ITC GROUP

Industrial Thermochemical Conversion Group

Case Study – Commercialization of Membrane Reactor Technologies for Efficient Production of High Purity Hydrogen from Methane Steam Reforming

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Fluidized Bed Membrane Reactors

Membrane Reactor Technologies (MRT™) is a Center of Excellence of NORAM Engineering and Constructors, Ltd. focused on the development and industrial introduction of a proven, proprietary technology to generate low-cost, high-purity hydrogen from natural gas steam reforming and renewable feeds. The technology has proved to be more efficiently than conventional methods.

Based on patented fluidized-bed membrane reactor (FBMR) technology, the process combines hydrocarbon reforming, shift conversion and hydrogen purification in a single step, enhanced by the equilibrium shift effect due to *in situ* hydrogen removal using Pd-based membranes.

MRT™ has completed a number of successful demonstration projects where FBMR reactors have produced high purity hydrogen. One unit was supplied to Tokyo Gas, giving improved performance in comparison with fixed bed membrane reformers. Another unit was built in association with Linde and the US DOE. MRT™ is also working to combine sorbent-enhanced reforming, with calcined limestone capture of CO_2, with membrane-

enhanced reforming. This combination can contribute to improved reforming efficiency, greenhouse gas capture and better energy integration.

Hydrogen Generation

MRT™'s Pure Hydrogen Generators generate high purity hydrogen at capacities to suit a range of end uses, wherever the gas is needed. Using natural gas, propane or renewable feeds, MRT™'s units will be part of a free-standing, autonomous approach to hydrogen distribution, eliminating the cost and environmental impact of transportation. Applications for the technology include:

- On-site generation for industrial end-users, such as glass manufacturers, edible oil processors, metal processors and semi-conductor manufacturers – lowering the cost of hydrogen.
- Production of hydrogen for industrial gas companies at depots and transfer stations – reducing the need for transportation and its attendant problems.
- Generation of hydrogen at refueling stations for fuel cell vehicles and for vehicles fueled by hydrogen-enriched blends such as Hythane, for combustion enhancement and reduction of tailpipe emissions.

Hydrogen Purification and Recovery

MRT™'s HydRec™ Membrane Purifiers are capable of purifying hydrogen gas to 99.999%$^{+}$ purity for a range of end-uses in a reliable and cost-effective way. Applications include:

- Final cleanup of electrolytic hydrogen, to remove traces of water vapour and other contaminants. A simple single stage Membrane Purifier can replace several stages of cleanup presently used in electrolyzer systems.
- Upgrade bulk-quality hydrogen to ultra-high purity hydrogen for chemical and fuel cell applications.
- Hydrogen recovery from mixed gas streams such as town gas or refinery fuel gas.

Hydrogen recompression, as well as fuel cells and other devices, can be incorporated to produce a fully integrated system.

The ITC group provides our clients with expertise in system engineering and custom design of advanced hydrogen generation, purification and recovery systems tailored to their needs. As parent company and manufacturing partner, NORAM and Axton Inc. bring their expertise in solving mechanical and materials issues in industrial applications.

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The ITC Group provides R&D and design expertise on fixed and fluidized bed systems involving reaction kinetics and thermodynamics, mass transfer and heat transfer phenomena. The group's research and piloting facility is located in Vancouver, British Columbia, Canada.