

ME 201

Thermodynamics

Incompressible Substance Property Evaluation Guide (For ME 201 see summary at end)

Most normal liquids and solids at normal pressures and temperature can be treated as incompressible substances provided that there are not phase changes occurring.

The equation of state for an incompressible substance assumes that the specific volume is only a function of temperature and it or the density are given in tabular form. Recall that

$$v = \frac{1}{\rho}, \text{ where } \rho \text{ is the density.}$$

For an incompressible substance we also a unique relationship among the two specific heats, as shown below

$$c_v = c_p$$

To evaluate changes in internal energy, enthalpy, and entropy for an incompressible substance we assume a constant specific heat and write

$$u_2 - u_1 = c_{P,avg} (T_2 - T_1)$$

$$h_2 - h_1 = c_{P,avg} (T_2 - T_1) + v_{avg} (P_2 - P_1)$$

$$s_2 - s_1 = c_{P,avg} \cdot \ln\left(\frac{T_2}{T_1}\right)$$

where

$$c_{P,avg} = c_P \left(@ \frac{T_1 + T_2}{2} \right) \text{ and}$$

$$v_{avg} = v \left(@ \frac{T_1 + T_2}{2} \right)$$

Summary for ME 201 Students
Relationships for an Incompressible Substance

$$v = \text{fn}(T) \text{ only}$$

$$c_v = c_p$$

Assuming Constant Specific Heat

$$u_2 - u_1 = c_{P,\text{avg}}(T_2 - T_1)$$

$$h_2 - h_1 = c_{P,\text{avg}}(T_2 - T_1) + v_{\text{avg}}(P_2 - P_1)$$

$$s_2 - s_1 = c_{P,\text{avg}} \cdot \ln\left(\frac{T_2}{T_1}\right)$$

where

$$c_{P,\text{avg}} = c_p \left(@ \frac{T_1 + T_2}{2} \right) \text{ and}$$

$$v_{\text{avg}} = v \left(@ \frac{T_1 + T_2}{2} \right)$$

Always Work in Absolute Temperature for an Incompressible Substances