



ROHINI

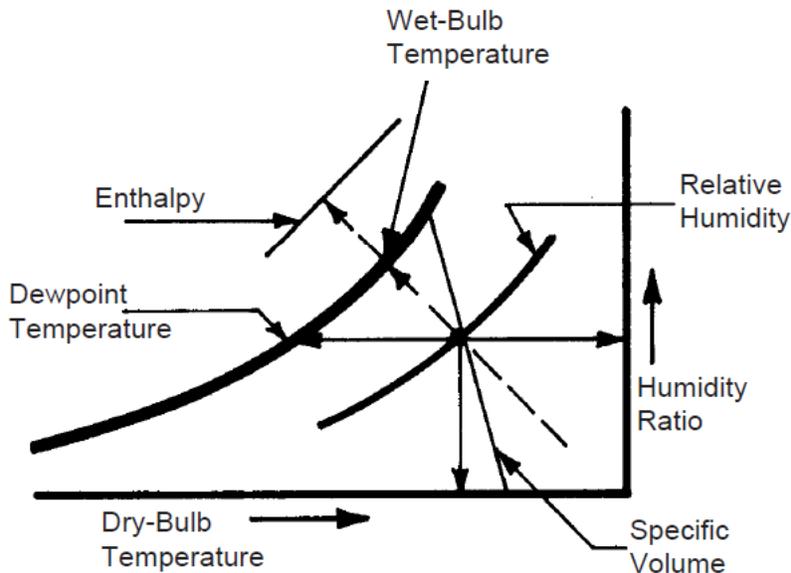
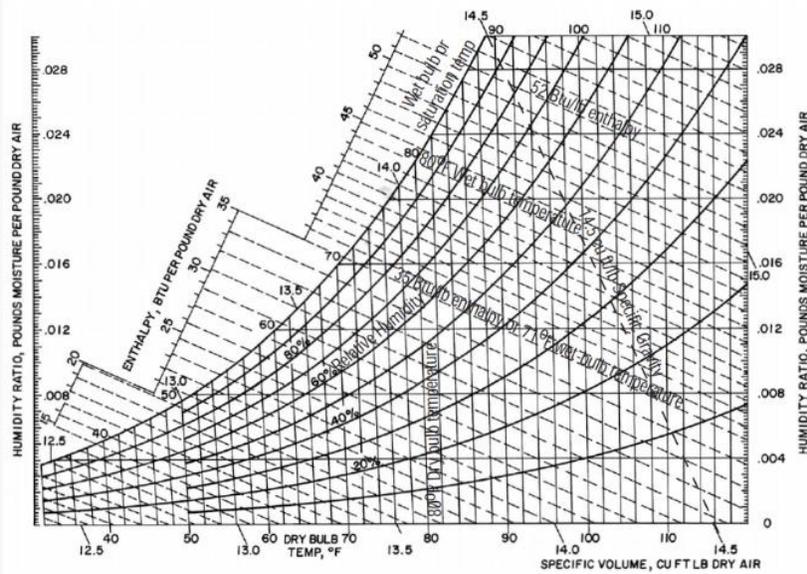
COLLEGE OF ENGINEERING & TECHNOLOGY

