Integrated Ionic Liquid and Absorption Process Design for Carbon Capture: Global Optimization Using Hybrid Models

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Abstract

A new method for integrated ionic liquid (IL) and absorption process design is proposed where a rigorous rate-based process model is used to incorporate absorption thermodynamics and kinetics. Different types of models including group contribution models and thermodynamic models are employed to predict the process-relevant physical, kinetic, and thermodynamic (gas solubility) properties of ILs. Combining the property models with process models, the integrated IL and process design problem is formulated as an MINLP optimization problem. Unfortunately, due to the model complexity, the problem is prone to convergence failure. To lower the computational difficulty, tractable surrogate models are used to replace the complex thermodynamic models while maintaining the prediction accuracy. This provides an opportunity to find the global optimum for the integrated design problem. A pre-combustion carbon capture case study is provided to demonstrate the applicability of the method. The obtained global optimum saves 14.8% cost compared to the Selexol process.

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