Power Generation and Utility Fuels Group

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WHY CO2 CAPTURE?

The Earth's carbon cycle

- Carbon contained in the atmosphere (760 billion tons)
  Annual increase (3.4 billion tons/yr.)

- Balance absorbed by on-land ecosystems (1.4 billion tons/yr.)
- Volume absorbed by on-land ecosystems (400 million tons/yr.)
- Absorption by forests, etc. (2.6 billion tons/yr.)
- Emissions from changes in land use (1.6 billion tons/yr.)
- Emissions from fossil fuels (6.4 billion tons/yr.)
- Absorption by oceans (1.6 billion tons/yr.)

- Carbon contained in plants and soil (2.26 trillion tons)
- Carbon contained in the oceans (38 trillion tons)
- Carbon contained in fossil fuels (3.7 trillion tons)

Ref: The IPCC Fourth Assessment Report
CO2 Capture Possibilities and Utilization

Technology Development Pathway

- **0.02 MWe (0.1 MWth) Lab-scale Unit**
- **0.7 MWe (2 MWth) Pilot-scale Unit**
- **100-500 MWe Full-scale Unit**
- **10-25 MWe Demonstration Unit**

**Concept**
- 1.5” ID Bench-scale Unit

**Proof of Concept**
- Fundamental Thermodynamic and Kinetic Studies

**Molecular and Process Modeling and Simulations**

**Shengli Power Plant**
- Shandong, China
- 1.0 M tons/yr
- US-China Climate Change Working Group
- MoU Signed July 8, 2014
How do we Remove the CO$_2$?
CO$_2$ Capture Chemistry

Amine (MEA) + Carbon Dioxide

\[
\text{HO-CH}_2\text{CH}_2\text{NH}_2 + \text{O=CO} \rightarrow \text{HO-CH}_2\text{CH}_2\text{NH-CO-} + \text{H}_2\text{O}
\]

2 eq Monoethanolamine (MEA)
A Typical CO$_2$ Capture Process Flow Diagram

Key Equipment:
1) Absorber
2) Stripper
3) Heat Exchangers
What Happens in an Absorber?

**Absorber** – the equipment that captures CO$_2$ using a chemical solvent

**Carbon Rich Stream** – the chemical solvent after it has absorbed the CO$_2$

- Exothermic chemical absorption
- Counter current
- Careful liquid and gas distribution
- Structured packing
What Happens in a Stripper?

**Stripper** – the equipment that regenerates the solvent and liberates the captured CO₂

**Carbon Lean Stream** – the chemical solvent after it has been regenerated and contains very little CO₂

- Heat is added with the reboiler
- Reverse the exothermic chemical absorption reaction
- Structured packing
What is Involved in PGUF?

Process Modeling and Simulation
Chemical Engineering
Chemical Process Development
Mechanical Engineering
Equipment and Structural Design
Analytical Chemistry
Emissions Studies
Solvent Chemical Changes
Materials Science
Metallurgy
Corrosion Studies
Energy Efficiency