

PSYCHROMETRICS

1. Definitions
2. Processes
3. Evaporative Cooling

Definitions

Psychrometrics:

Thermodynamics properties

Analyze conditions and properties

Moist Air

Definitions

Dry Air

Water Vapor

Moist Air

Saturation

Perfect Gas Equation

$$pV = nRT$$

Terms

Dry Bulb db – deg - Temperature of air with no evaporation occurring 72 deg

Wet Bulb wb – deg - Temperature of air at equilibrium with full evaporation occurring 56.2 deg

Relative Humidity RH – % - Percentage of moisture in the air compared to the maximum allowable AT THAT TEMPERATURE 40%

Terms

Dew Point dp – deg - Surface Temperature where Condensation Occurs 46.4

Enthalpy h – BTU/lb – Pressure x Volume Energy and Internal Energy 26.2

Absolute Humidity – lb/lb – general number is 0.008 lb/lb da , 1% lbs water / lb dry air

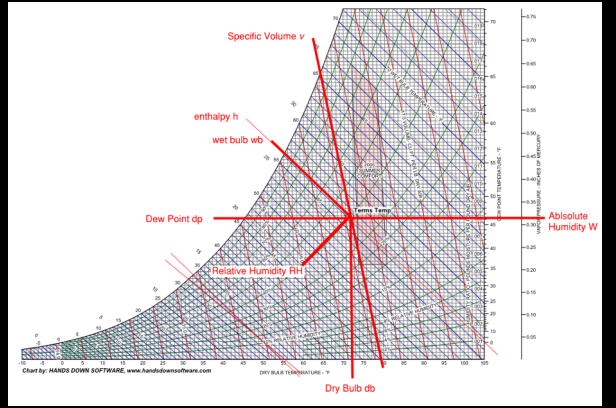
grains/lb – there are 7,000 grains in a lb

Specific Volume V – ft³/lb – 16.5 ft³/lb

Density p – lb/ft³ - 0.061 lb/ft³

Density and Specific volume are reciprocals of each other

Terms

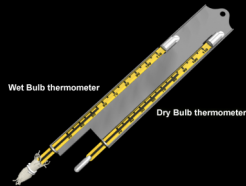


Process Terms

- Sensible Heating
- Sensible cooling
- Dehumidification/Cooling coil line
- Sensible heat load
- Evaporative Cooling
- Humidification
- Comfort window

Definitions

Dry Bulb
Wet Bulb



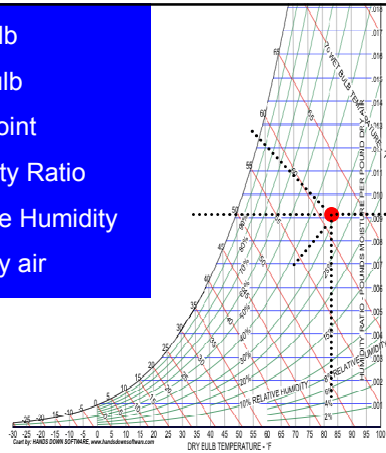
Dew Point



Fog Occurs When Air Is Saturated

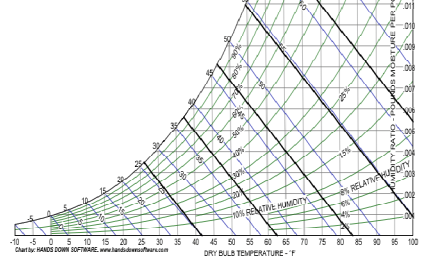


- Dry Bulb
- Wet Bulb
- Dew Point
- Humidity Ratio
- Relative Humidity
- lb of dry air

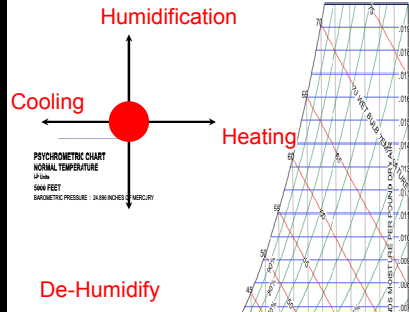


Enthalpy

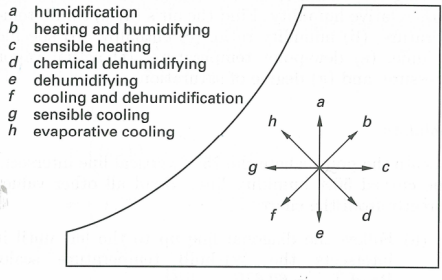
PSYCHROMETRIC CHART
NORMAL TEMPERATURE
14.7 psia
5000 FEET
BAROMETRIC PRESSURE : 24.89 INCHES OF MERCURY



