SRI International

2018 NETL CO_2 Capture Technology Project Review Meeting

Mixed-Salt Based Transformational Solvent Technology for CO_2 Capture

Palitha Jayaweera

Principal Scientist

Advanced Technology and Systems Division

SRI International

August 13 - 17, 2018 • Omni William Penn Hotel • Pittsburgh, Pennsylvania

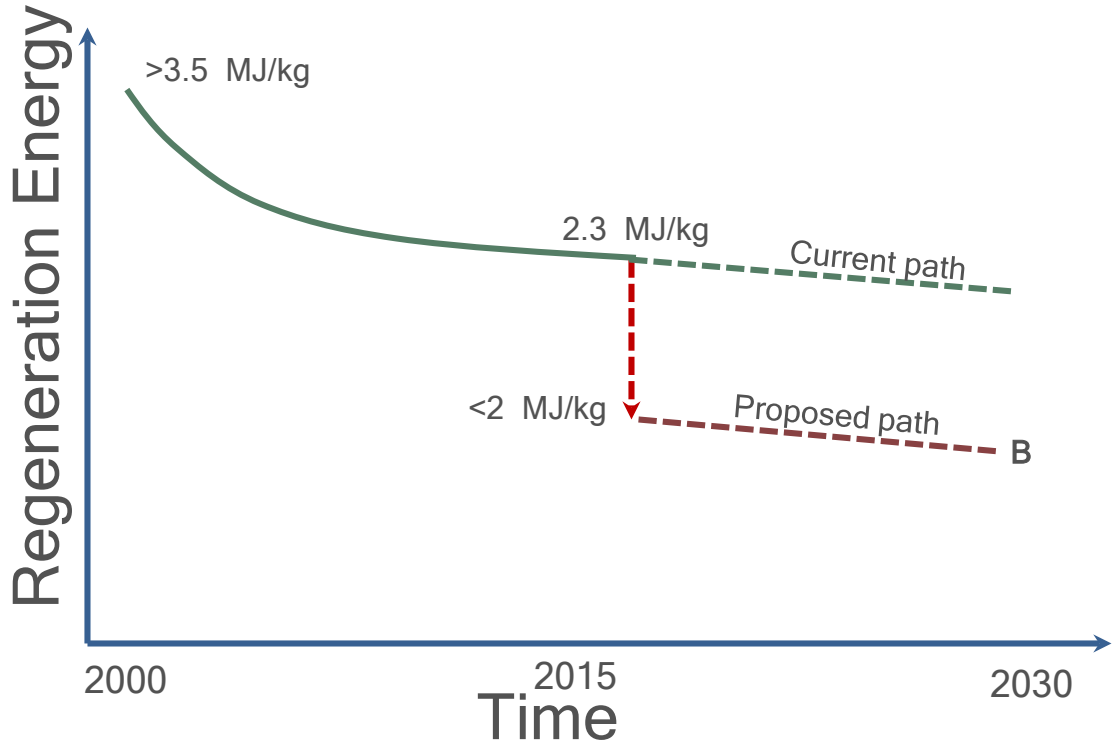
Presentation Outline

- Technology Background
  - Needs to reduce CO_2 capture costs
  - Advanced Mixed-Salt Process
  - Process Benefits
- New Project Structure
  - Objectives and Budget
  - Project Team and Organization
  - Development Path
  - Work Organization
  - Project Tasks
  - Available Resources
  - Project Status Update
- Acknowledgements

Reducing Capture Costs Beyond the Current Values

New transformational technologies

-A step reduction of the regeneration energy is required



- Low regeneration energy by solvent pairing
- Energy recovery by heat integration

Advanced Mixed-Salt Process Details

How it works:

Selected composition of potassium carbonate , ammonium salts and an additive

- Overall heat of reaction 35 to 60 kJ/mol (tunable)

