Carbon Capture, Utilization, and Storage
(이산화탄소 포집, 활용 및 저장) (38535)

- 2022 Final Examination -

Student ID: **Name:**

Notice

- Fill your name below and write the whole sentence in your answer sheet:
  "I, _____, swear I solve all problems by myself in this final examination.
  I will take any disadvantages if any dishonesty such as cheating is acted on my solution."
  5 points will be deducted from your total score if you do not fill in your name above.
- **You MUST solve each problem by hand.**
- Submission Deadline: 12:30 PM ~ 14:00 PM, June 13, 2022.
- No late submission is accepted.
- Submit your solution as *.pdf or *.word file on the cyber campus.
- Please follow the format that gives a name to your solution file:
  (Final)-(Student ID)-(Last name)-(First name)
  For example, the file name must be Final-XXXXXXX-Min-Baehyun.

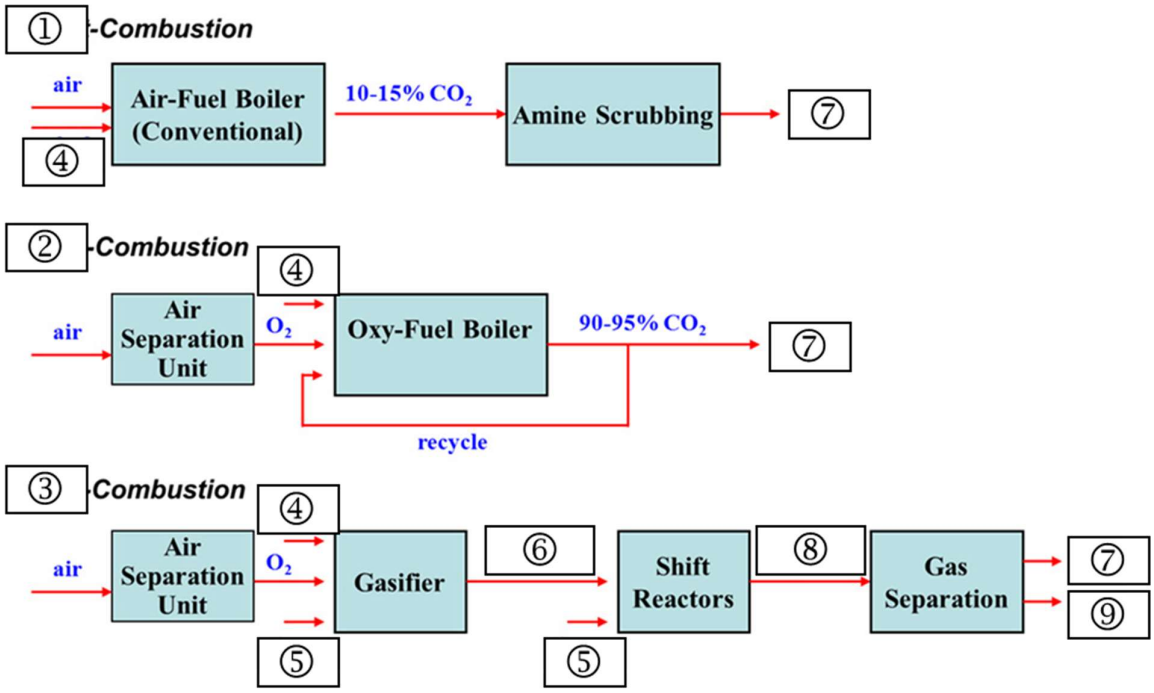
Problem 1.

Provide the full name of each acronym:

1-1. CCUS [1 pt.]
1-2. IPCC [1 pt.]
1-3. IEA [1 pt.]
1-4. BAU [1 pt.]
1-5. WAG [1 pt.]
1-6. GWP [1 pt.]
1-7. COP26 [1 pt.]
1-8. FEED [1 pt.]
1-9. API [1 pt.]

Problem 2.

Fill in the blanks from ① to ⑨. [9 pts.].



Problem 3.

Fill in the blanks from ① to ⑤. [10 pts.].

