

# Production of High-Purity O<sub>2</sub> via Gas-Liquid Membrane Contactor with O<sub>2</sub> Carrier Solutions

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## Objective

To develop a bio-mimetic hollow fiber membrane contactor (HFMC) process that can produce O<sub>2</sub> from air with greater than 95% O<sub>2</sub> purity at a cost substantially below the benchmark technology, cryogenic distillation.

## State-of-the-art mature air separation technologies

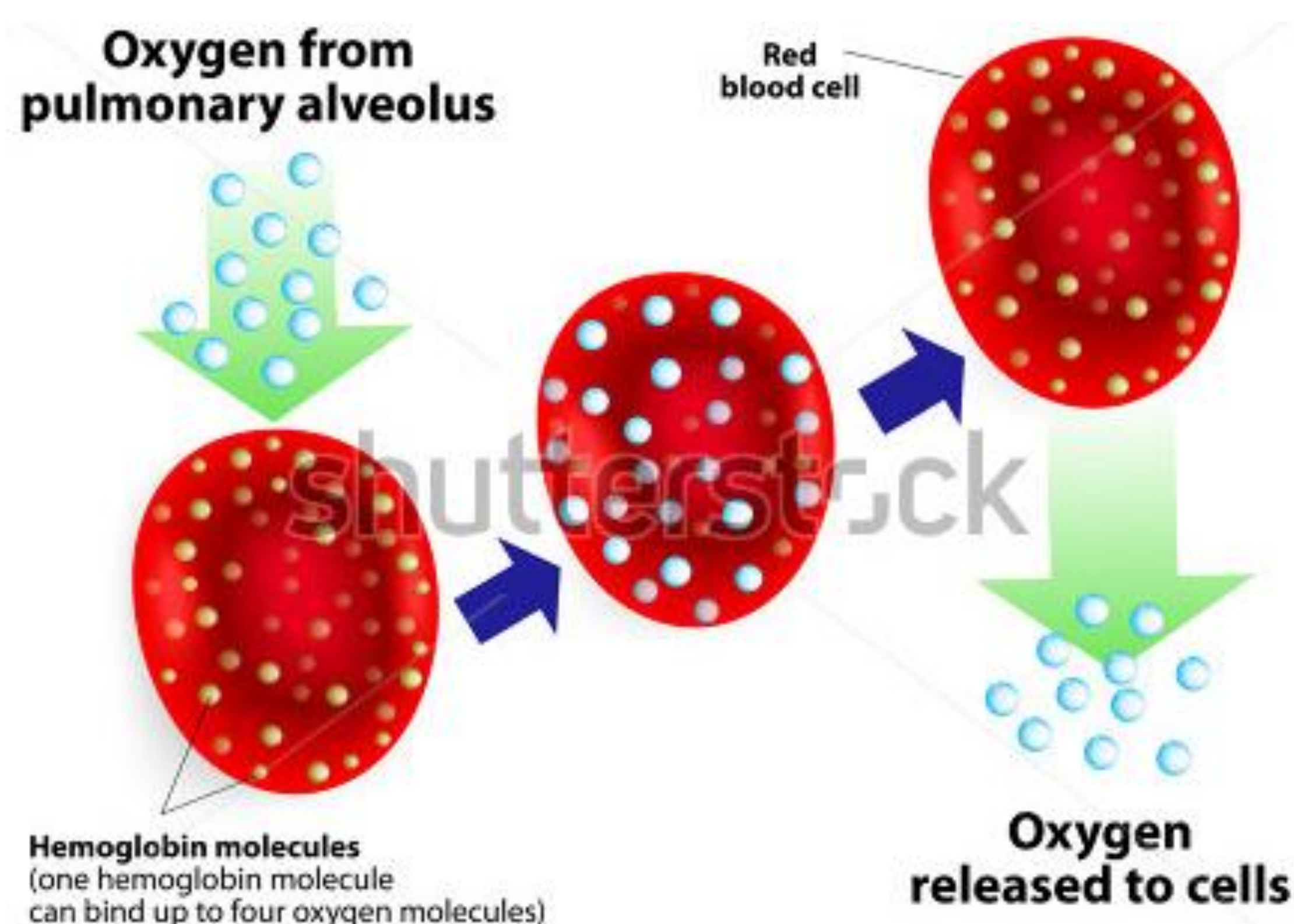
Technology	O <sub>2</sub> purity limit (vol.%)	Largest O <sub>2</sub> flow rate (Ton O <sub>2</sub> /day)
Cryogenic distillation	99+	>3,000
Pressure swing adsorption (PSA)	95	<350
Conventional gas separation membranes	40	<20