Absorber operation at 20° - 40° C at 1 atm

Regenerator operation at 90° - 120° C at ~10 atm

- Produce high-pressure CO_2 stream

K_2CO_3–NH_3–Additive-CO_2–H_2O system

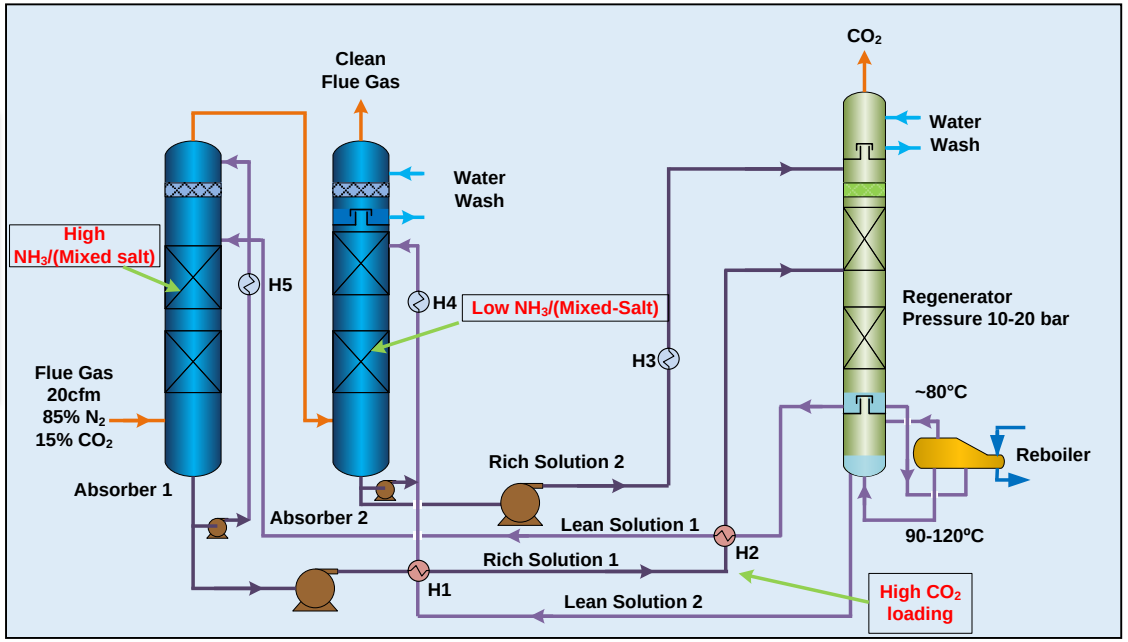
High CO_2 cycling capacity

Reduced Ammonia Emission

Reduced Reboiler duty

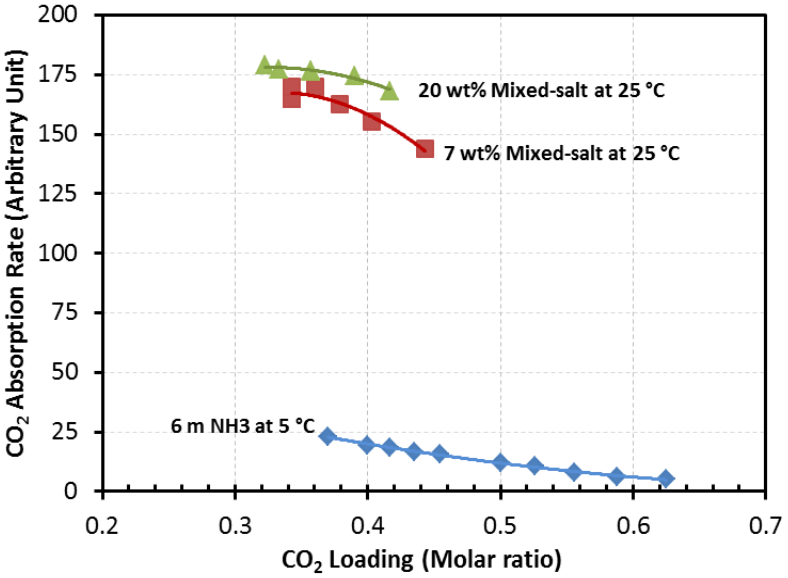
Reduced CO_2 Compression Energy

A significant step change for reaching DOE's reduced CO_2 capture cost targets.



