HEAT TRANSFER AND AXIAL DISPERSION IN FIXED BEDS FROM DYNAMIC RESPONSE

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ABSTRACT

Heat and mass transfer in packed beds are important in many ways in the chemical industry. Beds of packed particles are often used as storage bodies in thermal regenerators, adsorbers, chromatographic columns and catalytic reactors-to name only a few.

The evaluation of temperature profile as well as thermal condition in both radial and axial directions are essential in the design and control of reactors. These are influenced by the axial dispersion coefficient, radial dispersion coefficient, particle to fluid heat transfer coefficient and bed to wall heat transfer coefficient. In this context, determination of such transport coefficients becomes important.

The heat transfer coefficients in fixed beds have been determined by many investigators using steady state techniques. However, steady state techniques usually distort the natural mode of heat transfer in fixed beds and so it becomes necessary to devise dynamic methods by which the transient response of particles could be studied. In dynamic methods, the response of the system is recorded for pulse, step or sinusoidal perturbations.

The excitation of a packed bed by a pulse of heat and measurement of its response is experimentally convenient than

the same by a step or a sinusoidal stimulus and measurement of its response. In the present investigation the method of pulse response has been chosen to study axial dispersion of heat in beds randomly packed with glass ballotinis and mild steel spheres. The response curves have been analysed by method of moments, by using the properties i.e. intercept and slope of the equations obtained after transforming the data and model equations into the Laplace transform domain and by optimization method. Method of moments and slope and intercept method provided no estimates of the parameters in most of the cases. Optimization method gave estimates of the parameters in all the cases. But no definite relationship of these estimates with Reynolds number could be obtained due to a lot of scatter observed in the results. Further a numerical solution to the equations describing dispersion, convection and heat transfer in packed bed for a step change in the fluid inlet temperature has been presented and temperature profiles predicted for the same. The predicted temperature profiles agreed with some results reported in the literature. A sequential estimation technique has also been successfully employed to estimate the parameters of non ideal tubular reactors under laminar flow conditions involving liquid phase homogeneous linear and nonlinear reaction using a digital simulation of such reactors.

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