Experiment No. II

Determination of Heat Transfer Co-efficient in a Fluidized Bed

• Objective:

Investigation of the effect of

a) Superficial Velocity
b) Depth of Immersion

On the surface heat transfer co-efficient for a hot surface in an Air Fluidized Bed

• Preparation:

Ensure that the Voltmeter, Ammeter and Manometers have been zeroed.

Calibration of Orifice for Higher Flow Rates

i) Ensure that the manometers are correctly filled and zeroed.
ii) Turn on the compressed air supply – and with the control valve set the airflow to 1.5litre per sec on the variable area meter.
iii) Note the orifice differential pressure (x cm) indicated the right-hand manometer.

Calibration: Since air flow is proportional to $\sqrt{x}$, $k = \frac{1.5}{\sqrt{x}}$

Now, determine the higher flow rates from the equation $Q_m = k\sqrt{x}$

• Procedure:

Set the heater to a convenient height above the distributor (say 4 cm).

Turn the airflow to a high value and allow the bed to mix thoroughly for two or three minutes.

Adjust the variable transformer until the desired heater surface temperature (t_1) is obtained (about 100^0 C is suitable).

Allow conditions to stabilize, then note

i) Heater surface temperature **t_1**
ii) Bed temperature **t_2**
iii) Air temperature **t_3**
iv) Heater voltage **V**
v) Heater current **A**
vi) Air flow rate (or orifice differential)

Reduce the airflow, reset the variable transformer to obtain the desired value of t_1 then repeat the observations.

Repeat in convenient steps until the air control valve is closed.

Calculation of heat transfer coefficient (h) at steady state

Temperature correction at the Bed $\left(Q_b = Q_m \frac{t_2}{t_3} \right)$

$$V I = A_s \, h (t_1 - t_2)$$

$$h = \frac{V I}{A_s (t_1 - t_2)}$$

Where, V = Heater e.m.f (Volt)

I = Heater Current (Amp.)

A_s (Surface area of the Heater) = 1.6×10^{-3} m^2

Bed Data:

Bed Material: Fused Alumina Grit (Al_2O_3)

Mean Particle size = 250 µm

Density of particle = 3770 kg m^{-3}

Cross sectional area (S_b) = 8.66×10^{-3} m^2

Mass of particle = 1.3 kg

Bed Chamber:

Nominal Dia. = 105 mm

Nominal length = 220 mm

Density of air:

1.2 kg m^{-3}

Heating element:

Dia. = 12.7 mm

Long = 37 mm

Surface area 16 cm^2

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OBSERVATION AND RESULT SHEET

Height of Heater above Distributor (cm)	Orifice Differential Pressure (x) (cm H_2O)	Air Flow Rate $\left(Q_m = k\sqrt{x}\right)$ (lit/s)	Heater Surface Temperature (t_1) (^0C)	Bed Temperature (t_2) (^0C)	Air Inlet Temperature (t_3) (^0C)	Heater e.m.f (V) (volt)	Heater Current (I) (amp)	Corrected Air Flow Rate $\left(Q_b = Q_m \frac{t_2}{t_3}\right)$ (lit/s)	Superficial Velocity (V_{sup}) $\left(V_{sup} = \frac{10^{-3} Q_b}{S_b}\right)$ (m/s)	Heat Transfer Co-efficient $h = \frac{V I}{A_s (t_1 - t_2)}$ ($KW/m^2.K$)