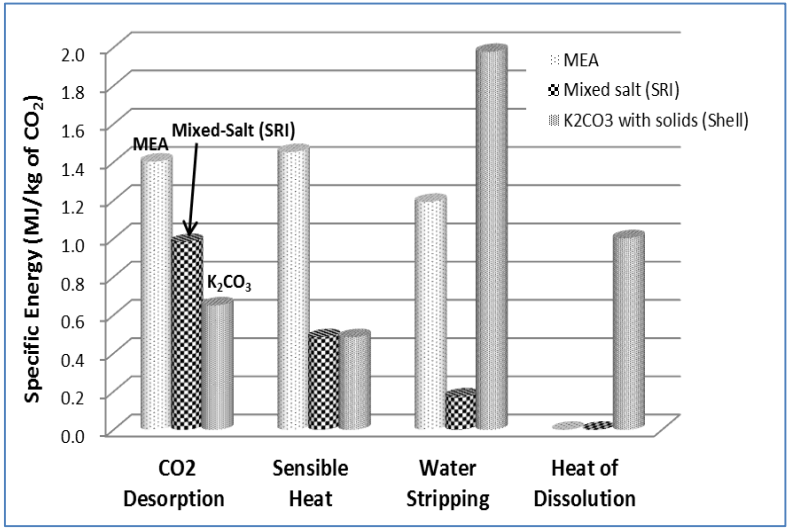
Process Enhancements

Enhanced Kinetics at High Temperature



Observed rate enhancement of CO_2 absorption efficiency by comparison of mixed-salt with NH_3

Low Energy Requirement for CO_2 Stripping

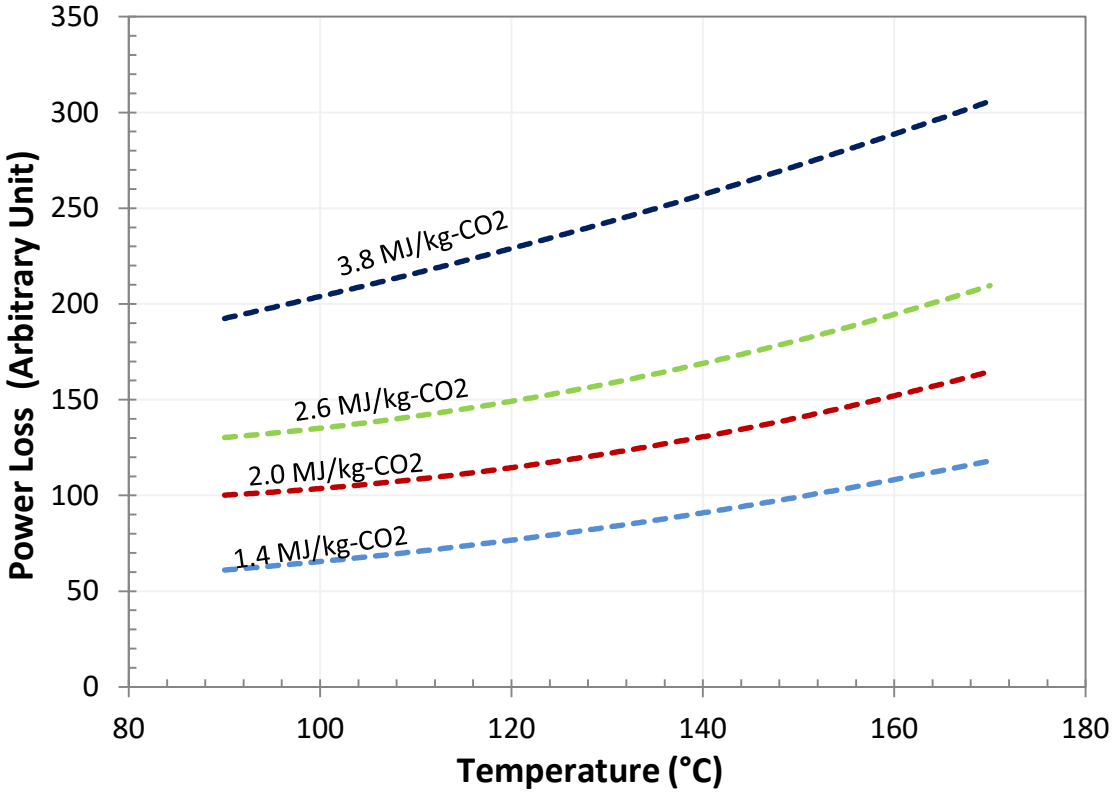


Estimated regenerator heat requirement for mixed-salt system with 0.2 to 0.6 cyclic CO_2 loading. Comparison with neat K_2CO_3 and MEA is shown

(Source for the Shell K_2CO_3 process, Schoon and van Straelen, 2011).

