Atomic Transport/ Dense Metallic Hydrogen Separation Systems

Participants -- Atomic Transport/Dense Metallic Systems

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Performance Goals

- General Comments
  - Targets for membrane AND for module??
  - Use metric units
  - Define pressure & T conditions (permeate and feed)
  - Cost target best at $/kg H2 for membrane AND for module
  - Durability includes meantime between failure, O&M costs ($/kg H2)
  - H2 purity targets of 99.999% -- really necessary? -- what contaminants can you live with?
  - Define contaminants + partial pressure

Technology Options – Atomic Transport/Dense Metallic Systems

- Pd alloy membranes
  - Free standing foils
  - Physical composites
  - Chemical composites
- Pd coated metals
- Process intensification
  - Membrane plus reactor

Barrier Categories-- Atomic Transport/Dense Metallic Systems

- Membrane Materials
- Supports
- Module Construction
- Module Testing
- Process Intensification
- Systems Analysis

Top Priority Barriers -- Atomic Transport/Dense Metallic Systems

Membrane Materials

- Lack of optimal fabrication methods
- Inadequate membrane durability for commercial applications
- Lack of understanding of novel alloys and impact on diffusivity and flux
- Lack of understanding of microstructural evolution in operation, and its effect on permeance and selectivity
- Need to identify all contaminants and concentrations in the feed

Top Priority Barriers -- Atomic Transport/Dense Metallic Systems

Membrane Supports

- Lack of low cost support that achieves target operating performance
- Lack of understanding of the impact of the support on thin membrane flux
- Intermetallic diffusion

Top Priority Barriers -- Atomic Transport/Dense Metallic Systems

Module Construction

- Lack of economical, large-scale manufacturing methods
- Lack of sealing and joint technology
- Module design for recyclablity

Top Priority Barriers -- Atomic Transport/Dense Metallic Systems

Module Testing

- Lack of benchmark or standard for durability

Top Priority Barriers -- Atomic Transport/Dense Metallic Systems

Systems Analysis

- Lack of comparative studies on alternative system configurations
- High cost of H2 compression

Top Priority R&D Needs – Atomic Transport/Dense Metallic Systems

- Membrane Material
  - Develop improved membrane fabrication methods
  - Conduct root cause analysis of degradations and failure mechanisms
  - Develop more durable membranes
  - Develop alloy compositions that optimize membrane performance and durability
- Membrane Support
  - Develop compact, low cost support materials and structures that are practical and cost effecitve
  - Develop improved understanding of inter-relations between membrane and support

Top Priority R&D Needs – Atomic Transport/Dense Metallic Systems

- Module Construction
  - Develop and demonstrate optimized module designs
  - Develop large-scale manufacturing methods
- Module Testing
  - Develop standard testing protocols that are application-specific
  - Develop gas feedstock specifications that are application specific
- Process Intensification
  - Perform reaction engineering studies to integrate reformer and/or WGS with the membrane
- Systems Analysis
  - Conduct comparative studies on alternative system configurations
  - Develop a user-friendly model to conduct scenario analysis

Take-Away Messages

- Multi-disciplinary R&D teams are needed to develop performance membrane systems
  - Teams to develop membranes, supports, and module
  - Teams needed to integrate modules into process system
  - This is a win-win effort!
- Membrane + module is key
- Systems analysis is key
- Process intensification can give us the “home run”