

Air Separation Technology Ion Transport Membrane (ITM)



Lower unit costs for oxygen and syngas

Reduced capital costs

Excellent integration with power generation cycles

Small footprint for greater flexibility

Low cooling water consumption

Background

Air Products has a long history of developing the products of today while being mindful of the impact on tomorrow. By their very nature, many of our gases and materials boost energy efficiency, increase the throughput and capital efficiency of machinery and equipment, enhance end product quality, and improve environmental performance. The economics of providing oxygen and syngas impact the widespread commercialization of an increasing number of clean energy processes. Working with our associates,

Air Products has developed ion transport membrane (ITM) technology, a groundbreaking way to provide reliable, cost-effective oxygen supply for high-volume applications, including:

- Clean coal-IGCC
- Enrichment
- Carbon capture
- Decarbonized fuel
- Gas to liquid
- Coal to liquid
- Oxyfuel combustion
- Gasification



ITM's very high oxygen flux leads to compact designs and drives costs down. Here, a scale drawing of a 2000 TPD ITM oxygen vessel is shown in comparison to a 2000 TPD cryogenic separation unit.

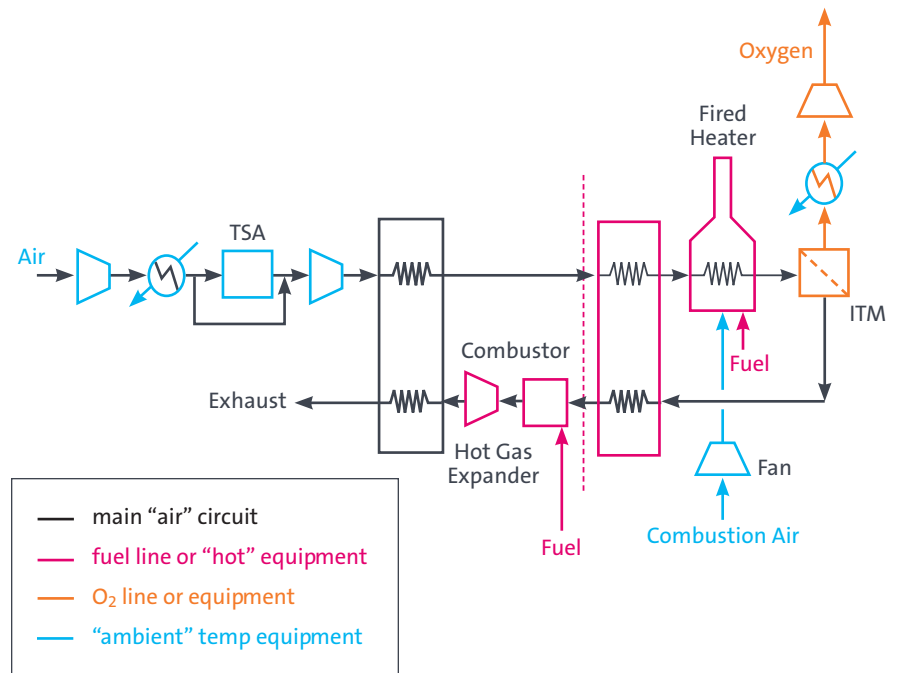
Description: a revolutionary technology using ceramic membranes

ITM is a technology for gas separation that works by transporting an ionized gas through a ceramic membrane. The crystalline metal oxide structure of our proprietary membranes incorporates oxygen ion vacancies, through which the oxygen ions diffuse. ITM's very high flux and very high selectivity contribute to reductions in both capital and operating costs.

ITM can offer multiple benefits

- 25%–35% reduction in the cost of oxygen over conventional cryogenic oxygen plants
- 30% reduction in capital requirements for syngas plants
- Significant reduction in power consumption (depending on application and product pressure) up to 1000 psig or more
- Consumes no net electricity
- Uses syngas, natural gas or other fuel
- Can be integrated with other high temperature processes to produce electrical power and/or steam from depleted air
- Substantial reduction in cooling water consumption
- Compact, modular design has significantly smaller footprint than cryogenic ASU plant or the syngas plant

ISTU Simplified Block Flow Diagram
 Ion Transport Membrane Oxygen Intermediate-Scale Test Unit (100-ton O₂/day)



ITM Oxygen

ITM Oxygen membranes are 100% selective for oxygen, delivering a high-purity oxygen product.

Membrane wafer Proprietary mixed conducting, nonporous ceramic planar membranes

Feed stream Compressed air (150–500 psig/10–34 bar) heated to 800–900 °C (1470–1650 °F)

Products Pure oxygen (99+%), power and/or steam

ITM Oxygen status

- Successfully operating 5-TPD subscale engineering prototype test plant since 2006
- Scale-up development plant to 100 TPD (ISTU)
- Serving oxygen, hydrogen, clean power, and gasification and carbon capture markets in the middle of the decade
- Developing additional commercialization partnerships

ITM Syngas

ITM Syngas membranes combine air separation and methane partial oxidation into a single-unit operation, resulting in significant cost savings for syngas production.

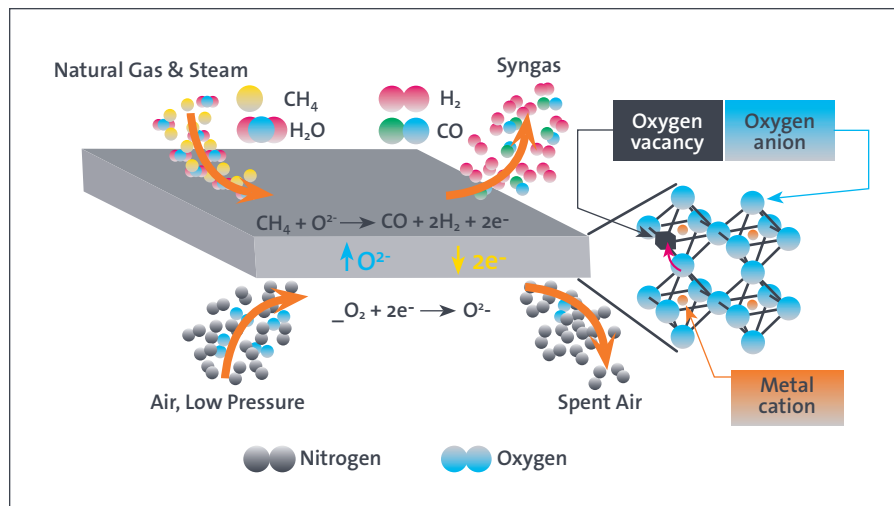
Membrane wafer Proprietary mixed conducting, nonporous ceramic planar membranes, different from the ITM oxygen membranes

Feed streams Natural gas, low-pressure air (20+ psig/1.4+ barg) heated to approach reactor inlet temperature, and steam

Products Synthesis gas (hydrogen and carbon monoxide) for ultraclean liquid fuels, hydrogen and/or chemicals

Air Products is currently in the fourth phase of a \$290 million program with the goal of reducing the cost of oxygen by one-third. We also have completed the second phase of a \$163 million program with the goal of reducing the syngas plant cost by more than 30%. In these precommercial development phases, we seek additional partners and pilot sites for ITM Oxygen and ITM Syngas. To learn more about how you can be a part of the development of this revolutionary technology, contact us at the following location.

tell me more



Air Products' ITM ceramic membranes have high oxygen flux and high selectivity for oxygen, making them ideal for tonnage oxygen and syngas production.

For more information,
please contact us at:

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www.airproducts.com/gasification