GAS SOLID OPERATIONS IN FLUIDIZED BEDS

BY

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CERTIFICATE

This is to certify that the thesis entitled 'GAS SOLID OPERATIONS IN FLUIDIZED BEDS' being submitted by K. Viswanathan to Indian Institute of Technology, Delhi, for the award of Degree of Doctor of Philosophy in Chemical Engineering, is a record of bonafide research work carried out by him. K. Viswanathan has worked under my guidance and supervision and has fulfilled the requirements for the submission of thesis, which to my knowledge has reached the requisite standard.

The results contained in this thesis have not been submitted in part or in full to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

PART I : ONE DIMENSIONAL MODELS

Available literature on the hydrodynamic aspects is critically reviewed. Inconsistencies in the existing equations are brought out. New expressions are developed wherever necessar and are adequately confirmed with available data in the literature.

Important available reactor models are critically reviewed. A new model called the Semicompartmental model is developed. Predictions of the model are generalised in terms of dimensionless reaction and exchange numbers. The predictions of concentration profiles and conversion levels are adequately compared with available data in the literature.

The model is then used to develop a model for the performance of a batch fluidized bed dryer (adsorber and desorber). For the first time, analytical predictions for the variation with time of outlet concentration, temperature, and moisture loading on the particles have been obtained, even for non-linear equilibrium relationships. A mathematical model is then presente for continuous fluidized bed adsorbers and desorbers. For this case, analytical expressions are derived for linear equilibrium relationships.

A simple method is developed to obtain the equilibrium relationship from dynamic batch fluidized bed adsorption/ desorption experiments itself.

New experimental data are presented on the time varying characteristics of a batch fluidized bed adsorber/desorber. Experimental results on the variation of outlet moisture concentration and temperature with time are shown to compare well with the model predictions. Further, the equilibrium relationship for adsorption obtained by the dynamic method is shown to compare reasonably well with that obtained directly by the static method.

PART II : MODEL FOR CIRCULATION

Available literature on the circulation of liquid in two-dimensional and axi-symmetric bubble columns is critically reviewed. A new model closely paralleling that due to Freedman and Davidson is presented for two-dimensional bubble columns. A theoretical model is developed for describing circulation in cylindrical columns. Predictions of the model are adequately confirmed with available experimental data.

Based on the liquid circulation model, a model is developed for the description of 'gross solid circulation' in fluidized beds. The model predicts the velocity profiles of solids, interstitial gas, and bubbles from first principles. Only qualitative comparison of predictions of the model with available experimental data have been possible. However, consideration of circulation of solids more fundamentally as in the present case may lead to more reliable models for scale-up of various fluidized bed operations. There exists great scope for further development of this model.

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