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UNIT III

Psychrometric Chart and Air Characteristics

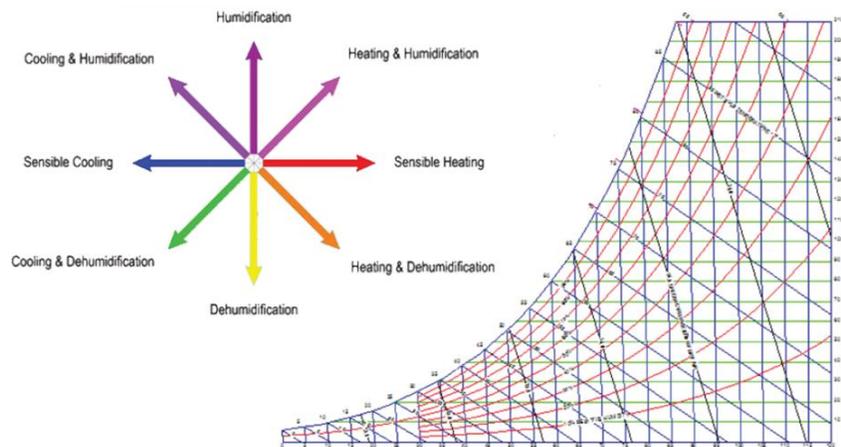


Uses of Psychrometric Chart

The psychrometric chart conveys an amazing amount of information about air. It provides an invaluable aid in illustrating and diagnosing environmental problems such as why heated air can hold more moisture, and conversely, how allowing moist air to cool will result in condensation. To predict whether or not moisture condensation will occur on a given surface you need three pieces of information; the temperature of the air, the relative humidity of the air, and the surface temperature. The psychrometric chart explains that by raising the surface temperature or by lowering the moisture content of the air or employ some combination of both can avoid surface condensation.

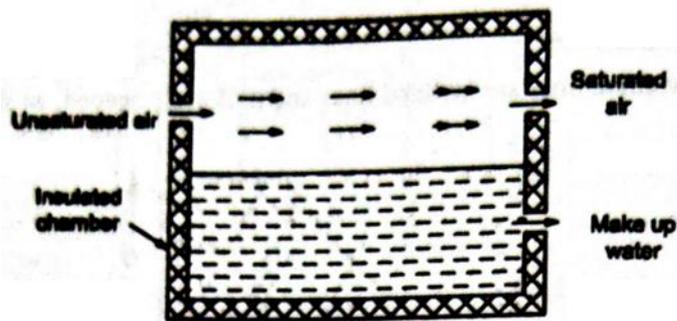
A rule of thumb is that, a 10°F rise in air temperature can decrease relative humidity 20

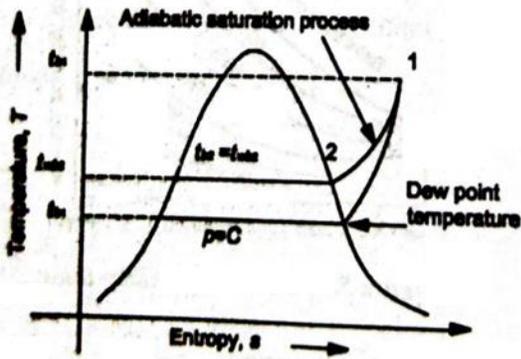
percent. Use of a psychrometric chart will show that this is true.



Adiabatic saturation process

When unsaturated air flows over a long sheet of water in an insulated chamber, the water is evaporated and specific humidity of air is increased. Both air and water are cooled as the evaporation takes place. The process continues until the energy transformed from the air to the water is equal to the energy required to vaporize the water.





When this point is reached, thermal equilibrium exists with respect to the water, air and water vapour, the air attains consequently the saturation point. The equilibrium temperature is called *adiabatic saturation temperature* of thermodynamic wet bulb temperature. The make-up water is introduced at this temperature to keep the water level constant. The adiabatic cooling process is shown in Figure for the vapour in the air-vapour mixture. Although the total pressure of the mixture is constant, the partial pressure of vapour increases corresponding to the adiabatic saturation temperature.

Vapour initially t_{d1} is cooled adiabatically to t_{d2} which is equal to adiabatic saturation temperature t_{wb2} . WBT lies between DBT and DPT. System is insulated and no work is done.

$$Gh_{a1} + m_1 h_{w1} + (m_2 - m_1) h_{f2} = Gh_{a2} + m_2 h_{w2}$$

where

$(m_2 - m_1)$ be the mass of water added

h_{f2} be the enthalpy of liquid water at $t_2 = t_{wb2}$

h_a is the specific enthalpy of dry air

h_w is the specific enthalpy of water vapour in air.

