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Simulation and Assessment of Carbon Dioxide Separation by Piperazine Blended Solutions Using E-NRTL and Peng-Robinson Models: Study of Regeneration Heat Duty

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Abstract : A high-pressure carbon dioxide (CO_2) absorption from a specific off-gas in a conventional column has been evaluated for the environmental concerns by the Aspen HYSYS simulator using a wide range of single absorbents and piperazine (PZ) blended solutions to estimate the outlet CO_2 concentration, CO_2 loading, reboiler power supply, and regeneration heat duty to choose the most efficient solution in terms of CO_2 removal and required heat duty. The property package, which is compatible with all applied solutions for the simulation in this study, estimates the properties based on the electrolyte non-random two-liquid (E-NRTL) model for electrolyte thermodynamics and Peng-Robinson equation of state for vapor phase and liquid hydrocarbon phase properties. The results of the simulation indicate that piperazine, in addition to the mixture of piperazine and monoethanolamine (MEA), demands the highest regeneration heat duty compared with other studied single and blended amine solutions, respectively. The blended amine solutions with the lowest PZ concentrations (5wt% and 10wt%) were considered and compared to reduce the cost of the process, among which the blended solution of 10wt%PZ+35wt%MDEA (methyldiethanolamine) was found as the most appropriate solution in terms of CO_2 content in the outlet gas, rich-CO_2 loading, and regeneration heat duty.

Keywords : absorption, amine solutions, aspen HYSYS, CO_2 loading, piperazine, regeneration heat duty
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