

Problem 6-5 solution

Eqn of state: $(P + b)v = RT$

From Eq. (6-16) $(\frac{\partial c_v}{\partial v})_T = T(\frac{\partial^2 P}{\partial T^2})_v = 0 \Rightarrow c_v = c_v(T)$. Next, $c_P = c_v + T(\frac{\partial P}{\partial T})_v(\frac{\partial v}{\partial T})_P = c_v + R$

$$\left. \begin{aligned} du &= c_v dT + [T(\frac{\partial P}{\partial T})_v - P] dv, \\ ds &= \frac{c_P}{T} dT - (\frac{\partial v}{\partial T})_P dP, \\ dh &= c_P dT + [v - T(\frac{\partial v}{\partial T})_P] dP \end{aligned} \right\} \Rightarrow \begin{cases} u = u_0 + \int_{T_0}^T dT c_v + \int_{v_0}^v dv [T(\frac{\partial P}{\partial T})_v - P] = u_0 + \int_{T_0}^T dT c_v + b(v - v_0), \\ s = s_0 + \int_{T_0}^T dT \frac{c_P}{T} - \int_{P_0}^P dP (\frac{\partial v}{\partial T})_P = s_0 + \int_{T_0}^T dT \frac{c_v}{T} + R \ln \frac{v}{v_0}, \\ h = h_0 + \int_{T_0}^T dT c_P + \int_{P_0}^P dP [v - T(\frac{\partial v}{\partial T})_P] = h_0 + \int_{T_0}^T dT c_v \end{cases}$$

Need $c_v(T)$ to determine u, s and h .

Problem 6-16 solution

(a):

If we know $c_v(T, v)$, $(\frac{\partial P(T, v)}{\partial T})_v$, and $P(T, v) \Rightarrow$ we know $\beta = \frac{1}{v}(\frac{\partial v}{\partial T})_P$, $\kappa = -\frac{1}{v}(\frac{\partial v}{\partial P})_T$ and $c_P = c_v + \frac{\beta^2 T v}{\kappa}$.

$$u = u_0 + \int_{T_0}^T dT c_v + \int_{v_0}^v dv [T(\frac{\partial P}{\partial T})_v - P],$$

$$s = s_0 + \int_{T_0}^T dT \frac{c_P}{T} - \int_{P_0}^P dP (\frac{\partial v}{\partial T})_P,$$

$$h = h_0 + \int_{T_0}^T dT c_P + \int_{P_0}^P dP [v - T(\frac{\partial v}{\partial T})_P]$$

(b)

If we know $P(T, v)$ we can find $(\frac{\partial P(T, v)}{\partial T})_v$.