ABSTRACT

Experimental investigations are made to study the heat transfer characteristics in circulating fluidized beds. The experimental work is divided into two parts. The first part is the cold bed studies where the axial variation of heat transfer coefficient along the riser wall, and the horizontal tube heat transfer characteristics in the top region of a CFB riser column including the effect of fins and fin shapes are investigated. For the axial heat transfer studies two mild steel test sections are used and their positions are interchanged along the riser wall at the desired locations. The horizontal tube sections (bare tube, V-fin tube and sqauare fin tube) are located at a height of 4.3 m above the distributor plate in the riser column.

The second part is the hot bed experiments where the heat transfer characteristics at various riser heights i.e 1.8m, 2.3m and 3.4m above the distributor plate are studied with the help of heat transfer probes. Experiments are also conducted to investigate the effect of fins for a water wall probe located at a height of 3.1 m above the distributor plate. Experiments are conducted with lateral fins as well as with both lateral and extended fins on the water wall probe.

Local sand of mean size 248 μm is used as the bed material. For cold bed studies the primary air velocity is varied between 4.21 m/s to 7.30 m/s. Heat fluxes of 529.41 W/m^2 and 960.85 W/m^2 for axial heat transfer studies and 5894.63 W/m^2 and 6941.79 W/m^2 for horizontal tube investigations are employed. In the hot bed both coal and liquid petroleum gas are burned. The primary air velocity is varied beween 3 to 7 m/s. For both cold and hot bed studies the suspension density ranged between 2 and 70 kg/m^3. For cold bed 17, 20 and 25 kg of sand and for the hot bed 25, 30 and 35 kg of sand are employed as the bed inventories.

One empirical model with the help of dimensional analysis is developed to predict heat transfer to the bare horizontal tube. The model results are compared with the experimental results, and a good agreement is observed. One simple analytical model to predict heat transfer to the water wall probe with lateral fins, and then with both lateral and extended fins is proposed. The model results are compared with the experimental data and a fair agreement is observed. The results predicted from the model are compared with the published literature and a reasonable agreement is observed.

The use of fins on horizontal tube sections reduces the heat transfer coefficient, but the heat flow ratio is enhanced due to increased surface area by the addition of fins. The square fin setion is more effective than V-fin section for the same operating conditions. The addition of extended fin to the water wall probe with lateral fins results in a drop in heat transfer coefficient, but the total heat flow rate again increases due to more surface area provided. The heat transfer coefficient increases with both bed temperature and suspension density, but the suspension density is the more dominating parameter.