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| **Unit Operations II - Chem.E**<br>First name: ……<br>Last name: ……. | |

# Continuous Assessment No. 1 - Correction

## Exercise –

It is desired to obtain **humid air (B)** having a temperature of **30°C** and a relative humidity of **40%** from **humid air (A)** at a temperature of **25°C** and a wet-bulb temperature of **13.5°C**.

**1)** Propose the operations necessary to carry out this humidification.

**2)** Indicate these operations on the humidity diagram.

**3)** Calculate the heat required if the mass flow rate of dry air treated is **3 kg/s**.

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## Response –

Assumption atmospheric pressure: P = 101.325 kPa

**1) Operations necessary to carry out this humidification:**

Initial state (1):

$T_{db,1}$=25 °C

$T_{wb,1}$=13.5 °C

Using the property that the enthalpy of moist air is approximately equal to that of saturated air at the wet-bulb temperature:

$$h_1 \approx 38\ kJ/kg_{dry\ air}$$

From this, we deduce:

$$H_1 \approx 0.0050\ kg/kg_{dry\ air}$$

Final state (2):

$T_2 = 30$

$H_{R,2} = 40\%$

$$P_v^s(30 \circ C) \approx 4.24\ kPa$$

$$P_{v,2} = 0.4 \times 4.24 = 1.696\ kPa$$

$$H_2 = 0.0106\ kg/kg_{dry\ air}$$

We observe:

$$T_2 > T_1$$
$$H_2 > H_1$$

Required operations:

- Sensible heating, and
- Humidification by steam injection.

**2) Representation on the Psychrometric Chart:**

On the humidity (psychrometric) chart:

***i.*** Plot point (1): 25 °C, $T_{wb}$ = 13.5 °C

***ii.*** Draw a horizontal line (sensible heating): → temperature increases at constant humidity ratio.

***iii.*** Then humidification by steam injection:

→ simultaneous increase of H and h

→ inclined trajectory upward until reaching point (2).

Final point (2) is located at: 30°C and 40% relative humidity.

**3) Calculation of Required Heat :**

Enthalpies:

$$h_1 \approx 38\ kJ/kg_{dry\ air}$$

$$h_2 = 1.005(30) + 0.0106(2500 + 1.88(30))$$

$$h_2 \approx 57.2 kJ/kg_{dry\ air}$$

Enthalpy variation

$$\Delta h = h_2 - h_1$$

$$\Delta h = 57.2 - 38$$

$$\Delta h = 19.2\ kJ/kg_{dry\ air}$$

Required thermal power

$$Q = m_{dryair} \times \Delta h$$

$$Q = 3 \times 19.2$$

$$Q = 57.6\ kW$$