Psychrometry

- Psychrometry is the study of air-water vapour mixtures
- For an n component mixture in general, we need to specify n+1 properties to specify the thermodynamic state at equilibrium
  - We need to specify **p, T and mass fraction of water vapor**
    - For atmospheric air, p = 1.0133 bar
    - we need the Temperature (measured by a thermometer)
    - and mass of water vapor per kg of dry air (humidity ratio)

Definitions

- Dry Bulb Temperature (DBT)
  - temperature of the mixture as measured by a standard thermometer. The word ‘dry’ is used to imply that the the sensor is exposed to the vapour mixture without any liquid present
- Wet Bulb Temperature (WBT)
  - the temperature at which water evaporating into moist air at a given dry-bulb temperature and humidity ratio can bring air to saturation adiabatically at the same pressure p

Absolute and relative humidities

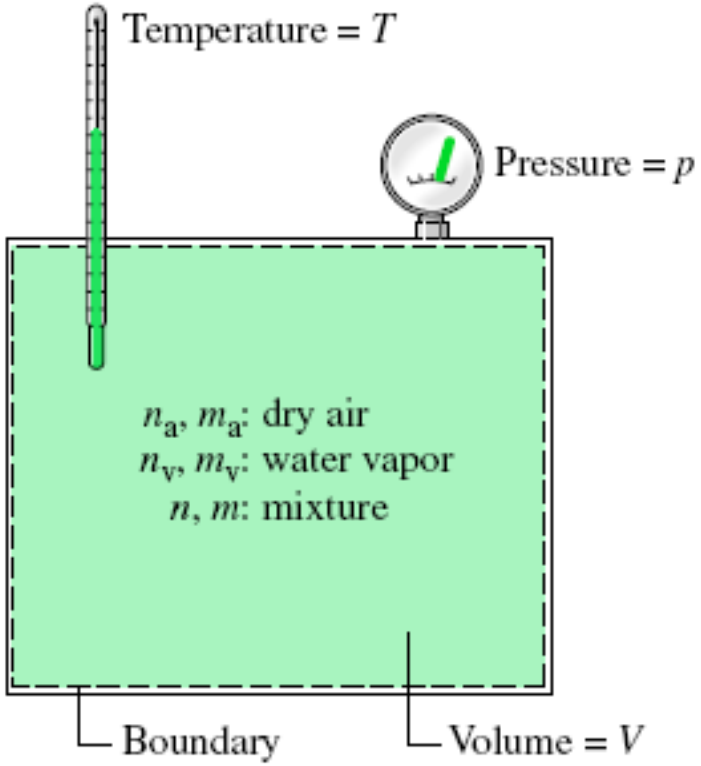
- Humidity Ratio
  - The mass of water vapor present in per unit mass of dry air

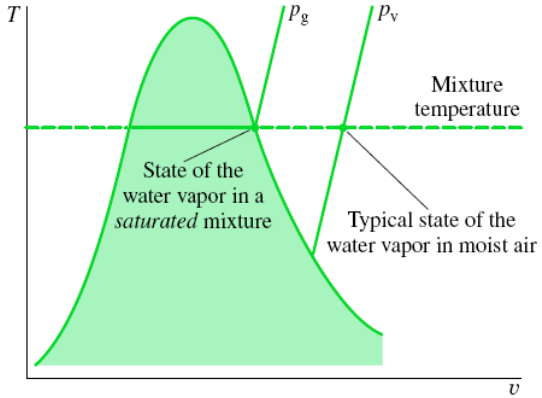
$$\omega = \frac{m_{\mathrm{v}}}{m_{\mathrm{a}}}$$

