SOLIDS AND LIQUIDS – specific heats

Solids and Liquids are considered to be incompressible substances ($\Delta v = 0$)

It can be shown that for solids and liquids \( c_v = c_p = c \) and \( c(T) \) is a function of temperature \( T \) only.

**Internal energy change**

\[
c = \frac{d\varepsilon}{dT} \quad \Rightarrow \quad u_2 - u_1 = \int_{T_1}^{T_2} c \, dT = c_{avg} \cdot (T_2 - T_1)
\]

\[\Delta u = c_{avg} \cdot (T_2 - T_1) \quad (4-35)\]

**Enthalpy Change**

\[
h = u + Pv
\]

\[
dh = du + vdP + P \, dv
\]

\[
\Rightarrow \quad h_2 - h_1 = \int_{P_1}^{P_2} dp + \int_{T_1}^{T_2} c \, dT
\]

\[
\Delta h = c_{avg} \cdot \Delta T + v \Delta P
\]

(4-37)

**Solids and liquids**

For \( v dP = 0 \) \( \Rightarrow \)

\[
\Delta h = \Delta u = c_{avg} \cdot (T_2 - T_1)
\]

**Solids:** \( v dP = 0 \) \( \Rightarrow \) \( \Delta h = \Delta u = c_{avg} \cdot (T_2 - T_1) \)

**Liquids:** for \( P \) const \( (\Delta P = 0) \) \( \Rightarrow \)

\[
\Delta h = \Delta u = c_{avg} \cdot (T_2 - T_1)
\]

**Approximation formula for Enthalpy \( h \) of compressed liquid**

\[
\Delta h = v \cdot \Delta P
\]

Consider isothermal process from \( (T, P_{sat@T}) \) to \( (T, P) \)

\[
h_h = h_{f@T} + v_{f@T} \cdot (P - P_{sat@T})
\]

(4-38)

**Calorimeter**

\[
Q = W_{in} - W_{out} = m(u_2 - u_1)\text{ = } mc(T_2 - T_1) = mc\Delta T
\]

\[
c = \frac{\dot{W} \cdot \Delta T}{m \cdot \Delta T} = \frac{(1.5 \cdot 272)}{(1.0 \cdot (95.4 - 23.9)} = 5.71 \quad \text{[kJ/kg \cdot K]}
\]

\[
\Delta t = \frac{c \cdot m \cdot \Delta T}{W} \quad \text{time needed to raise the temperature by} \Delta T
\]

\[
\text{with the power} \ W
\]

\[
\text{[s]}
\]