Power Generation and Utility Fuels Group

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Gasification

Background and Process Description

Combustion vs. Gasification

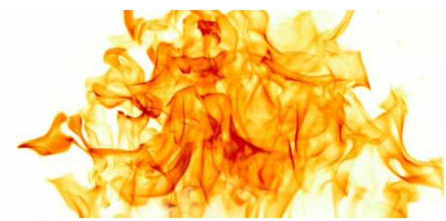
Combustion with oxygen

$$C + O_2 \longrightarrow CO_2$$

$$H_2 + ½\, O_2 \longrightarrow H_2O$$

Generate:

CO_2 + water



Heat

Ash

Partial combustion with oxygen and reactions with water

$$C + {}^{1}/_{2}\, O_2 \longrightarrow CO$$

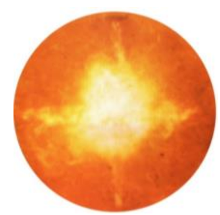
$$CO + H_2O \longrightarrow CO_2 + H_2$$

$$C + H_2O \longrightarrow CO + H_2$$

(CO, H_2: Syngas)

Generate:

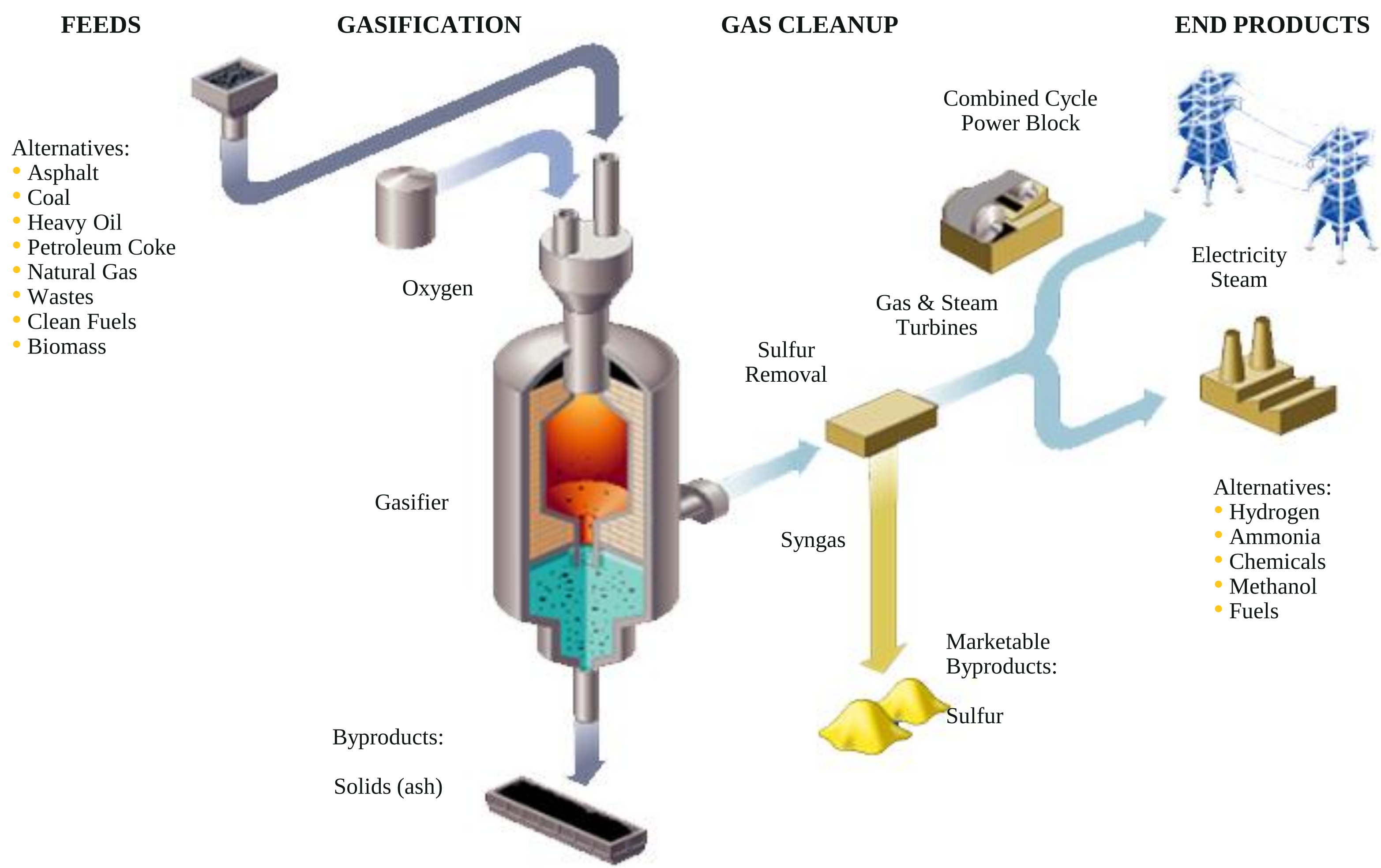
Syngas



Less Heat

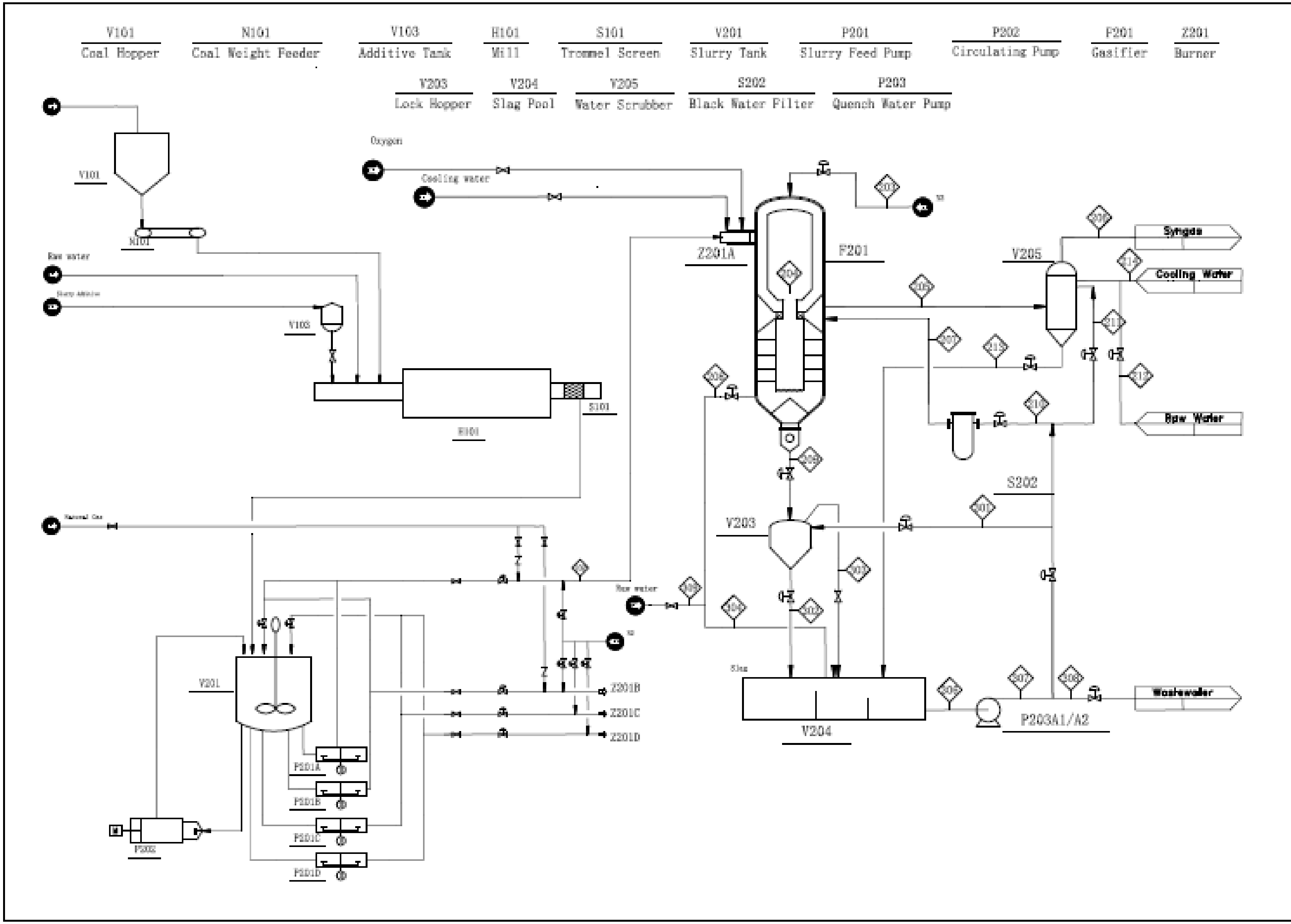
Slag

Gasification Utilization Strategies

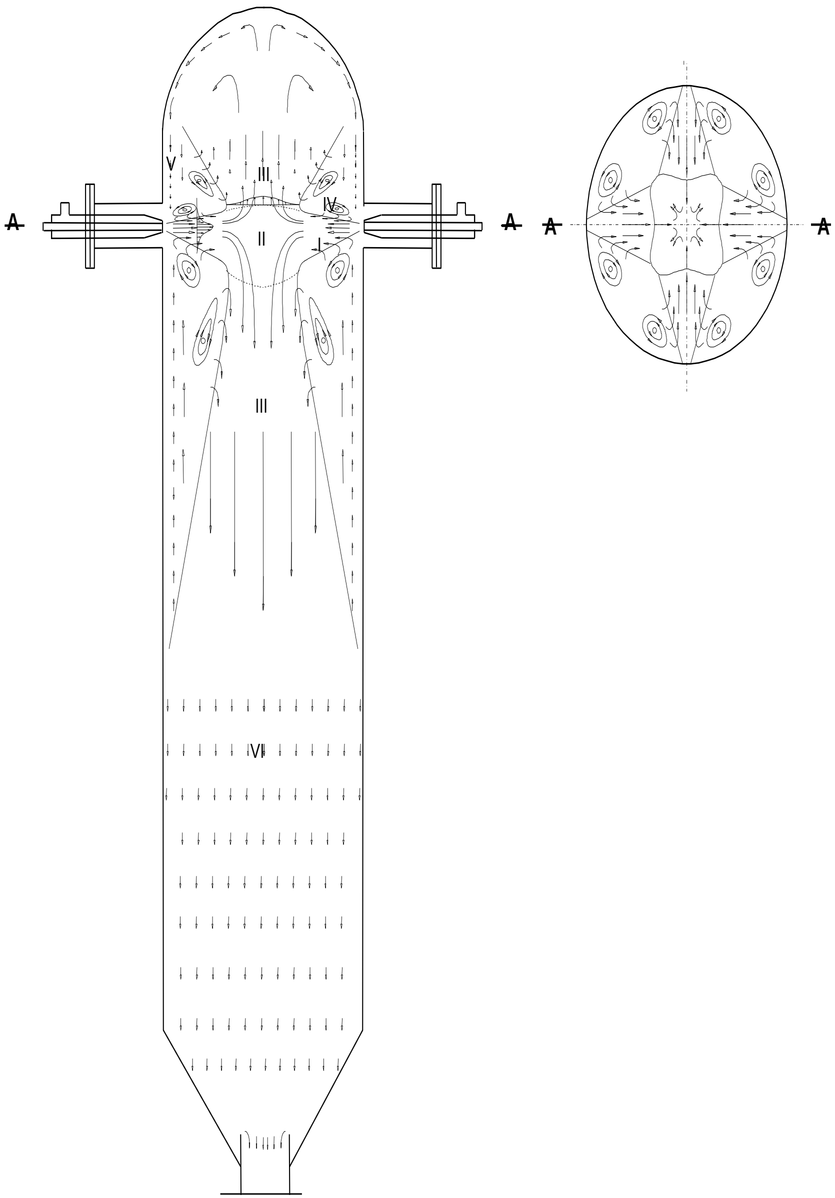


Source: The Department of Energy's (DOE) National Energy Technology Laboratory (NETL) / GE Texaco

OMB Process Flow Diagram

