# Quality/ Dryness Fraction

⇒ Why PV Diagram of water is different than any of the pure substance PV diagram.

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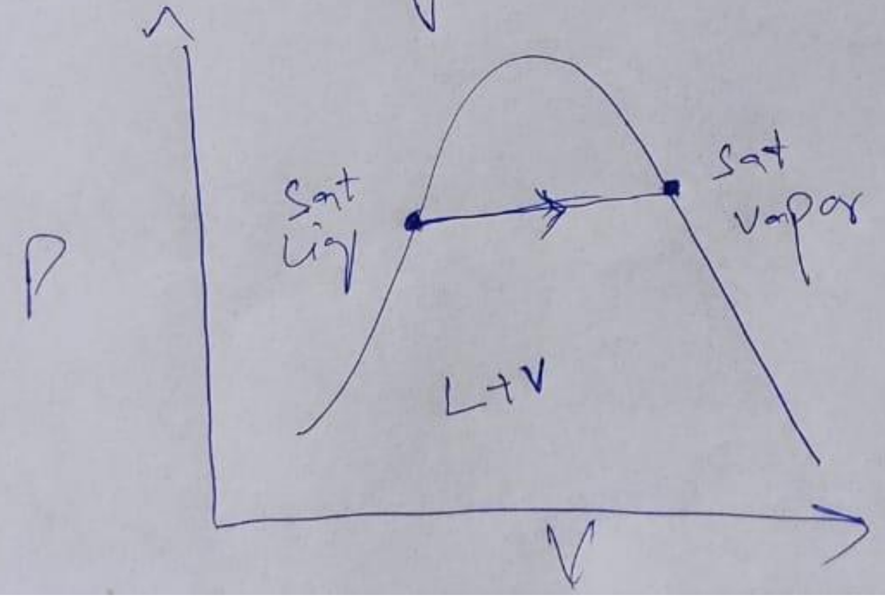
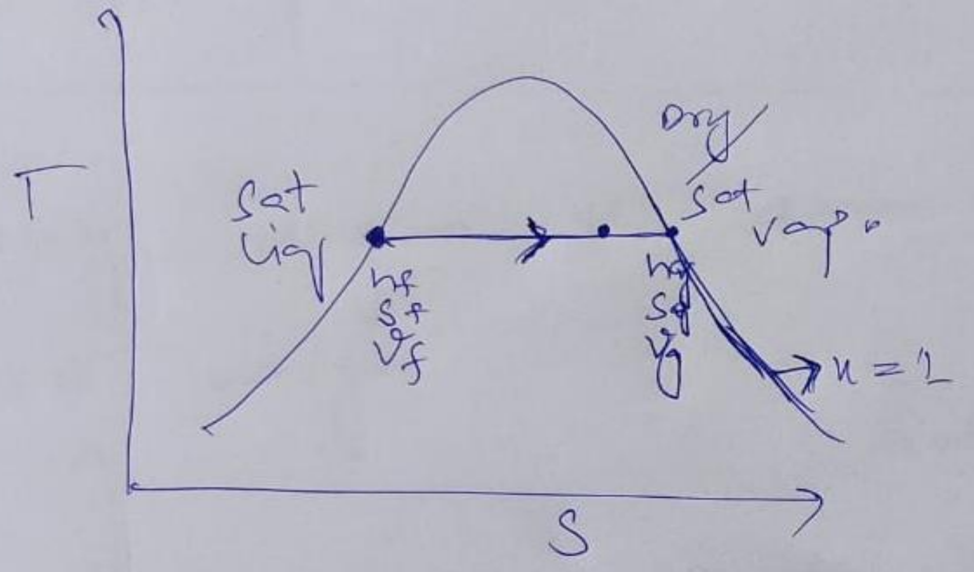
In a property diagram the dome constitutes of L+V reigon

Quality / Dryness fraction.



⇒ To find out the entropy, specific enthalpy, specific volume in the zone/dome.