Absorber side: Reduced packing height
Regenerator side: Reduced water evaporation

Power loss due to Steam Extraction

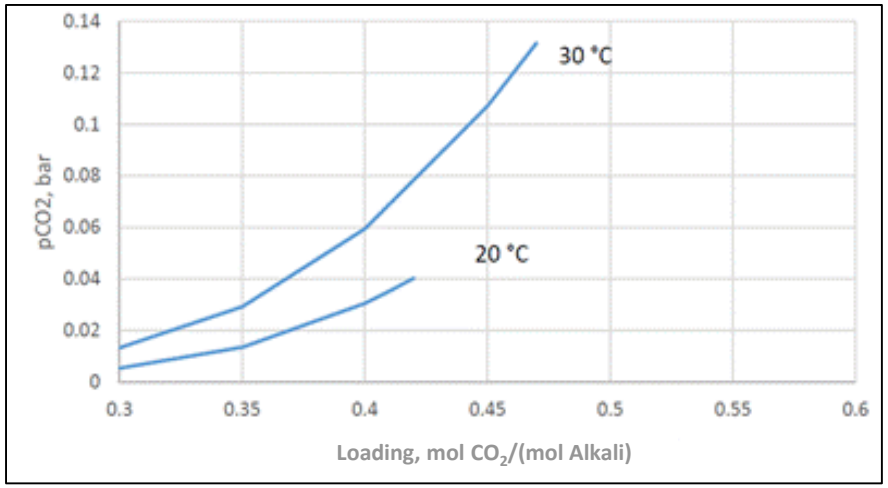


The net loss in power output from the steam cycle due to steam extraction for capture as a function of solvent regeneration temperature and the solvent heat requirement for regeneration.

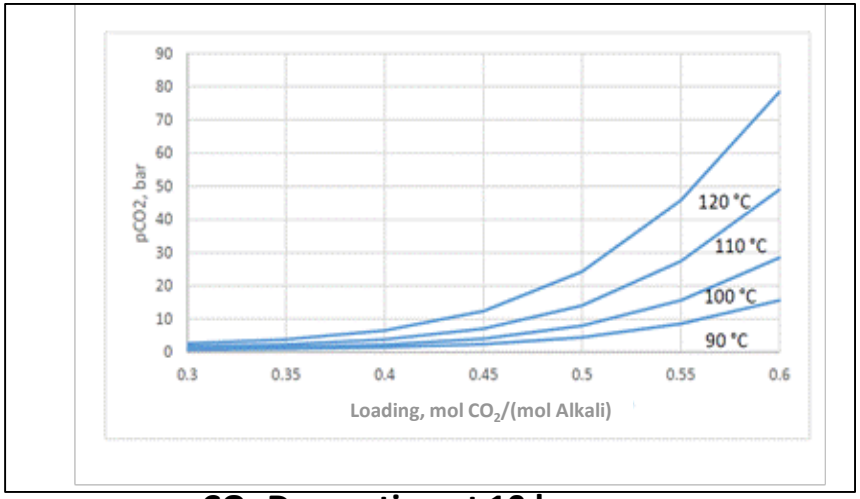
Source: Adapted from Luquiaud and Gibbins, Chem Eng Res Des (2011); the Mixed-Salt data are from SRI's TEA

Modeling Data

CO_2 Partial Pressure of 10 molal Advanced Mixed-Salt Solution



CO_2 Absorption at 20 ˚ and 30˚C .



CO_2 Desorption at 10 bar

For the regeneration, the modeled composition can desorb CO_2 at > 10 bar at 100° C, a much lower temperature than MSP.

