Process simulation, cost estimation and comparison of CO_2 capture using MEA and MDEA solvents

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Abstract: The amine-based solvent method for carbon capture is important for reducing carbon dioxide (CO_2) emissions in multiple industrial sectors. Blended amine systems like methyl diethanolamine/piperazine (MDEA/PZ) have the capacity to reduce energy consumption and increase efficiency compared to the traditional monoethanolamine (MEA). This study simulated CO_2 absorption and desorption processes employing 29 wt.% MEA and a blended solvent of 30 wt.% MDEA and 20 wt.% PZ in Aspen HYSYS v14, utilizing absorbers and desorbers with 10 and 6 stages, respectively. The effectiveness of each solvent system was assessed based on an assumed CO_2 removal efficiency of 85%, with equipment sizing and cost estimation performed using Aspen In-Plant Cost Estimator. The simulation findings demonstrated heat of consumption values of 3.77 MJ/kg CO_2 for MEA and 3.65 MJ/kg CO_2 for the MDEA/PZ blend. The computed CO_2 capture costs were 31 €/ton CO_2 for MEA and 28 €/ton CO_2 for MDEA/PZ. In parameter variations, the MDEA/PZ blend consistently demanded less energy than MEA. There is some work in the open literature comparing the energy consumption of the MEA and the MDEA/PZ blend, but little work on comparing total cost. The results indicate that blends like MDEA/PZ can be an alternative to MEA offering lower energy requirements and lower total cost.

Keywords: *Carbon capture, MEA, MDEA/PZ blend, Aspen HYSYS, simulation, cost estimation*