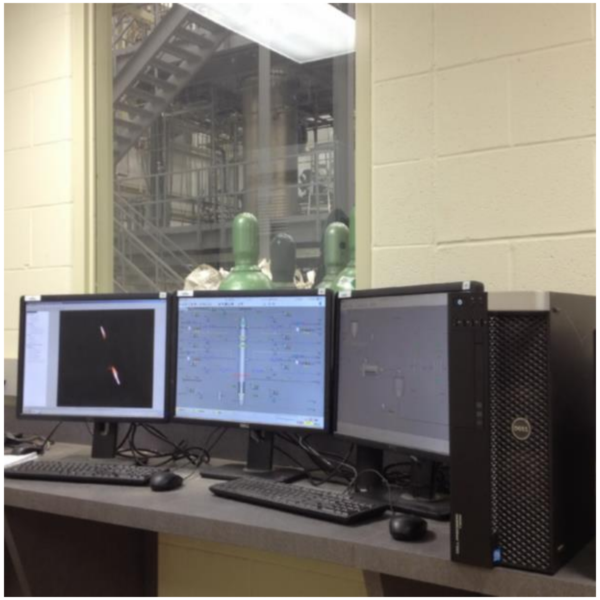


OMB Gasification

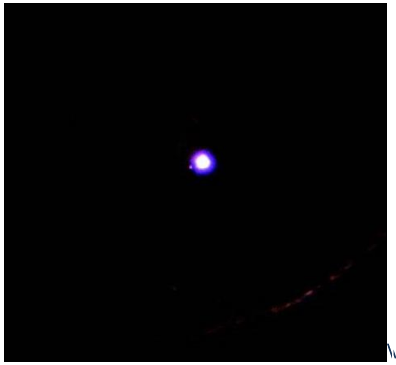


- OMB Enhances the Mixing and Resonance Time Distribution
- High-Temperature Reaction Reduces/Eliminates Tar Formation
- High Performance (98% carbon conversion)
- High Availability (98% as a stretch goal)
- High Load Flexible (40%-120%)
- Industrial process technology
- 38 projects (Including 1 in US), 109 gasifiers
- Total capacity > 130,000 Tons coal per day

