

Chapter 14

Gas-Vapor Mixtures and Air-Conditioning

Study Guide in PowerPoint

to accompany

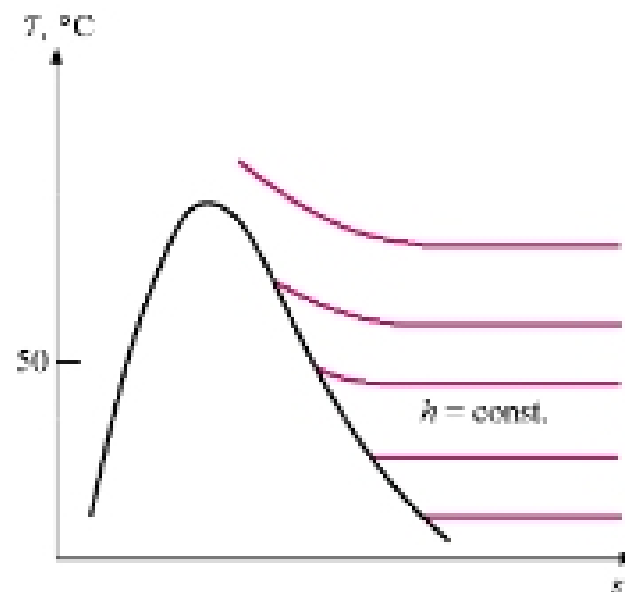
Thermodynamics: An Engineering Approach, 8th edition
by Yunus A. Çengel and Michael A. Boles

We will be concerned with the mixture of dry air and water vapor. This mixture is often called atmospheric air.

The temperature of the atmospheric air in air-conditioning applications ranges from about -10 to about 50°C . Under these conditions, we treat air as an ideal gas with constant specific heats. Taking $C_{pa} = 1.005 \text{ kJ/kg}\cdot\text{K}$, the enthalpy of the dry air is given by (assuming the reference state to be 0°C where the reference enthalpy is taken to be 0 kJ/kg)

$$\begin{aligned} h_a &= C_{pa} T \left(\frac{\text{kJ}}{\text{kg}_a} \right) \quad T \text{ in } ^{\circ}\text{C} \\ &= \left[1.005 \frac{\text{kJ}}{\text{kg}\cdot^{\circ}\text{C}} \right] T \quad \frac{\text{kJ}}{\text{kg}_a} \end{aligned}$$

The assumption that the water vapor is an ideal gas is valid when the mixture temperature is below 50°C . This means that the saturation pressure of the water vapor in the air-vapor mixture is below 12.3 kPa . For these conditions, the enthalpy of the water vapor is approximated by $h_v(T) = hg$ at mixture temperature T . The following T - s diagram for water illustrates the ideal-gas behavior at low vapor pressures. See Figure A-9 for the actual T - s diagram.



The saturated vapor value of the enthalpy is a function of temperature and can be expressed as

$$h_v = h_g(T) \cong 2501.3 + 1.82T \left(\frac{\text{kJ}}{\text{kg}_v} \right) \quad T \text{ in } ^\circ\text{C}$$

Note: For the dry air-water vapor mixture, the partial pressure of the water vapor in the mixture is less than its saturation pressure at the temperature.

$$P_v \leq P_{sat @ T_{mix}}$$