

Prof. Gary T. Rochelle

CPE 5.462, 17 PhD (4 graduating 2015)

Projects for 1 or 2/funding for 0 student

Technology Area

CO₂ Capture from Flue Gas

(to address Global Climate Change)

By **Aqueous Amine Absorption/Stripping**

Funded by 17 companies & DOE

Fundamental Areas

Mass Transfer with Reaction in the Boundary Layer

Applied Aqueous Solution Chemistry

Aqueous Thermodynamics

Aqueous Reaction Kinetics/Engineering

Crystallization in Aqueous Solutions

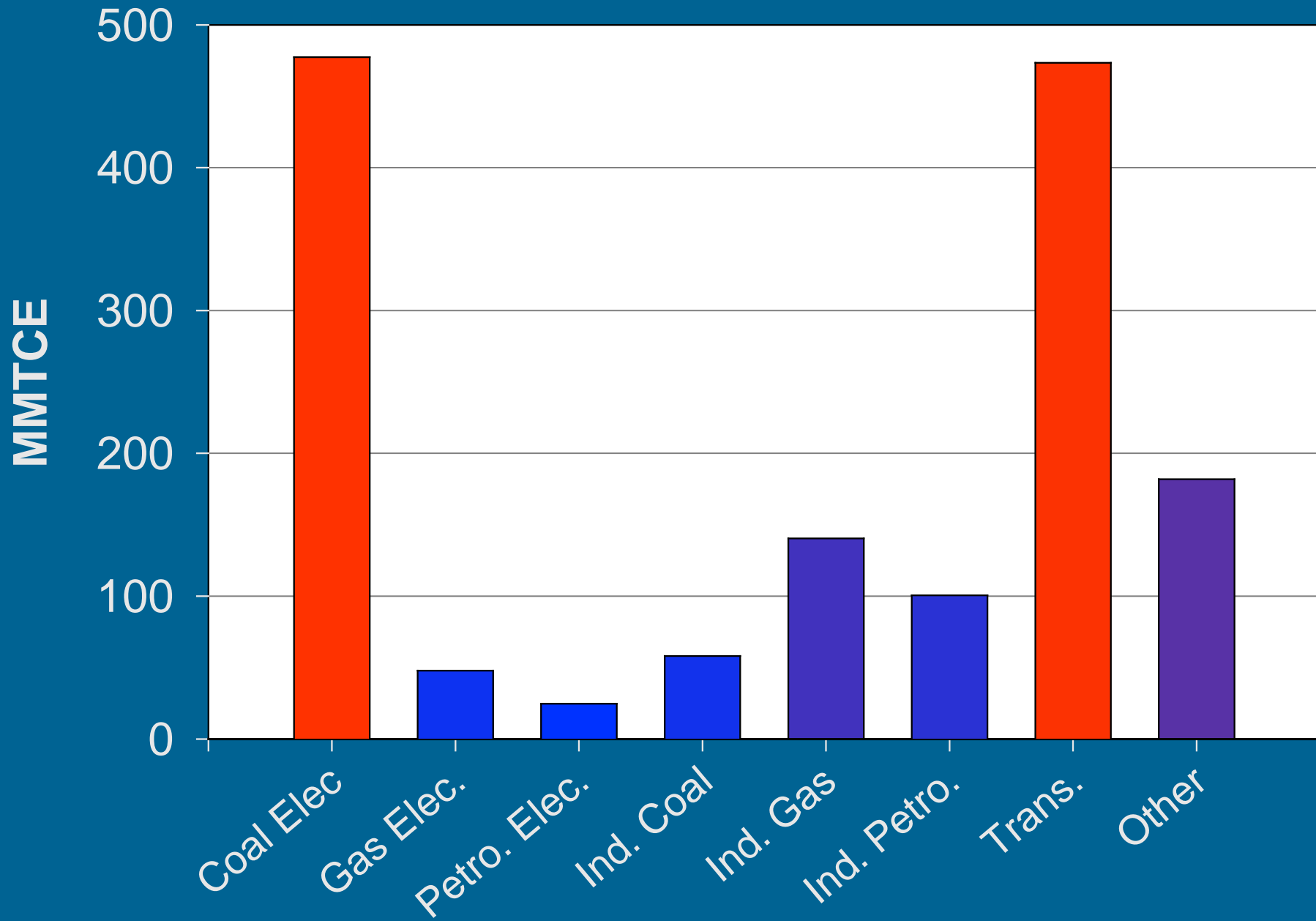
Applied Process Simulation & Optimization

