

1 Psychrometric Charts

- Psychrometric charts list several properties of liquid-vapor mixtures, providing a concise compilation of a large quantity of physical property data.
- Commonly used for analysis of humidification, drying and air-conditioning process.
- The following quantities may be found on a psychrometric chart

- **Dry-bulb temperature** T : The x-axis of the chart. This is the air temperature as measured by a thermometer.
- **Absolute humidity** h_a : [kg H₂O(v)/kg Dry Air], also known as the moisture content, y-axis.
- Ex. If the absolute humidity is 0.015 kg H₂O(v)/kg Dry Air, then for every 1 kg of DA, there is 0.015 kg of water vapor. The total mass = 1.015kg = 1.0 kg DA + 0.015 kg water vapor. The mass fraction of water is:

$$x_{\text{H}_2\text{O}} = \frac{0.015}{1.015} = 0.0148 \quad (1)$$

- **Relative humidity** h_r : $100 \times p_{\text{H}_2\text{O}} / p_{\text{H}_2\text{O}}^*(T)$. Curves on the psychrometric chart correspond to specified values (90%, 80%, etc). The curve that corresponds to the left boundary of the chart is the **saturation curve**, or 100% h_r .
- **Dew point** T_{dp} : The temperature at which humid air becomes saturated if it is cooled at constant pressure.
- **Humid volume**: \hat{V}_H [m³/kg DA]. The volume of air occupied by 1 kg of DA plus the water that accompanies it.
- Example: Suppose you have 150 kg of air at 30 °C and $h_r = 30\%$, Find the volume of this air.
 - * Step 1: Find the absolute humidity. From the chart $h_a = 0.0080$ kg H₂O (v)/kg DA.
 - * Step 2: From the chart, $\hat{V}_H = 0.87$ m³/kg DA.

* Step 3:

$$V = 150 \text{ kg humid air} \left(\frac{1.00 \text{ kg DA}}{1.008 \text{ kg humid air}} \right) \left(\frac{0.87 \text{ m}^3}{\text{kg DA}} \right) = 129 \text{ m}^3 \quad (2)$$

- **Wet-bulb temperature:** The temperature determined by the reading given by a thermometer that has been wrapped in a wet wick. The evaporation of water from the wick causes the removal of heat from the thermometer bulb, which causes a drop in the bulb temperature and the thermometer reading.
- **Specific enthalpy of saturated air:** The diagonal line above the saturation curve.
- **Enthalpy deviation:** Used to determine the enthalpy of humid air that is not saturated.
- Example: Air at 35 °C and 10 % relative humidity.
 - * Enthalpy of deviation -0.52 kJ/kg DA
 - * Enthalpy for saturated air = 45.0 kJ/kg DA
 - * Enthalpy of air at 35 °C and 10 % relative humidity = (45.0 + - 0.52) kJ/kg DA = 44.5 kJ/kg DA.