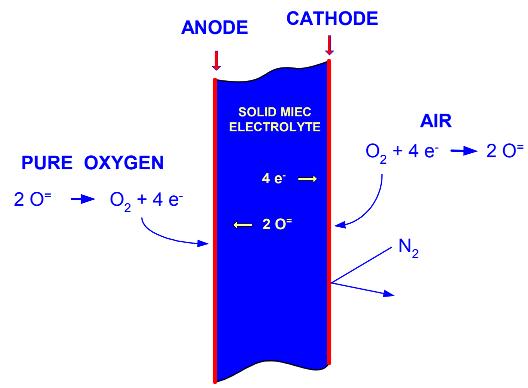
Ion Transport Membrane Technology For Production of Pure Oxygen

Oxygen is the third most widely used chemical in the world, with an annual worldwide market of over $9 billion. Uses for pure oxygen range from relatively small scale (1) breathing oxygen systems for patients with pulmonary disorders and (2) medical oxygen systems for hospitals to large industrial applications like (3) chemical synthesis, (4) enriched air for refining systems (e.g. FCC regenerators), (5) syngas generation for GTL (Gas to Liquids) plants or (6) commercial coal or coke gasification systems. It is estimated that oxygen separation accounts for ~15% of the capital cost of an IGCC (Integrated Gasification Combined Cycle) system and as much as 25% of the cost of a grass-roots GTL plant.

The ability to separate oxygen from air has proven invaluable to many industries, because using pure oxygen in high-temperature furnaces improves their efficiency and reduces emissions. However, the high cost of oxygen has been a barrier to the widespread application of oxygen-enriched combustion and oxygen-blown gasification in coal-fired power plants. The separation of pure oxygen from air is currently carried out by cryogenic distillation in which air is cooled down to the liquefaction temperature of oxygen (-183 °C) at which point nitrogen is still in the gas phase (nitrogen must be cooled to -196 °C to liquefy). Because the boiling points of oxygen and nitrogen are so close, however, this process requires hundreds of equilibrium stages in the distillation columns, thus contributing to a high capital cost; and because of the very low temperatures involved, it is extremely energy intensive, thus increasing operating costs.



In recent years, a new technology for separating oxygen from air has been explored. This technology involves the use of Ion Transport Membranes (ITMs) which selectively separate pure oxygen from air at temperatures between 700 °C and 1,000 °C. These solid oxide electrolytes of varying compositions have been shown to have high oxygen production rates and produce >99.95% pure oxygen. The use of ITMs is expected to reduce the cost of oxygen production by 30-50% versus cryogenic distillation.

One of the debits of existing ITM systems, however, is their high operating temperatures, which result in higher manufacturing costs (because of more exotic materials of construction, etc). Like solid oxide fuel cells, the goal for these oxygen separation systems for some time has been the development of an electrolyte that operates effectively in the 400-700 °C range. Until now, no such materials have been available. A recent discovery by researchers at the University of Houston's Texas Center for Superconductivity (TcSUH), however, has shown that certain layered mixed metal oxides have unusually high oxygen mobility. More importantly, this high mobility occurs some 400 – 500 °C lower than in metal oxides currently under development by other companies. Trans Ionics has licensed the novel electrolyte and its use in oxygen separation and solid oxide fuel cells from the University of Houston and is in the process of commercializing the technology to produce cost-effective, pure oxygen production systems that can save significant quantities of energy versus units using cryogenic oxygen separation.

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