PSet # 6

4.27 state 1 is Saturated

1 MPa, $x = 10\%$

$v_1 = v_f + (0.1)(0.19436 - 0.001127)$

$= .0204 \ m^3/kg$

state 2 is sat. liquid

$P_2 = 101.42 \ kPa$

$v_2 = v_f = .001043 \ m^3/kg$

Spring loaded. Linear Process

$$-\left(\frac{P_1 + P_2}{2}\right)(\Delta v)(m) = {}_1W_2$$

$= +\ 8.34 \ kJ$ +ve Work done On the system

4.35 $x_1 = 0.25$; Const Volume process

$P_1 = 100 \ kPa$, $x_1 = 0.25$

$v_1 = v_f + x_1 v_{fg}$ $u_1 = u_f + x u_{fg}$

$= .42431 \ m^3/kg$ $= 939.4 \ kJ/kg$

$v_2 = v_1 = .42431$

From table locate Temp or pressure where v_g matches $.42431 \ m^3/kg$

$u_2 @ T_2 \simeq 146^\circ c = 2556.2 \ kJ/kg$

$\dot{W}_{elec} = (110)(8)\,\Delta t = (\Delta u)\,m$

$$\Delta t = \frac{[(2556.2) - (939.4)](5)(1000)}{(110)(8}$$

$\simeq 150$ min

Pset #6

4.42 Similar to class discussion

$\Delta E = Q$

$\Delta E = \Delta U_A + \Delta U_B$

Calculate final state from masses / volume to be $0.22/27\ m^3/kg$

$P_2 = 300\ kPa$
$v_2 = .22/27\ m^3/kg$ > Table for u_2

$Q_{out} = -\underline{\underline{3959}}\ kJ$ → Indicating from System

4.57 $R_{\text{Nitrogen}} = 0.2968$

$c_v = 0.743\ kJ/kg\,°C$
$c_p = 1.039\ kJ/kg\,°C$

Process linear

$$P - P_1 = \frac{F_s - F_{s,1}}{A} = \frac{k}{A^2}(V - V_1)$$

$$c = \frac{k}{A^2} = \frac{4^2 k}{\pi^2 D^4} = 16{,}211\ \frac{kN}{m^5}$$

$$P_2 = P_1 + 0.1 c V_1$$

$\Rightarrow 132.0\ kPa$

$$T_2 = \frac{P_2 V_2}{mR} = 363\ K$$

$$\Delta u = c_v \Delta T = 46.8\ kJ/kg$$

$$\Delta h = c_p \Delta T = 65.5\ kJ/kg$$

4.71 $Q_{in} = \Delta U = mc_v(T_2 - T_1)$ for constant volume process

$Q_{in} = \Delta H = mc_p(T_2 - T_1)$ for Const Pressure

Pset # 6

$c_{p\,av} = 0.952\ kJ/kg.k$
$c_{v\,av.} = 0.692\ kJ/kg.k$

$\Big\rangle$ A-2b @ $T_{av} = \frac{T_1 + T_2}{2}$
$= 163°C$

$Q_{in\,v} = 190.3\ kJ$
$Q_{in\,p} = 261.8\ kJ$

4.79 For Constant pressure proces

$\cancel{\Delta H = \Delta U + W}$
$\cancel{\Delta E = Q + W}$ (First law)
$\cancel{W = \Delta E - Q}$
$\cancel{= \Delta H}$

$\Delta H - \Delta U = W$

$W = W_e + W_{system}$

$Q + W = \Delta E = \Delta U$

$-60\ kJ + W_e - W_{system} = \Delta U$

$\Delta U + W_{system} = \Delta H$

$W_e = \Delta H + Q_{out} =$
$(15)(350 - 298) + 60$ kJ

h_1, h_2 from air tables (A-17)

or $c_{pa}(T_2 - T_1)$.

4.96 $Q_{in} = \Delta U = m(u_2 - u_1)$
$= mc_v(\Delta T)$

$\frac{Q_{in}}{\Delta t} = \frac{mc_v\,\Delta T}{(1)} = \frac{(184.6)(.465)(700-30)}{1}$

kJ/min

4.127

$$W_{system} = \left(\frac{P_1 + P_2}{2}\right)(\Delta V)$$
$$= \underline{150\,kJ}$$

With no spring, $W_{system} = P\Delta V$
$$= 60\,kJ$$
$$\delta W = 150 - 60 = \underline{\underline{90\,kJ}}$$

4-128

$T_1 = T_{sat} @ P_{sat} = 125\,kPa = 106°C$

$V_1 = m_f v_f + m_g v_g$
$= 2 \times .001048 + 3 \times 1.375 = 4.127\,m^3$

$V_3 = 1.2 V_1 = 4.953\,m^3$

$v_3 = \frac{V_3}{m} = \frac{4.953}{5} = 0.9905\,m^3/kg$

$\left.\begin{array}{l} P_3 = 300\,kPa \\ v_3 = .9905\,m^3/kg \end{array}\right\} T_3 = 373.6°C$

b) $P_2 = 300\,kPa$

$V_2 = 4.127\,m^3$

$v_2 = \frac{4.127}{5} = 0.8254\,m^3/kg$

$\boxed{v_2 > v_g}$ completely Vapor

c) $W_{system} = (300)(4.953 - 4.127) = \underline{247.6\,kJ}$

4.147 $\Delta u = 0$; $u(T)$ only

$Q_{in} = W_{system}$ $\quad \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow V_2 = 0.8\,m^3$

$= (200)(0.8 - 0.4) = 80\,kJ$