Results

Steam Team:
Provided energy penalty data for economic analysis
30MW average energy penalty required for ammonia regeneration

Flue Crew:
Developed models of Absorber and Stripper
Performed economic analysis to compare relationship of dimensions with efficiency of CO2 capture and removal

Recommendations

•25% CO_2 removal system is economically feasible in coal fired plants
Higher removal rate results in higher energy penalties

•Sequestration : Coalbed Methane (based on cost calculations)
•Location:
Approximately 100-150km from power plant

•Compressor :
RG Man Turbo Compressor

Team structure

Team structure:

® Reports
+ Presentation
° Ethics
§ Exhibit
¥ Minutes
@ Website

Team Leader
° ® George Vrana

Flue Crew
Alan Babjak ®
Dahye Lee ® § ¥
Frank Costanzo ° +
Taeho Hwang § +

Steam Team
Courtney McWethy ® ¥ §
Daniel Gonzalez ° ®
Jeff Bart ° +
Joshua Marheine +
Timothy Baldwin §

CHE 296
Sithambara Kuhan ®★
Wai Kit Ong § ★
Farouk Yaker § ☎
Sanghyuk Im °
James Cheever °
Michael Schillaci ☎ ®

CHE 296
Urszula Zajkowska + ☎
Mark Pyciak + ☎
Katherine Lazicki ®
Riju Konwar + ☎

CHE 296
Michael Clark ° @
Jennifer Guifoyle ★ @
Kenneth Ogata § ★

Sponsor:

Sargent & Lundy LLC

Faculties: Professor Don Chmielewski
Professor Satish Parulekar
Paula Moon

IPRO 302

CO_2 Mitigation:
A Techno-Economic Assessment

Objective :
Design of a retrofit addition to an existing pulverized coal-fired power plant to remove carbon dioxide from flue gas steam

Steam Team

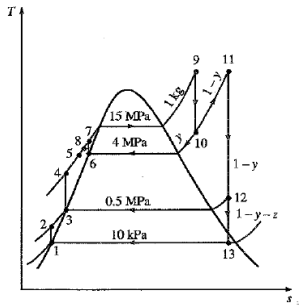
Key Tasks

•Created Matlab model of supercritical steam cycle

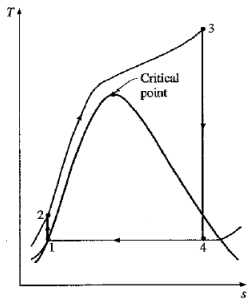
•Determined flow rate of CO_2 annually before removal

•Modify cycle to provide steam to run CO_2 removal unit

•Cool flue gas before entering CO_2 removal unit



Sub critical Steam Cycle



Supercritical Steam Cycle

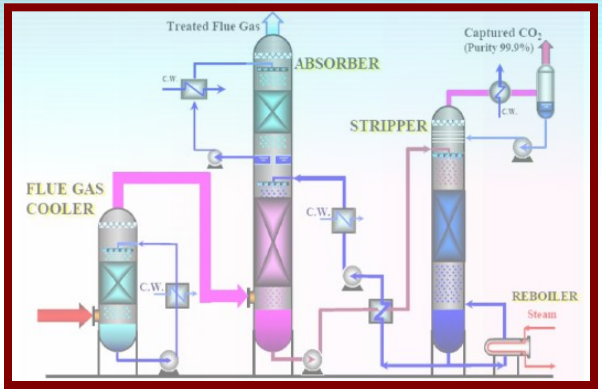
Challenges/Obstacles

•Not having access to T-S diagram for supercritical cycle until final weeks

•Changing from a sub critical model to a supercritical model with limited time

•Few team members were acquainted with Matlab coding

Flue Crew



Key Tasks:

•Produce a CO_2 removal unit design with removal percentages of 25%, 50%, and 90% for absorbent inlet temperatures of 35°F

•Determine the energy requirements of our stripper operation

•Perform economic analysis on each case

Reaction:

$$(NH_4)_2CO_3 + H_2O + CO_2 \leftrightarrow 2\ NH_4HCO_3$$

Forward reaction In Absorber
Backward reaction in Stripper

What is Absorber and Stripper?
Absorber: CO_2 absorbed from flue gas into stagnant liquid
Stripper: separate and regenerate CO_2 from solution

Heat integration:
Steam from the plant used to combine heat difference between steam cycle and CO2 technology process

Pressurization Team

RG Man Turbo Compressor
Ideal Compressor - Type RG multistage integrally geared centrifugal compressor manufactured by Man Turbo
Volumetric flow rate – 2,000m^3/h to 500,000m^3/h
Maximum Discharge pressure – 225bar
Estimated compressor capital costs - $55 million.

Sequestration Team

Key tasks:
•Research various sequestration methods
•recommend the most cost effective methods
<u>Four major sequestration methods:</u>

Coalbed Methane-injection of CO_2 into exhausted coal seams to displace and recover methane
Enhanced Oil Recovery-injection of CO_2 into oil wells to boost oil recovery by 10-20%
Saline – injection of CO_2 into porous rocks to be trapped over a long period
Terrestrial-use of forestry to remove CO_2 from the atmosphere and store it in wood