Development of Carbon Molecular Sieves Hollow Fiber Membranes based on Polybenzimidazole Doped with Polyprotic Acids with Superior H₂/CO₂ Separation Properties

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Project Objective

Objective: develop carbon molecular sieves (CMS) hollow fiber membranes with H₂ permeance of 1000 GPU and H₂/CO₂ selectivity of 40 at 200-300 °C.

BP 1 Materials development
- Optimize CMS materials with an H₂ permeability of 200 Barrers and H₂/CO₂ selectivity of 40 with simulated syngas; and
- Optimize the hollow fiber membranes based on PBI doped with polyprotic acids.

BP 2 Membrane development
- Optimize membranes achieving the targeted H₂/CO₂ separation performance;
- Test membranes using simulated syngas containing H₂S, CO and water vapor;
- Determine the efficiency of the membrane reactors for the WGS reaction; and
- Conduct the techno-economic analysis.

Defining Membrane Properties for H₂/CO₂ Separation

• Hybrid membrane and cryogenic process is effective for CO₂ capture
• Target: H₂ permeance of 1000 GPU, H₂/CO₂ selectivity of 40


Our Approach: Carbonizing PBI/Polyprotic Acids

Three steps:
1. PBI with superior H₂/CO₂ separation properties
2. Doping PBI with polyprotic acids to improve H₂/CO₂ selectivity
3. Carbonizing to enhance H₂ permeance

Thin film studies
- Carbonizing PBI increases H₂ permeance
- Carbonized PBI/H₃PO₄ shows superior H₂/CO₂ separation properties

Hollow fibers of PBI: Carbonizing PBI increases H₂ permeance

Preliminary Data on PBI Doped by H₃PO₄

- Doping PBI with H₃PO₄ dramatically increases H₂/CO₂ selectivity
- PBI/H₃PO₄ is stable in the presence of water at 150 °C


Preliminary Data on Carbonized PBI or PBI/H₃PO₄

DOE/NETL
- Develop CMS membranes
- Coordinate

UB:
- Perform TEA
- Prepare membranes
- Run parametric tests

LANL:
- Prepare membranes
- Run parametric tests

Collaboration

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