Class: 4th Stage
Subject: air conditioning and refrigration
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Heating and Humidification

Objectives practical study of the source processes for heating air with addition of moisture

Introduction

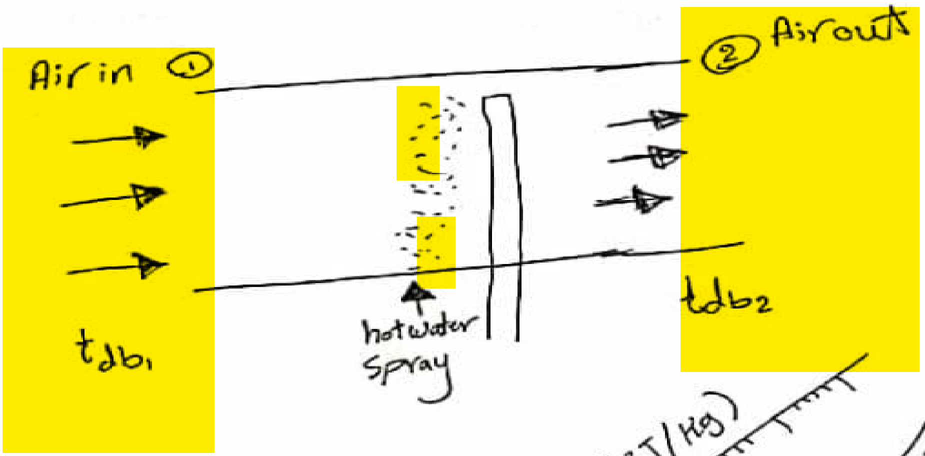
Procedure

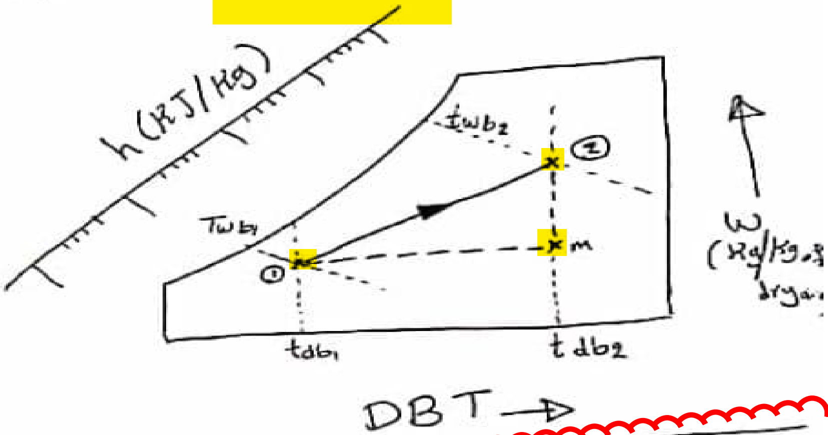
This is the process of introducing moisture into the airstream. In winter, humidification frequently is required because the cold outside air, infiltrating into a heated space or intentionally brought in to satisfy the space ventilation requirement, is too dry. In summer, humidification is usually done as part of an evaporative cooling system. Humidification is achieved in various ways that range from using spray washers to passing the air over a pool of water to injecting steam.
Heating and Humidifying is the process of simultaneously increasing both the dry-bulb temperature and humidity ratio of the air. The total heat gained (Q or q) in going from the initial to the final condition can be broken into sensible and latent heat portions. To separate the total enthalpy into sensible and latent heat, consider a horizontal movement on the chart as sensible heat and a vertical movement as latent heat. The humidity ratio is constant for the horizontal movement (sensible) and the dry-bulb temperature is constant for the vertical movement (latent).

On psychrometric chart, this process is shown as a line sloping upward and to the right. The heating and humidification of the air is best considered by looking at the two processes sequentially. The first, from state 1 to state 0, is the sensible heating that occurs when the air passes through the heat exchanger. The second, from state 0 to state 2, is the humidification process.

