Chemistry Study Materials for Class 12
(NCERT Based Notes of Chapter – 05)
Ganesh Kumar Date:- 21/06/2021

Surface Chemistry

Applications of adsorption

The important applications of adsorption are:

1. Production of high vacuum: For the complete evacuation of a vessel, activated charcoal is used.
2. Gas masks: The poisonous gases in coal mines can be removed by using gas masks containing activated charcoal.
3. Control of humidity: Silica and aluminium gels are used as adsorbents for removing moisture and controlling humidity.
4. Animal charcoal is used for the purification of cane sugar solution.
5. Adsorption finds application in heterogeneous catalysis.
6. A mixture of noble gases can be separated by adsorption on coconut charcoal at different temperatures.
7. In curing diseases: A number of drugs are used to kill germs by getting adsorbed on them.
8. In froth floatation process for the purification of sulphide ores in metallurgy.
9. Adsorption indicators like eosin, fluoresce in etc. are used in volumetric analysis.
10. Chromatographic analysis for the separation of a mixture is based on adsorption.

CATALYSIS

A catalyst is a substance that changes the rate of a chemical reaction without undergoing any permanent chemical change by itself. The process of changing the rate of a chemical reaction by a catalyst is known as Catalysis.

Eg: MnO_2 (Manganese dioxide) acts as a catalyst in the decomposition of $KClO_3$

(Potassium chlorate) $2KClO_3 \rightarrow 2KCl + 3O_2$

Promoters and poisons

Promoters are substances that enhance the activity of a catalyst while poisons decrease the activity of a catalyst. For example, in Haber's process for the manufacture of ammonia, molybdenum (Mo) acts as a promoter for the catalyst iron.

$$N_2 + 3H_2 \xrightarrow{Fe/Mo} 2NH_3$$

Types of Catalysis

Positive and Negative Catalyst

A catalyst that increases the rate of a chemical reaction is called Positive catalyst and that decreases the rate of a chemical reaction is called negative catalyst (inhibitors).

E.g. In the Haber's process for the manufacture of ammonia, Fe acts as a positive catalyst

$$N_2 + 3H_2 \xrightarrow{Fe/Mo} 2NH_3$$

For decreasing the rate of dissociation of H_2O_2, Phosphoric acid is used as a negative catalyst.

Homogenous and Heterogeneous Catalysis

Homogeneous Catalysis

A catalytic process in which the reactants and the catalyst are in the same phase (i.e., liquid or gas), is said to be homogeneous catalysis.

e.g.: (i) In the *lead chamber process* for the manufacture of Sulphuric acid, oxidation of sulphur dioxide into sulphur trioxide is done in the presence of Nitric Oxide as catalyst

$$2SO_2(g) + O_2(g) \xrightarrow{NO(g)} 2SO_3(g)$$

Here the reactants (sulphur dioxide and oxygen) and the catalyst (nitric oxide) are all in the same phase.

(ii) Acid catalysed hydrolysis of methyl acetate

$$CH_3COOCH_3(l) + H_2O(l) \xrightarrow{HCl(l)} CH_3COOH(aq) + CH_3OH(aq)$$

(iii) Hydrolysis of sugar is catalysed by H^+ ions furnished by sulphuric acid.

$$C_{12}H_{22}O_{11}(l) + H_2O(l) \xrightarrow{H2SO4} C_6H_{12}O_6(aq) + C_6H_{12}O_6(aq)$$

Heterogeneous catalysis

The catalytic process in which the reactants and the catalyst are in different phases is known as heterogeneous catalysis.

Some of the examples of heterogeneous catalysis are:

(i) In *contact process* for the manufacture of H_2SO_4, Oxidation of sulphur dioxide into sulphur trioxide is done in presence of V_2O_5.

$$2SO_2(g) + O_2(g) \xrightarrow{V2O5(s)} 2SO_3(g)$$

Here the reactants are in gaseous state while the catalyst is in the solid state.

(ii) In *Haber's process* for the manufacture of ammonia finely divided iron is used as catalyst.

$$N_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$$

Here the reactants are in gaseous state while the catalyst is in the solid state.

(iii) Oxidation of ammonia into nitric oxide in the presence of platinum gauze in Ostwald's process.

$$4NH_3(g) + 5O_2(g) \xrightarrow{Pt(s)} 4NO(g) + 6H_2O(g)$$

Here also the reactants are in gaseous state while the catalyst is in the solid state.

(iv) Hydrogenation of vegetable oils in the presence of finely divided nickel as catalyst.

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