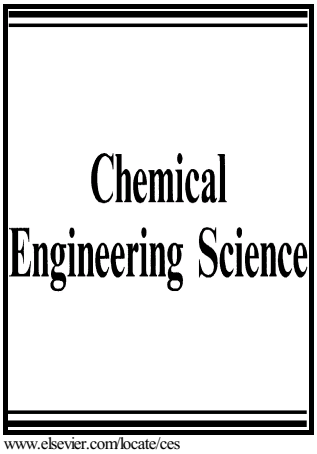

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Analogy of Absorption and Distillation processes. Wetted-wall Column Study.

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Abstract

This article is the second one from a pair focusing on the mass transfer fundaments and the analogy between the processes of absorption and distillation. The wetted wall column, a device with known interfacial area, was built for this purpose enabling evaluation of the mass-transfer coefficients instead of the volumetric mass-transfer coefficients usually provided by experiments in the packed columns. The analogy of the processes has been assessed by comparison of the mass-transfer characteristics (HETP, individual mass-transfer coefficients k_L and k_G) evaluated on the basis of the absorption experiments with those found under the distillation conditions. In the prior paper the results of the absorption experiments performed under distillation-like conditions have been published in the form of dimensionless correlations $Sh_L = 0.33\mathrm{Re}_L^{-0.12} Sc_L^{0.47}$ and $Sh_G = 0.012 Re_{LG}^{0.90} Sc_G^{0.61}$.

In this paper we present results of the distillation experiments in the form of the HETP data and mass-transfer coefficients evaluated by the profile method. The experimental data are compared with those predicted on the basis of the absorption experiments results. The experimental HETP data acquired on the methanol-n-propanol and ethanol-n-propanol systems agree within 10-20 % with the data predicted. The distillation mass-transfer coefficients evaluated by the profile method were correlated in the dimensionless form $Sh_L = 0.25\mathrm{Re}_L^{-0.12} Sc_L^{0.47}$ and $Sh_G = 2.3 \cdot 10^{-3} Re_{LG}^{1.07} Sc_G^{0.61}$. The distillation k_L values have been found to be 24 % lower and the k_G values 13 % lower than the ones predicted according to absorption correlations. The gas-phase mass-transfer coefficient, k_G, exhibits higher dependence on the vapor velocity than it was found in standard absorption measurements. Similar difference was found also for packed columns in previous works. Apparently, there is at least one unaccounted phenomenon which affects differently the mass-transfer performance of absorption and distillation packed columns. Poor results of the present diffusion models have been noticed in this work preventing deeper study of these differences. Improvement of these models is found to be inevitable for the further research in this area as well as for the reliable rate-based modeling of the industrial absorption and distillation columns.

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