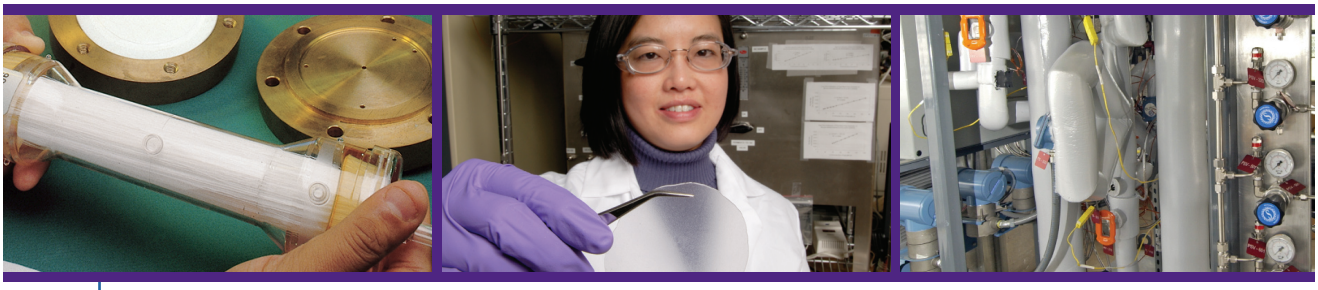
Membrane Separation Technologies



As part of its clean energy research program, RTI International is conducting research and development on advanced gas separation membranes and membrane-based separation processes for removing contaminants from industrial process gas streams, including gasification synthesis gas and post-combustion flue gas. RTI has a dedicated team of scientists and engineers and state-of-the-art laboratory facilities for synthesis, characterization, and evaluation of membranes. RTI also offers membrane process simulation software for modeling multicomponent gas separation processes.

Membrane Separation Technologies

For a number of industrially important applications, membrane-based gas separation is an increasingly viable, cost-effective, alternative or complementary separation technology to traditional unit operations such as distillation, absorption, pressure swing adsorption, direct compression-condensation, and cryogenics. Membrane processes inherently offer some advantages over conventional separation operations:

- Separation and concentration of contaminants into a single process stream
- Continuous (non-batch) process, no regeneration step
- Modular design suitable for scale-up
- Compact design for easy retrofit and integration into existing and new processes
- Minimal maintenance and operator attention

In collaboration with industrial and academic partners, RTI develops cost-effective alternatives using membranes and membrane processes for industrial gas separation applications, particularly for synthesis gas cleaning and conditioning and carbon dioxide capture from post-combustion flue gas.

Polymer Membranes

RTI membrane research activities are focused on the development of both size-selective and "reverse-selective" polymeric membrane materials. Unlike conventional size-selective membranes, reverse-selective polymer membranes are more permeable to larger, more condensable or more polar gases and vapors (e.g., carbon dioxide, hydrogen sulfide, condensable hydrocarbons, etc.) than to smaller, less condensable gases (e.g., hydrogen).

RTI has developed novel reverse-selective polymeric membranes for cleaning and conditioning synthesis gas streams to meet contaminant control targets for power generation and chemical processes. In these applications, the reverse-selective membranes selectively separate carbon dioxide, hydrogen sulfide, and carbonyl sulfide from the synthesis gas as a low-pressure waste stream, leaving the hydrogen- and carbon monoxide-enriched product stream at high pressure for downstream utilization. The chemistry of these membranes has been tailored to give them high permeability and high selectivity for polar and acidic gas species. Process modeling has shown that reverse-selective membrane processes can provide significant cost advantages over amine absorption systems, the industry standard for acid-gas removal.

RTI and collaborators have developed unique reverse-selective membranes that achieve step-out separation performance through targeted harnessing of plasticization by acidic or polar species.
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RTI has also worked on the development of hydrogen-selective polymer membranes with high thermal stability (decomposition temperature > 500 °C) for producing purified hydrogen from synthesis gas and reformate gas. Such thermally stable membranes are potentially useful for directly separating hydrogen from hot gasifier or water-gas-shift reactor process streams to obtain purified hydrogen and a high-pressure, concentrated carbon dioxide stream for sequestration or reuse.

In a current DOE-funded program, RTI and a team of industrial partners are working to develop and integrate a polymer membrane-based process for capturing carbon dioxide from post-combustion flue gas. The project focuses on novel high-performance fluorinated polymer membrane materials, improved hollow-fiber membrane module design, and process development for efficient integration of the carbon dioxide capture system into an existing coal-fired power plant.

Membrane Preparation, Development, and Characterization

RTI has in-house expertise and fully equipped facilities for membrane synthesis, characterization, and testing. RTI collaborates closely with academic and industrial partners in the process industry and in membrane manufacturing on novel membrane polymer synthesis and membrane module development and process applications. Membrane permeation testing facilities at RTI are well-equipped for determining gas permeances and selectivities of planar and tubular, polymeric and inorganic membrane materials and membrane modules over a wide range of pressure and temperature operating conditions and gas environments in bench- and pilot-scale systems. RTI's membrane testing facilities also allow the determination of the long-term effect of realistic gas environments on membrane performance. The range of test conditions include

- Multicomponent gas mixtures at high pressures (up to 1,500 psia) and high temperatures (up to 350 °C)
- Toxic and corrosive gases (CO, H_2S, CO_2, SO_2, etc.)
- Humidified gas mixtures

Pilot-Plant Operation

RTI has experience with the design and operation of pilot-scale membrane process units. RTI's membrane pilot skids can be integrated into existing operations to demonstrate long-term performance with actual process gases.

Membrane Process Simulation and Modeling

RTI researchers have expertise in conducting modeling and simulation of membrane processes. RTI has developed simulation software for modeling a multicomponent gas separation process in a hollow-fiber membrane contactor. The membrane simulator software is available as a stand-alone package or as a module that can integrated into various third-party simulation environments such as AspenPlus® and HYSYS.

Doing Business with RTI

RTI offers comprehensive membrane development, characterization and testing services to industrial and government clients, aiming to provide the most efficient and cost-effective R&D services possible. RTI takes a pragmatic approach to managing intellectual property and has the necessary systems in place to best serve clients' needs.

More Information

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