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Hons Part II, Paper III, Grp A.
Lecture = (08) Thermodynamics.

Entropy change in ideal gas and mixing of gas →

As we know entropy is the measure of degree of randomness or disorderness of the System. If we calculate change in entropy for ideal gas then, At first we take a Cylinder which occupy one mole of ideal gas and the Container (Cylinder) Contains a frictionless, weightless movable piston at Constant pressure. Let us Suppose the ideal gas is going to expand reversibly from volume V_1 to V_2. In this process the condition is reversible so the $P_{int} = P_{ext}$ (aprox) and the gas is expanding against external pressure at all possible stages. In this Condition the maximum work done is PdV.

$$W = PdV.$$

from 1st law of thermodynamics

$$q = E + W$$

$$\text{or } dq = dE + dW \quad \text{---} \quad I$$

We know, $C_V = \frac{dE}{dT}$, so $dE = C_V \cdot dT$] II

& also $PV = RT$, so, $P = \frac{RT}{V}$]

Now we put the value of dE & P from equation II to I we have

$$dq = C_V \cdot dT + RT \frac{dV}{V} \quad \text{---} \quad III$$

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Devideing by T to equation III we have

$$\frac{dq}{T} = \frac{C_v \cdot dT}{T} + R\frac{dv}{v}$$

we know. $\frac{dq}{T} = ds$

So $ds = C_v \cdot \frac{dT}{T} + R\frac{dv}{V}$

for a rev change from initial state to final state, total change in entropy can be written as Δs.

So, $\Delta s = \int_{S_1}^{S_2} ds = C_v \int_{T_1}^{T_2} \frac{dT}{T} + R\int_{V_1}^{V_2} \frac{dv}{V}$

$$\Delta s = C_v \ln \frac{T_2}{T_1} + R \ln \frac{V_2}{V_1} \quad \text{——— IV}$$

for an ideal gas $\frac{V_2}{V_1} = \frac{P_1}{P_2}$ (Boys $P_1V_1 = RT$)

$$\Delta s = C_v \cdot \ln \frac{T_2}{T_1} + R \cdot \ln \frac{P_1}{P_2} \quad \text{——— V}$$

This is for one mole of gas. but for n mole of gas:

$$\Delta s = C_v \cdot \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1} \quad \text{——— VI}$$

How change in entropy for ideal gas at Constant Volume:-

I At Constant Volume $V_1 = V_2$, So form eqn (i)

$$(\Delta S)_V = n C_V \ln \frac{T_2}{T_1}$$

$$(\Delta S)_V = 2.303\, n C_V \log_{10} \frac{T_2}{T_1}$$

II At Constant pressure:-

At Constant Pressure $P_1 = P_2$

So form

$$(\Delta S)_P = n C_P \ln \frac{T_2}{T_1}$$

$$\text{Or } (\Delta S)_P = 2.303\, n C_P \log \frac{T_2}{T_1}$$

III At Isothermal Condition:-

At Constant temperature (Isothermal) $T_1 = T_2$

$$(\Delta S)_T = n R \ln \frac{V_2}{V_1}$$

$$= n R \ln \frac{P_1}{P_2}$$

$$(\Delta S)_T = 2.303\, n R \log_{10} \frac{P_1}{P_2}$$

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Physical Significance of entropy :—

i) By the help of value of entropy a State of matter can be identified

$\Delta S_G > \Delta S_L > \Delta S_S$.

ii) The value & Sign of ΔS predict the given process or reaction is Spontaneous or not.

If ΔS = +ve the process is Spontaneous

Exceptions : i) lequifaction of gas

ii) freezing of water.

iii) It help to find out the value of Free energy

$$\Delta G = \Delta H - T\Delta S.$$

the above equation give the relation between ΔH, ΔS & ΔG which are responsible for driving force of Spontaneous changes.