Model-based design of stratified packings for enhanced mass transfer using optimal control theory

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Abstract

Various examples show that stratified columns can improve the transport performance of particle packings. However, to date, there is no universal approach to design these packings to yield optimal performance. This study proposes a novel model-based method for designing particle packings in which mass transfer occurs between a liquid phase and a stationary phase using optimal control theory. The primary objective is to provide a general design strategy that is applicable across different unit operations in chemical, pharmaceutical, and food applications. Optimal control is utilized to determine the optimal particle diameter as a function of the axial position within the column. We demonstrate the approach using two case studies and three different optimization criteria. Numerical results indicate that the proposed method is highly effective, e.g., the solvent demand is reduced by up to 32.47 %. Moreover, the optimally graded packing yields a significantly sharper breakthrough curve of an adsorption column.

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