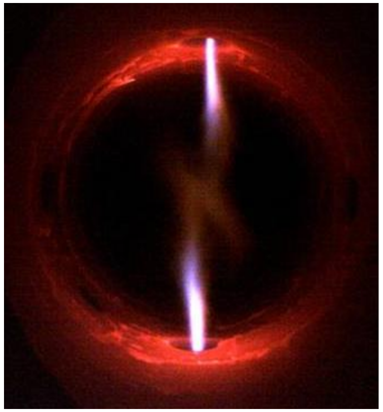
Gasification Unit Pictures

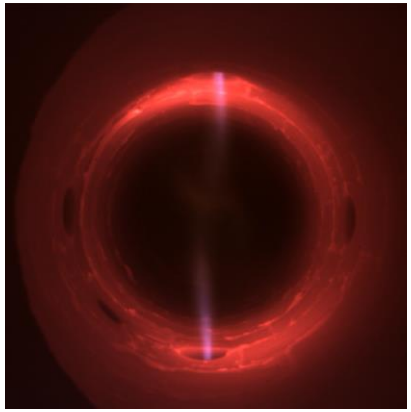


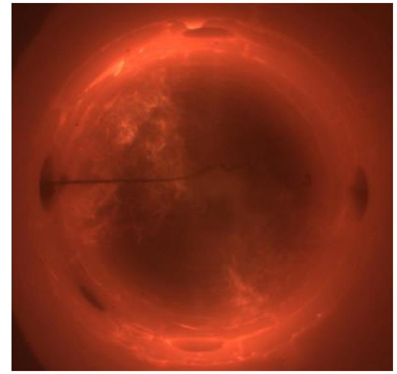
Gasification Operation Pictures

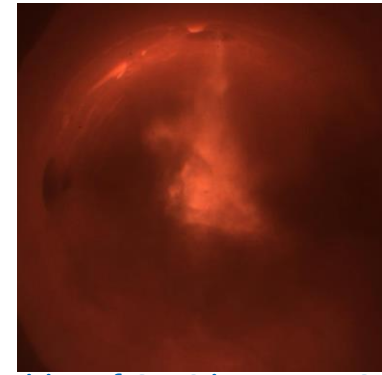

Ignition

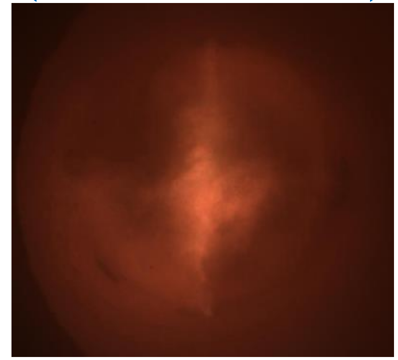

145°C

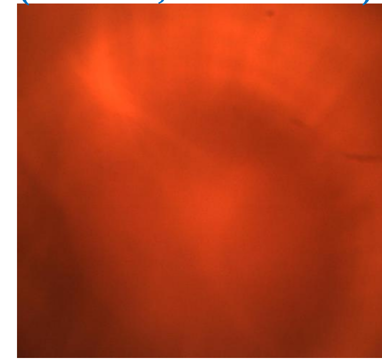

450°C


600 °C


Injection of CWS in Burner C, D (Burner A, B with NG on)


Ignition of CWS in Burner C, D (Burner A, B with NG on)


2 Burner CWS gasification (Burner A, B with NG on)


4 Burner CWS gasification (Lens of endoscope fouled)

- Gasifier installed and currently being tested
- Downstream components online soon

Future Research Areas

1.) Host site for technology development around CTL

- Gasification
- Carbon Capture
- FT
- WGS and Refining

2.) Gasification Technology

- High concentration CWS
- Increase H/CO ratio and Reduce Downstream Clean-up
    - In-situ WGS with warm sulfur removal
    - Collaboration with Catalyst group, ECUST
- Coal/Biomass Blending Gasification Research
- Dynamic Modeling and Controls

3.) Carbon Capture

- New Solvents
- New catalysts
- New processes and technologies

4.) Gas Conversion by F-T Synthesis

- Catalysts (Co, Fe, etc.)
- Types of F-T reactors
- Fine tuning based on selectivity of desired product(s)