AMSP ⟶ Pathway to reach DOE 2030 CO_2 capture goals

New Project

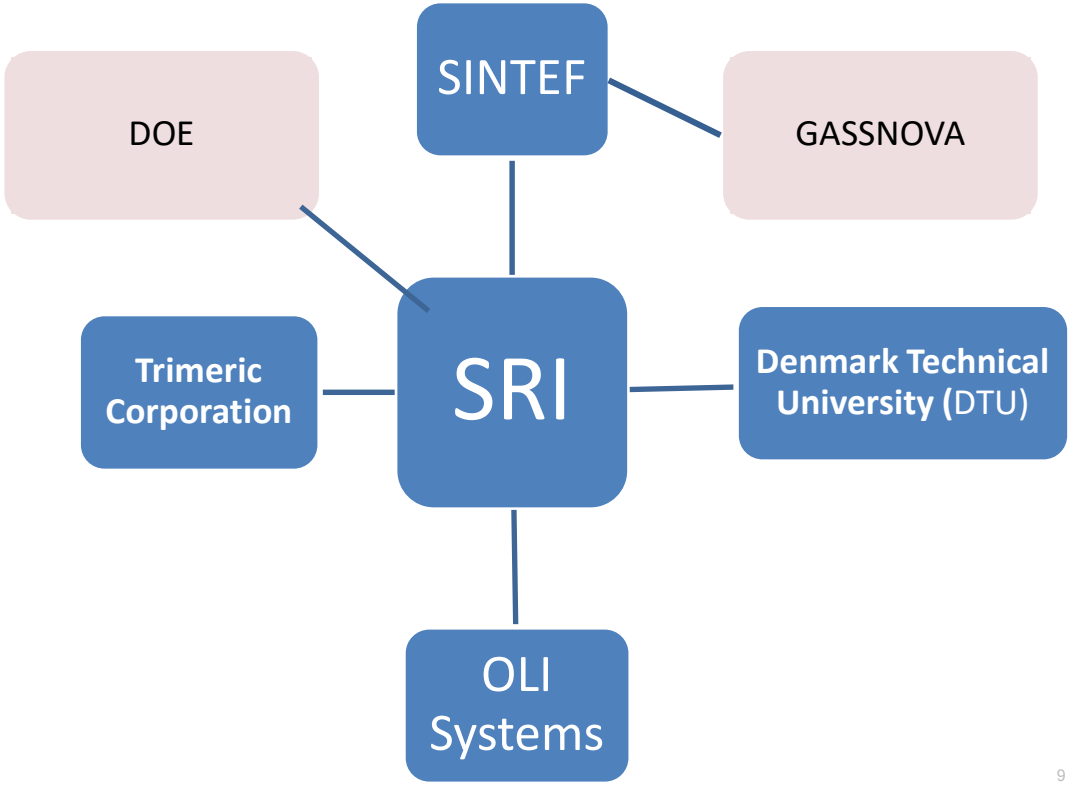
Mixed-Salt Based Transformational Solvent Technology for CO_2 Capture

- Project Objectives
  - Very high CO_2 loading capacity
  - Solvent rich system
  - Potential to reach DOE cost target \$30/ton CO_2 by 2030
- Project budget (Contract No: DE-FE0031597)
  - DOE Funding: \$2,999,992 (~79%)
  - Partner Share: \$782,817 (~21%)

