Example Find the internal energy and entropy of water/steam at 1 bar & 100°C when $x = 0,\ 0.5\ \&\ 1$

$x = 0$

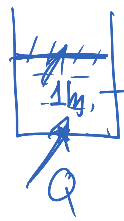
$x = 1$

$$u = u_f + x\,u_{fg}$$
$$h = h_f + x\,h_{fg}$$
$$s = s_f + x\,s_{fg}$$

$u_f = 418.94$ kJ/kg
$u_{fg} = 2087$ "
$h_f = 419$ "
$h_{fg} = 2257$ "
$s_f = 1.3069$ kJ/kg K
$s_{fg} = 6.0480$ "

$u_{fg} = u_g - u_f$

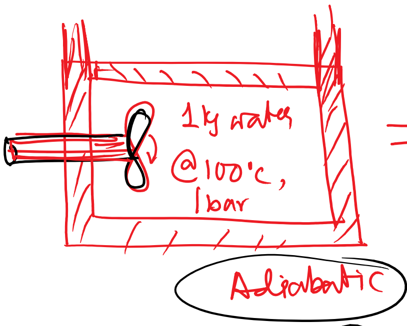
Steam Table



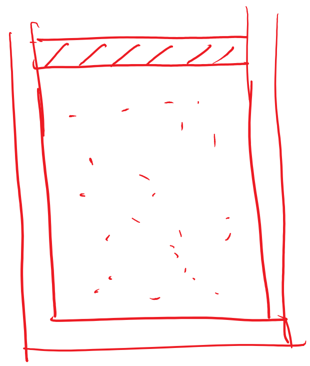
$$Q = \Delta U + p\Delta V$$
$$h = u + pv$$
$$dh = du + pdv + vdp$$
$$dh\big|_{p=c} = du + pdv = \delta q$$

Latent heat

2257 kJ/kg.



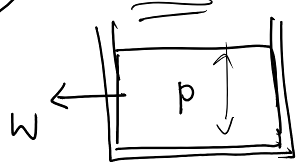
⇒



$$W = -2087.6 \text{ kJ}$$

Find ΔS, & S_{gen}, & Electric Energy needed at the fan

1st Law



$$Q - W = \Delta U$$
$$q - w = \Delta u$$
$q = 0$
$$w = -\Delta u$$
$$= -(u_g - u_f)$$
$$= -2087.6 \text{ kJ/kg.}$$

1 kg mass ⇒ $W = -2087.6$ kJ

$$\Delta S = m\,\Delta s$$
$$= 1\,(s_g - s_f) \quad (\to s_{fg})$$
$$= 1 \times 6.0480 \text{ kJ/K}$$

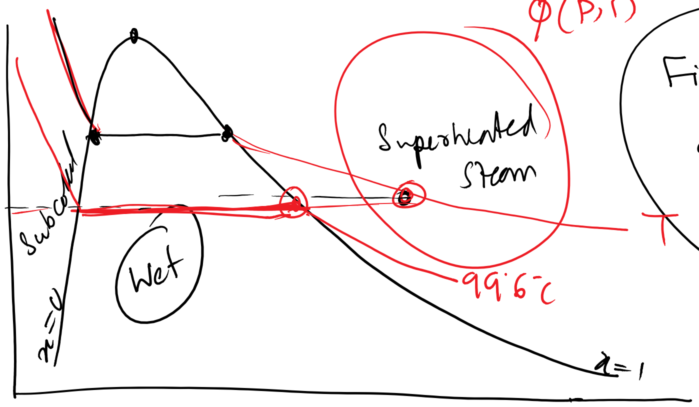
2nd Law

$$\Delta S = \sum Q/T_b + S_{gen}$$
($Q = 0$)

2nd Law

$$\Delta S = \sum Q/T_b + S_{gen}$$

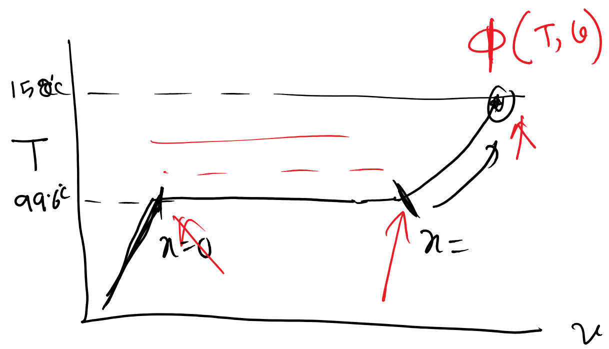
$$\boxed{\Delta S = S_{gen} = 1 \times 6.480 \ kJ/K}$$



Find u, h, s at 1 bar & 150°C

1 bar & 25°C

$$t_{sat}\big|_{p=1\,bar} = 99.63°C$$



If t is above $t_{sat}\big|_p$ it is superheated

If $t = t_{sat}\big|_p \Rightarrow$ wet

If $t < t_{sat}\big|_p \Rightarrow$ Subcooled

$$\boxed{p = 10 \text{ bar } \& \ 250°C}$$

u, h, s

↳ is it subcooled / wet / superheated

Look up for t_{sat} at 10 bar $\Rightarrow$

$t > t_{sat}$

$\Rightarrow$

$$\boxed{\text{Water at 1 bar } \& \ 70°C}$$

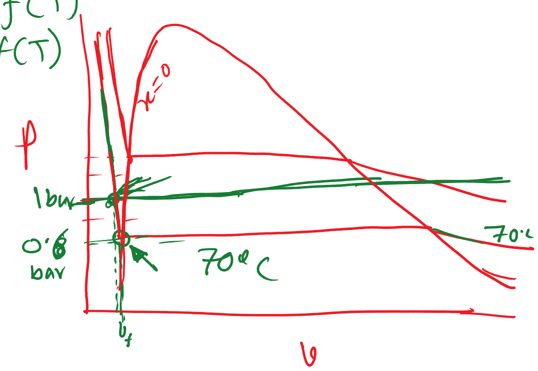
$$v \cong v_f\big|_{70°C}$$

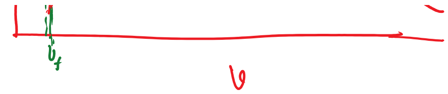
$$\boxed{u \cong u_f\big|_{70°C}}$$

$$h = u + pv$$

$v = f(T)$

$u = f(T)$





$h = u + pv$

s

$$h - h_{sat}\big|_{70^\circ C} = u - u_{sat}\big|_{70^\circ C} + \left[(pv) - (pv)_{sat\ 70^\circ C} \right]$$

$\Delta(pv)$

$$\Delta(pv) = p\Delta v + v\Delta p \quad (\Delta v \to 0)$$

$$= v\Delta p$$

$$= 0 + v\Delta p$$

$$h = h_{sat}\big|_{70^\circ C} + v\Delta p$$

$$= h_{sat} + v\left(p - p_{sat\ 70^\circ C}\right)$$

Have the Mollier Chart Ready