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Analysis of non-isothermal tubular reactor packed with immobilized enzyme systems

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Abstract

The dynamic and steady state performance of a non-isothermal tubular reactor packed with spherical encapsulated enzyme particles has been modeled in terms of different dimensionless transport and kinetic parameters. The dynamic concentration profile for an initially substrate-free reactor reaches a maximum before achieving steady state. The steady state dimensionless bulk substrate concentration, unlike the temperature, progressively decreases along the reactor bed. On increase in the external mass transfer coefficient K_L and Biot number Bi_m for mass transfer, the concentration profile decreases more steeply. The simulation study shows that the biocatalyst particles may be considered isothermal. The exit substrate concentration decreases with increase in Peclet number Pe_m for mass transfer, i.e. backmixing effects, indicating that a plug flow reactor will have a higher overall conversion than a perfect mixer. The dynamic bulk temperature rises more rapidly near the reactor inlet with increase in the Peclet number Pe_h for heat transfer, i.e. thermal backmixing effects. The external resistance to mass and heat transfer becomes negligible above a critical value of K_L and external heat transfer coefficient h. The bulk substrate concentration, unlike the temperature, decreases with increase in the dimensionless heat α of reaction. For typical Michaelis–Menten kinetics, the exit conversion and temperature will be limited between those for zero- and first-order kinetics.

Keywords: Immobilized enzyme; Bioreactor; Modelling; Michaelis–Menten kinetics; Temperature