Dividing by G on both sides, and since $h_{w2} = h_{g2}$,

$$h_{a1} + \omega_1 h_{w1} + (\omega_2 - \omega_1) h_{f2} = h_{a2} + \omega_2 h_{g2}$$

$$\omega_1 = \frac{(h_{a2} - h_{a1}) + \omega_2 (h_{g1} - h_{f1})}{h_{w1} - h_{f2}} = \frac{C_{Pa} (T_2 - T_1) + \omega_2 h_{fg2}}{h_{w1} - h_{f2}}$$

$$\text{where } \omega_2 = \frac{m_2}{G} = \frac{m_s}{G}$$

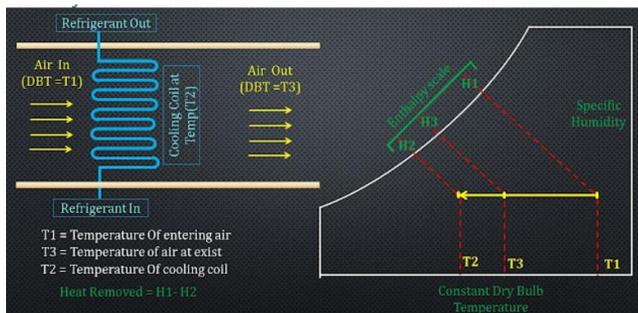
$$\text{Specific humidity, } \omega = 0.662 \frac{P_s}{P - P_s}$$

1. Sensible cooling:

Sensible cooling is the process of removing heat from a substance to lower its temperature without changing its moisture content. This is achieved by passing the substance, like air, over a cooler surface, which lowers its dry-bulb and wet-bulb temperatures while keeping its humidity ratio constant. A common example is an air conditioner lowering the air temperature as it passes over a cold evaporator coil. cooling of air without any change in its specific humidity is called sensible cooling.

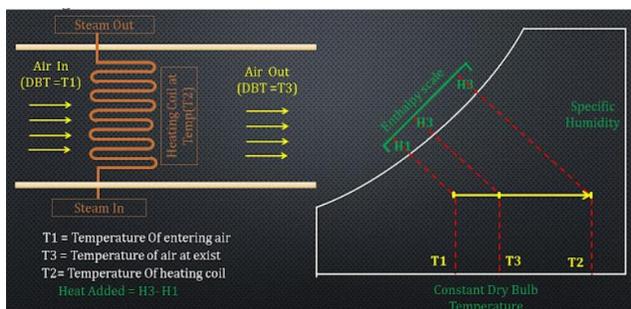
In perfect cooling entering air at temperature T_1 will be cooled down to temperature T_2 , but perfect cooling is not possible in a practice because of loss of cooling effect due to some reason such as conduction, Convection and Bypass hence air leaving will not be called from T_1 to T_2 but for some higher temperature T_3 .

$$\text{Heat rejected} = H_1 - H_3$$



2. Sensible heating:

Sensible heating is the process of increasing or decreasing the temperature of a substance without changing its phase, such as when you heat a pot of water on a stove. It is the energy you can "sense" or measure with a thermometer, in contrast to latent heat, which is released or absorbed during a phase change like melting or boiling. In HVAC systems, sensible heating is the transfer of heat that raises the temperature of air. Hitting of air without change in its specific humidity is called sensible heating. It is added $H_3 - H_1$.

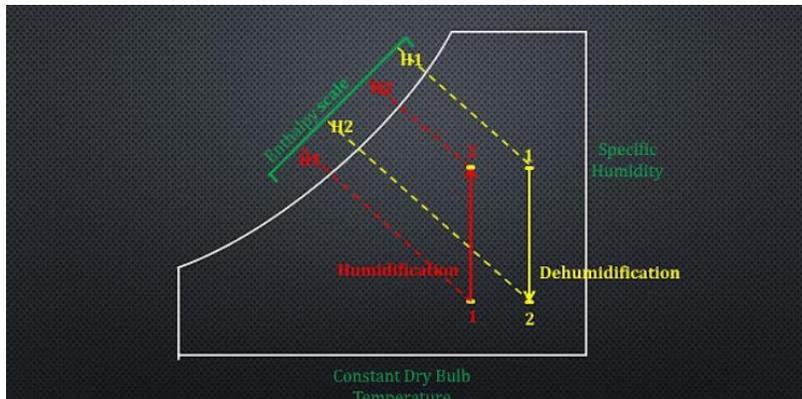


3. Humidification and dehumidification:

Addition of moisture to air without change in its a dry bulb temperature is known as humidification.

similarly removal of moisture without change in dry bulb temperature is known as dehumidification.

