Answer:

1) a) F b) F c) T d) T e) F

2) steady flow : $q\text{-}w = h_2 - h_1$

$h_2 = q - w + h_1 = 200$ kJ- (-12 kJ)+ 93.42 kJ=305.42 kJ

at p=140kPa -> the enthalpy of saturated vapor is hg(P=140kPa)=236.04 kJ

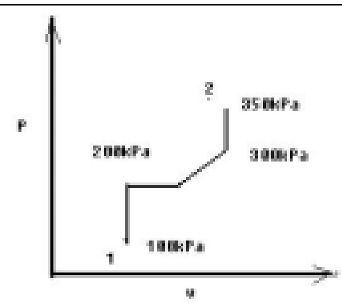
now at the exit h_2> hg(P=140kPa) ---→ the exit state is in the superheated vapor

→from superheated table at 140kPa -> T_2~ 60^oC

3)

a) Take the water inside the cylinder as our system. When the piston touches the top stops, the pressure of water is P= 200kPa + 100kN/m x 1m / $1m^2$= 300kPa The final pressure is 350kPa and the piston hits the top stops before reaching the final state.

b) the pressure increases from 100 kPa to 200kPa while the piston sits on the lower stops. Before the piston hits the upper stops, the pressure is constant at 200kPa. When the spring is compressed, the pressure increases linearly with volume until 300kPa. After the piston hits the upper stops, the pressure rises again while volume is held constant.



c) work = 200kPa(2-1) + (200+300)/2 *1=450 kJ

d) p2=350kPa v2= 3m3/1kg= 3 m^3/kg -> this is beyond superheated table-> use ideal gas law as an approximation → T=pv/RT= 350x3/0.4615=2275K~2000C

e) 1st law for a closed system

Q-W = U2-U1 → Q= W+ U2-U1

State 1: U1= m1 u1 P1=100kpa v1= 1 kg/m3

Staturated state x1= (v1-vf)/vfg= 0.59

u1 = 0.59 x ug + (1-0.59)x uf= 1650.3 kJ

Sate 2: Use superheated table as a base -> u2=u_superheated at (1300C)+ Cv*(2000-1300)~ 5662 kg/kg (Cv~1.4 kJ/kg)

Q= 450kJ + (5662- 1650.3) ~ 4462 kJ

4) As the air entering the turbine has uniform properties (constant in time):

1st law: $m_i h_i - W_{out} = m_2 u_2$

since m1=0 and Qin=Qout=Win=0

with constant Cp and Cv -> $W_{out} = m_i C_p T_i - m_2 C v T_2$

$m_2 = m_i$= PV/RT= 500 x1 /(0.287x250)= 6.969 kg

W_{out}= 6.969 kg x (1 x 300 – 0.713x 250) = 848.5 kJ