### ▪ Cryogenic distillation

- The most mature technology for large scale and high purity (>99%) O<sub>2</sub> production
- Cost estimate with Integrated Environmental Control Model: \$35.80/ton O<sub>2</sub> for an IGCC plant producing 500 MW<sub>e</sub> net with Illinois 6 coal and shift/Selexol for CO<sub>2</sub> capture

## Our inspiration

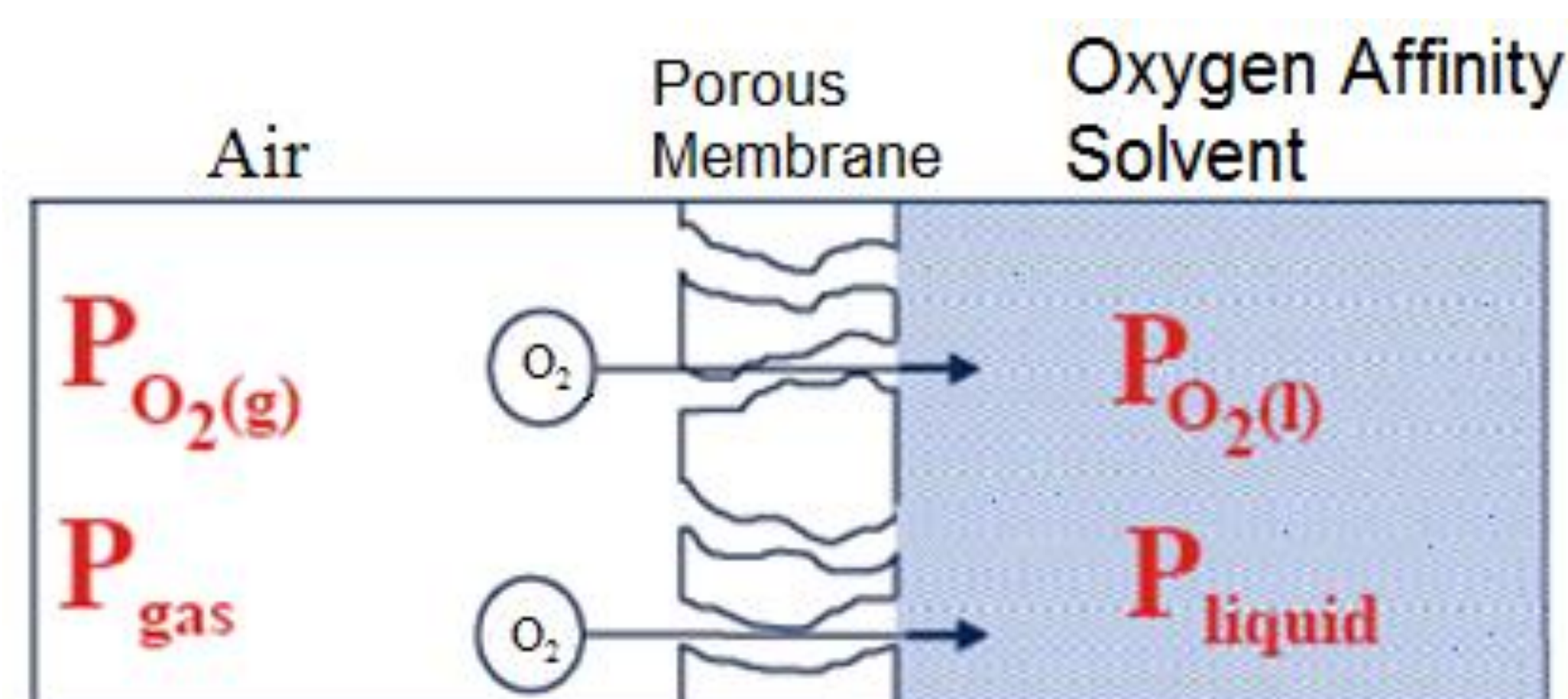
...Red Blood Cell



We use membrane contactor to realize our concept...

