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Supporting Materials: Process Flow Diagrams

Post-Combustion CO_2 Capture from An Industrial Power Plant Using Five Chemical Solvents: A Comparative TEA

1. PFD of the SO_2 and NO_2 Scrubbing System (SNS):

The PFD of the SNS system developed in Aspen Plus V.12.1 is depicted in Figure S1, and as can be seen the split flue gas stream from the power plant available at 1 bar and 324.82 K is compressed to 1.38 bar and 364.48 K before entering from the bottom of the GPU to meet the DIW in a counter-current flow pattern. The downflow DIW reacts with SO_2 and NO_2 as given in the Section 5.1 of the manuscript.

The water coming from the bottom of the GPU is pumped to the Reverse Osmosis Unit (ROU), consisting of multiple membranes, to remove the SO_4^- and NO_3^- ions dissolved in the water as a reject (retentate), whereas the clean DIW stream (permeate) is cooled and sent back to the top of the GPU to capture more SO_2 and NO_2. The polished gas (SO_2 and NO_2 free) is sent as a feed to the bottom of the CO_2 absorption unit (CAU). It should be noted that this SNS system is an integral part of the overall process PFD for CO_2 capture whether in Pathway (i) or (ii).

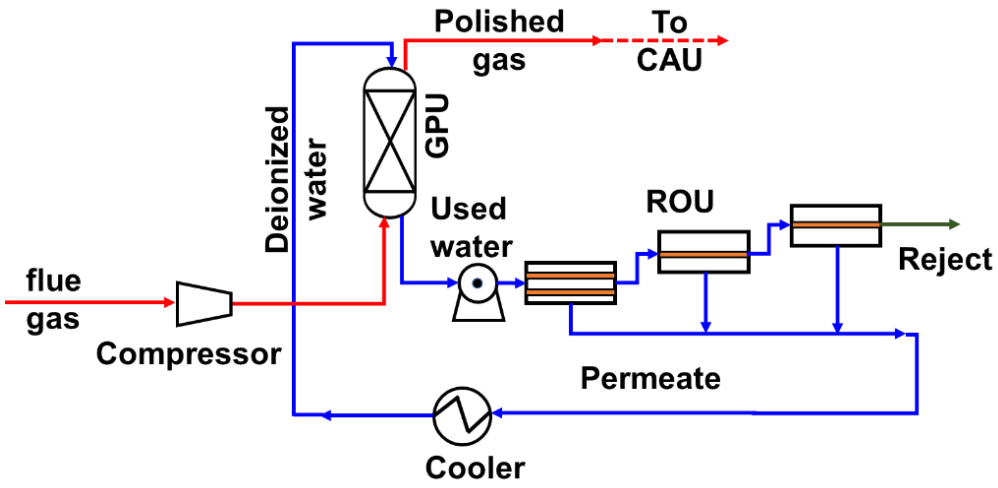

Figure S1 Process flow diagram of the SNS system.

2. Pathway (i): PFD of the CO_2 Absorption System Using ABs (MEA, AMP and PZ/MDEA)

The PFD for Pathway (i) in the CAS using the three conventional solvents (MEA, AMP, and PZ/MDEA) is depicted in Figure S2, and as can be seen the polished gas coming from the SNS system enters from the bottom of the CAU to react with the solvent coming downward. The PFD comprises in addition to the SNS system, four main units: (1) CAU for CO_2 capture from the polished flue gas, (2) crossflow heat exchanger for CO_2-rich solution heating and regenerated solvent cooling, (3) stripper for solvent regeneration from the bottom CO_2-rich solution, and (4) CO_2 compression unit for conditioning the CO_2 stream for subsequent sequestration. The CO_2-rich solution coming from

the bottom of the CAU is directly sent to the heat exchanger and stripper for regenerating the solvent. The CO_2 released is sent to the compression unit.