$h_f$ = specific enthalpy of sat liquid

$s_f$ = specific entropy of sat liq

$v_f$ = specific volume of saturated liquid

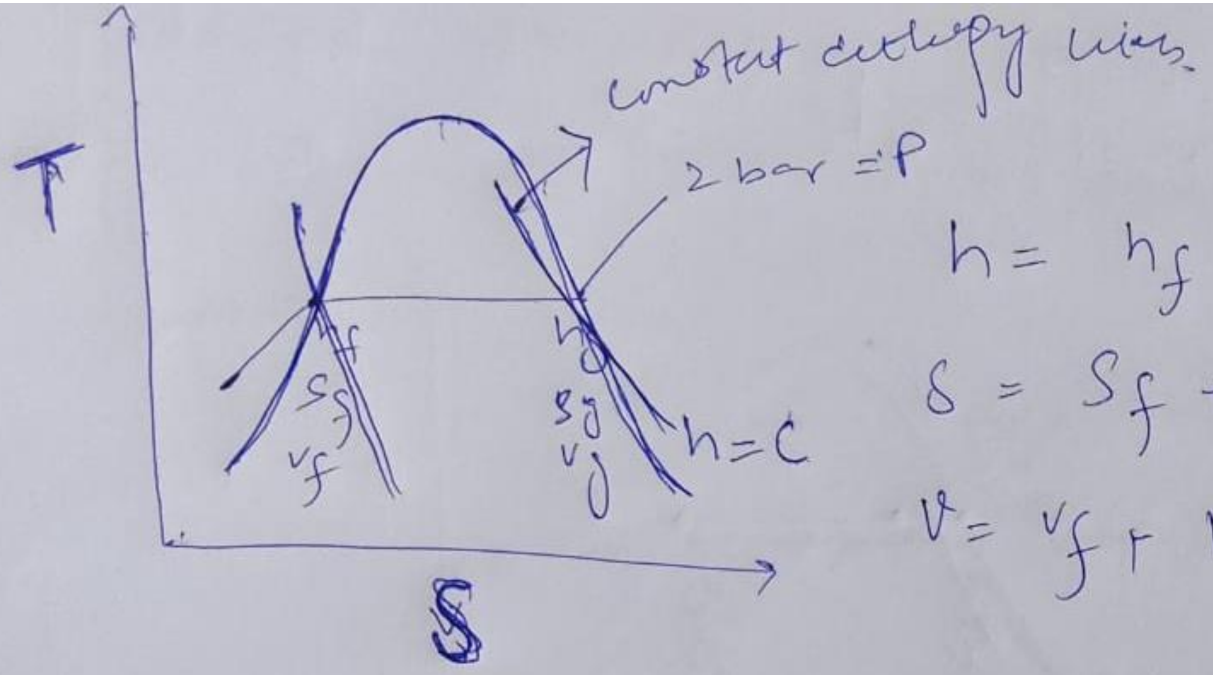
$$x = \frac{m_{vapo}}{m_{total}}$$

$h_g$ = sp. enthalpy of Dry/sat sat vap

$s_g$ = sp. entropy of sat vap

$v_g$ = specific volume of sat vapor

$\left.\begin{array}{l} h_f \\ s_f \\ v_f \end{array}\right\}$ at a certain pressure/temperature




$$h = h_f + x h_{fg} = h_f + x(h_g - h_f)$$

$$s = s_f + x s_{fg} = s_f + x(s_g - s_f)$$

$$v = v_f + x v_{fg} = v_f + x(v_g - v_f)$$

$h_{fg}$ = specific enthalpy of vaporization $= h_g - h_f$

$s_{fg}$ = specific entropy of vaporization $= s_g - s_f$

$v_{fg}$ = specific volume of vaporization $= v_g - v_f$

Quality of a vapor is essentially the % by mass of the vapor in the mixture.

$$x = \frac{m_{vapor}}{m_{total}} \qquad m_{total} = m_{vap} + m_{liq}$$

Ex 123.6 kg Water after boiling ~~out of which~~ 85.6 kg of liquid remain find Quality

$M_{vap} = 123.6 - 85.6 = 38\ kg$

$$x = \frac{38}{123.6} = 0.307 = 30.7\,\%$$

Specific Volume

$$V_{total} = V_{liquid} + V_{gas}$$

$$V_T = V_f + V_g \qquad V = m v$$

$$m_T = m_f + m_g$$

$$m_T v_T = m_f v_f + m_g v_g \qquad \therefore m_f = m_T - m_g$$

$$m_T v_T = (m_T - m_g) v_f + m_g v_g \qquad \boxed{x = \frac{m_g}{m_T}}$$

$$v_T = \left(\frac{m_T - m_g}{m_T}\right) v_f + \frac{m_g}{m_T} v_g$$

$$v_T = (1-x)\,v_f + x\,v_g$$

$$= v_f - x\,v_f + x\,v_g$$

$$= v_f + x(v_g - v_f)$$

$$\boxed{v_T = v_f + x\,v_{fg}}$$

By this relation you can find out specific volume of wet vapour $v_T$.

Or if $v_T$ is known you can also calculate quality.

Problem Solving.

Similarly all other thermodynamic properties develop similar relations

$$U_{total} = U_{liq} + U_{gas} \Rightarrow u = u_f + x\, u_{fg}$$

$$H_{total} = H_{Liq} + H_{g} \Rightarrow h = h_f + x\, h_{fg}$$

$$S_{total} = S_{liq} + S_{gas} \Rightarrow s = s_f + x\, s_{fg}$$

$$V_{total} = V_{liq} + V_{g} \Rightarrow v = v_f + x\, v_{fg}$$