Breakout Session 4: Chemical Separations and Crosscutting Technologies

Technology Needs, Barriers, & Challenges

- Membranes: material operating range, low flux rates, lifetime/durability
- Contamination and fouling impacts
- Separation selectivity and specificity
- Replacement technologies for current energy-intensive distillation processes
- Specific separations: solvent-water, azeotropes, gas/oil/water separations from oil/gas extraction, CO2 capture, rare earth extraction, bio-based (improved ionic liquids, concentration/separations in aqueous solutions)
- Materials and manufacturing: high contact area materials/equipment, new adsorbents/materials for higher selectivity
- Capital barriers: overcome existing capital base; cost in scaled-down operations
- Ensuring safe operations
- Need demo facility for validating separation technology: test in relevant environment not pristine conditions

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R&D Needs

- Membranes: improved selectivity and lifetime; for membrane reactors, for chemical and battery applications, platform systems (address classes of chemicals), for water purification (low pressure systems), roll to roll technology for membrane production
- Materials: new low cost materials, inverse selectivity
- Novel anti-fouling technologies
- Membrane-based solvent recovery
- Continuous bio-based process technologies
- Micro-channel membrane technology
- Improved distillation columns
- Biological or fermentation based technology advancements
- Rapid prototyping/modeling, 3-D printing opportunities
- Pilot test facility to test/validate separations (including membrane performance)
- Utilization of data visualization advancements
- Research/address balance of plant issues
- Processes for rare earth separations

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Metrics and Impacts

- Potential suggestions for impact in 5 years:
  - Modular reactors that achieve same level of efficiency as large-scale plants (e.g., conversion, yield, energy efficiency)
  - Less than 2X capital for modular compared to large-scale plants (per unit output)
  - 1000 hour run time in relevant environment (demonstrated)
  - Membrane technology – twice as effective
  - Order of magnitude type metric opportunities (e.g., membrane lifetime, flux)
  - 20% energy savings (or output improvement) to get industrial interest
  - 20% CO2 emissions reduction
  - 20% improvement in economics
  - 20% energy reduction in 2 years; 50% energy reduction in 5 years (for specific applications)
  - Case studies for technology advances with validated improvement measures

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Other Considerations

- Need to better define potential areas for collaboration
  - Membrane substrates (manufacturing supply chain)
  - Dehydrogenation
  - Alkane/alkene separations
  - CO2 recovery
  - Super-acid catalysts
  - Modeling and simulation/data visualization
  - 3rd party validation
  - Separations for dilute streams
  - Water separations/treatment
  - Modular reactors/designs
  - Analysis tools
  - Membranes for shale gas clean-up
  - Stranded natural gas products
  - Involve engineering/construction companies

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Potential Areas for Collaboration

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