- Relative Humidity
  - Ratio of partial pressure of water vapor present in air to that required to saturate the air

$$\phi = \frac{p_{\mathrm{v}}}{p_{\mathrm{g}}}\Bigg)_{T,p}$$

Relationship between ω and ϕ





Humidity Ratio $\omega = m_v/m_a$

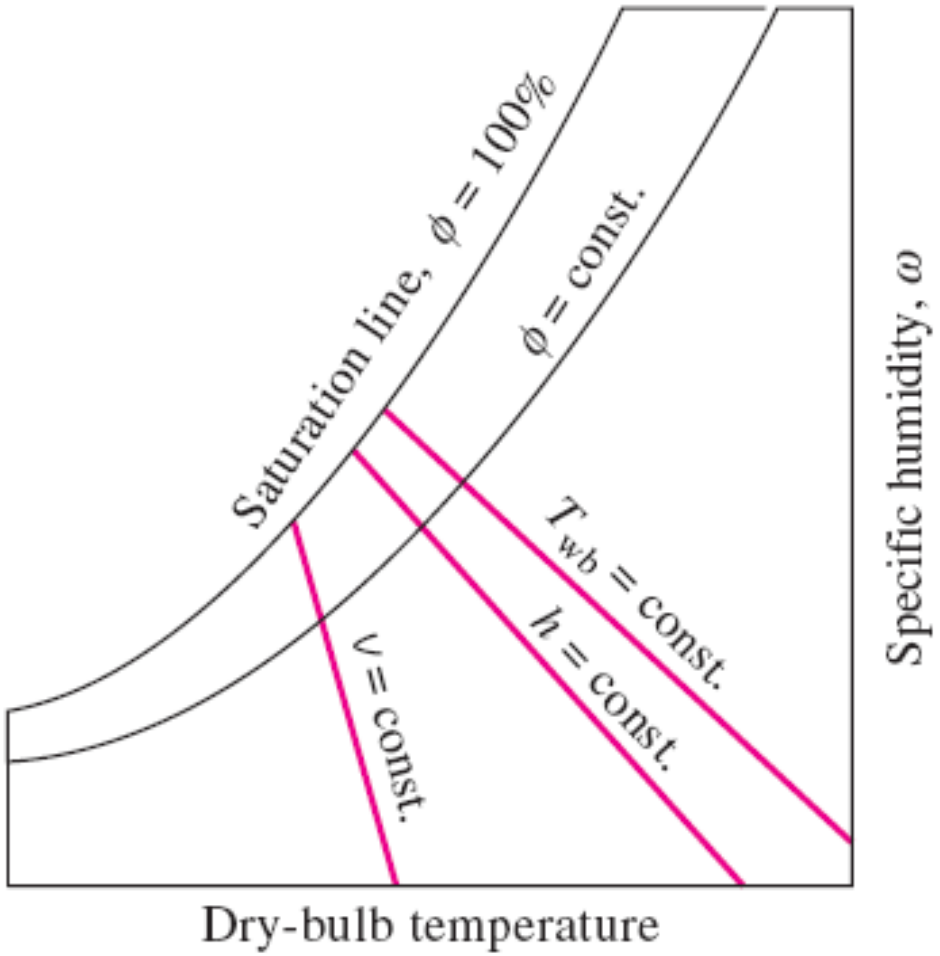
Relative humidity = p_v/p_g

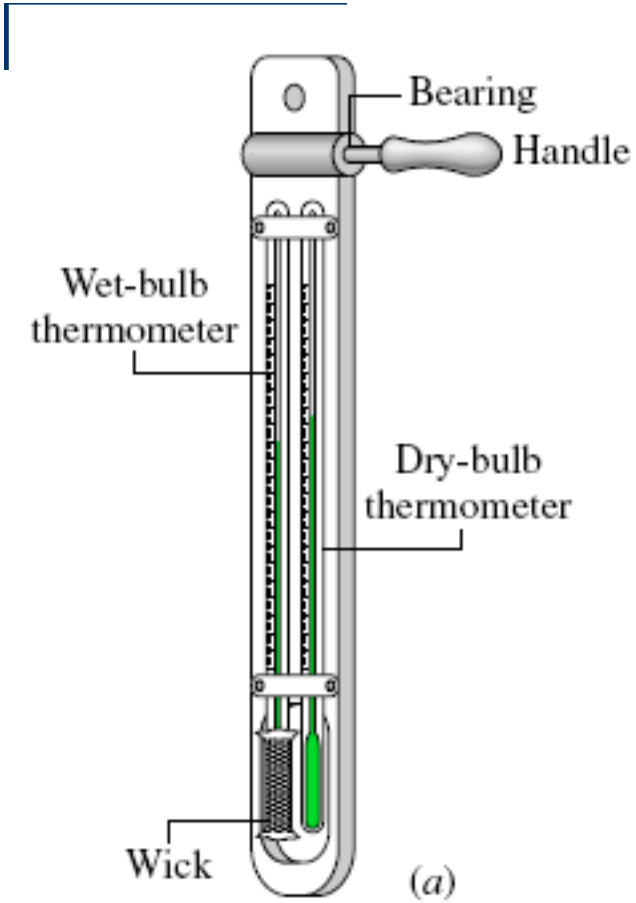
$$\omega = \frac{m_v}{m_a} = \frac{M_v p_v V/\bar{R}T}{M_a p_a V/\bar{R}T} = \frac{M_v p_v}{M_a p_a}$$

