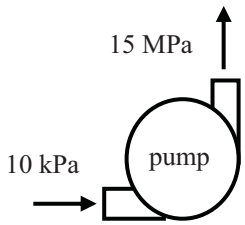
8-73 An adiabatic pump is used to compress saturated liquid water in a reversible manner. The work input is to be determined by different approaches.

Assumptions **1** Steady operating conditions exist. **2** Kinetic and potential energy changes are negligible. **3** Heat transfer to or from the fluid is negligible.

Analysis The properties of water at the inlet and exit of the pump are (Tables A-4 through A-6)

$$\left.\begin{array}{l} P_1 = 10 \text{ kPa} \\ x_1 = 0 \end{array}\right\} \begin{array}{l} h_1 = 191.81 \text{ kJ/kg} \\ s_1 = 0.6492 \text{ kJ/kg} \\ \nu_1 = 0.001010 \text{ m}^3/\text{kg} \end{array}$$

$$\left.\begin{array}{l} P_2 = 15 \text{ MPa} \\ s_2 = s_1 \end{array}\right\} \begin{array}{l} h_2 = 206.90 \text{ kJ/kg} \\ \nu_2 = 0.001004 \text{ m}^3/\text{kg} \end{array}$$



(*a*) Using the entropy data from the compressed liquid water table

$$w_P = h_2 - h_1 = 206.90 - 191.81 = \mathbf{15.10 \text{ kJ/kg}}$$

(*b*) Using inlet specific volume and pressure values

$$w_P = \nu_1 (P_2 - P_1) = (0.001010 \text{ m}^3/\text{kg})(15{,}000 - 10)\text{kPa} = \mathbf{15.14 \text{ kJ/kg}}$$

Error = **0.3%**

(*b*) Using average specific volume and pressure values

$$w_P = \nu_{avg} (P_2 - P_1) = \left[1/2(0.001010 + 0.001004) \text{ m}^3/\text{kg}\right](15{,}000 - 10)\text{kPa} = \mathbf{15.10 \text{ kJ/kg}}$$

Error = **0%**

Discussion The results show that any of the method may be used to calculate reversible pump work.