[11] calculation of enthalpy:-

we know that from enthalpy of the system

$$dH = dE + pdv$$

$$\text{or, } \Delta H = \Delta E + p\Delta V$$

$$\text{or, } \Delta H = \Delta E + \Delta (PV) \quad \text{——— (1)}$$

For one mole of an ideal gas

$$PV = RT$$

$$\text{or } \Delta PV = R\Delta T$$

Now putting the value of ΔPV in equation (1) then we get.

$$\Delta H = \Delta E + R\Delta T \quad \text{——— (2)}$$

In isothermal process temperature is constant

i.e $\Delta T = 0$, $R\Delta T = 0$

Further, Internal energy of an ideal gas in isothermal process will be constant.

i.e $\Delta E = 0$

so eqn (2) is reduced to $\Delta H = 0$

Thus in an isothermal process of an ideal gas change in enthalpy is also zero.

iii) Calculation of heat:-

We know that from 1st law of thermodynamics.

$$dq = dE + pdv$$

$$\text{or, } \Delta Q = \Delta E + p\Delta V$$

$$\Delta Q = \Delta E + \omega \quad \text{——— (1)}$$

We know in isothermal process change in internal energy is zero. so equation (1) takes the following form.

$$\Delta Q = \omega \quad \text{——— (2)}$$

It means in an isothermal expansion the change in heat of the system will be equal to the workdone by the system.

iv) Calculation of workdone:-

~~It has~~ since workdone is equal to product of pressure and change in volume. i.e

$$\omega = -p\Delta V$$ { workdone by the system — ; " to " " + }

$$\text{or, } \omega = -pdv$$

change in volume may occur either reversibly or irreversibly. It has been observed change in heat in reversible process is maximum. so workdone in this process will also be maximum. As workdone is equal to change in heat.

The total workdone obtained in an isothermal reversible expansion is calculated as.

$$\omega = -pdv \quad \text{——— (1)}$$

For one mole of an ideal gas

$$pV = RT$$

$$\text{or, } p = \frac{RT}{...} \quad \text{——— (2)}$$

Now putting the value of p From eqn (2) in equation (1) than we get

$$\omega = -RT \frac{dv}{v} \quad \text{—— (3)}$$

If the volume of the system changes from v_1 to v_2 when pressure falls from p_1 to p_2 in an isothermal reversible expansion. Than maximum workdone has been calculated by ~~Than m~~ integrating equation (3) between volume range v_1 to v_2

$$\omega_{max} = RT \int_{v_1}^{v_2} \frac{dv}{v}$$

$$\text{or, } \omega_{max} = -RT \ln \frac{v_2}{v_1} \quad \text{—— (4)}$$

$$\text{or, } \omega_{max} = -2.303\, RT \log \frac{v_2}{v_1} \quad \text{—— (5)}$$

Equation (5) is the expression for maximum workdone in an isothermal reversible expansion of an ideal gas. Further From Boyle's law

$$p_1 v_1 = p_2 v_2$$

$$\text{or, } \frac{v_2}{v_1} = \frac{p_1}{p_2} \quad \text{—— (6)}$$

Now putting the value of $\frac{v_2}{v_1}$ in equati (5) From of (6) then we get.

$$\omega_{max} = -2.303\, RT \log \frac{p_1}{p_2}$$

$$\text{or, } \omega_{max} = 2.303\, RT \log \frac{p_2}{p_1} \quad \text{—— (7)}$$

[R = 8.314

~~Another~~ Equation (7) is another expression for maxn workdone in therm of pressure

* Relationship between change in heat at constant pressure and at constant volume.

we know that from expression for enthalpy

$$\Delta H = \Delta E + P\Delta V \quad \text{——— (1)}$$

we know that change in heat at constant pressure is specially the change in enthalpy while change in internal energy is the change in heat at constant volume. so equation (1) may be written as:-

$$Q_p = Q_v + P\Delta V \quad \text{——— (2)}$$

Let us consider during a process n_1 moles of reactant changed to n_2 moles of product. so change in no. of moles $\Delta n(g) = n_2 - n_1$

further, we know from ideal gas equation

$$pv = nRT$$

$$\Delta P\Delta V = \Delta nRT \text{ at const. Temp}^n$$

Now putting the value of $P\Delta V$ in equation (2) than we get

$$Q_p = Q_v + \Delta nRT \quad \text{——— (3)}$$

Equation (3) gives the relationship between change in heat at constant pressure and at constant volume.

Q:- calculate the change in internal energy for the following reaction $N_2 + 3H_2 \xrightarrow[2-4]{} 2NH_3$
if change in enthalpy of the process is 240 kiloJ/mole at 27°C

$$\Delta n = 2-4 = -2$$

$$Q_p = Q_v + (-2)RT$$

$$Q_p = Q_v - 2RT$$

$$240 = Q_v - 2 \times 8314 \times 300K$$

$$\Delta v = 240 + (2 \times 8.314 \times 300)$$