Environmental chemistry: Chemical Speciation

Introduction

The term speciation means identification of inorganic or organomettalic species of an element/chemical in environment.

The chemical reactivity and properties , toxicity of an element depends on the nature / form of chemical entity or species.

The speciation of a metal in natural water can change its kinetic and thermodynamic properties.

For eg. Cu^{2+} in free ionic form is toxic to phytoplankton , while copper complexed to organic ligands is not toxic.

The different forms of a metal in solution would be differently solution. For eg. Fe(II) is solution in aqueous solution whereas Fe(III) is nearly insoluble.

THE CHANGE IN FORM OF CHEMICAL SPECIES MAY BE DUE TO ONE OF THE FOLLOWING REASONS:

- Due to the difference in oxidation state: The common oxidation of iron are +2(ferrous) and +3(ferric) and almost all the aqueous chemistry of iron is confined to these two +2 and +3 oxidation states. In natural water ferrous form Fe(II) changes easily to ferric form Fe(III) due to air oxidation .

Due To The Hydrolysis of Ions:

- The hydrolysis of ions and other Species is a common method of generation of new Species. For e.g. Hydrolysis of acetate ions in water generates undissociated acetic acid , and solution will have two acetate Species viz. Acetate ions and acetic acid molecule.

$$CH_3COO^- + H_2O \dashrightarrow CH_3COOH + OH^-$$

- ***Due to the complex formation:***
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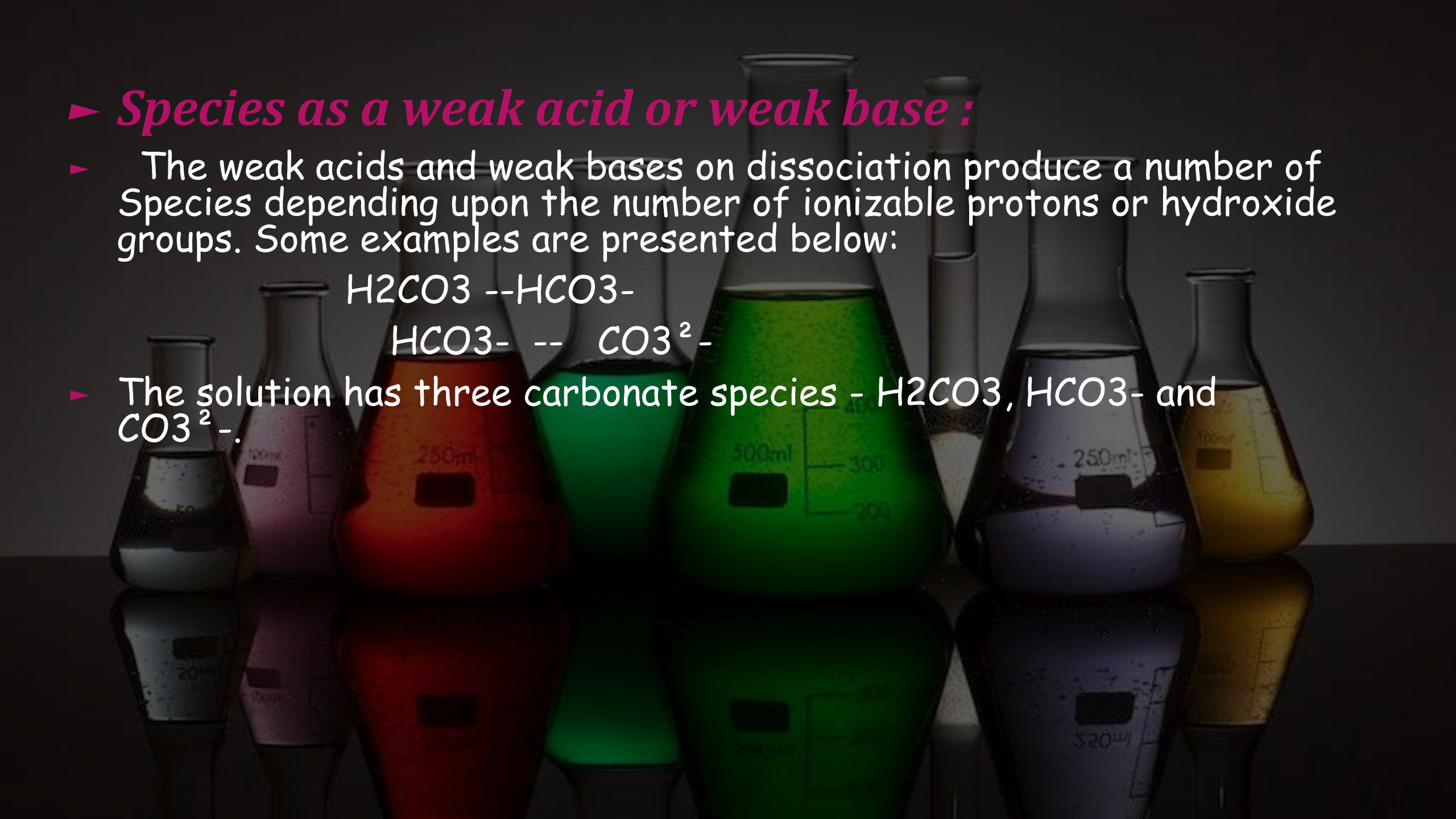
- Complex formation between metal ions and ligands is a common process for generating differently complexed Species. For e.g. In an aqueous solution the presence of copper (II) cation and chloride ion can lead to several chlorocopper(II) complexes as in the following reactions.
- $Cu^{2+} + Cl^- \text{ -----} \; CuCl^+$
- $CuCl^+ + Cl^- \text{ -------} \; CuCl_2$
- Cu^{2+} ion undergoes hydrolysis also as follows:

