II.B.4 Integrated High Temperature Coal-to-Hydrogen System with CO_2 Separation

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Objectives

The objective of this project to GE Global Research (GEGR) is to design a single module to perform two functions: hot gas clean-up and hydrogen separation from coal-derived syngas. GEGR will develop a high-temperature membrane material, which is at the core of the design. The simplified "one box" process would combine shift reactors with the high temperature CO_2-selective membrane; this would convert CO to CO_2, remove sulfur compounds, and remove CO_2 in a fully-integrated system, leaving behind high purity hydrogen.

Approach

Guided by GE's Design for Six Sigma Process (DFSS), the technology development effort will follow three tasks. First, a "one-box" design concept will be analyzed to meet targets of higher efficiency lower capital cost, and smaller footprint to produce the performance targets for the system and the new membrane. Second, feasibility of high-temperature CO_2-selective membrane materials that also remove H_2S will be demonstrated. Third, a detailed design will be produced of a "one box" syngas cleanup module using the membrane materials developed, and the performance and cost metrics will be predicted. The outcome will be the scientific basis for an integrated coal-to-H_2 clean-up system that includes system designs and membrane materials suitable for scale-up and demonstration.

Accomplishments

- Developed a conceptual reactor design and performance targets for system and membrane.
- Synthesized inorganic mesoporous membrane structures with varying pore sizes and architectures and identified functional materials that enhance CO_2 and H_2S transport. Characterized membrane selectivity and permeability as a function of temperature.

Future Directions

- Integrate syngas clean-up and conversion module design and predict performance of optimized integrated module.
- Prepare projected capital and operating costs of integrated module.