Exp-7

HUMIDIFICATION & DEHUMIDIFICATION SETUP

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OBJECTIVE:

To study the mass transfer operation in humidification & dehumidification column for different flows & thermodynamic conditions

WORKING PRINCIPLE:

The mass transfer coeff. k_a, can be measured in a humidification column in which the area of contact b/w two phases is known and boundary layer separation doesn't take place. Humidification & dehumidification column also provides useful info. on mass transfer to and from fluids in turbulent flow, too.

For turbulent flow mass transfer to pipe wall involving evaporation of liquids in wetted wall & towers, fell and Sherwood proposed the correlation various dimensionless groups that control the phenomenon are:

$$N_{Sh} = 0.023 \left(N_{Re}^{0.81}\right)\left(N_{Sc}^{0.44}\right)$$

$$\frac{k_a x d}{D} = 0.023 \left(\frac{d \times v \times \rho}{\mu}\right)^{0.81} \left(\frac{\mu/\rho}{D\rho}\right)^{0.44}$$

where, $Re = \frac{d v \rho}{\mu}$, $Sc = \frac{\mu}{\rho D}$, Sherwood no. $= \frac{k_a d}{D}$

EXPERIMENTAL PROCEDURE:

Starting procedure:

1. Ensure that switches given on the panel are at off position.
2. Close all the valves provided on the setup
3. Fill the sump tank with water
4. Connect the air supply to the set-up.
5. Set the desired air temp. in the DTC by operating the increment or decrement and set button of DTC
6. Switch ON the pump
7. Allow water to flow through condenser by control valve provided & ensure that water is coming out from the outlet of condenser

(8) Start the compressed air supply & adjust the flow rate of air by rotameter provided

(9) Start the operation with min. overflow

(10) Switch ON the heater & wait till desired temp. achieves

(11) Allow water to flow through humidification column & adjust the flow rate by rotameter & control valve

(12) After every 10-15 min., note down the temp. & flow rate readings by DTI & rotameter provided up + steady state

(13) Simultaneously the temp. of the water in & out is noted & flow rates measured

(14) Repeat the experiment for diff. air & water flow rates

(15) Repeat experiment for diff. air temp.

CLOSING PROCEDURE:

(1) Switch OFF the heater.

(2) Switch OFF the pump

(3) Switch OFF the main power supply

(4) Drain water tank by open the drain valve

OBSERVATION TABLE:

Set-1 Data:

Diameter of column = 0.048m

Length of column, L = 0.5m

Total pressure, $P_T = 1.01325$ bar

Diffusivity of air $D = 25.83 \times 10^{-6} m^2/s$.

Observation Table												
SL. No	Fa	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Fw
1	15	26.2	26.4	32.3	30.2	26.5	26.3	26.7	26.4	26.8	27	30
2	23	26.8	26.6	37	33	26.7	26.9	27.2	26.7	27	26.8	30
3	23	26.9	26.6	37.5	33.4	26.6	26.8	27.2	26.7	27	26.4	40
4	23	26.8	26.6	37.6	34.2	27.2	26.7	27.6	27	27.4	27	60

CALCULATIONS :

$H_1 = 0.0266$ kg/kg dry air (T_3, T_4)

$H_2 = 0.0217$ kg/kg dry air (T_5, T_6)

$H_3 = 0.0218$ kg/kg dry air (T_7, T_8)

$H_4 = 0.0227$ kg/kg dry air (T_9, T_{10})

$T = 302.4$ K

$\rho = 1.16$ kg/m^3 $\quad \mu = 1.857 \times 10^{-5}$ N.s/m^2

$A = \frac{\pi}{4} d^2 = 0.001809$ m^2 $\quad V = \frac{f_a}{1000 \times 60 \times A} = 0.13$ m/s

Calculation Table										
SL. No	H1	H2	H3	H4	T	Rho	Viscocity	A	V	Ka
1	0.0266	0.0217	0.0218	0.0227	302.4	1.167286	0.00001857	0.001809	0.138225	5.53E-05
2	0.0308	0.0223	0.0221	0.0223	304.85	1.157905	0.00001869	0.001809	0.211946	7.73E-05
3	0.0315	0.0221	0.0221	0.0216	305.05	1.157146	0.0000187	0.001809	0.211946	7.72E-05
4	0.0334	0.0226	0.0224	0.0225	305.4	1.15582	0.00001871	0.001809	0.211946	7.71E-05

RESOLT:

The exp. was performed and the k_a values are obtained as given below:-

	k_a
Set - 1	5.53×10^{-5} m/s
Set - 2	7.73×10^{-5} m/s
Set - 3	7.72×10^{-5} m/s
Set - 4	7.71×10^{-5} m/s

PRECAUTIONS:

1. Never ~~leave~~ run the apparatus when voltage is $<180V$ or $>230V$
2. Never Switch ON main power supply before ensuring that all the ON/OFF
3. Operator selector switch of temp. indicator gently
4. Always keep the apparatus free from dust
5. Wet-bulb bottle should be filled with water before starting the experiment.