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Effects of Enzyme Microcapsule Shape on the Performance of a Nonisothermal Packed-Bed Tubular Reactor

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Abstract: The effects of enzyme microcapsule shape (spherical, cylindrical and flat plate) on the performance of a nonisothermal, packed-bed reactor have been modeled as a function of Biot number and Peclet number for mass and heat transfer (Bi_m, Bi_h, Pe_m and Pe_h), and dimensionless heat of reaction α. Under the given simulation conditions, only higher values of Bi_m and Bi_h ($>2{\cdot}5$) confirm the influence of microcapsule shape on the reactor performance such that the axial and overall conversion and bulk temperature decrease as follows: spherical > cylindrical > flat plate. In terms of the shape-independent modified Biot number, $Bi^* = Bi/\{(n+1)/3\}$, this order is retained for $2 < Bi^* < 8$. The influence of increasing Pe_m, Pe_h, and α on conversion and bulk temperature also follows the above order. For the flat plate, the exit conversion and temperature are not influenced by Pe_m and Pe_h, that is, mass transfer and thermal backmixing effects, respectively. On the other hand, for the spherical and cylindrical microcapsules, overall backmixing effects are negligible only beyond a critical value of Pe_m (~ 7) and Pe_h ($\sim 1{\cdot}75$). The conversion and bulk temperature increase with the increase in α, independent of the microcapsule shape. The spherical and cylindrical microcapsules, unlike the flat plate, cannot be considered isothermal.

Key words: encapsulated enzyme, microcapsule shape, packed-bed reactor, nonisothermal operation.