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TOPIC:- **classification of solvent**

UNIT 1: General classification of solvent

1.0 **Introduction**

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Main content

Classification of solvents

1) **Acid solvent**
2) **Basic or protophilic solvent**
3) **Amphiprotic solvent**
4) **Protonic or protic solvent**
5) **Non protonic/aprotic solvent**
6) **Coordinating solvent**
7) **Inert solvent**

1.0 **Introduction**

Several bases exist for classifying solvents. For example, based on their content of hydrogen, solvents can be grouped into protic and aprotic solvents. Solvents may be classified based on their ability to accept or donate proton, according to their tendency to coordinate or based on their polarity. Which ever classification method is adopted is not conclusive because solvent classification method is done for convenience and several classification approach interwoven with each other. In this section, the various classifications are briefly considered.

2.0 Objectives of the study

I. To understand what is acidic solvent
II. To understand what is basic or protophillic solvent
III. To understand what is amphiprotic solvent
IV. To understand what is protonic/protic solvent
V. To understand what is aprotic solvent
VI. To understand what is coordinating solvent
VII. To understand what is inert solvent

Acidic solvents

Solvents that have strong tendency to donate protons are called acidic solvent because they are acidic in nature Example are H_2SO_4,HF and CH_3COOH.

Basic or protophillic solvents

Basic or protophillic solvents have strong tendency to accept protons and are basic in nature Examples are ammonia, hydrazine, ethylenediamine, etc

Amphiprotic solvents

Solvents which neither have a strong tendency to gain nor lose protons are called Amphiprotic solvents. Example: H_2O ,CH_3CH_2OH ,CH_3OH.The most important nonaqueous solvents of this class are the lower alcohols methanol and ethanol. They resemble water in their acid–base properties.But because of their lower dielectric constants, facilitate processes producing ions to a much smaller extent. In particular, the ion products of these solvents are much smaller ($K_s = 10^{-17}$ for CH_3OH and 10^{-19} for C_2H_5OH, compared with 10^{-14} for water), and the dissociation constants of molecular acids and bases are uniformly lower than in water by four to five powers of 10. Nitric acid, for example, which is almost completely dissociated in water (*K*a about 20), has *K*a =

2.5 × 10^{-4} in methanol. On the other hand, the equilibrium constants of processes such as $NH4^{+} + ROH \rightleftharpoons NH3 + ROH2^{+}$ and $CH3CO2^{-} + ROH \rightleftharpoons CH3CO2H + RO^{-}$ are similar in all three solvents, since they do not involve any change in the number of ions.

Protonic/protic solvents

Solvents that could be a source of protons (H^{+} ions) are called protonic or protic solvents. Some examples of protonic/protic solvents are water, hydrogen flouride, tetraoxosulphate (VI) acid and hydrochloric acid. Protic solvents often have hydrogen bound to oxygen (such as OH^{-}) or a nitrogen (as in amine). Consequently, any solvent that contains H^{+} is called protic solvent.

Aprotic/non protonic solvents do not contains ionizable hydrogen atom are called non- Protonic Solvents. Example include SO2, N2O4, C6H6,CHCl3, CCl4

Most protic and aprotic solvents that are commonly used are polar. Polar protic solvent are useful in dissolving salts because they have high dielectric constant and high polarity as shown in Table

1. General characteristics of polar protic solvents are:
   - i. Display of hydrogen bonding
   - ii. Possession of acidic hydrogen
   - iii. Ability to dissolve salts which may be cation by unshared free electron pair or anions by hydrogen bonding

Example of polar protic solvents are water, alcohol, hydrogen fluoride and ammonia. They are recommendable solvent for SN1 reactions while polar aprotic solvents are favourable to SN2 reactions.

Polar aprotic solvent do not contain acidic hydrogen indicating that they are hydrogen bond acceptor, which normally have intermediate constants and polarity. According to IUPAC, polar aprotic solvents are those solvents that have high dielectric constant and high dipole moments. For example, acetronitrile. Other examples are contained in Table 1. Consequently, characteristics of polar aprotic solvents are,

- i. They accept hydrogen bonds
- ii. They do not have acidic hydrogen

iii. They dissolve salts

Generally, polar aprotic solvents are incompatible with strong bases including Grinard reagents and n-butyllitium (which requires ethers and not nitriles, amides or sulfoxides).

i. Ionizable solvents: Solvents that can undergo self-ionization (i.e autoionization) are called ionisablesolvents. Examples are NH3, HF ,SO2 ,N2O4 ,ClF3,BrF3 and POCl3.
ii. Nonionizable solvents: Solvents such as benzene, which do not ionize at all are called non-ionizing solvents. Most hydrocarbon and carbon tetrachloride are other examples of non-ionizing solvents.

Coordinating solvent

Based on the ability to coordinate with cation or anion, non-aqueous solvents can be classified into the following two groups,

Coordinating solvents: Coordinating solvents are those solvents that have the ability to coordinate with the metal ion or anions of the solute . Common example of coordinating solvents are ammonia, sulphur (IV) oxide, nitro methane etc.

Non coordinating solvents: Solvents such are carbon tetrachloride and saturated hydrocarbons cannot coordinate with metal ion or anion and are referred to as non- coordinating solvents.

Inert solvents

Solvents with low relative permittivities (or dipole moments) and very weak acidic and basic properties are called inert solvents. Examples of inert solvents are CH2Cl2, CHCl3 and benzene; inert solvents such as n-hexane andcyclohexane). Inert solvent usually have low polarity and high permittivity. There are useful as solvents where solvent interaction must be check. This is because their low permittivity, electrical conductivity and dipole moment makes them to be less reactive.