## What is a membrane contactor?

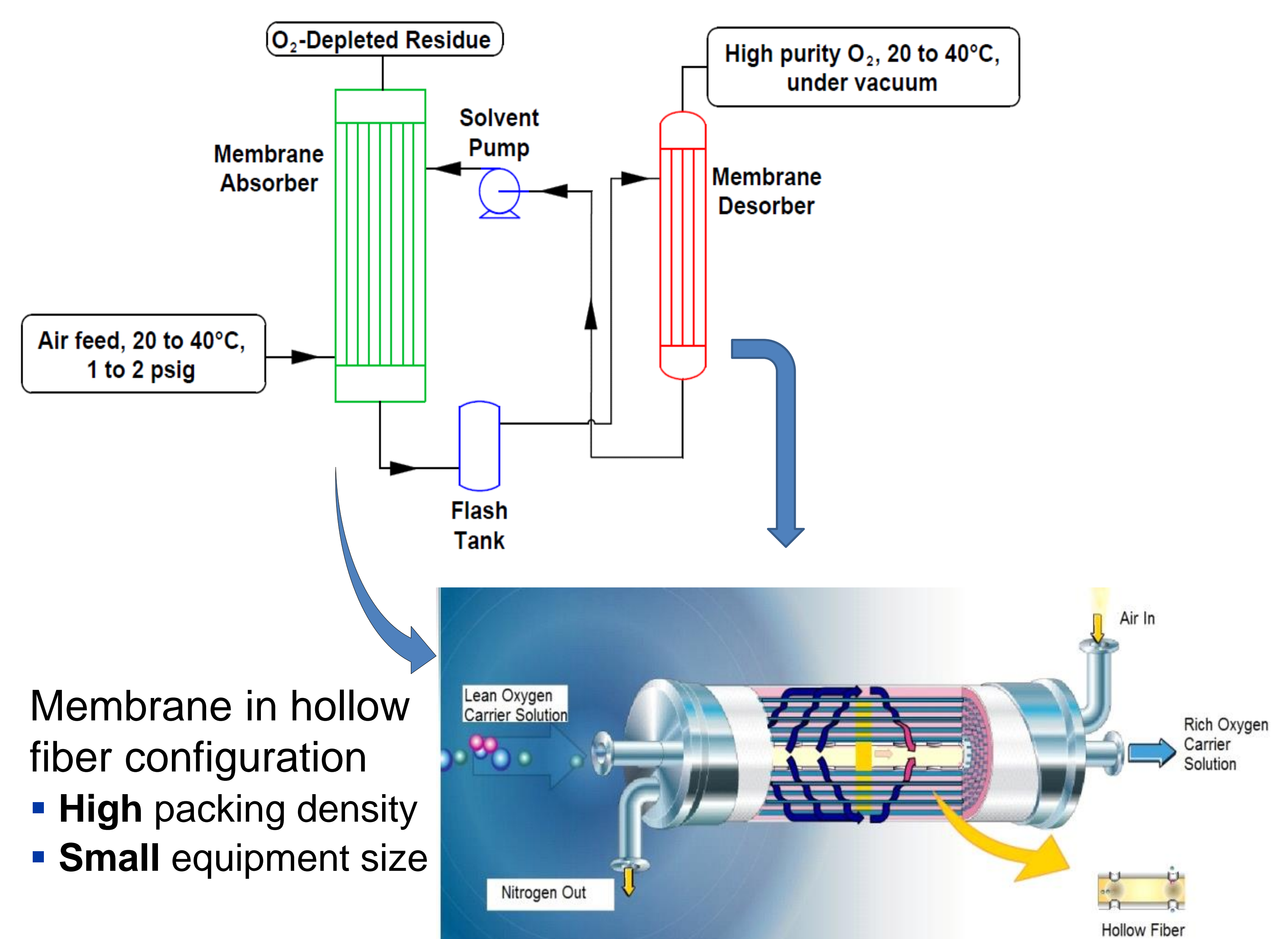
- High surface area membrane device that facilitates mass transfer
- Gas on one side, liquid on other side



- Membrane does not wet out in contact with liquid
- **Separation mechanism:** O<sub>2</sub> permeates through membrane, reacts with the solvent; N<sub>2</sub> does not react and has low solubility in solvent

## Our innovative Technology

A membrane contactor process with hollow fibers and O<sub>2</sub> carrier solution mimics “blood vessels” and “blood” to produce > 95% purity of O<sub>2</sub>



