drugs with severe side effects can be trapped in the porous confines of MOFs.

Zeolite:

- Zeolites are **highly porous, 3-D meshes of silica and alumina**.
- Zeolites are hydrated, crystalline microporous aluminosilicates, whose structures enclose channels and/or cavities of molecular dimensions.
- It is made of **silicon, aluminum and oxygen** that form a framework with cavities and channels inside where **cations, water and/or small molecules may reside**.
- They are often also referred to as molecular sieves.
- Zeolites were **introduced in 1954 as adsorbents for industrial separations and purifications.** Because of their unique porous properties.
- In nature, they occur where **volcanic outflows have met water**. Synthetic zeolites have proven to be **a big and low-cost boon**.

Principle of the technology in oxygen concentrators:



[Ref: all about circuits]

- They are **synthetic frameworks of silica and alumina with nanometer-size pores** that are rigid and inflexible.
- Beads of one such material, **zeolite 13X**, about a millimeter in diameter, are **packed into two cylindrical columns in an oxygen concentrator**.
- The chemistry here is tailored to the task of **separating oxygen from nitrogen in air**.
- Being highly porous, zeolite beads have **a surface area of about 500 square meters per gram**.
- At high pressures in the column, **nitrogen** is in a tight embrace with the zeolite. Interaction between the negatively charged zeolite and the asymmetric nucleus (quadrupole moment) of nitrogen causes it to be **preferentially adsorbed on the surface of the zeolite.**
- **Oxygen remains free**, and is thus enriched.
- Air has 78% nitrogen, 20.9% oxygen and smaller quantities of argon, carbon dioxide, etc. Once nitrogen is under arrest, what flows out from the column is **90%-plus oxygen**.
- After this, **lowering the pressure in the column releases the nitrogen**, which is flushed out, and the cycle is repeated with fresh air.

Key Facts:

- The polyethylene of plastic bags is made from **repeating units of the ethylene molecule**.
- In **biological systems**, proteins are 1-dimensional polymers of amino acids.