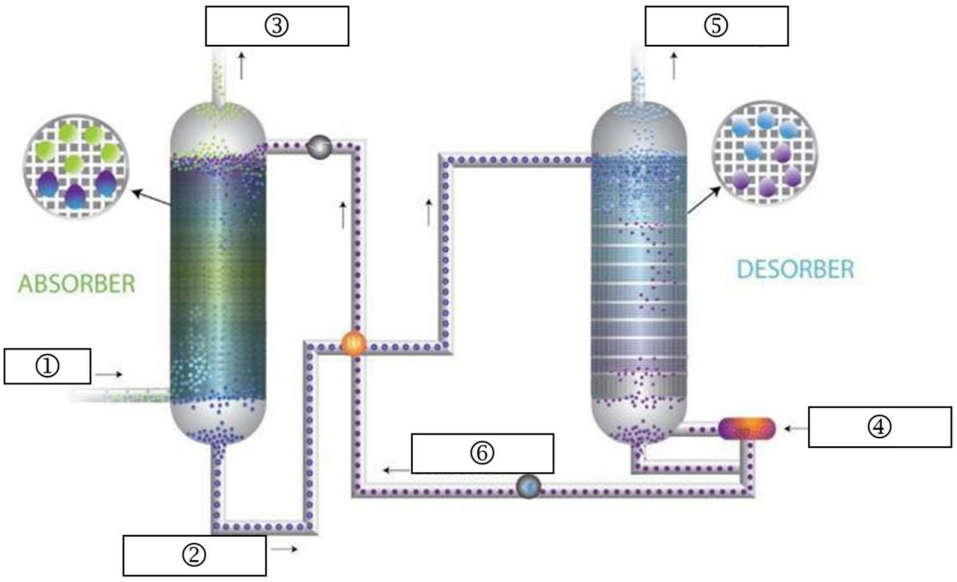
3-1. (①), (②), and (③) CO_2 is desirable for CO_2 transportation [6 pts.].

3-2. CO_2 concentration greater than or equal to (④) % is recommended for CO_2 transportation [2 pts.].

3-3. Water concentration less than or equal to (⑤) ppm is recommended for CO_2 transportation [2 pts.].

Problem 4.

Fill in the blanks from ① to ⑥ for solvent absorption (i.e., liquid stripping). [12 pts.].



Problem 5.

Fill in the blanks from ① to ③. [5 pts.]

"*Three major capture technologies are* (①), (②), and (③). *Besides, there are emerging technologies such as membrane contactors, cryogenics, mineralization, algae, etc.*"

Problem 6.

Solve Problem 6 under the following conditions.

- A 800 MW coal fired power plant in Korea emits 5 million tonnes of CO_2 annually. This plant costs $1,000 million to build and the annual operating cost is $100 million. This plant costs $250 million to decommission.
- Another plant with CCS also sends out 800 MW but emits 0.5 million tonnes of CO_2 annually. The extra CCS equipment adds $800 million to the capital cost and $80 million to the annual operating cost. This plant costs $100 million to decommission.
- 2 years are required for construction of each plant. 2 years are also required for decommissioning the plant with CCS. Both plants operate for 26 years (7,000 hours each year).
- Thus, the total period is as follows: 30 years = construction for 2 years + operation for 26 years + decommissioning for 2 years.
- Assume a 10% discount rate.
- For all answers, you MUST round off all values (e.g., discount factor) to the second decimal place for this problem (최종 답은 소수 둘째자리까지 구하시오.).

6-1. How much is the incremental cost of electricity (COE) ($/MWh) if CCS is implemented at this power plant? [10 pts.]

