CO_2 CAPTURE USING HYDRAULIC AIR COMPRESSION

OBJECTIVES

- Capture carbon dioxide gas that is emitted from a 40 MW power plant without increasing system temperature.
- Reduce maintenance costs using a gravity-based compression design.
- The CO_2 needs to transfer/dissolve into the water using the pressure that is developed as the water mass piles down with simple gravity.
- Separate carbon dioxide from other gases such as nitrogen, argon, oxygen etc...
- Dissolved CO_2 will bubble out whilst flowing up the riser and the pressure decreases to atmospheric. The water flowing up will only need pumping input on the last 15% of the height.

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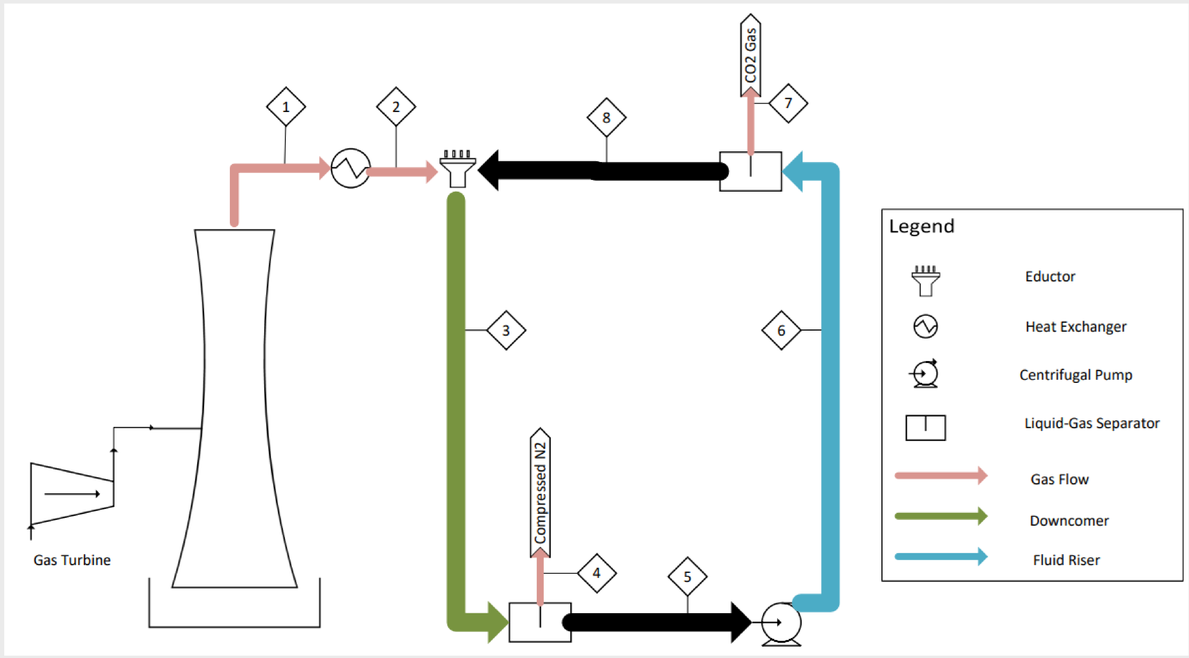
Hydraulic Air Compressor: Isothermal compression and mass transfer of a gas is achieved with a significant height drop of a liquid solvent and gas mixture.



DOWNCOMER

Temperature-controlled flue gas from the power plant's stack tower is introduced into a mixing point with a high volume stream of water (or other choice of solvent). This forms a two-phase flow of gas entrained in bubbles being dragged down by the solvent. Dropping down a significant height compresses the flow due to hydrostatic pressure, which pressurizes the gas phase.

This is used to separate nitrogen out of the solvent at the bottom of the system, a historic application of the design, while also increasing solubility of CO_2 in the solvent. Both effects combine to capture the greenhouse gas, and prepare it for extraction in the next section.

RISER

The kinetic energy of the water flow will lead it up the riser without the need of outside energy input, most of the way. A pump is included to assist the water flow on the last 6 meters of the flow cycle.

Similar to soda, the dissolved CO_2 will escape the fluid in the riser as atmospheric pressure is reached. A low pressure separator is implemented to capture the gas and direct the fluid back to the mixing point for recycling.

FUTURE WORK

- Bench-scale experiment: Experimental design will help to solidify scaled efficiency of captured CO_2.
- Addition of additives: Careful application of additives such as salt or MEA may help to increase solubility of the solvent.
- Locations: The depths of an ocean can be taken advantage of to facilitate this system. Pressure increase down the pipe will be equal with the pressure of ocean depth.
- Multiple stages: Running the extracted CO_2 through additional solvent loops would increase the amount captured from the flue gas.
- Scale up for larger power plants: Design for real-world power plants can provide a measure to reduce carbon emissions.
- Applications of compressed nitrogen: Nitrogen extracted at the high pressure separator is useful as a side-product, or for use as a pressurized coolant gas.
- Other gas sources: Alternative sources of CO_2 or similar gasses can be captured using this system, barring the effects of the gas mixture.