Mass Transfer in Gas/Liquid Contactors

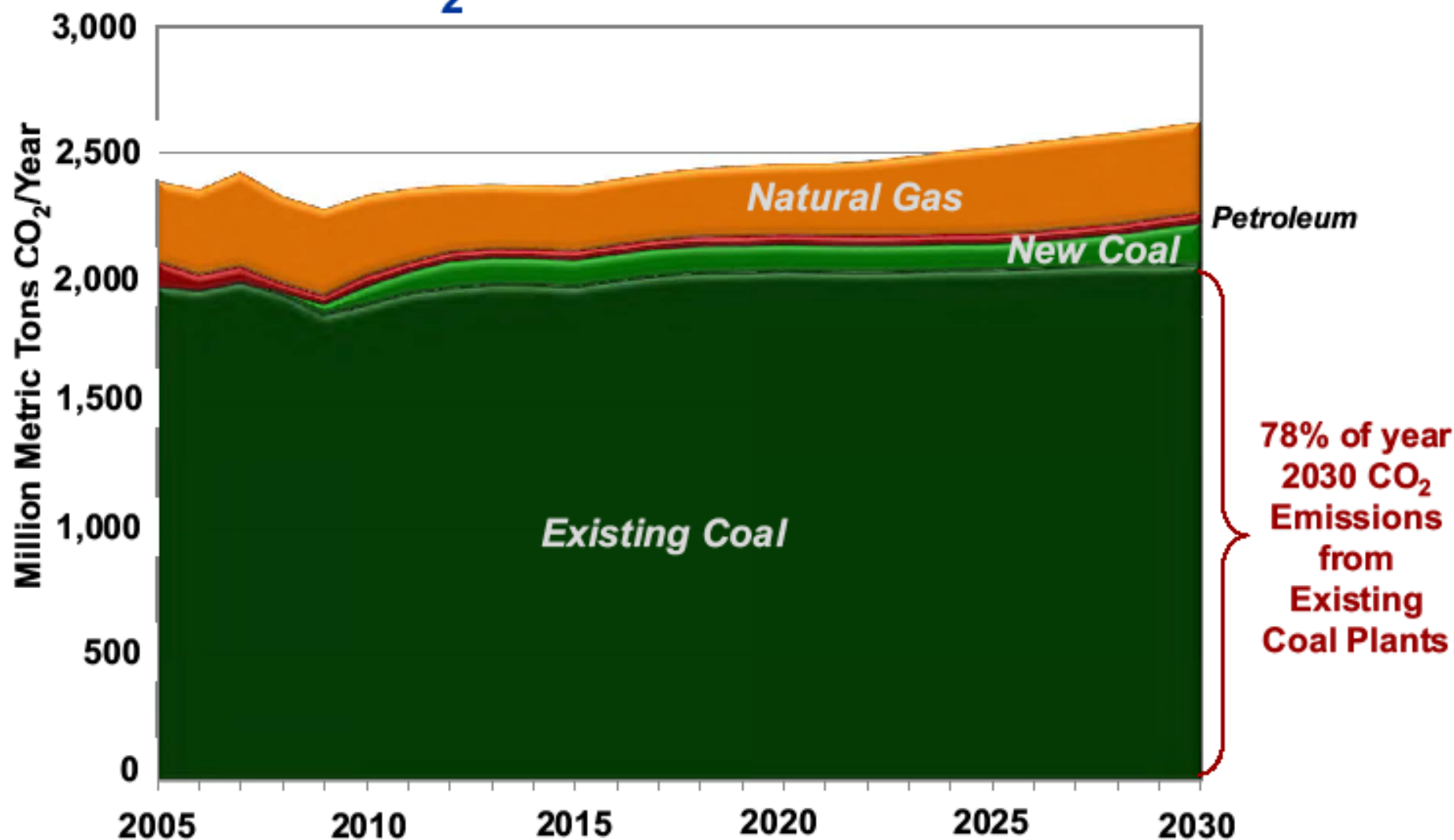
The Present Problem

- Global climate change is happening
- Because of CO₂ emissions
- From Coal Combustion