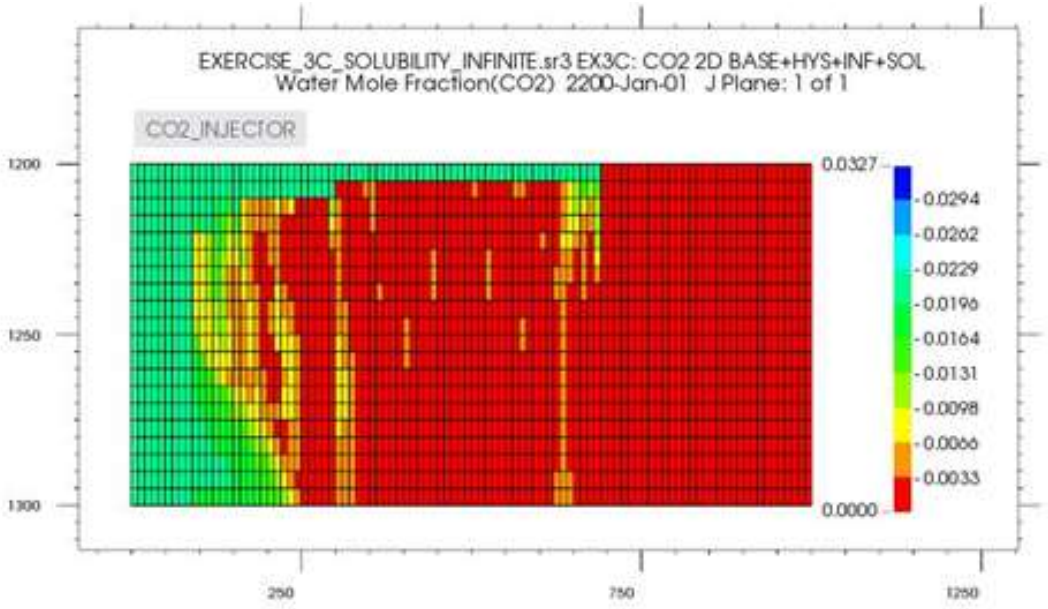
6-2. How much is the cost of CO_2 avoided ($/tonne)? [10 pts.]

Problem 7.

CO_2 has been injected for 1 year (2000-2001) and migrated for subsequent 199 years (2001-2200) in a saline aquifer under the following conditions:

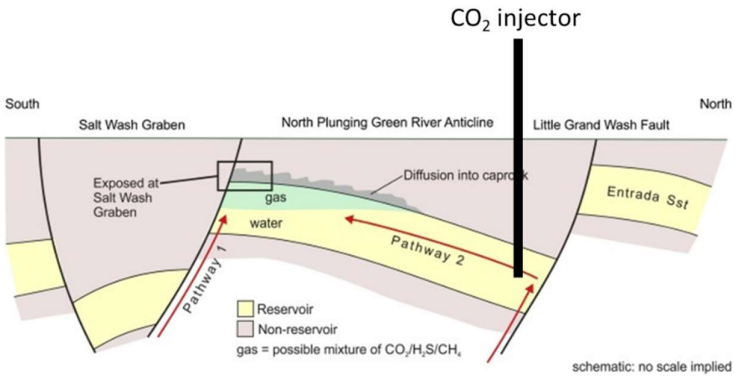
- Below figure shows the distribution of water mole fraction (CO_2) at the end of numerical simulation (date: January 1, 2200).
- A CO_2 injection well is installed to the left of the saline aquifer in the below figure.
- Boundary condition: Infinite acting aquifer is attached to the right of the saline aquifer in the figure.
- Initial gas saturation = 0.00
- Hysteresis and solubility trapping mechanisms are implemented in the numerical simulation.

Interpret the injection and migration of CO_2 plume between 2000 and 2200 based on your engineering knowledge [10 pts].



Problem 8.

Field operators plan to inject and store CO_2 permanently in a geological structure with rollover anticline and thrust-faults as follows:



8-1. Draw a fault-seal risk web and seal probability condition. [10 pts.]

8-2. Assess the overall trap potential of this storage site. The operators provide the following geological conditions in cooperation with geologists, geophysicists, and petroleum engineers:

- Caprock capacity = 0.9
- Caprock geometry = 0.9
- Caprock integrity = 0.7
- Juxtaposition property = 0.8
- Fault zone property = 0.5
- Post-injection reactivation = 0.6

Note that every geological condition above is a probability value ranging between 0 and 1. [10 pts.]

8-3. Based on your engineering knowledge on the overall trap potential, judge if this site is a good candidate for a geological carbon storage project. [5 pts.]

---------- This is the End of the Final Examination ----------