Exothermic and Endothermic reactions.

(1) **Exothermic reactions:** The chemical reactions which proceed with the **evolution of heat** energy are called exothermic reactions. The heat energy produced during the reactions is indicated by writing +q or more precisely by giving the actual numerical value on the products side. In general exothermic reactions may be represented as, $A + B \rightarrow C + D + q$ (heat energy)

In the exothermic reactions the enthalpy of the products will be less than the enthalpy of the reactants, so that the enthalpy change is negative as shown below

$$\boxed{\Delta H = H_p - H_r}; \quad H_p < H_r; \; \Delta H = -ve$$

Examples: (i) $C(s) + O_2(g) \rightarrow CO_2(g) + 393.5kJ$ (at constant temperature and pressure)

or $C(s) + O_2(g) \rightarrow CO_2(g); \; \Delta H = -393.5kJ$

(ii) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l); \; \Delta H = -285.8kJ$

(iii) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g); \; \Delta H = -92.3kJ$

(iv) $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g); \; \Delta H = -694.6kJ$

(v) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O; \; \Delta H = -890.3kJ$

(vi) Fermentation is also an example of exothermic reaction.

(2) **Endothermic reactions:** The chemical reactions which proceed with the absorption of heat energy are called endothermic reactions. Since the heat is added to the reactants in these reactions, the heat absorbed is indicated by either putting (–) or by writing the actual numerical value of heat on the reactant side

$A + B \rightarrow C + D - q$ (Heat energy)

The heat absorbed at constant temperature and constant pressure measures enthalpy change. Because of the absorption of heat, the enthalpy of products will be more than the enthalpy of the reactants. Consequently, ΔH will be positive $(+ve)$ for the endothermic reactions.

$$\Delta H = H_p - H_r; \; H_p > H_r; \quad \Delta H = +ve$$

Example: (i) $N_2(g) + O_2(g) + 180.5\,kJ \rightarrow 2NO(g)$

or $N_2(g) + O_2(g) \rightarrow 2NO(g); \Delta H = +180.5\,kJ$

(ii) $C(s) + 2S(s) \rightarrow CS_2(l) \Delta H = +92.0kJ$

(iii) $H_2(g) + I_2(g) \rightarrow 2HI(g); \Delta H = +53.9kJ$

(iv) $2HgO(s) \rightarrow 2Hg(l) + O_2(g); \Delta H = +180.4kJ$

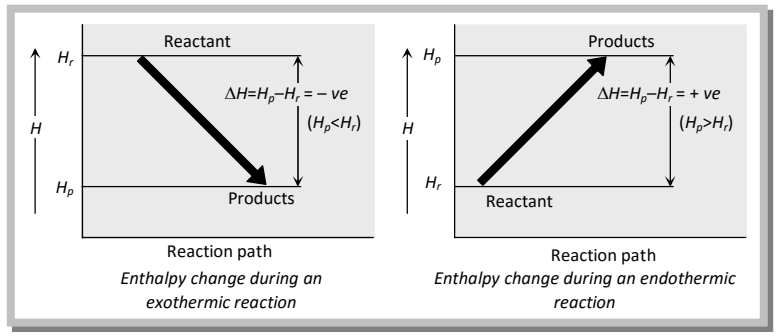
(v) $SnO_2(s) + 2C(s) \rightarrow Sn(s) + 2CO_2(g); \Delta H = +360.0kJ$

(vi) $Fe + S \rightarrow FeS$

(vii) Preparation of ozone by passing silent electric discharged through oxygen is the example of endothermic reaction.

(viii) Evaporation of water is also the example of endothermic reaction.

The enthalpy changes for exothermic and endothermic reactions are shown in figure.



Similarly, if we consider heat change at constant volume and temperature, ΔE is – ve, now it may be concluded that

For exothermic reaction: ΔH or $\Delta E = -ve$
For endothermic reactions: ΔH or $\Delta E = +ve$