Practical enhancement factor model based on GM for multiple parallel reactions: Piperazine (PZ) CO₂ capture - DTU Orbit (25/12/2018)

Practical enhancement factor model based on GM for multiple parallel reactions: Piperazine (PZ) CO₂ capture

Reactive absorption is a key process for gas separation and purification and it is the main technology for CO₂ capture. Thus, reliable and simple mathematical models for mass transfer rate calculation are essential. Models which apply to parallel interacting and non-interacting reactions, for all industrially relevant reaction regimes must be developed and validated against experimental measurements. In a previous work, we presented the general model (GM) enhancement factor model for (m+n)-th order reversible reactions and validated it against the numerical solution of the two-film model for absorption, desorption and pinch conditions. In this work, we apply the GM model to multiple parallel reactions. We deduce the model for piperazine (PZ) CO₂ capture and we validate it against wetted-wall column measurements using 2, 5 and 8 molal PZ for temperatures between 40 °C and 100 °C and CO₂ loadings between 0.23 and 0.41 mol CO₂/2 mol PZ. We show that overall second order kinetics describes well the reaction between CO₂ and PZ accounting for the carbamate and bicarbamate reactions. Here we prove the GM model for piperazine and MEA but we expect that this practical approach is applicable for various amines, blends of amines and promoted amines with similar kinetics. We believe that this practical implementation of mass transfer rate calculation will be in the accuracy range of a wetted wall column experiment for other parallel reaction systems. This is in line with our observation from other similar solvents studied, not shown here. Furthermore, we compare the GM model and the numerical solution of the complete two-film model predictions to MEA wetted-wall data and we prove that it is safe to assume that GM and the two-film model give practically identical results. We demonstrate that the expected predictability of CO₂ mass transfer rates using off-the-shelf correlations generally is ±20%.

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