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Thermo Test 1

1.) $V = 1 m^3$ $m = 2.8 kg$ $P = 1 MPa$

a.) Closed system

b.) $v = \frac{1 m^3}{2.8 kg} = 0.357 \frac{m^3}{kg}$, v^v @ 1MPa is 0.194

$v^v < v$ ∴ initial state is ~~Saturated vapor~~ $\boxed{\text{Superheated Steam}}$

c.) ~~$T_{approx} = 500°C$~~ $T = T_1 + \frac{v - v_1}{v_2 - v_1}(T_2 - T_1)$

$$T_{approx} = 500°C + \frac{0.357 \frac{m^3}{kg} - 0.3541 \frac{m^3}{kg}}{0.3777 \frac{m^3}{kg} - 0.3541 \frac{m^3}{kg}}(550°C - 500°C) = 506°C$$

$\boxed{\approx 500°C}$

d.) $P_2 = 0.1 MPa$ @ 0.1 MPa $v = 0.357$, $v^L = .001043$
$v^v = 1.6939$

$v^L < v < v^v$ ∴ $\boxed{\text{Saturated mixture}}$

$$q = \frac{v - v^L}{v^v - v^L} = \frac{0.357 - 0.001043}{1.6939 - 0.001043} \boxed{= 0.210}$$

e.) $W_{EC} = -\int_a^b P\,dV = -P\Delta V \boxed{= 0}$ V is constant

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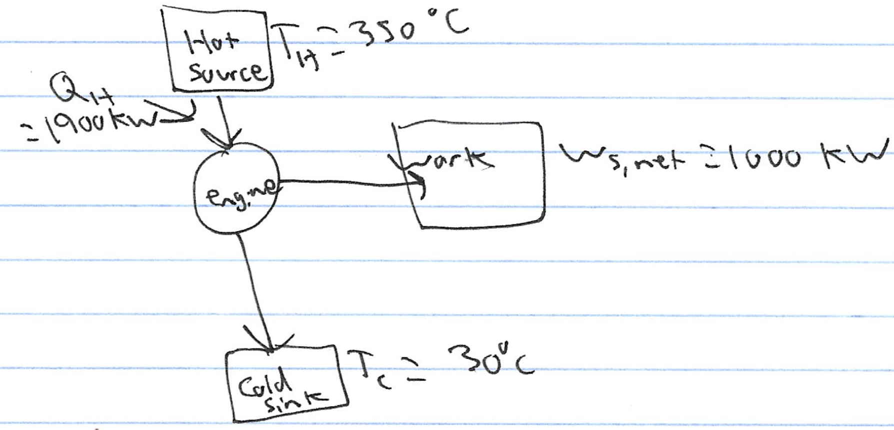
Thermo test 1

2.) $T = 350°C$ $\quad W_{s,net} = 1000\ kW$ $\quad Q_H = 1900\ kW$

$$\cancel{\eta_0 = \frac{W_{s,net}}{Q_H} = \frac{1000}{1900} = 0.526}$$

a.)



$$\eta_0 = \frac{W_{s,net}}{Q_H} = \frac{1000}{1900} \boxed{= 0.526}$$

b.) $\dfrac{Q_C}{Q_H} = \dfrac{T_C}{T_H}$ $\qquad Q_C = \dfrac{Q_H \cdot T_C}{T_H} = \dfrac{1900\ kW \cdot 303.15\ K}{623.15\ K}$

$Q_C = 924.3\ kW$

$Q_C < Q_H$ ∴ The process $\boxed{\text{is}}$ $\boxed{\text{Possible}}$

c.) $W_{s,net} \approx 1000\ kW$

I would invest because it produces a large amount of work and it is more efficient than many Processes we use today

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Thermo test I

3.) $\Delta z = 75\ m$ $\quad \dot{m} = 30 \frac{kg}{s}$ $\quad \Delta H, \Delta v = 0 = Q$

a.) $\boxed{\text{open system}}$: water flowing through barrier

b.) $\frac{d}{dt}\left[m\left(u + \cancel{\frac{v^2}{2}} + gz\right)\right] = \sum_{in}\left(\cancel{H} + \cancel{\frac{v^2}{2}} + gz\right)\dot{m} - \sum_{out}\left(\cancel{H} + \cancel{\frac{v^2}{2}} + gz\right)\dot{m} + \cancel{\dot{Q}} + \cancel{\dot{W}_{EC}} + \dot{W}_s$

$\frac{d}{dt}\left[m(u + gz)\right] = gz\dot{m}_{in} - \cancel{g\underbrace{z}_{0}\dot{m}_{out}} + \dot{W}_s$

$\dot{m}(\Delta u + gz) = gz\dot{m} + \dot{W}_s$

$\cancel{\dot{m}\Delta u + \dot{m}gz = gz\dot{m} + \dot{W}_s}$ $\quad \cancel{\boxed{\therefore \dot{m}\Delta u = \dot{W}_s}}$

$\cancel{c.)\ \dot{W}_s = \dot{m}\Delta u \quad \dot{m}(\Delta u + gz) = gz\dot{m} + \dot{W}_s}$

$\cancel{\dot{m}\Delta u + \dot{m}\Delta gz \quad z_2 = 0,\ z_1 = 75\ m}$

$\dot{m}\Delta u + \dot{m}g(\cancel{z_2} - z_1) = gz\dot{m} + \dot{W}_s$

$\dot{m}\Delta u - gz\dot{m} - \dot{m}gz = \cancel{\boxed{\dot{W}_s = \dot{m}\Delta u - 2\dot{m}gz}}$

$\boxed{\dot{W}_s = -2\dot{m}gz}$

c) $\dot{W}_s = \dot{m}\left(\Delta u - 2\left(9.8\frac{m}{s^2}\right)(75\ m)\right)$

$\dot{W}_s = 30\frac{kg}{s}\left(\overset{0}{\Delta u} - \frac{1470\ m^2}{s^2}\right)$ $\quad \Delta u = \overset{0}{\cancel{\Delta H}} + \overset{0}{\cancel{\Delta P V}}$

$\therefore \dot{W}_s = 30\frac{kg}{s}\left(-1470\frac{m^2}{s^2}\right) = -44100\ kW$

$\boxed{= -4.41 \times 10^4\ kW}$