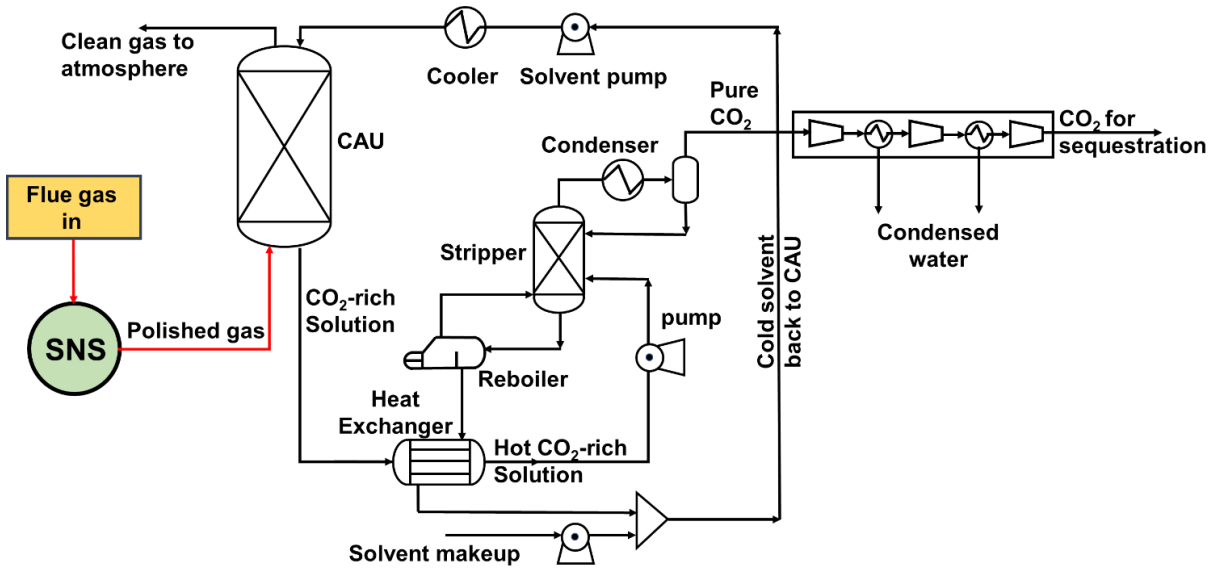

Figure S2 PFD of the CO_2 Absorption System using ABs (MEA, AMP, and PZ/MDEA).

3. Pathway (i): PFD of the CO_2 Absorption System Using the AAs (SGS and PGS)

In this PFD, the polished gas comes from the SNS system enters from of the bottom of the CAU to react with the solvent coming downward. When using SGS and PGS, the PFD of the process shown in Figure S2 was modified as depicted in Figure S3. The modification was introduced because both SGS and PGS reactions with CO_2 exhibit phase separation. For this purpose, the solution coming from the bottom of the CAU goes to a decanter and only the bottom phase (CO_2-rich) is sent for regeneration in the heat exchanger/stripper system. Also, the CO_2 released is sent to the compression unit as when using MEA, AMP, and PZ/MDEA solvents.