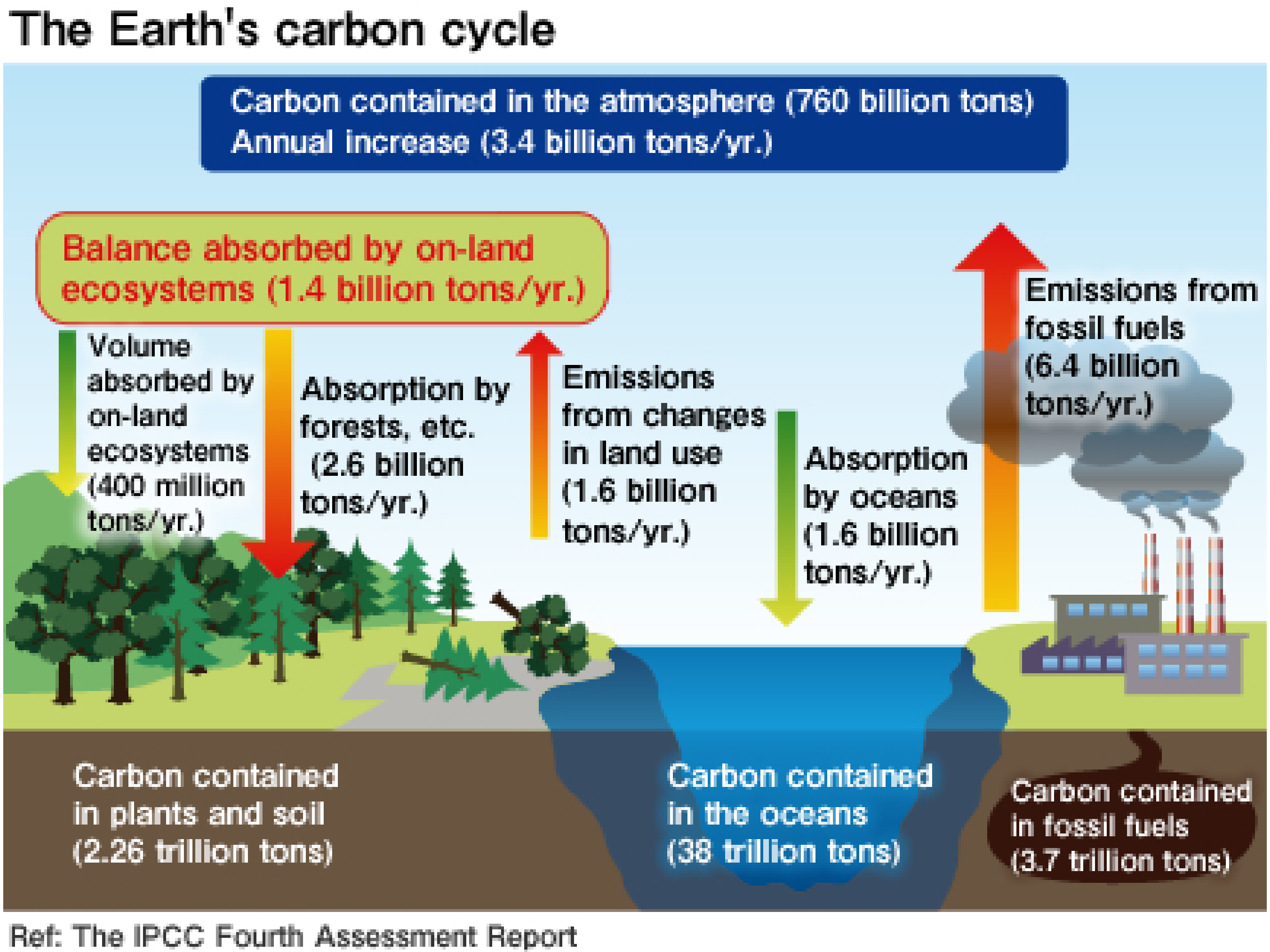
Center for Applied Energy Research

Carbon Capture

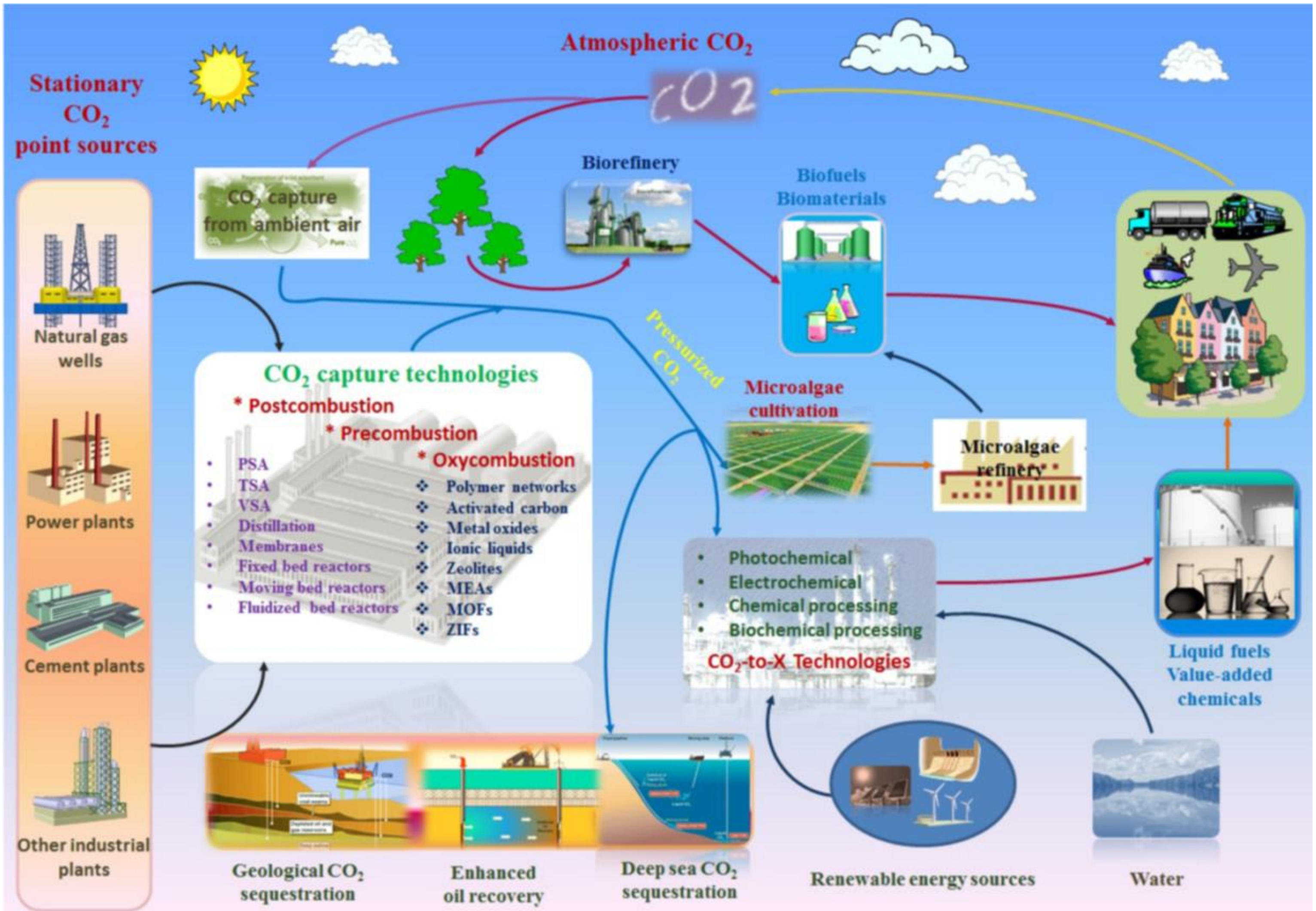
Background and Process Description

caer.uky.edu

Why CO_2 Capture?

