Heat Capacity of Saturated Vapour

- Let 1 gram of liquid is converted into its vapour at temperature T K

- If L = Latent heat of vaporization
- then increase in entropy = L/T

So $$S_g - S_l = L/T$$

$$\frac{dS_g}{dT} - \frac{dS_l}{dT} = \frac{1}{T}\frac{dL}{dT} - \frac{L}{T^2}$$

On multiplying above equation

$$T\frac{dS_g}{dT} - T\frac{dS_l}{dT} = \frac{dL}{dT} - \frac{L}{T}$$

$$\boxed{C_g - C_l = \frac{dL}{dT} - \frac{L}{T}}$$

↳ Clausius latent heat equation

Now Let us use this equation for steam (water vapour)

For water

$L = 538$ cal / gram

$\frac{dL}{dT} = -0.705$ cal / gram K

$C_g - C_l \cong -2.14$

because $C_l = 1$ so $C_g = -1.14$

i.e. the specific heat of saturated vapour is −ve.

Why specific heat of saturated steam is −ve

* when the temperature of saturated steam at 100°C is increased by a degree it becomes unsaturated.

* To make it saturated we have to apply pressure so that its pressure becomes saturated vapour pressure of liquid at 101°C

* During the compression the heat is generated which has to be withdrawn to make its temperature to be constant at 101°c

* So the actual heat required to raise the temp by 1 degree
= heat supplied (HS) − heat withdrawn (HW)

* in case of steam $HS < HW$
So the specific heat of steam is −ve because the actual heat required to raise the temp by 1 degree is −ve.

In other cases also, we have to consider these two heats. HS and HW and depending upon the fact that whether $HS > HW$ or $HS = HW$ or $HS < HW$ the specific heat is +ve, zero or −ve.