Membrane in hollow fiber configuration

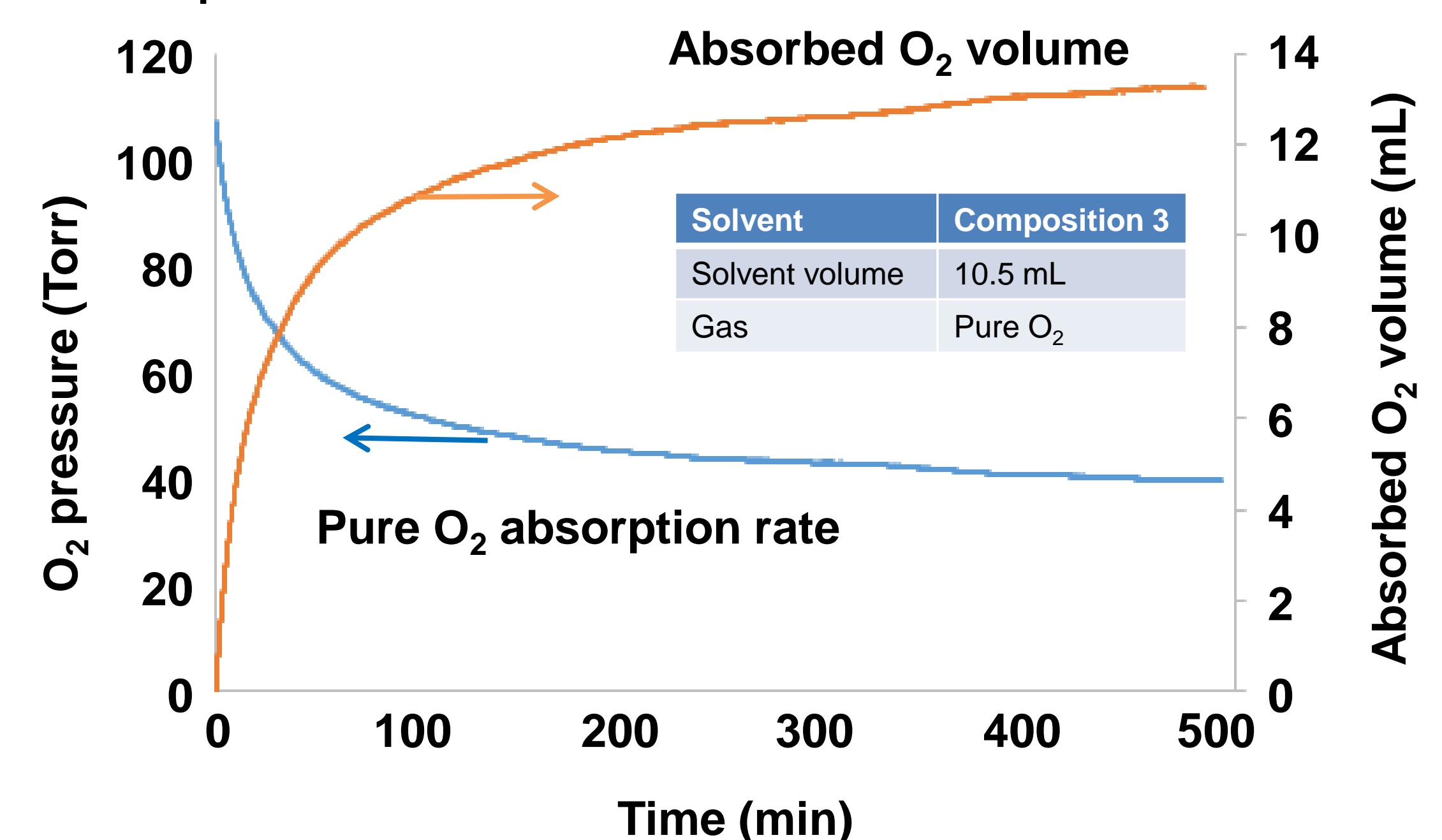
- High packing density
- Small equipment size

## Accomplishments

- Oxygen carrier solvent (Co-PEI aqueous solution) developed and showed high O<sub>2</sub> loading capacity and low viscosity

Composition	Kinematic viscosity (10 <sup>-6</sup> m <sup>2</sup> /s)	O <sub>2</sub> capacity per volume of solution (L(STP)/L of solution)	Kinematic viscosity after O <sub>2</sub> absorption (10 <sup>-6</sup> m <sup>2</sup> /s)
1	2.0	0.59	2.8
2	2.2	0.78	2.8
3	2.3	1.1	3.0

- Oxygen absorption rate measured



- The production of concentrated O<sub>2</sub> validated experimentally in the bio-mimetic process: using a polypropylene membrane and with argon sweep approach, O<sub>2</sub> concentration greater than 98.1% was observed in desorbed gas stream on an argon free basis.

## Acknowledgments

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