ABSTRACT

This thesis presents the results of the investigation of heat transfer studies carried out for small and large particles of single bare tube and bare tube bundles (in-line and staggered) in gas-solid fluidized bed. Experimental data was generated initially and artificial neural network was used to predict heat transfer parameters.

Measurements of average heat transfer coefficients were made by the local thermal simulation technique in a square, bubbling gas-fluidized bed (0.305m x 0.305m) with immersed horizontal bare tube where air is used as fluidized gas at atmospheric conditions. Studies were conducted with a single bare tube, in-line and staggered bundles of tubes using beds of small (average particle diameter less than 1 mm i.e. 305µm to 561µm) sand particles, and of large (average particle diameter greater than 1mm) particles of raagi and mustard. The fluidization velocity varied from 0.19 m/s to 1.4 m/s and the static bed height was maintained at 31cms for all experimental runs. The heated bare tube of 28.6mm outer diameter was located at a height of 26.5cm from the distributor plate. The influence of bed particle diameter (Dp), fluidizing velocity (U) were studied on single bare tube and bare tube bundle arrangement.

For small particles it was observed from the experimental data that the heat transfer behaviour of single bare tube and bare tube bundles (in-line and staggered) followed the general trends reported by earlier investigators. The experimental results showed that there is very little difference between the thermal behaviour of single bare tube and bare tube bundles (in-line and staggered). These observations, valid within the parametric range employed here, are in general accordance with those of earlier investigators.
New, direct, and physically meaningful correlations to predict average Nusselt numbers based on easily measurable quantities are presented for single bare tube and bare tube bundles (in-line and staggered). It is found that new, direct correlations give better predictions than indirect correlations with the additional advantage of eliminating the necessity of individual correlations like bed porosity $\varepsilon$ and sphericity of solid particle $\phi_s$.

The various new correlations predict the experimental data within a maximum deviation range from $\pm8\%$ to $\pm13\%$ and are valid for $3780 < \text{Ar} < 13858$.

In large particles also new and direct physically meaningful correlations to predict average Nusselt number are presented for single horizontal bare tube and bare tube bundles (in-line and staggered), incorporating experimentally easily measurable quantities.

The various new correlations predict the experimental data within a maximum deviation ranging from $\pm10\%$ to $\pm13\%$ and valid for $140000 < \text{Ar} < 2.54 \times 10^5$.

This study also concerns a systematic approach to predict experimental heat transfer parameters using artificial neural network in MATLAB environment. This thesis highlights the use of feed forward network especially with back propagation structures using Levelberg – Marquardt’s learning rule. The training style used in this study was batch training. Data for training of artificial neural network was divided into two parts. One set of parameters known as training data is used for training network. Second part of data known as test data is used for the testing of the extent of learning the network while the network is being trained. In the present study 70% of data is used for training and remaining 30% is used for testing. Performance evaluation of the network was done by regression analysis and most of the results obtained match very well with experimental data in training and testing.
Information generated in the present investigation will be useful for the design of heat exchangers for waste heat recovery system. Prediction of heat transfer through artificial neural network gives higher reliability with decreased decision-making time and the accuracy of prediction is acceptable in site conditions and can be employed by Mechanical and Chemical engineers.