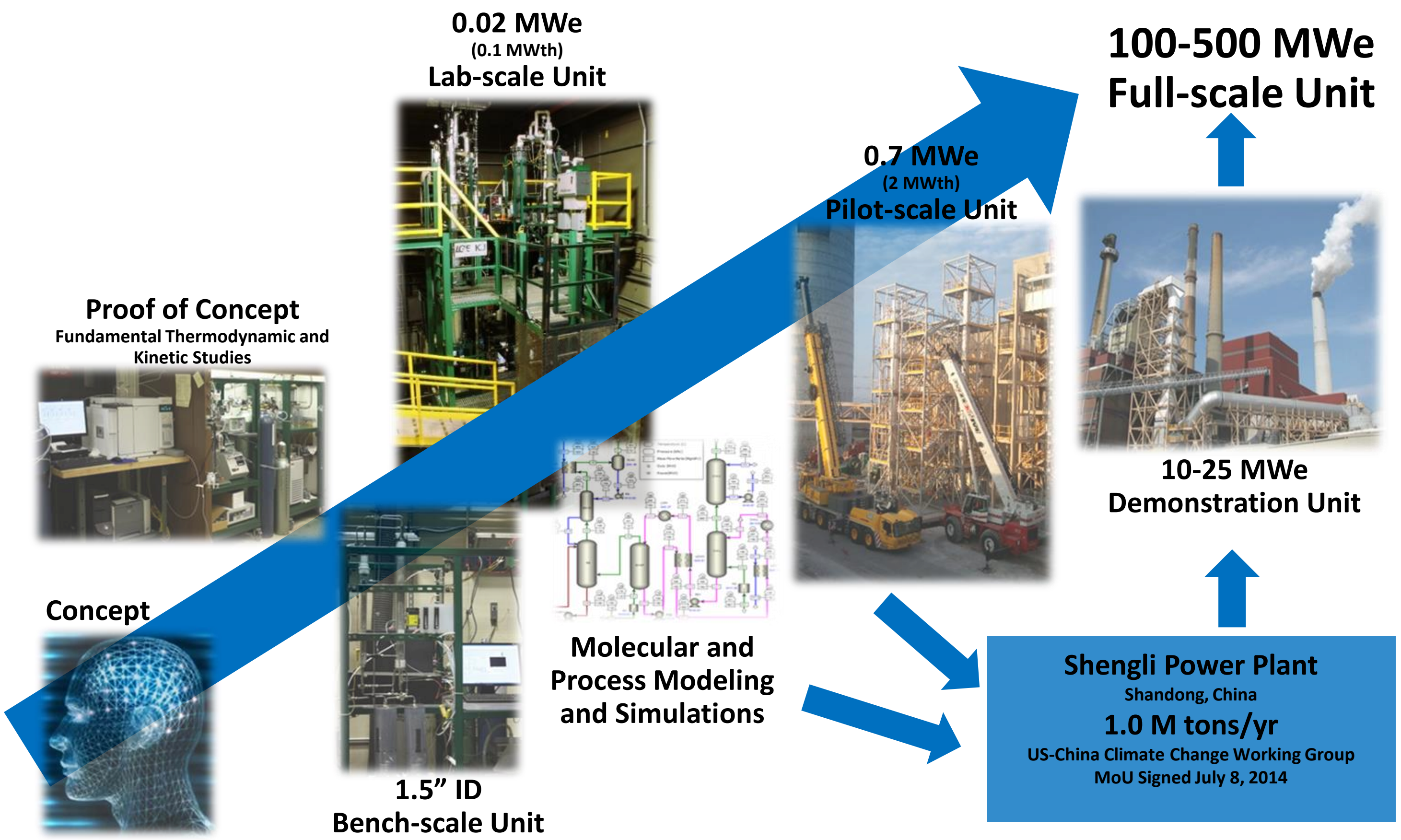


CO_2 Capture Possibilities and Utilization

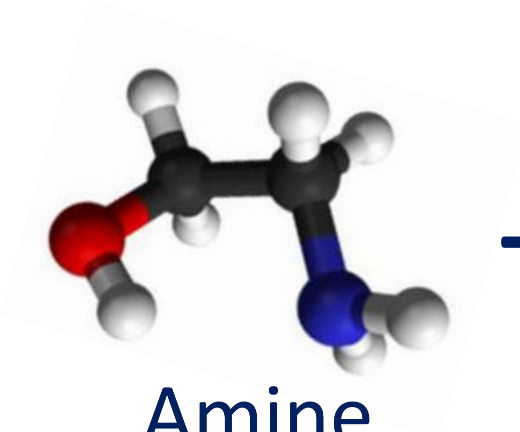


Yuan Z., Eden M.R. Industrial &Engineering Chemistry Research Pub date: Nov 30, 2015