②

① "Example on Heating and humidification"





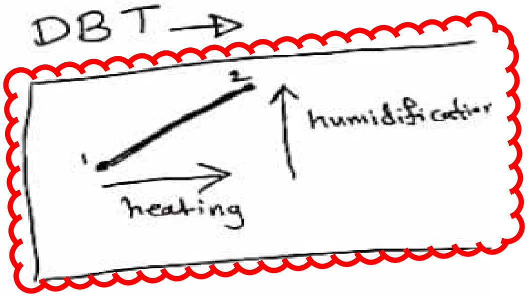
* aT entering

T_{db_1}, T_{wb_1}, ...

* at exiting

T_{db_2}, T_{wb_2}, ...

* process from ① → ②



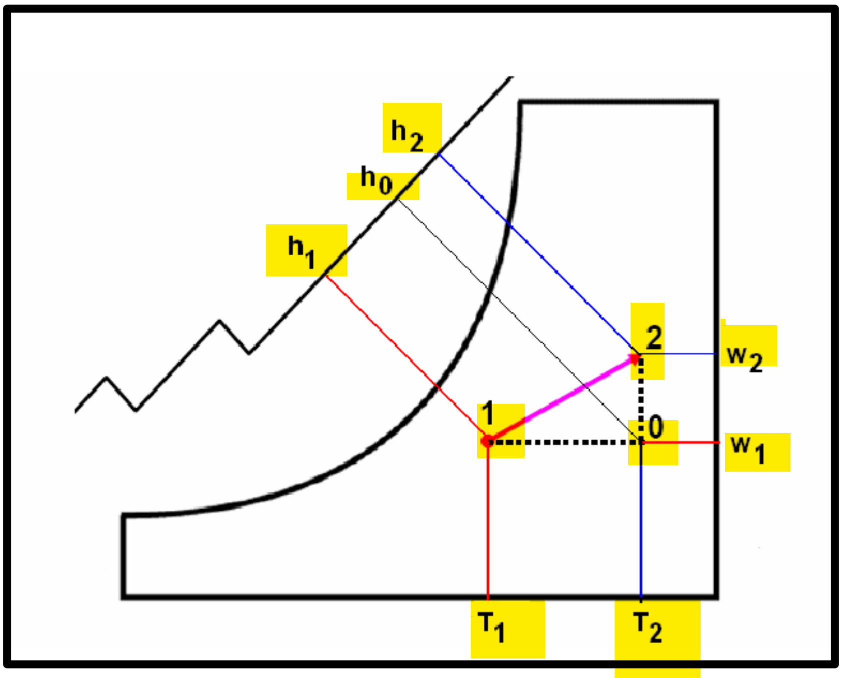
* Sensible heating from ① → m

$$Q_s = \dot{m}(h_m - h_1)$$

* Latent heat from ② → m

$$Q_L = \dot{m}(h_2 - h_m)$$

$$Q_{Total} = Q_s + Q_L$$
$$= \dot{m}(h_m - h_1) + \dot{m}(h_2 - h_m)$$
$$= \dot{m}h_m - \dot{m}h_1 + \dot{m}h_2 - \dot{m}h_m$$
$$= \dot{m}h_2 - \dot{m}h_1$$
$$= \dot{m}(h_2 - h_1)$$



Theory and Principles

Governing Equation for Heating and Humidification

If the condition of the air is changing from state 1 to state 2, consider that the intersection of a horizontal line through state 1 and a vertical line through state 2 occurs at state 0. Then the change in heat can be expressed as:

$$Q_s = m_a \times (h_o - h_2)\ \ OR\ q_s = (h_o - h_2)\ \ \ldots\ldots\ldots\ldots(1)$$

$$Q_l = m_a \times (h_1 - h_o)\ \ OR\ q_s = (h_1 - h_o)\ \ \ldots\ldots\ldots\ldots(2)$$

$$Q_T = m_a \times (h_1 - h_2)\ \ OR\ Q_T = (Q_s + Q_L)\ \ldots\ldots\ldots\ldots(3)$$

Where:

- Q_s = sensible heat added.
- Q_L= latent heat added.

- Q_T= Total heat added.
- m_a = Mass of dry air, [= (volume of air)/(specific volume of moist air]
- h = Enthalpy of dry air.

The rate of moisture addition to the air, Mw, is determined by a water vapor mass balance:

$$M_w = m_a \times (W_2 - W_1) \quad \text{...(4)}$$

Where:

- W_2 = humidity ratio of the moist air upstream of the humidifier.
- W_1 = humidity ratio of the moist air downstream of the humidifier.