Basic Processes



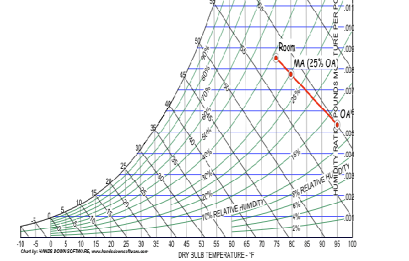
PSYCHROMETRIC CHART
NORMAL TEMPERATURE
14.7 psia
5000 FEET
BAROMETRIC PRESSURE : 24.89 INCHES OF MERCURY



- a humidification
- b heating and humidifying
- c sensible heating
- d chemical dehumidifying
- e dehumidifying
- f cooling and dehumidification
- g sensible cooling
- h evaporative cooling

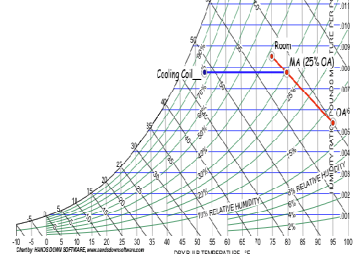
Mixed Air

PSYCHROMETRIC CHART
NORMAL TEMPERATURE
14.7 psia
5000 FEET
BAROMETRIC PRESSURE : 24.89 INCHES OF MERCURY



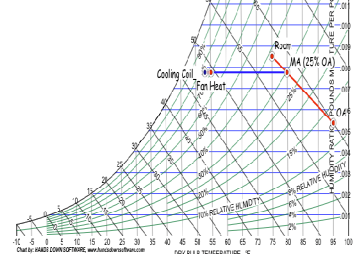
Cooling Coil

PSYCHROMETRIC CHART
NORMAL TEMPERATURE
14.7 psia
5000 FEET
BAROMETRIC PRESSURE : 24.89 INCHES OF MERCURY

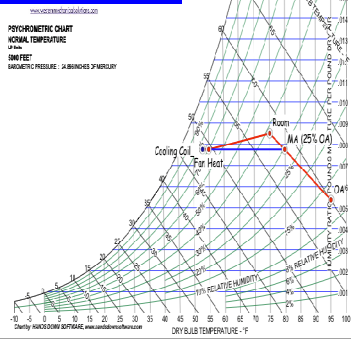


Fan Heat

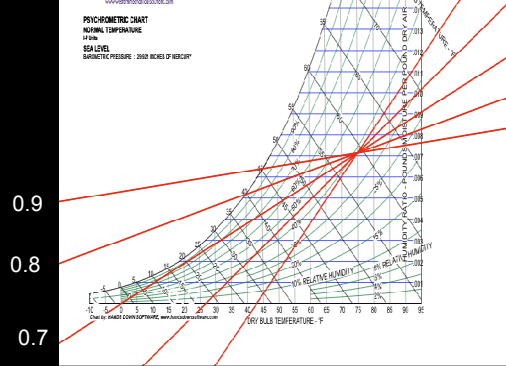
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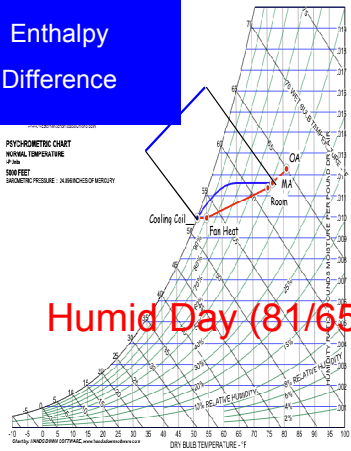
People Latent Load



