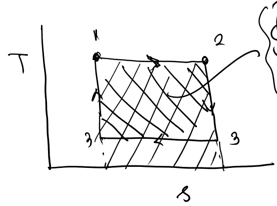
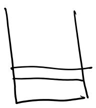
T-S diagram

($\delta q = T\,ds$) only for rev.

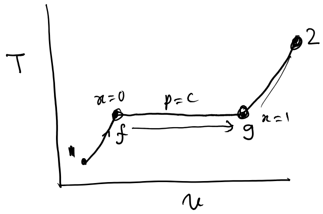


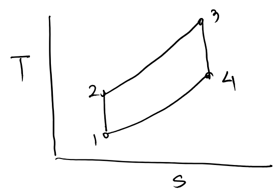
$\oint \delta q = \oint \delta W$ only for Int. rev. Cycles



1 bar 25°C

1 bar 100°C





① P_1, T_1

$1 \rightarrow f \rightarrow$ Subcooled liq. heating

$f - g \rightarrow$ phase chang from $x=0$ to $x=1$

$g - 2 \rightarrow$ heating of superheated vapor

$$s_f - s_1 = C_p \ln T_f/T_1$$

| similar to heating an incompressible liq or solid

$$s_g - s_f = \frac{h_{fg}}{T_{sat}}$$

$$s_2 - s_g = \int_g^2 \frac{C_p\,dT}{T} - R \ln \frac{P_2}{P_g} \rightarrow 0$$

C_p of steam ?? X

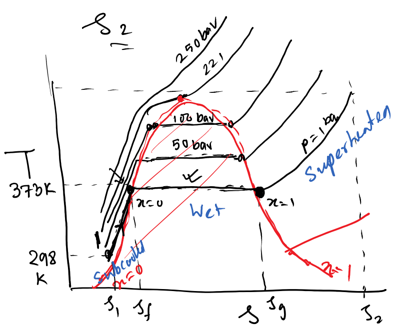
Use steam table/chart to find s_2

$$\delta q = T_{sat}\,ds$$

$$\int_f^g dh = \int_f^g T_{sat}\,ds$$

$$\Rightarrow h_g - h_f = T_{sat}(s_g - s_f)$$

or $s_g - s_f = h_{fg}/T_{sat}$ → s_{fg}



open SH steam Table

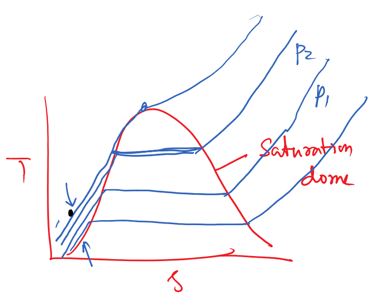
p = 1 bar page

T = 300°C

h

u

s ✓



5 kg of Water at 20 bar & 20°C & you heat it to 500°C at 20 bar, find the heat needed, work done & ΔS.

$$W = m \int p\,dv = m\,p \times (v_2 - v_1)$$

$$v_1 \approx v_f\big|_{@20°C} = 0.001002\ m^3/kg$$

$$v_2 = 0.17568\ m^3/kg$$

$$W = m \times p \times (v_2 - v_1) =$$ (p → (20×100) kPa)

$$Q = m(h_2 - h_1)$$

$$\Delta S = m(s_2 - s_1)$$

20°C → v_f =

$t_{sat@20bar} = 212.4°C$

Superheated Steam Table

page of 20 bar

v(20 bar, 500°C)

$$h_1 \approx h_{f@20°C} + v_{f@20°C} \times (20 - P_{sat@20°C})$$

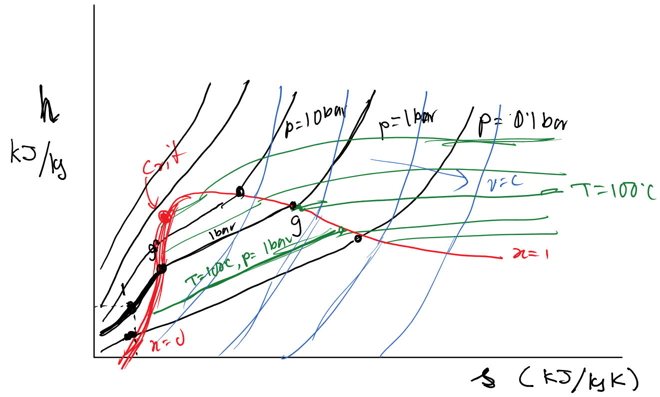
$\Delta S = m(s_2 - s_1)$

$h_1 \approx h_{f@20^\circ c} + v_{f@20^\circ c} \times (20 - P_{sat@20^\circ c}) \times 100$