Project Team

Mixed-Salt Based Transformational Solvent Technology for CO_2 Capture

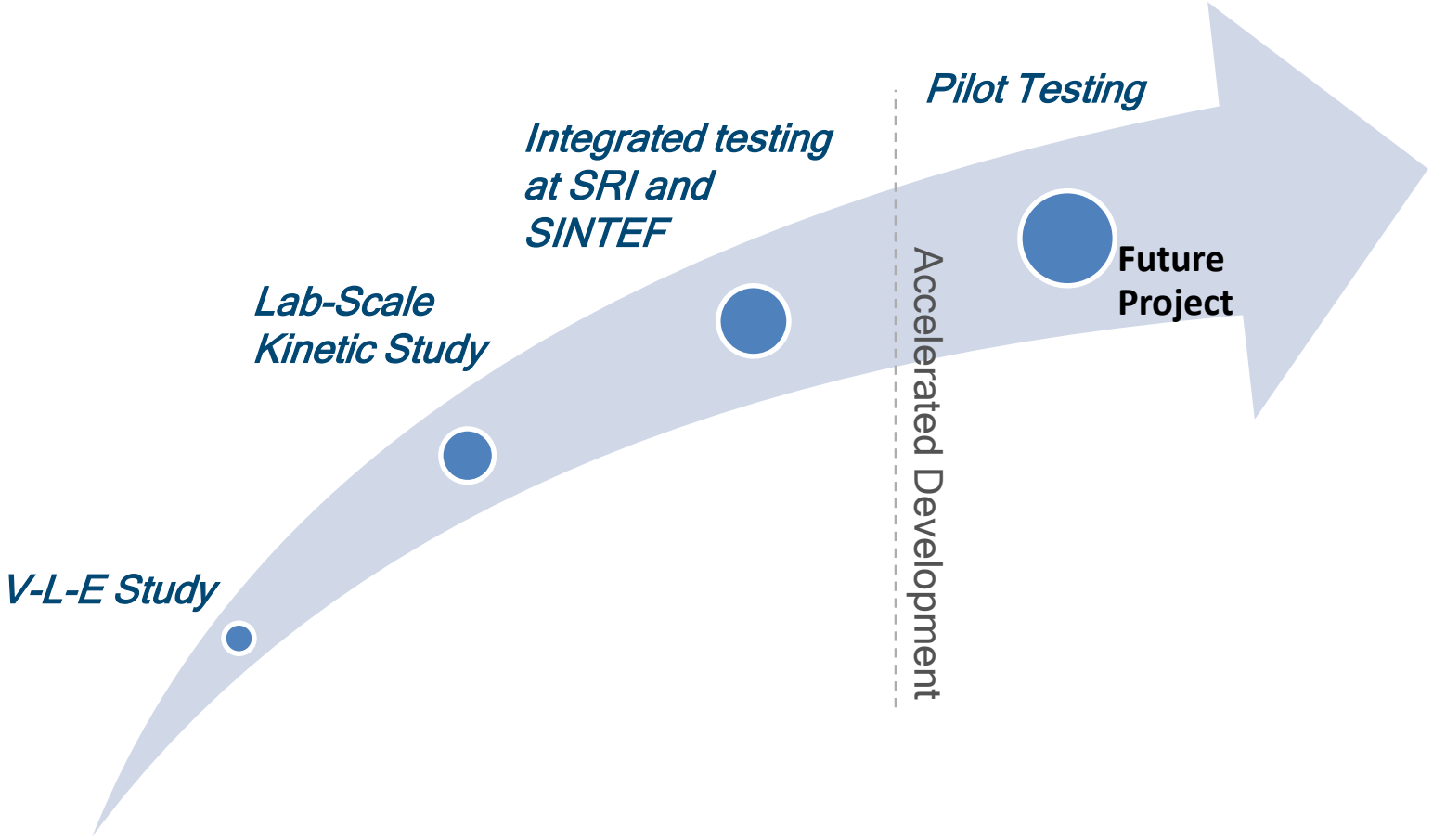
Project Manager: Andrew Jones, NETL
Prime Contractor: SRI International
Project Team: US and International Partners



Opportunities for US-Norway Collaborations leading to new IP and new markets

Mixed-Salt Based Transformational Solvent Technology for CO_2 Capture

Team : SRI (USA), SINTEF (Norway), OLI (USA), DTU (Denmark), Trimeric (USA)
Funding : US DOE (SRI Project) & CLIMIT (SINTEF Project)