Technology Development Pathway

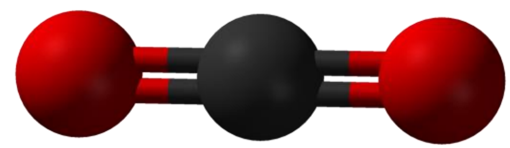


CO_2 Capture Chemistry

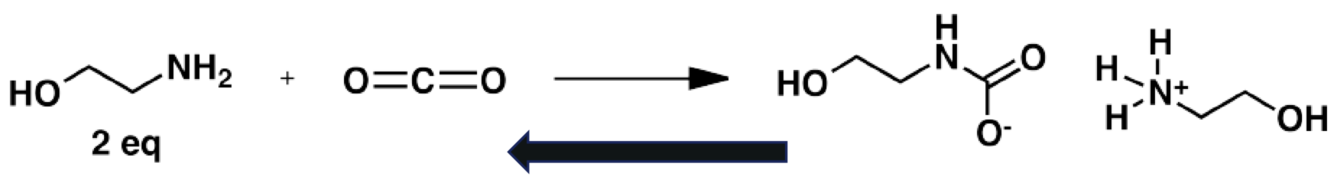


Amine
(MEA)

+



Carbon
Dioxide

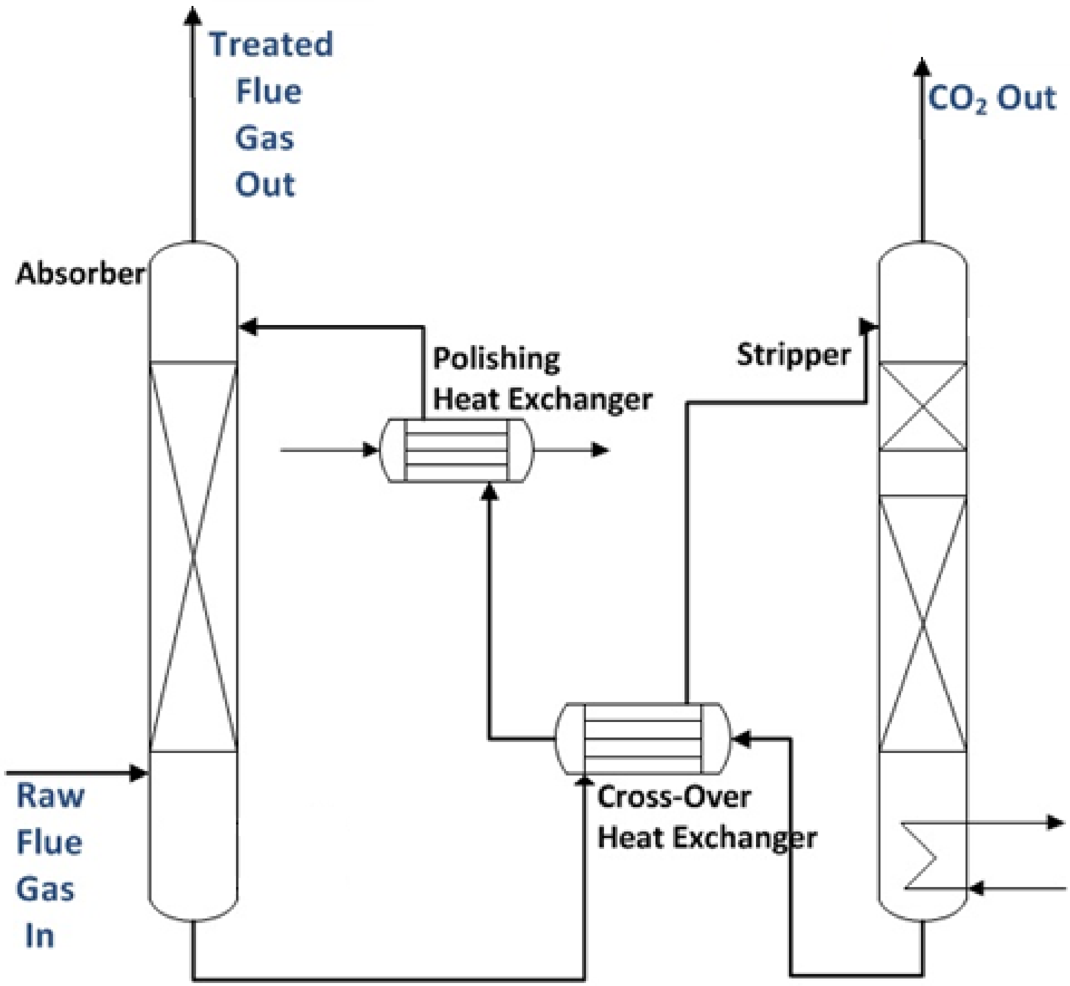


2 eq

Monoethanolamine
(MEA)