$s \approx s_{f@20^\circ c}$

h_2 = Directly from the SH steam table

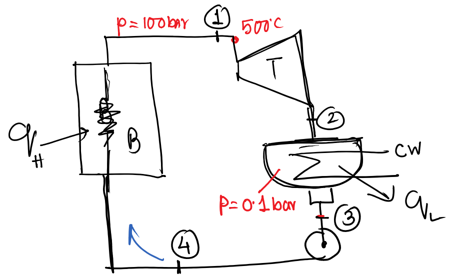
$s_2 =$

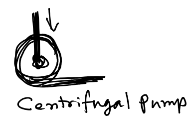


p, T

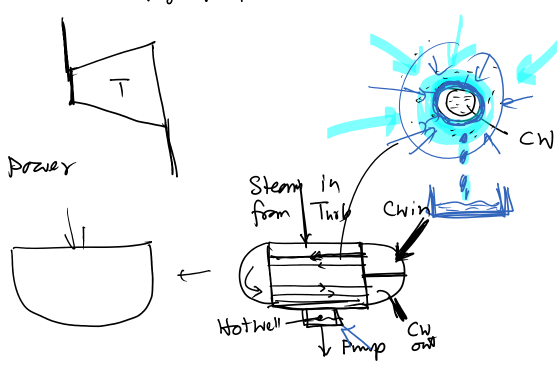
at $p=C \Rightarrow \quad dh = Tds \Rightarrow \boxed{\frac{dh}{ds} = T} \rightarrow$?

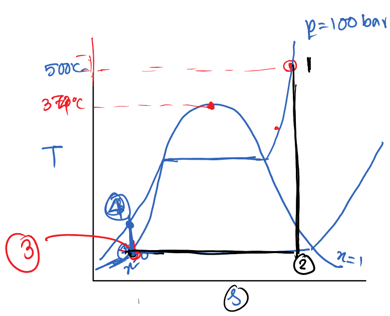
1 bar 25°c

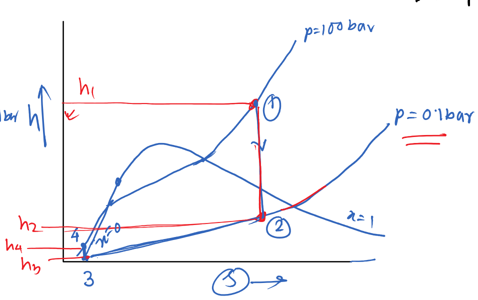


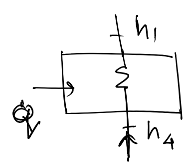


Find the efficiency of the vapor power cycle









$0 = \dot{Q} - \dot{W} + \dot{m}(h_{in} - h_{out})$

$\frac{\dot{Q}}{\dot{m}} = (h_{out} - h_{in})$

$q = (h_1 - h_4)$

Heat added in boiler

$q_H = (h_1 - h_4)$ kJ/kg

Work done by Turbine

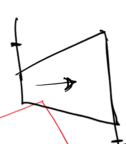
$w_T = (h_1 - h_2)$ kJ/kg

Heat rejected in condenser

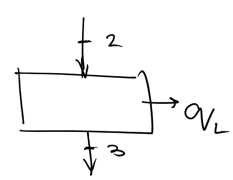
$q_L = (h_2 - h_3)$

Work consumed by pump.

$w_p = (h_4 - h_3)$



expansion in a turbine



Find h_1, h_2 from Mollier Chart

h_3 & h_4 from Steam table (saturation table)

$\eta = 1 - \frac{q_L}{q_H} = \frac{w_T - w_p}{q_H}$

h_3 & h_4 (sat wat.

$$\eta = 1 - \frac{q_L}{q_H} = \frac{w_T - w_p}{q_H}$$

$$w_{net} = (w_T - w_p)$$