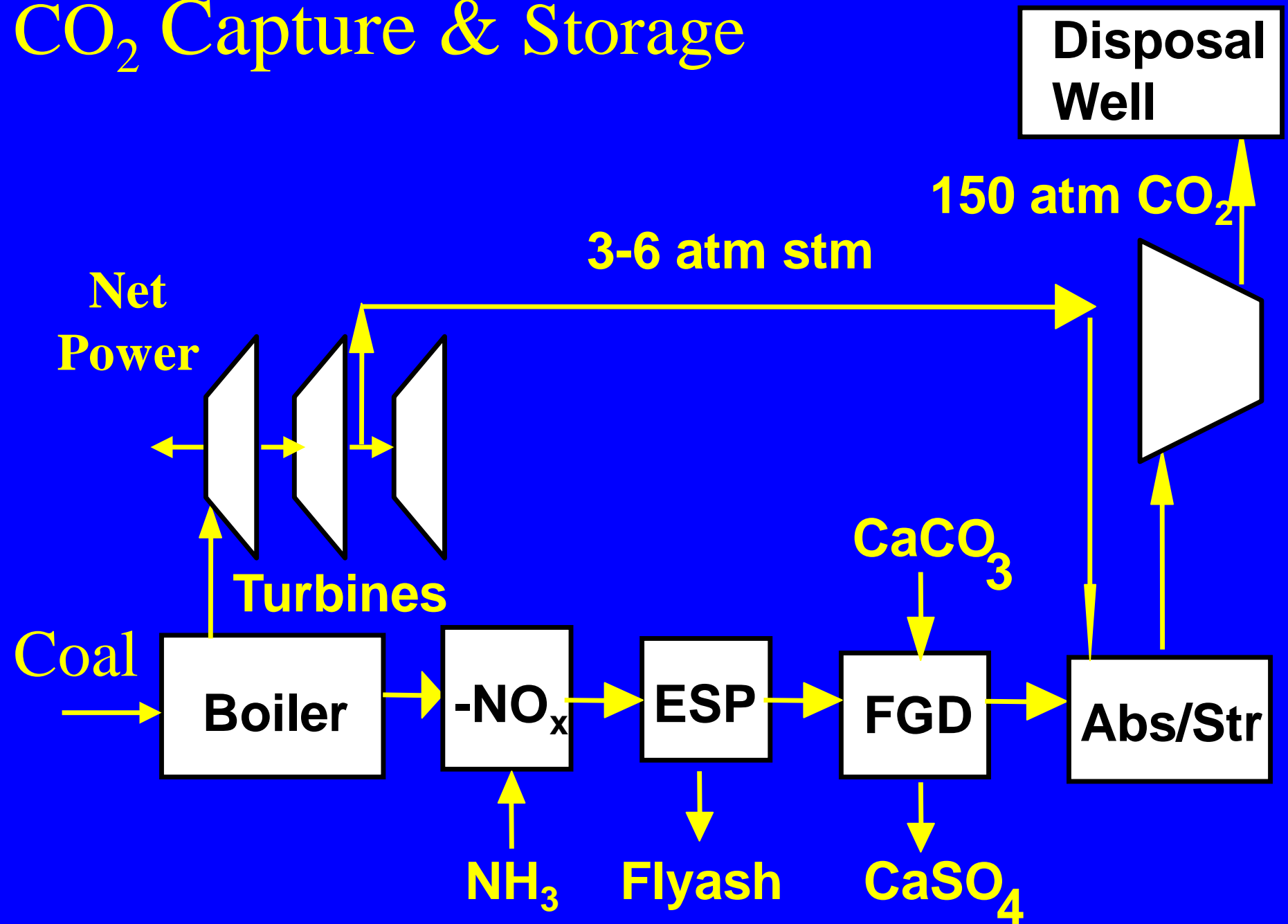
CO₂ Emissions by Source (1998)



