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Investigating the Effective Interfacial Area of Packing in Rotating Packed Beds

Jia Tean Ding, Cheng-Hsiu Yu*

Department of Chemical Engineering, National Taiwan University of Science and Technology, Taipei 106335, Taiwan

Abstract

Rate-based models are widely applied for estimating column efficiency nowadays. These models assume that vapor and liquid achieve equilibrium at the interface, and separation occurs due to mass transfer between the contacting phases. Therefore, accurately estimating the contacting phases such as the effective interfacial area (a_e) and film thickness is crucial for the calculations, especially for processes involving chemical reactions. The rotating packed bed (RPB), a process intensification apparatus, has been applied in industrial separation processes due to its superior mass transfer performance compared to conventional packed bed columns. To support the development of carbon dioxide (CO_2) chemical absorption process with RPBs, several RPB models have been proposed. Yu et al. (2022) demonstrated that the RPB can be modeled as a conventional packed bed (PB) after accounting for the unique features of RPBs. They further pointed out that the RPB model with Onda correlation provides better predictive results than the models with two effective area correlations of RPBs, although the Onda correlation was developed for random packings in PBs. Their results imply that reliable a_e correlations are essential for accurately predicting the CO_2 removal efficiency in the RPB. After a thorough literature review, it is observed that although several interfacial area correlations for specific packing types in RPBs have been developed, a general correlation that captures the key characteristics of RPBs is still lacking, which hinders the development of RPB. In this regard, this study aims to develop a generalized and dimensionless correlation for estimating the effective interfacial area of RPBs. The correlation showed satisfactory estimation against the data from HiGee literature. It could support the development of rate-based RPB models for industrial separation processes.

Keywords: Rate-based modeling, Rotating pakced beds, Effective interfacial area, Chemical absorption

References

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* Corresponding author. Tel.: +886-2-2737-6614
E-mail address: chenghsiu.yu@mail.ntust.edu.tw