Theories of catalysis.

There are two theories of catalysis which is described as follows.

(1) **Intermediate compound theory**

(i) This theory was proposed by **Clement and Desormes in** 1806**.** According to this theory, the desired reaction is brought about by a path involving the formation of an unstable intermediate compound, followed by its decomposition into the desired end products with the regeneration of the catalyst.

(ii) The intermediate compound may be formed in either of two ways

(a) When the intermediate compound is reactive and reacts with the other reactants.

$$AB + X \rightarrow \underset{\text{intermedia te}}{BX} + A$$

$$BX + C \rightarrow CB + X \qquad \text{.....(i)}$$

(b) When the intermediate is unstable and decomposes to give the final product.

$$A + B + X \rightarrow \underset{\text{intermedia te}}{ABX} \rightarrow AB + X \qquad \text{.....(ii)}$$

Where, A, B and C are the reactant molecules and X is the molecule of the catalyst. The first type of reaction sums up to, $AB + C \rightarrow CB + A$

While the second to, $A + B \rightarrow AB$ in many cases, the intermediate compounds postulated to be formed are known compounds and often their presence is detected.

(2) **Adsorption theory**

(i) This theory is applicable to reactions between gases in the presence of a solid catalyst. Some typical examples are as follows.

(ii) The contact process for the oxidation of SO_2 to SO_3 with atmospheric oxygen in the presence of platinum as the catalyst.

(iii) The Haber's process for the synthesis of ammonia with iron as the catalyst.

(iv) Adsorption results in the loosening of the chemical bonds in the reactant molecules, so that their rupture becomes easier. This is confirmed by the observed lower activation energies for heterogeneous catalytic reactions in the presence of the catalysts as compared to that for the same reaction in the absence of the catalyst.

(v) The metals copper and nickel are found particularly suitable for reactions involving hydrogen gas. These metals are known to strongly chemisorb hydrogen gas. Typical example includes the dehydrogenation of ethanolvapors when passed over heated metal at $350^{o}C$. $CH_3CH_2OH \xrightarrow[350^{o}C]{Ni} CH_3CHO + H_2$

(vi) Aluminum oxide in some physical forms is a good adsorbent for water vapor. It is also a useful catalyst for reactions involving dehydration processes (i.e. processes involving the

removal of water from molecules). For example, formation of ethane from ethyl alcohol,

$$CH_3CH_2OH \xrightarrow[350^oC]{Al_2O_3} CH_2 = CH_2 + H_2O$$

ethanol ethene