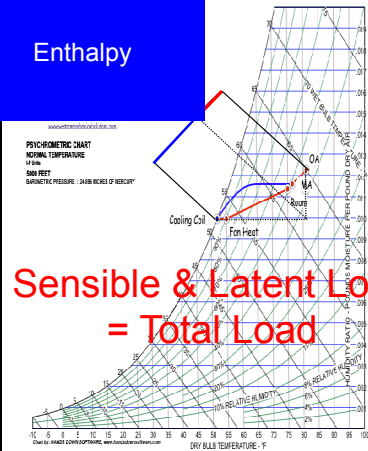
Latent



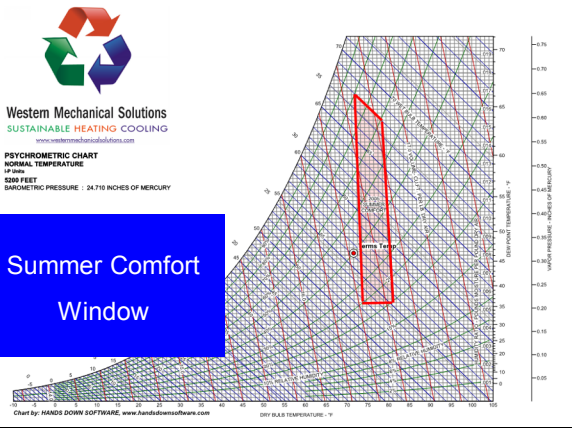
Enthalpy Difference



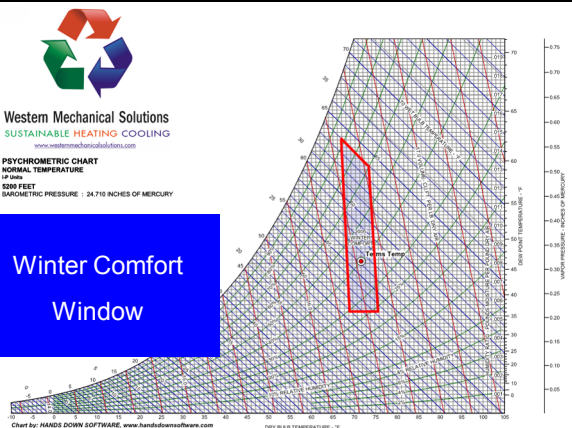
Enthalpy

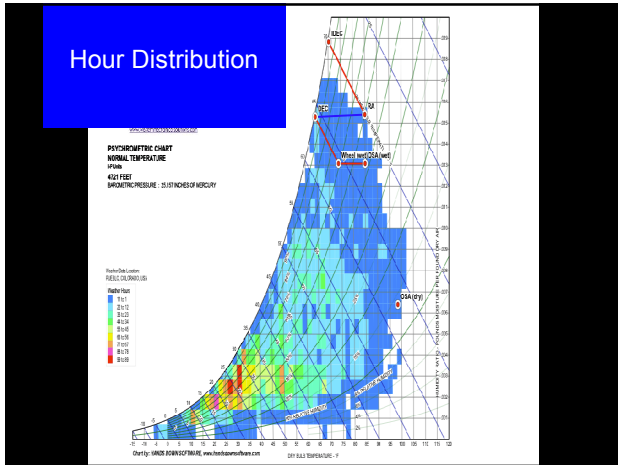


Summer Comfort Window



Winter Comfort Window





- ### Psychrometric – Formula's
- $M_{oa} = CFM / V_{oa}$
 - $M_{oa} = \text{lb}/\text{min}$
 - $CFM = \text{ft}^3/\text{min}$
 - V_{oa} – Specific volume – ft^3/lbm

- ### Psychrometric – Formula's
- Heat Transfer
 - $q = M * C_p * (t_1 - t_2) = \text{Btu}/\text{hr}$
 - M = mass of fluid lbm/hr
 - C_p – Specific heat of the fluid – $\text{BTU}/\text{lb} * \text{degF}$

- ### Psychrometric – Formula's
- Air heat of absorption / rejection Sensible
 - $q_s = M_{oa} * C_p * (t_1 - t_2) = \text{Btu}/\text{hr}$
 - $q_s = \mathbf{CFM} * 60 * C_p * (t_1 - t_2) / \mathbf{V_{oa}} = \text{Btu}/\text{hr}$
 - q_s – Sensible heat transfer
 - M_{oa} = mass of air lbm/hr
 - C_p – Specific heat of moist air – $\text{BTU}/\text{lb} * \text{degF}$
 - t_1 = entering temp degF
 - t_2 = leaving temp degF
 - $M_{oa} = CFM / V_{oa}$
 - $CFM = \text{ft}^3/\text{min}$
 - V_{oa} – Specific volume – ft^3/lbm

- ### Psychrometric – Formula's
- Air heat of absorption / rejection Sensible
 - **Generally at sea level**
 - $q_s = CFM * 1.08 * (t_1 - t_2) = \text{Btu}/\text{hr}$
 - q_s – Sensible heat transfer
 - $CFM = \text{ft}^3/\text{min}$
 - V_{oa} – Specific volume – ft^3/lbm
 - **Generally at altitude**
 - $q_s = CFM * 0.89 * (t_1 - t_2) = \text{Btu}/\text{hr}$
 - Density at sl = 0.075, Alt = 0.062
 - Density Ratio is $0.062/0.075 = 0.827$
 - Multiply $0.827 * 1.08 = 0.89$

- ### Psychrometric – Formula's
- Air heat of absorption / rejection Latent
 - $q_l = M_{oa} * (W_1 - W_2) * H_{fg} = \text{Btu}/\text{hr}$
 - $q_l = \mathbf{CFM} * 60 * (W_1 - W_2) * H_{fg} / \mathbf{V_{oa}} = \text{Btu}/\text{hr}$
 - q_l – total heat transfer
 - M_{oa} = mass of air lbm/hr
 - $W_1 - W_2$ = Difference in design humidity ratio
 - H_{fg} – latent heat of vaporization at indoor conditions – BTU/lbv
 - V_{oa} – Specific volume – ft^3/lbm