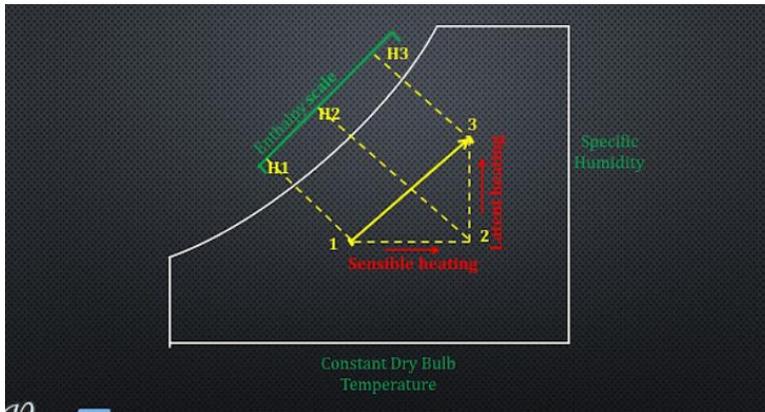
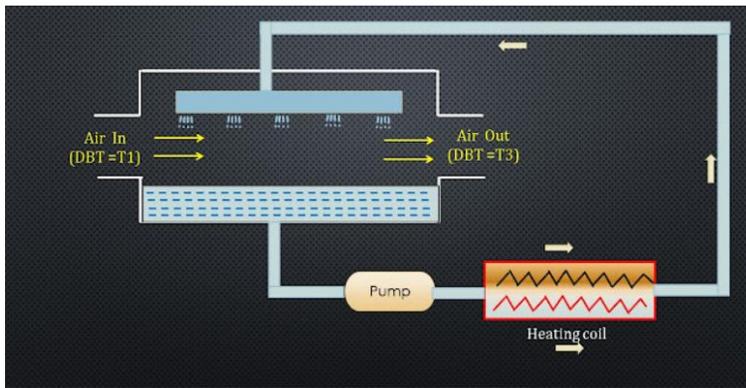
H2 - H1 does not involving change in temperature but actually practice absolutely modification and humidification is not possible. It is always accompanied by heating or cooling.



4. Heating with Humdification:

Heating with humidification is a combined process that simultaneously increases the temperature and moisture content of air, typically in HVAC systems during winter. This is achieved by using a heating element to raise the air temperature and a humidifier to add water vapor, either through steam injection or water spraying. The heating portion involves adding sensible heat to increase the air's temperature, while the humidification portion adds latent heat to increase the moisture content. As shown in the figure spraying hot water in air increases DBT and specific humidity of incoming air .This process is called heating and humidification and it generally used in winter air conditioning.

Total heat added = H3-H1



5. Cooling with Dehumidification:

Cooling with dehumidification is the process of lowering both the air temperature and its moisture content by passing air over a coil colder than the air's dew point. This causes water vapor to condense on the coil, which is then collected as liquid water, reducing both humidity and temperature. It is a fundamental part of how air conditioners work and is especially useful in hot, humid climates to improve comfort.

How it works

- **Airflow over cold coil:** Warm, humid air is blown across a cooling coil, which contains a cold refrigerant or chilled water.
- **Heat transfer:** Heat from the air is absorbed by the refrigerant, which is then carried away, cooling the air.
- **Condensation:** When the air cools below its dew point temperature, the water vapor it holds condenses into liquid water on the surface of the cold coil.
- **Moisture removal:** This condensed water drips off the coil, effectively removing moisture from the air and lowering the overall humidity.