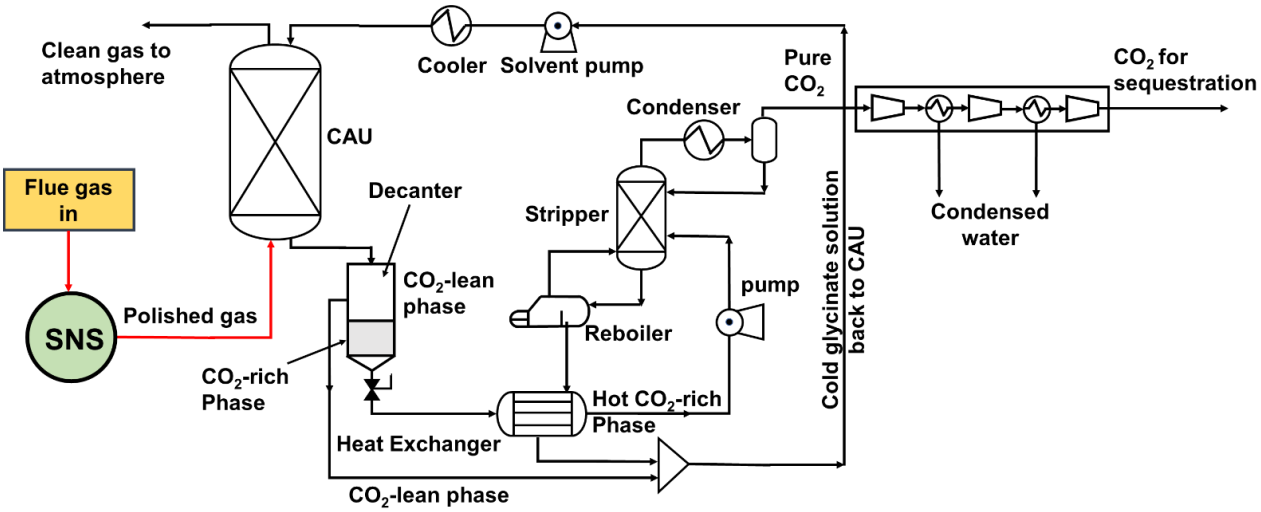

Figure S3 Pathway (i) PFD of the CO_2 Absorption System using AAs (SGS and PGS).

4. Pathway (ii): PFD of the CO_2 Absorption System Using the AAs (SGS and PGS)

The PFD of Pathway (ii) for CO_2 capture is shown in Figure S4, where the polished flue gas coming from the SNS system is sent to the CAU to capture more than 90% of CO_2 and produce $NaHCO_3$ or $KHCO_3$ nanomaterials. In addition to the SNS system, Pathway (ii) comprises three primary units: (1) CAU for CO_2 capture, (2) UFU for separating the $NaHCO_3$ or $KHCO_3$ solid nanoparticles produced, and (3) Hydroxide Makeup chamber for replenishing NaOH or KOH consumed as required. The CO_2-rich solution from CAU was pumped to the ultrafiltration unit (UFU) to separate the nanomaterials from the solution. The filtrate from the UFU was mixed with NaOH or KOH solution in the makeup chamber (CSTR) facilitating the conversion of glycine to sodium or potassium glycinate. After pumping and cooling, the sodium or potassium glycinate solution was recycled back to the CAU for capturing more CO_2.

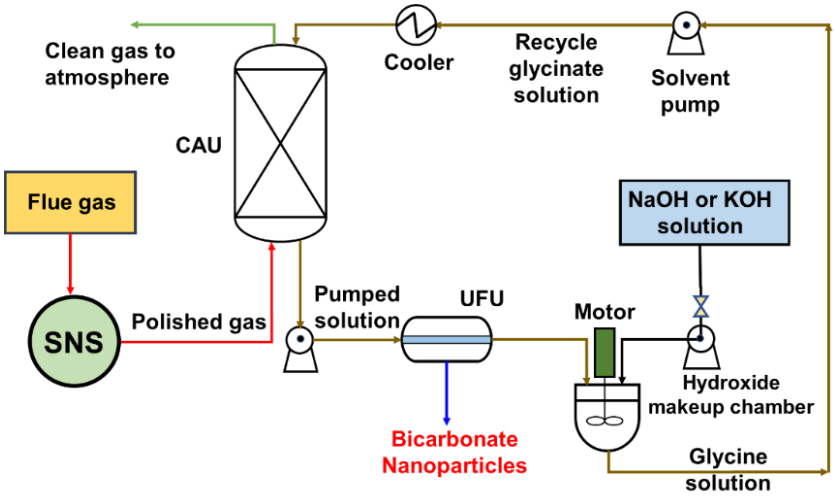

Figure S4 Pathway (ii) PFD of the CO_2 Absorption System using AAs (SGS and PGS).