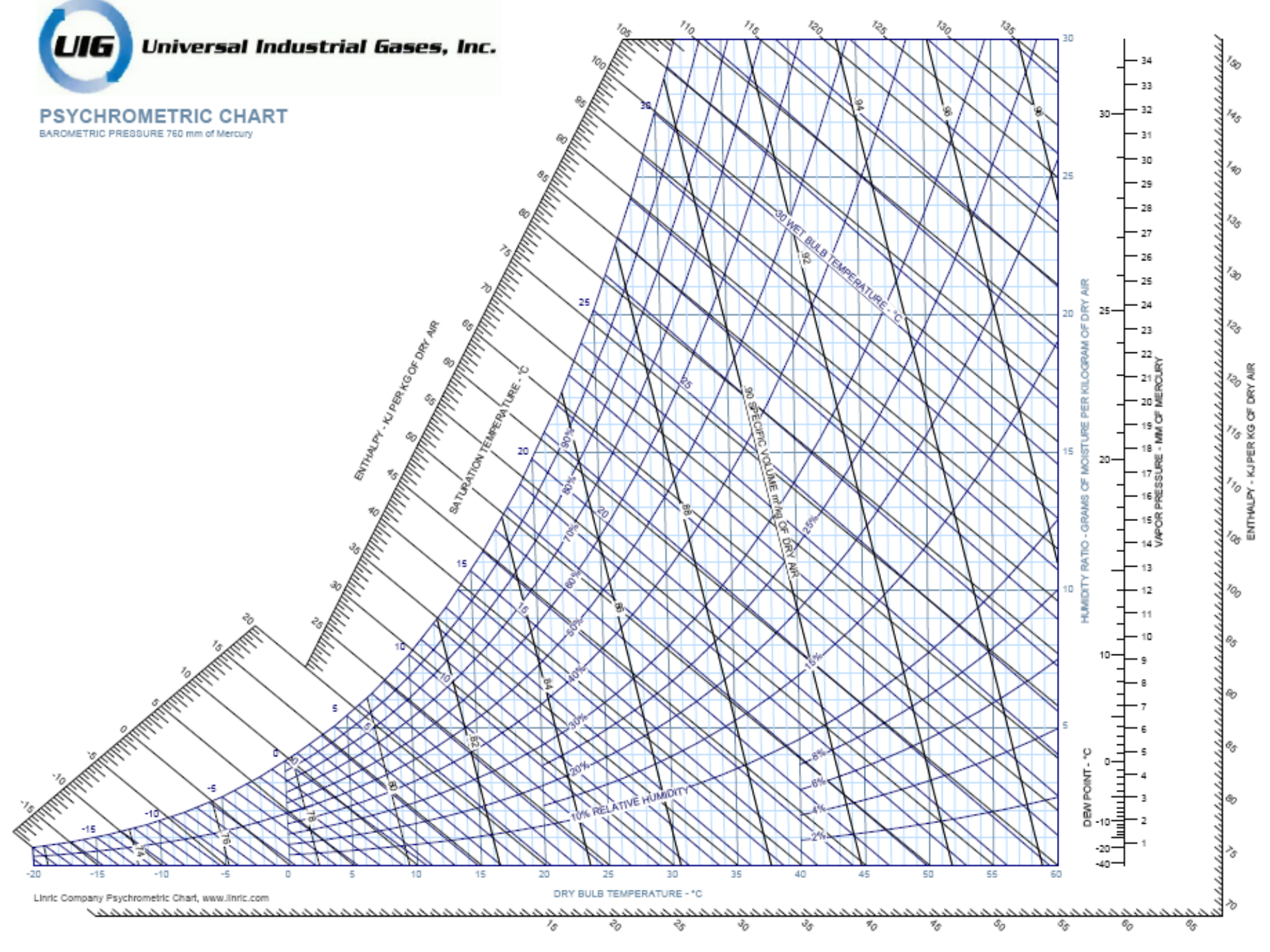
$$p_a = p - p_v$$

$$\omega = \frac{0.622\phi P_g}{P - \phi P_g}$$

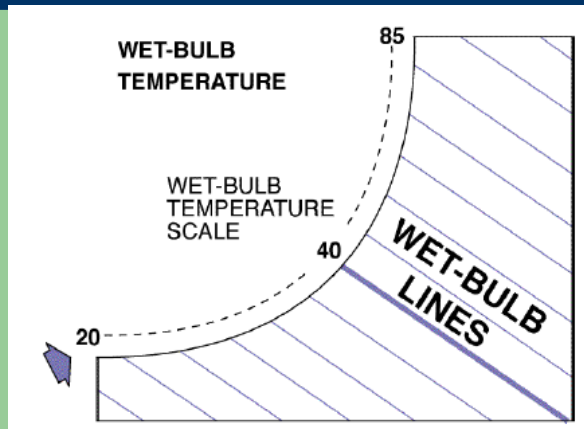
Psychrometric chart, DBT and WBT

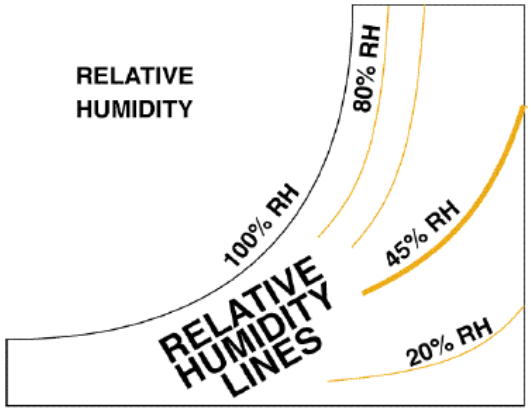


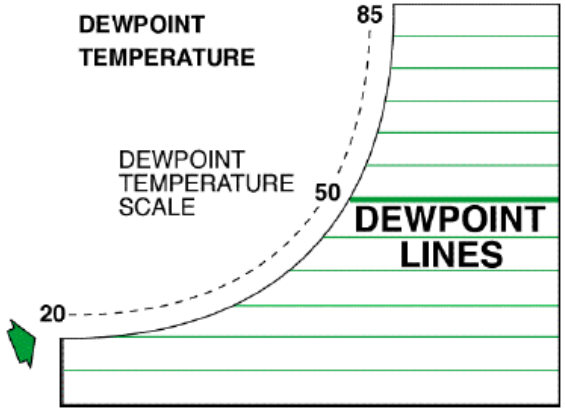


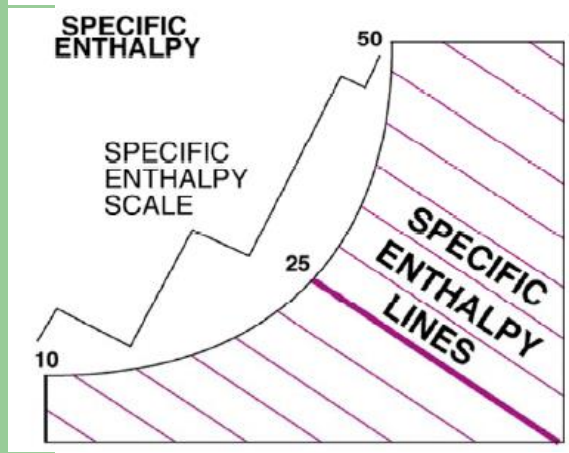

Universal Industrial Gases, Inc.
PSYCHROMETRIC CHART
BAROMETRIC PRESSURE 760 mm of Mercury
ENTHALPY - KJ PER KG OF DRY AIR
SATURATION TEMPERATURE - °C
WET BULB TEMPERATURE - °C
SPECIFIC VOLUME m³/kg OF DRY AIR
10% RELATIVE HUMIDITY
HUMIDITY RATIO - GRAMS OF MOISTURE PER KILOGRAM OF DRY AIR
VAPOR PRESSURE - MM OF MERCURY
DEW POINT - °C
ENTHALPY - KJ PER KG OF DRY AIR
DRY BULB TEMPERATURE - °C
Linric Company Psychrometric Chart, www.linric.com

