EC - Engineering Chemistry

4 Credit course, 3 from theory and 1 from practical (lab)
Course is divided into 6 Modules

- Water
- Polymer
- Phase Rule
- Chemical Fuels
- Corrosion
- Battery

28/01/2025 Lecture 1

Characteristics imparted by impurities in water -> Hardness of water Degree of hardness -> Determination of hardness by EDTA method -> Softening of hard water -> ION exchange method -> Zeolite method of softening of hard water -> Internal treatment by phosphate

Water

(i) Types of impurities in water

Dissolved Impurities	(a) Inorganic Salts • Cation - Ca^{2+}, Mg^{2+}, Na^{+} • Anions -
Suspended Impurities	(a) Inorganic - Clay & Soil (b) Organic - Oil, Vegetables and animal matters
Colloidal Impurities	Clay and finely divided silica colloidal particles
Micro-organism	Bacteria, algae, fungi, etc.

(ii) Hardness of Water (Important)
Hardness of water is originally defined as the soap consuming capacity of a water sample. The soap containing capacity is due to the certain salt of calcium, magnesium and other heavy metals dissolved in it
The soap is generally consisting of sodium salts of fatty acids such as Oleic acid, Palmitic acid and stearic acid

Hard water won't give lather, but soft water does.
Calcium and magnesium react with sodium salts of long chain fatty acid present in the soap to form insoluble scums of calcium and magnesium soaps.

Oleic Acid	
Palmitic Acid	
Stearic Acid	

-> Hard Water

- Does not produce good lather (foam) with soap
- Consumes more soap.
- Contains bio-carbonates, chlorides and sulphates of calcium & magnesium.

$2C_{17}H_{35}COONa + CaCl_2 \rightarrow (COO)_2Ca + NaCl$

$2C_{17}H_{35}COONa + MgSO_4 \rightarrow (C_{17}H_{35}COO)_2Mg + Na_2SO_4$

Other metal ions such as Fe^{2+}, Mn^{2+}, Al^{3+} also contribute to hardness
Hard water is such a type of water which does not form **Lather**

(29/01/2025) || Module 1 - Water Treatment

-> Soft Water

Soft water when treated with soap produces more lather and consumes less soap and this is due to absence of dissolved Ca and Mg in water

$C_{17}H_{35}COONa + H_2O \rightarrow NaOH + 2C_{17}H_{35}COONa$

-> Temporary Hardness (carbonate hardness)

Temporary hardness is formed by presence of dissolved "bicarbonate of calcium and magnesium" and other heavy metal ion.
It is destroyed by boiling of water.

- During boiling bicarbonate are decomposed in insoluble carbonate and hydroxide, which are deposited at the bottom of the vessel

$Ca(HCO_3)_2 \rightarrow (Heat)\ CaCO_3\ (Insoluble) + CO_2 + H_2O$

$Mg(HCO_3)_2 \rightarrow (Heat)\ MgCO$

-> Salts producing hardness of water

Temporary Hardness	1. Calcium Bicarbonate - $Ca(HCO_3)_2$ 2. Magnesium Bicarbonate - $Mg(HCO_3)_2$
Permanent Hardness	1. Calcium Chloride - $CaCl_2$ 2. Magnesium Chloride - $MgCl_2$ 3. Calcium Sulphate - $CaSO_4$ 4. Magnesium Sulphate - $MgSO_4$

-> Equivalent of calcium carbonate

Hardness is expressed in terms of equivalent of calcium carbonate because it is most insoluble salt in water.

Equivalent of $CaCO_3$ = (Mass of hardness producing substances * 50 / Chemical equivalent of hardness producing substances)

-> Units of hardness

- ppm = parts per million
- mg/L = Milligram per litre
- Degree Clarke (^{0}Cl)
- Degree French (^{0}Fr)