HEAT

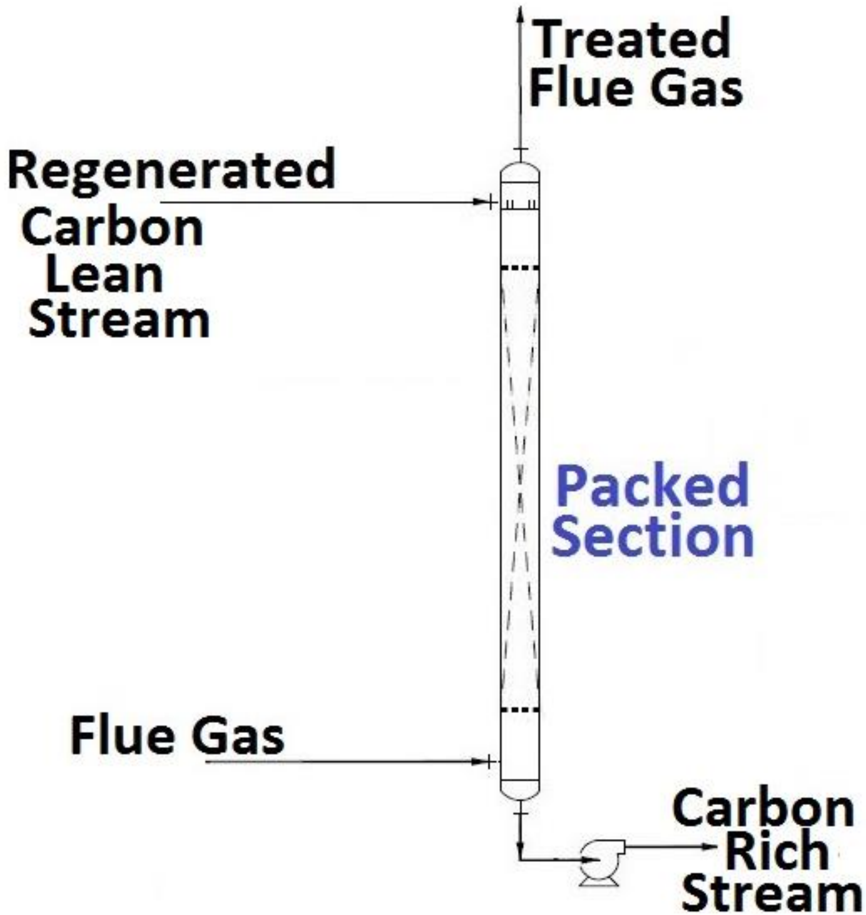
Typical CO_2 Capture Flow Diagram



Key Equipment:

1) Absorber
2) Stripper
3) Heat Exchangers

What Happens in the Absorber?

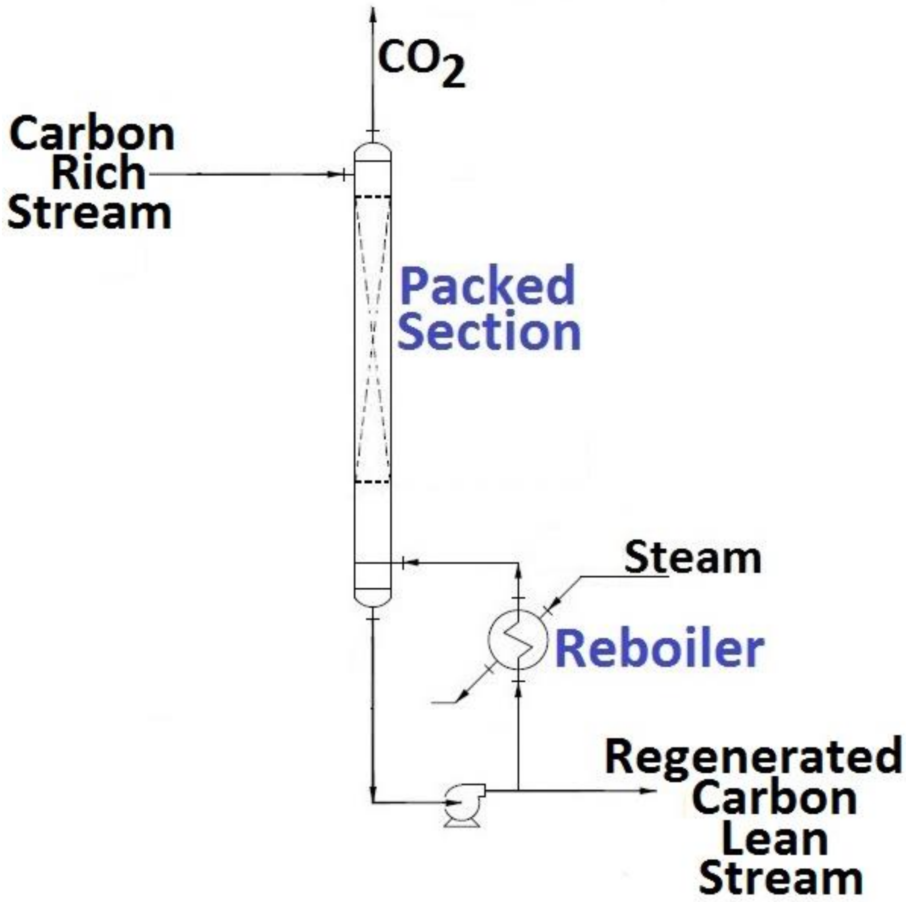


Absorber – the equipment that captures CO_2 using a chemical solvent

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 the Stripper?



Stripper – the equipment that regenerates the solvent and liberates the captured CO_2

Carbon Lean Stream – the chemical solvent after it has been regenerated and contains very little CO_2

- Heat is added with the reboiler
- Reverse the exothermic chemical absorption reaction
- Structured packing

What is Involved in the PGUF Group?

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

Engineering