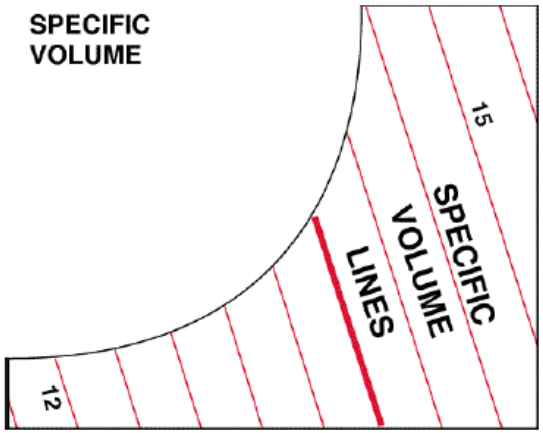
Various lines on psychrometric chart

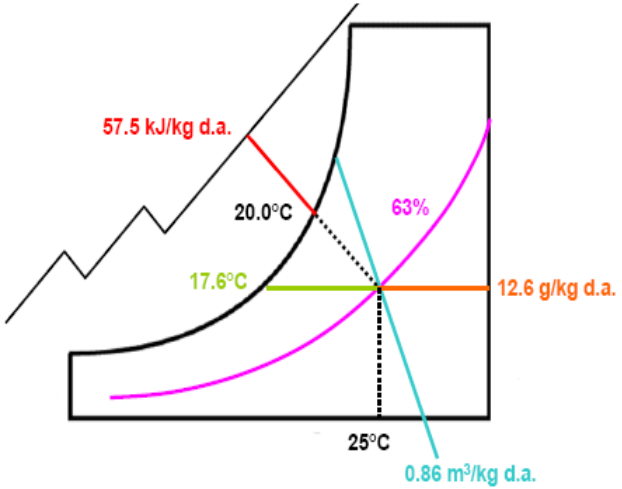






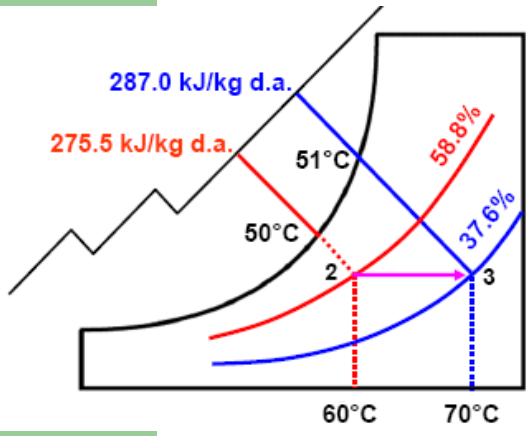




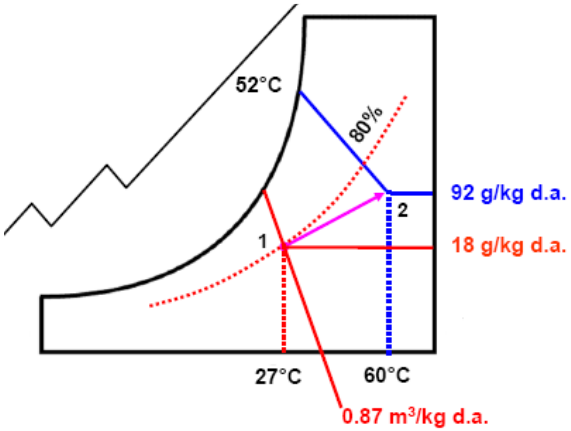


Has a slightly smaller slope than WBT lines