U.S. Electricity Generation CO₂ Emissions Forecast

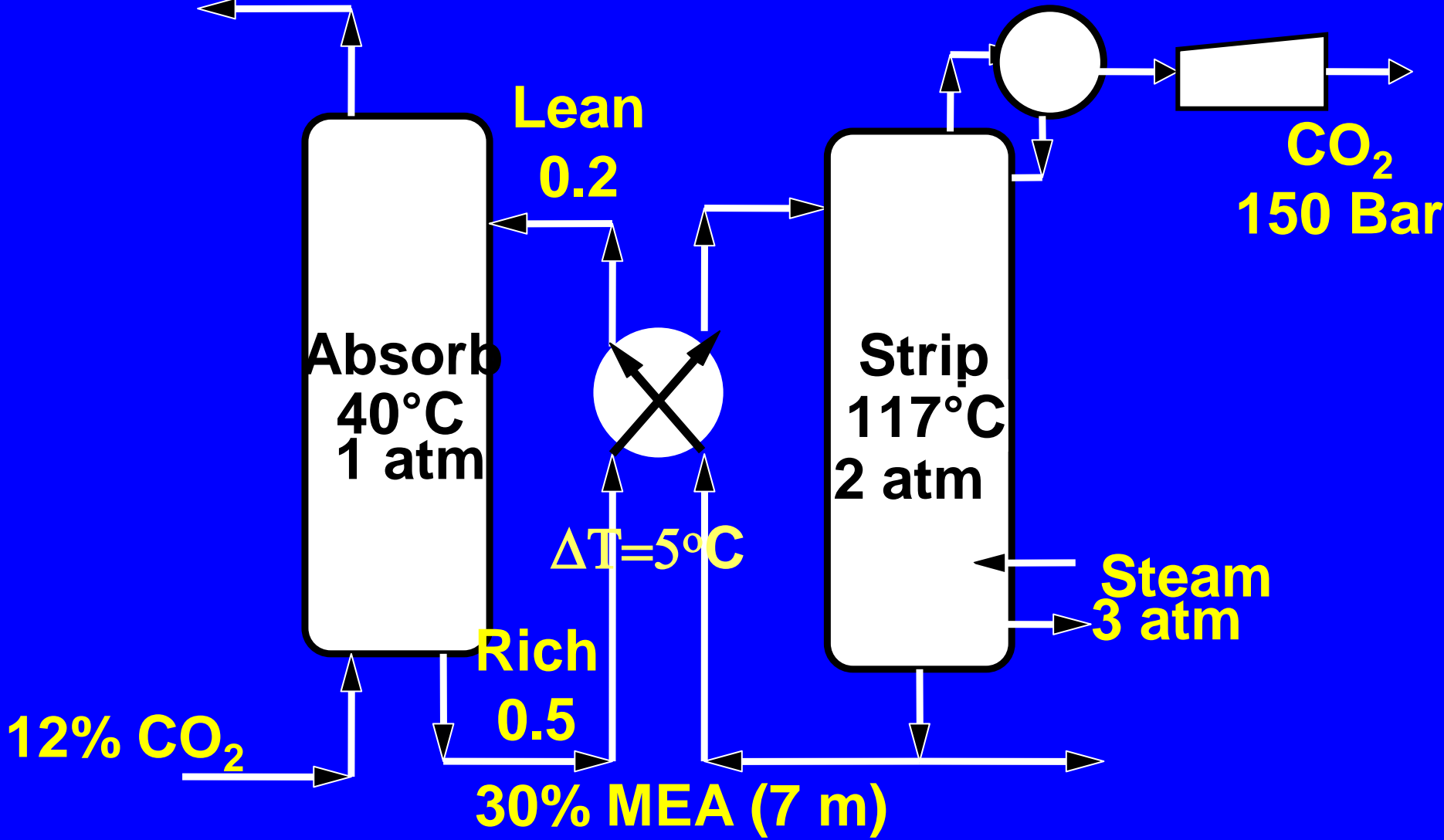


CO₂ Capture & Storage



MonoEthanolAmine Absorption/Stripping

1.2% CO₂



12% CO₂

Lean
0.2

Absorb
40°C
1 atm

Rich
0.5

$\Delta T = 5^\circ\text{C}$

30% MEA (7 m)

Strip
117°C
2 atm

Steam
3 atm

CO₂
150 Bar

Practical Problems

- Energy = 20-30% of power plant output
 - Steam for stripping
 - CO₂ Compression
 - Gas pressure drop
- Amine degradation and aerosol loss
 - 10% of cost
 - Environmental impact
- Capital Cost
 - 5 x 50 ft diameter absorbers and strippers
 - 50 ft packing

Approaches to Practical Problems

- Better Solvents – 2-methyl-piperazine et al.
 - Faster CO₂ Transfer
 - Greater Stability - Oxidation inhibitors
 - Lower amine volatility
- Better Processes
 - Regeneration by advanced flash stripper
 - Solvent Reclaiming
 - Nitrosamine Decomposition
- Better contacting
 - Packing to get G/L area
 - Aerosol removal by Brownian diffusion

Experiments on Energy Use

- Measure & Model Thermo with high amine & ions
 - Hot Gas FTIR - CO₂ & Amine Vapor pressure
 - NMR speciation
 - Heat Capacity
 - Hindered Amines, Blends, PZ derivatives
- Measure & Model Mass Transfer w Reaction
 - Wetted Wall Column
 - Hindered Amines, Blends, PZ derivatives
 - Structure/kinetics relationships

Experiments on Solvent Management

- Oxidation
- Thermal degradation
- Aerosols
 - Grow amine aerosol in a bench-scale absorber
 - Measure amine aerosol size distribution
- Reclaiming

Modeling & Pilot Plant

- System economic optimization
- Validate Models with Pilot Plant
- Develop & Test Innovative Flowsheets
- Model and control amine aerosols

Summary of available activities

- Experimental
 - Oxidative and thermal degradation
- Modeling
 - Solvent thermodynamics and rates