EXAMPLE: Heating with humidification

A steady-flow heating and humidification process is used to provide moist air at a dry bulb temperature of 77°F with a relative humidity $\phi = 45\%$. Outdoor air at $T_{DB} = 40°F$ and $\phi = 90\%$ enters the heating section at a rate of 2100 ft³/min where the temperature is increased to 75°F. The air then enters the humidifier section so that the desired exit conditions are achieved. The entire device operates at a constant total pressure of 1 bar.

(a) Draw the two-step process on a psychrometric diagram.

(b) Determine the mass flow rate of dry air through the device.

(c) Determine the heat transfer rate to the heating section.

(d) Determine the mass flow rate of steam in the humidifying section.

(e) Determine the temperature of the steam if it has a pressure of 1.01325 bar.

(a)