



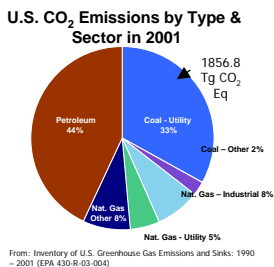
Pilot Plant for CO₂ Capture using Aqueous Piperazine/Potassium Carbonate

Overview

CO₂ capture and sequestration technology for coal-fired power plants is currently in the developmental stage. Economic evaluations with the current state of the art monoethanolamine (MEA) solvent show that electricity costs will increase between 50-90%. Research is needed to develop solvents that have lower energy requirements for solvent regeneration, faster absorption rates, and less corrosion and packing with large contact areas and low pressure drop. The focus of this research will be to demonstrate a new solvent in a pilot-scale absorber/stripper system and to optimize the packing selection process.

Environmental Issue

- 86% U.S. Energy from Fossil Fuel (2001)
- 21% Increase in U.S. CO₂ Emissions from Electricity Generation (1990 – 2001)
- Concern of Global Warming from Greenhouse Gases
- Renewed Interest in CO₂ Capture and Sequestration



Motivation

- New Solvent Developed by T. Cullinane (2002) - 2.5 m Piperazine / 2.5 m K₂CO₃
- CO₂ Absorption Rate 1 to 3 Times Faster than 30 wt% MEA and Heat of Absorption 10-25% Less than MEA
- Use 1.5-2.5 less Packing and Pressure Drop OR
- Operate with Closer Approach to CO₂ Saturation – Use 10-30% Less Energy than MEA Systems

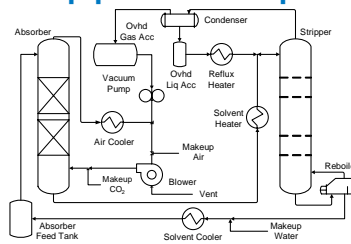
Research Objectives

- Verify Cullinane Research on Large Scale
 - Temperature Effects on VLE, Kinetics and Diffusivity/Viscosity
- Determine Effective Area of K+/PZ system
 - Measure K_ga / Use Cullinane k_g'
 - Compare to Wilson/SRP Air-Water Data
 - Temperature, Viscosity, Surface Tension
- Validate Structured Packing as Alternative
- Target Application – Coal-Fired Power Plants

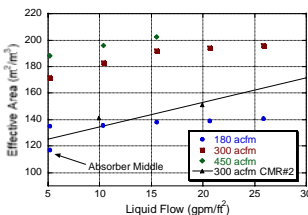


Absorber/Stripper Setup

- Pickle Research Center
- Column ID – 16.8 in
- Packed Height – 20 ft in 2 beds (10 ft each)
- P_{ABS} – 1 atm
- P_{STRP} – 0.2 to 2 atm
- Multi-use facility (distillation/extraction)

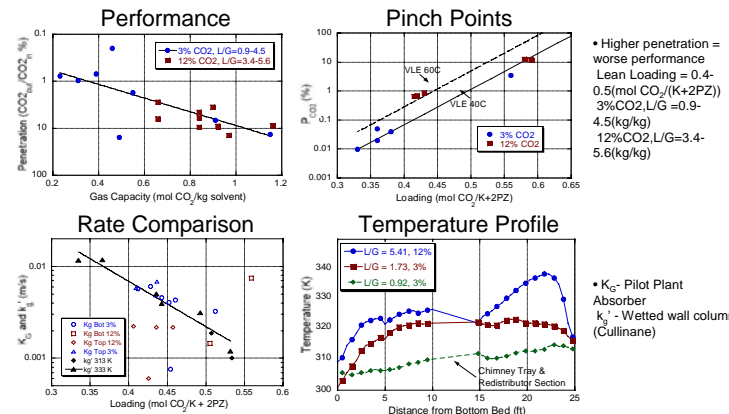


Flexipac 1Y Effective Area
Spec Area = 410 m²/m³, 0.1 N KOH



- Campaign 1 - Pilot Plant Setup & Troubleshooting and Characterize Absorber (Completed)
- Campaign 2 – Characterize Absorber & Stripper with Alternative Packing (10/04)
- Campaign 3 – MEA Baseline (2/05)
- Campaign 4 – Demonstrate Optimized Process based on absorber/stripper models (5/05)

Absorber Results



Impact/Conclusions

- Bench-Scale Rate Data Verified in Pilot Plant (16 Points)
- Penetration Increases with Capacity for 3 and 12% CO₂
- 12 Points in Pinch Regions
- >90% Removal with 20 ft packing - Flexipac 1Y 30% More Area Than CMR#2
- No Measurable Corrosion with 1000 ppm Vanadium
- Pilot plant data will be used to validate an absorber model that can be useful for designing commercial units

Acknowledgements

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