Opportunities for reducing CO_2 from small and large-scale applications

Existing Infrastructure for Testing

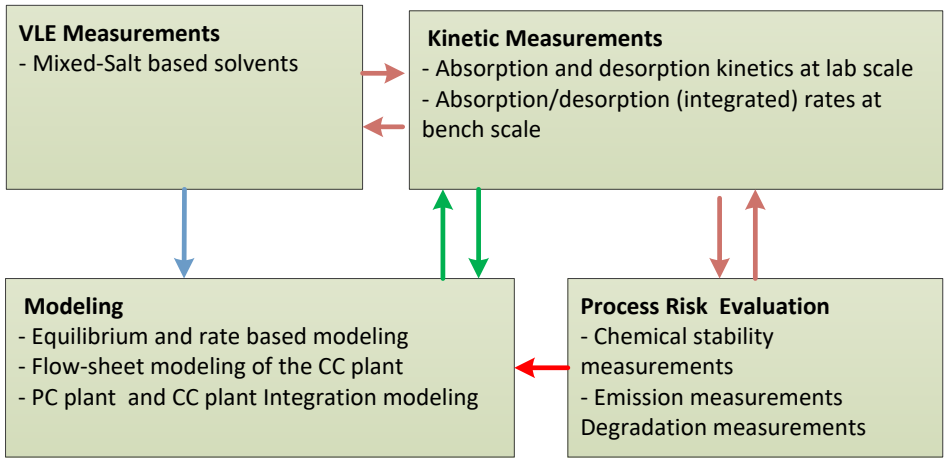
Photographs of large bench scale setup

Large bench scale system

Lab scale system

A: Rich solution inlet locations
B: Discharge locations for high NH_3/K solutio
C: Discharge locations for low NH_3/K solution
D: Heat exchangers (Cold rich↔ Hot lean)

Work Organization



- SRI International, USA
  - Advanced mixed-salt composition development and testing
- DTU, Denmark (Cost-share partner)
  - VLE Measurements & Thermodynamic modeling
- OLI Systems, USA
  - Flowsheet Model Design (energy and mass balance)
- Trimeric, Corp., USA
  - Process Techno Economic Analysis
- SINTEF, Norway (Cost-share partner)
  - Emission and degradation studies
  - Alternative Mixed-salt composition development and testing

Project Tasks

BP1: 18 months BP2: 18 months

- Task 1: Project Management and Planning (SRI)
- Task 2: Vapor-Liquid-Equilibria Measurements (DTU)
- Task 3: Process Kinetic Assessment (SRI)
- Task 4: Emission and Degradation Measurements (SINTEF)
- Task 5: Rate-Based Model Development (OLI)
- Task 6: Preliminary Techno-economic Analysis (Trimeric)
- Task 7: Integrated System Testing (SRI)
- Task 8: Process Flowsheet Model Development (OLI)
- Task 9: Techno-economic Analysis (Trimeric)

*** Tasks in Red will be performed in BP2**

Project Status Update

As of (7/31/2018)	Status
Task 1.0 - Project Management and Planning	
Task 2.0 – VLE Measurements at DTU	
Subcontract award	Completed
VLE measurements	To begin soon
Task 3.0- Kinetic Measurements at SRI	
Bench-scale setup and test plan development	Started
Absorption measurements	To begin soon
Task 5.0- Rate Based Model Development at OLI	
Subcontract award	Completed
Flow-sheet modeling	To begin soon
Task 6.0- Preliminary Techno Economic Analysis (OLI/Trimeric/SRI)	
Subcontract Award to Trimeric	In progress
Preliminary TEA	To begin soon

Acknowledgements

NETL (DOE)

- Andrew Jones, Steven Mascaro, Jose Figueroa, Lynn Bricket, John Litynski and other NETL staff members

SRI Team

- Indira Jayaweera, Palitha Jayaweera, Elisabeth Perea, Regina Elmore, Srinivas Bhamidi, Bill Olsen, Marcy Berding, Chris Lantman, and Barbara Heydorn

US and International Collaborators

- OLI Systems (Prodip Kondu and Andre Anderko), POLIMI (Gianluca Valenti, Davide Bonalumi, and Stefano Lillia), Stanford University (Adam Brant and Charles Kang), Kaj Thomsen, Eli Gal, and Trimeric Corporation (Andrew Sexton)

Industrial Partner/Observer

- IHI Corporation and BHGE

SRI International

Thank You

Contact:

Palitha Jayaweera

palitha.jayaweera@sri.com

1-650-859-2989

Headquarters
333 Ravenswood Avenue
Menlo Park, CA 94025
+1.650.859.2000

Additional U.S. and international locations

www.sri.com

Disclaimer