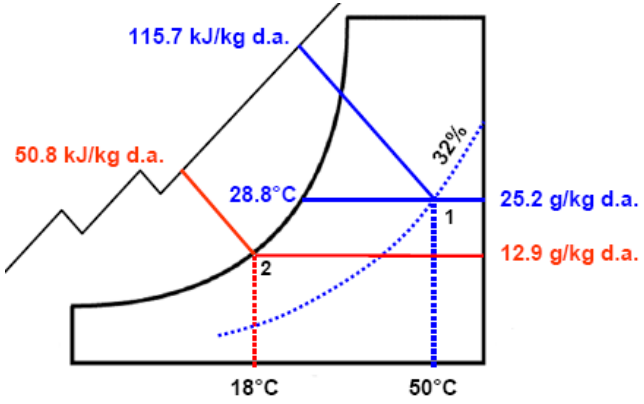
A few processes on psychrometric curve



Sensible heating

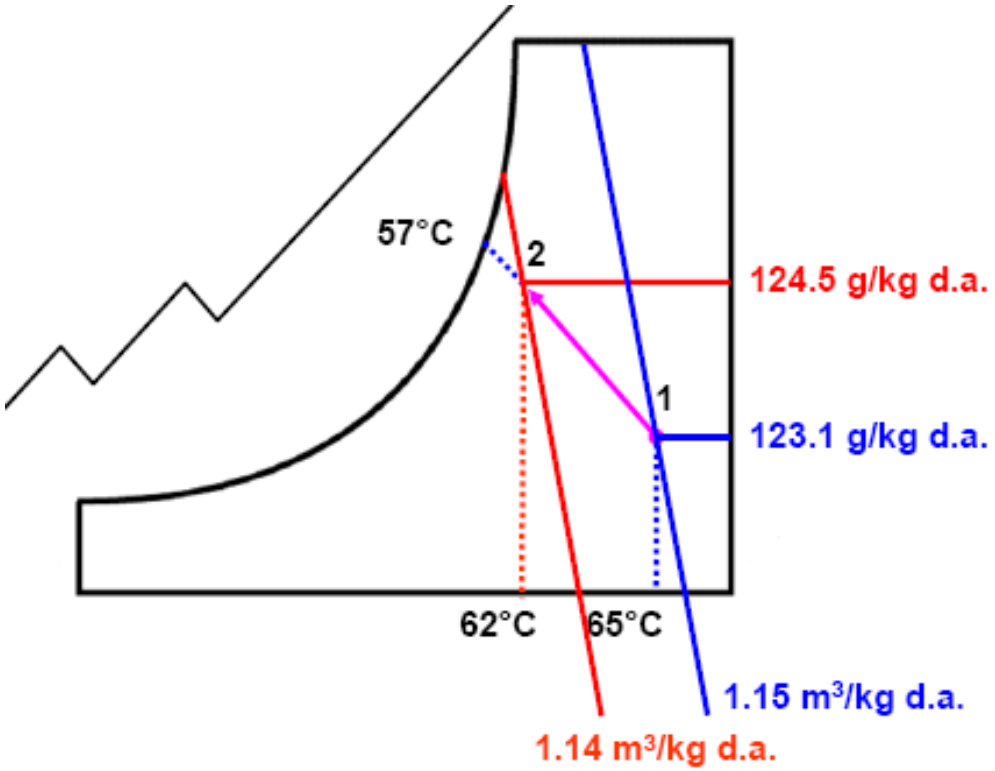


Humidification & heating



Cooling and dehumidification

Evaporative cooling



Psychrometric process in CT