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APPLICATION OF AN ARTIFICIAL NEURAL NETWORK IN GAS-SOLID (AIR-SOLID) FLUIDIZED BED : HEAT TRANSFER PREDICTIONS

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ABSTRACT

This paper presents heat transfer analysis of in-line arrangement of bare tube bundles in gas-solid(air-solid) fluidized bed and predictions are done by using Artificial Neural Network (ANN) based on the experimental data. Measurement of average heat transfer coefficient was made by local thermal simulation technique in a cold square bubbling air-fluidized bed of size 0.305m x 0.305m. Studies were conducted for bare tube bundles of in –line arrangement using beds of small (average particle diameter less than 1mm) silica sand particles and of large (average particle diameter greater than 1mm) particle (raagi and mustard). Within the range of experimental conditions influence of bed particle diameter (D_p), fluidizing velocity (U) were studied, which are significant parameters affecting heat transfer.

Artificial neural networks (ANNs) have been receiving an increasing attention for simulating engineering systems due to some interesting characteristics such as learning capability, fault tolerance, and non-linearity.

Here, feed-forward architecture and trained by back-propagation technique is adopted to predict heat transfer analysis found from experimental results. The ANN is designed to suit the present system which has 3 inputs and 2 outputs. The network predictions are found to be in very good agreement with the experimental observed values of bare tube heat transfer coefficient (h_b) and Nusselt number of bare tube (Nu_b).

KEYWORDS: Artificial neural network; Gas-solid fluidized bed; Particle diameter; Fluidizing velocity.

INTRODUCTION

An Artificial Neural Network (ANN) is a massively parallel-distributed processor made up of simple processing units that has a natural propensity for storing experimental knowledge and making it available for use [1]. It is an information-processing paradigm that is inspired by the way the biological nervous system such as brain process information. It is composed of large number of highly interconnected processing elements (neurons) working in unison to solve specific problem. Neural networks are widely accepted as a technique offering an alternative way to tackle complex and ill-defined problems. Thy can learn from examples, are able to deal with non-linear problems, and once trained can perform prediction at very high speed. It has a wide variety of applications: pattern recognition,prediction,estimation,decisionmaking,system control,etc.

Various types of ANNs are Multi Layer Perceptrons (MLPs), Radial Basis Function Neural Networks (RBFNNs) and Counter propogation Neural Networks (CPNNs), etc. The most commonly used method for prediction in mechanical and chemical engineering application is MLP, which is a feed forward neural network. It consists of multi-layer hierarchical structure, which consists of input layer, output layer and at least one layer of processing units between them. The layers between the input and output layers are termed hidden layer. Each layer has some units corresponding to neurons. The units in neighboring layers are fully interconnected with links corresponding to synapses. The strengths of the connections between 2 units are called “weights”. The number of hidden layers or number of units in hidden layers is arbitrarily defined. In each hidden layer and output layer, the processing unit sums its input from the previous layer and then applies the sigmoidal / logistic function to compute its output to the next layer according to the following equation :

$$S = \sum_{i=1}^{p} W_{ij} X_i$$