



## Lecture .6

### Special cases of the equation $\Delta H = \Delta E + P\Delta V$

#### 1) Reactions involving gaseous substances

Where  $(n_R \neq n_P)$  and in which the volume changes are large and cannot be neglected, and by imposing the behavior of gases ideally,

$$PV_R = n_R RT$$

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Where :

$n_R$  : Number of gas moles produced.

$n_P$  : Number of gas moles interacting (At constant pressure and temperature) .

$T$  : Temperature in kelvin (K).

$R$  : The general Fixed of gases (8.314 J / K. Mole) .

From the equation:  $\Delta H = \Delta E + P\Delta V$

We will modify  $P\Delta V$  as follows:

$$P\Delta V = P (V_P - V_R)$$

$$P\Delta V = P V_P - P V_R$$

$$P \Delta V = n_P RT - n_R RT$$

$$P \Delta V = RT (n_P - n_R)$$

$$P \Delta V = \Delta n_{(g)} RT$$

Compensate the last equation in equation  $\Delta H = \Delta E + P\Delta V$  ,therefore we get on :

$$\Delta H = \Delta E + \Delta n_{(g)} RT$$

**2) Reactions in which interacting and resulting gases are involved)**

Where ( $n_P = n_R$ ) and therefore the value of  $\Delta n = 0$

Then the equation:  $\Delta H = \Delta E + P\Delta V$

From the equation:  $\Delta H = \Delta E + \Delta n RT$

Since  $\Delta n = 0$

$$\therefore \Delta H = \Delta E$$

**3) Reactions involving solid or liquid substances only (not involving gas substances):**

In which the volume changes are small  $\Delta V=0$  and therefore can be neglected, then the equation:

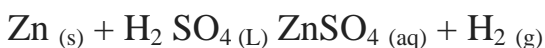
$$\Delta H = \Delta E + P\Delta V$$

since  $\Delta n = 0$

$$\therefore \Delta H = \Delta E$$

**Example :**

Calculating the change in the internal energy of the reaction:



If the released heat is 34200 Cal of zinc at (17 ° C)

Note that (R = 2 Cal / mole .K)

**Solution :**

$$\Delta n = 1 - 0 = 1$$

Applying the relationship  $\Delta H = \Delta E + \Delta n RT$

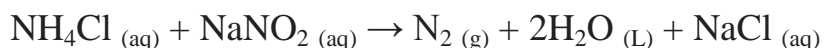
$$\Delta E = \Delta H - n RT$$

$$\Delta E = [(- 34200 \text{ Cal}) - (1 \times 2 \times (17 + 273))]$$

$$\Delta E = - 34780 \text{ Cal}$$

**Example :**

If the change in internal energy is equal to -333kJ for the following interaction:



When one mole of  $\text{N}_2$  is produced, if the production of one mole of nitrogen makes the system increase by 22.4 L, at one air pressure. Calculate the change in the Enthalpy interaction?

**Solution :**

$$\Delta E = -333 \times 10^3 \text{ J}, \quad P = 1 \text{ atm}, \quad \Delta V = 22.4 \text{ L}$$

$$P \Delta V = 1 \text{ atm} \times 22.4 \text{ L} = 22.4 \text{ L} \cdot \text{atm}$$

$$22.4 \text{ L} \cdot \text{atm} \times 101.325 \text{ J / L} \cdot \text{atm} = 2269.68 \text{ J}$$

Applying the relationship:  $\Delta H = \Delta E + P\Delta V$

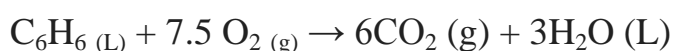
$$\Delta H = [(-333 \times 10^3) + (1 \times 22.4) 101.325]$$

$$\Delta H = -330730.88 \text{ J}$$

$$\Delta H = -330.73 \text{ kJ}$$

**Example :**

If the heat associated with combustion of one molten gasoline is equal to (-3264.3) kJ at a fixed volume and temperature (298K), Calculate the change in the enthalpy of the reaction ( $\Delta H$ ), if you know that gasoline burns with oxygen equation:



Note that the value of ( $R = 8.314 \text{ J / mole} \cdot \text{K}$ ).

**Solution :**

The amount of heat at a fixed volume reflects the internal energy:

$$q_v = \Delta E$$

$$\Delta E = -3264.3 \times 10^3 \text{ J}$$

$$\Delta n = n_p - n_R = 6 - 7.5 = -1.5$$

$$\Delta H = \Delta E + \Delta n RT$$

$$\Delta H = (-3264.3 \times 10^3 \text{ J}) + (-1.5 \text{ mole} \times 8.314 \text{ J / K} \cdot \text{mole} \times 298 \text{ K})$$

$$\Delta H = -3268016.358 \text{ J}$$

$$\Delta H = -3268.02 \text{ kJ}$$