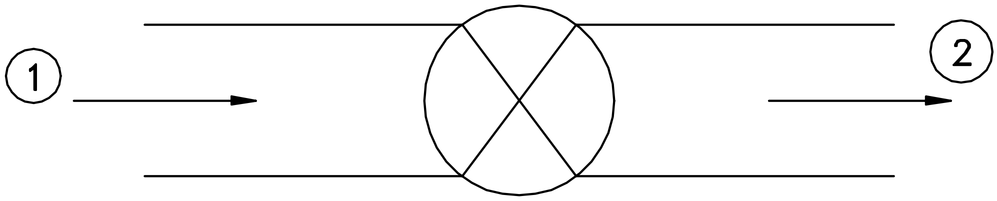
Problem: 8-58

Given: Steam throttled from 1000 psia, 850 $^\circ F$ through an adiabatic valve to 300 psia.

Find: Exit state using generalized enthalpy chart and compare to Mollier chart.

Assumptions: SSSF



$$\dot{m}_1(h + \cancel{pe} + \cancel{ke})_1 + \cancel{\dot{W}}^{\,0} - \cancel{\dot{Q}}^{\,0} = \dot{m}_2(h + \cancel{pe} + \cancel{ke})_2 + \left.\cancel{\frac{\partial E}{\partial t}}^{\,0}\right|_{C.V.}$$

from an energy balance

$$\dot{m}_1 h_1 = \dot{m}_2 h_2 \Rightarrow h_1 = h_2$$

from Table B.8

$$\begin{aligned}
T_c &= 647.27\ K \approx 1165.1\ R \\
P_c &= 218.167\ atm \approx 3206.2\ psia \\
T_1 &= 850\ ^\circ F = 1309.7\ R \\
T_2 &= ? \\
P_1 &= 1000\ psia \\
P_2 &= 300\ psia
\end{aligned}$$

Then

$$
\begin{aligned}
T_1^* &= \frac{T_1}{T_c} \quad \frac{1309.7}{1165.1} &= 1.124 \\
P_1^* &= \frac{P_1}{P_c} \quad \frac{1000.0}{3206.2} &= 0.312 \\
T_2^* &= \frac{T_2}{T_c} \quad &= ? \\
P_2^* &= \frac{P_2}{P_c} \quad \frac{300.0}{3206.2} &= 0.094
\end{aligned}
$$

From Fig. B.15

$$\beta_1 = \frac{\hat{h}_{pa} - \hat{h}_1}{T_c} \approx 0.6 \ cal/gmole \cdot K = 0.6 \ Btu/lbmole \cdot R$$

From Table B.6a

$$\hat{c}_p = 8.04 \ Btu/lbmole \cdot R$$

Since $h_1 = h_2$, then $\hat{h}_1 = \hat{h}_2$, or

$$
\begin{aligned}
\hat{h}_{pg,1} - \beta_1 T_c &= \hat{h}_{pg,2} - \beta_2 T_c \\
\hat{h}_{pg,1} - \hat{h}_{pg,2} &= (\beta_1 - \beta_2) T_c \\
\hat{c}_p (T_1 - T_2) &= (\beta_1 - \beta_2) T_c \\
T_2 &= T_1 + (\beta_1 - \beta_2) \frac{T_c}{\hat{c}_p} \\
&= 850^\circ F + (\beta_2 - 0.60) \left(\frac{1165.1}{8.04} \right) \\
&= 763.05^\circ F + 144.91 \beta_2
\end{aligned}
$$

Since β_2 depends on T_2, we'll have to iterate

Guess T_2	$T_2^* = T_2/T_c$	β_2	New T_2
800	1.081	0.19	790.58
790.6	1.073	0.195	791.3
791.3	1.073	0.195	791.3

Using the generalized enthalpy charts

$$\boxed{T_2 \approx 791.3 \ ^\circ F}$$

From the Mollier diagram (Fig. B.2)

$$
\begin{aligned}
h_1\ (1000\ psia,\ 850\ ^\circ F) &= 1415\ Btu/lbm \\
T_2\ (300\ psia,\ 1415\ Btu/lbm) &\approx \boxed{790\ ^\circ F}
\end{aligned}
$$

The two methods agree fairly closely.

From steam tables

$$
\begin{aligned}
h_1\ (1000\ psia,\ 850\ ^\circ F) &= 1418.3\ Btu/lbm \\
T_2\ (300\ psia,\ 1418.3\ Btu/lbm) &\approx \boxed{794.9\ ^\circ F}
\end{aligned}
$$