STUDIES IN GAS - SOLID SYSTEMS

THESIS SUBMITTED BY

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CERTIFICATE

This is to certify that the thesis entitled "STUDIES IN GAS-SOLID SYSTEMS" submitted by me to the Indian Institute of Technology Delhi, for the award of the degree of 'Doctor of Philosophy' is the record of bonafide research work carried out by me.

The thesis or any part thereof has not been submitted to any other University or Institution for the award of any degree or diploma.

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ABSTRACT

Available literature on hydrodynamic aspects of a spouted bed dryer as well as the batch and the continuous drying in the same are reviewed. From a route different from the one available in the literature an expression is derived for the stable spouting pressure drop.

A mathematical model is developed to predict the complete batch drying dynamics. A computer program based on the same has been written and tested. With the help of this, the variation with time of the solids moisture content, the temperature and the outlet moisture concentration, are predicted.

A movel method is given to obtain the Arrhenius relationship for internal moisture diffusivity from simple batch spouted bed drying data. The method is shown to yield excellent results vis-a-vis the available diffusivity data of wheat and peas.

A number of experimental drying runs are performed in batch and continuous spouted bed modes with wheat, paddy, maize and peas. The predictions of the batch model compare well with the data of Q,T and C as a function of time. A generalized correlation is developed to predict the specific drying rates of all the materials:

$$\phi_m = \overline{\frac{dQ}{dt}} = k(50Q_o + 0.118\ T_o - 12.5)10^{-5}\ \text{kg/kgs} \qquad (A)$$

where the single parameter k is shown to account for the difference in the type of grains studied. It is also proposed that

the k-value, representing the relative drying rate of any material with respect to wheat, remains independent of mode of drying (i.e. the k-values for spouted drying and tray drying are equal).

The complete dynamics of continuous drying predicted by the model of Viswanathan[118] is shown to compare favourably with the measured data. As predicted, the moisture content of initially dumped, solids, Q_d, is shown to play a critical role in determining the type of dynamics obtained. For example, for low Q_d, the solids temperature passes through a maximum which is not found in high Q_d.

A number of tray drying experiments have also been performed with 12 different grains. The k-values estimated from tray drying data for paddy, maize and peas, compare well with those estimated from spouted bed drying. Therefore, for any grain, the k-value may be obtained from tray drying and the same may be used in Eq. (A) presented above to design a spouted bed dryer.

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