  $Cu^{2+} + H_2O \text{ -------} \; CuOH^+$

  $CuOH^+ + H_2O \text{ -------} Cu(OH)_2(s)$
- So the aqueous solution has following copper(II) species, namely, Cu^{2+},$CuOH^+$
- , $Cu(OH)_2(s)$, $CuCl^+$ and $CuCl_2$.



- ***Species as a weak acid or weak base :***
- The weak acids and weak bases on dissociation produce a number of Species depending upon the number of ionizable protons or hydroxide groups. Some examples are presented below:

H_2CO_3 --HCO_3^-

HCO_3^- -- CO_3^{2-}

- The solution has three carbonate species - H_2CO_3, HCO_3^- and CO_3^{2-}.

Toxicity of the chemical species also depends upon the species present. For e.g. Hg is not toxic but (CH3)2Hg is highly toxic.

The mobility or transport of the element concerned in the environment depends upon the physical properties like volatility, and solubility etc. The mobility and transport of a toxic species effect the man and other organism.

Arsenic mainly exists in environment as Arsenite, As(III), Arsenate and Organo arsenic. Only arsenite form of arsenic is toxic.

Arsenic in marine organism is present largely as an arsenobetaine , which is not toxic.

Thus for the evaluation of toxic effect of an element, accurate determination of the total conc. Of the element is not enough, the conc. Of all the species of element must be known in order to assess its compact on the organism and environment.

Speciation Of Mercury:

Pollution of water by mercury was the main reason for the studies on speciation of mercury.

Mercury exists in three oxidation states:

1)Elemental mercury, Liquid: poorly absorbed by ingestion and skin contact , so inert and non-toxic.

Elemental mercury, vapour: highly toxic

2)Mercurous: Salts of mercury is insoluble in water and poorly toxic

3)Mercuric: soluble in water, toxic

Speciation of mercury in aqueous system:

In natural water mercury conc are very low , In surface water, mercury occurs in the form a hydroxyl and chloro complexes. In marine water the dominant mercury compounds are chloro complexes. The existence and migration of different mercury species in water environment is largely governed by redox conditions and the ph of the medium.


Thankyou...