Water Quality: Definition, Characteristics, and Perspectives
Chemical water – quality parameters

• Water is called a universal Solvent
• Chemical parameters of water are:
  1. Total dissolved solids,
  2. Alkalinity,
  3. Hardness,
  4. Fluorides,
  5. Metals,
  6. Organics,
  7. Nutrients.
Chemistry of solutions

- **Atom** the smallest unit of element
- **Molecule**s of elements or compounds are constructed of atoms.

\[ H + H \rightarrow H_2 \]
\[ H_2 + O \rightarrow H_2O \]

**Molecular mass** is the sum of the atomic mass of all atoms in a molecule.

For example:

Atomic mass of oxygen (O) = 16, for Hydrogen (H) = 1

Molecular mass for water (H₂O) = 18
• **A mole** of an element or compound is its molecular mass in gm.

For example:
one mole of oxygen (O₂) = 32, water (H₂O) =18

• One mole of a substance dissolved in sufficient water to make one liter of solution is called a **one molar solution**.

• The charged species is called **ions**. Produced when compounds dissociate in water.

• +ve ions called **cations**, -ve ions called **anions**

• **Neutrality** means the number of cations = the number of anions.

\[ \text{NaCl} \iff \text{Na}^+ + \text{Cl}^- \]
• **The valence** is the number of charges on an ion.
  The valence of \((Na^+)=1\),
  The valence of \((Cl^-)=1\)

• **The equivalence** of an element is the number of hydrogen atoms that element can hold in combination or can replace in a reaction (= valence in most cases)

• **An equivalent** of an element is its gram molecular mass (mole) divided by its equivalence.

• **A milliequivalent** of an element is its milligrams molecular mass divided by its equivalence.
Example

How many grams of calcium will be required to combine with 90 g of carbonate to form calcium carbonate?

Solution:

1- One equivalent of Carbonate (CO₃²⁻) = \( \frac{\text{equivalent mass}}{\text{equivalence}} = \frac{12 + 3(16)}{2} = 30 \text{ g/equiv} \)

2- One equivalent of Calcium(Ca²⁺) = \( \frac{40}{2} = 20 \text{ g/equiv} \)

3- The no. of equivalents of Carbonate must equal to the no. of equivalents of calcium.

4- No. of equivalents of calcium = \( \frac{90 \text{ g}}{30 \text{ g/equiv}} = 3 \text{ equiv} \)

5- So, we need 3 equiv of carbonate = 3 equiv X 20 g/equiv = 60 g.
• The **concentration** of substance **A** can be **expressed** as an equivalent concentration to substance **B** as the following:

\[
\frac{(g / L)A}{(g / \text{equiv})A} \times (g / \text{equiv})B = (g / L)A \quad \text{expressed as } B
\]

Generally, the constituents of dissolved solids are reported in terms of equivalent **calcium carbonate** concentrations
Example

What is the equivalent calcium carbonate concentration of:

- 117 mg/L of NaCl?
- 2x10^{-3} mol/L of NaCl?

1- One equivalent of Calcium Carbonate (CaCO₃)

\[
equiv \frac{\text{equivalent mass}}{\text{equivalence}} = \frac{40 + 12 + 3(16)}{2} = 50 \text{ g/equiv}
\]

2- One equivalent of Sodium Chloride (NaCl)

\[
\frac{23 + 35.5}{1} = 58.5 \text{ g/equiv}
\]

\[
\frac{117 \text{ (mg/L) NaCl}}{58.5 \text{ (g/equiv) CaCO₃}} \times 50 \text{ (g/equiv) CaCO₃} = 100 \text{ (mg/L) NaCl as CaCO₃}
\]

3- One mole of a substance divided by its valence is one equivalent →

\[
\frac{2 \times 10^{-3} \text{ mol/L}}{1 \text{ mol/ equiv}} = 2 \times 10^{-3} \text{ equiv/L}
\]

Thus, \(2 \times 10^{-3} \text{ equiv/L} \times 50 \text{ (g/equiv) CaCO₃} = 100 \text{ (mg/L) NaCl as CaCO₃}\)