Engineering Chemistry

CYC 102

Dr. Sukriti

School Of Basic Sciences

Indian Institute of Information Technology Una
Himachal Pradesh

Overview

- Impurities in water
- Water analysis
- Hardness of water
- Type of Hardness
- Summary

Impurities in water

A) Suspended particles

- Silt, pipe work debris, colloids-organic/inorganic

B) Turbidity

- Warmer water, less light, less oxygen
- Marine ecosystem disturbed

c)Dissolved inorganic salts

- Bicarbonates, sulphates, chlorides of Ca and Mg, carbon dioxide/acidic carbonic acid
- Sodium salts, Silicates, ferrous and ferric iron from rusty iron pipes
- Aluminum from dosing chemicals and minerals, Phosphates from detergents and Nitrates from fertilizers

Impurities in water…Contd.

D) Water and its pH

- Changes in pH risk life of organism.
- Neutral conditions-most adapted.
- Acid rains-air pollution and matter from tailpipes.

E) Dissolved organics

- Decay of vegetable matter, paper making, industrial waste.
- Residues of pesticides, detergents, fats, oils and solvents.

F) Dissolved gases

- Carbon dioxide-anion exchange.
- Oxygen- degassing or anion exchange.

Impurities in water…Contd.

G) Micro-organisms

- Amoebae, bacteria, rotifers, diatoms, algae
- Potable laboratory water supply-10 colony forming units per millitre (CFU/mL) or less.

H) Total dissolved solids (TDS)

- Rain water-purest form-10 mg/L TDS
- Optimal level of TDS is to maintained.

Levels of Total dissolved solids:

Sources of water	Total dissolved solids (mg/L)
Drinking water	25-250
Distilled water	0.5-1.5
Rivers	100-20,000
Sea water	3500
Lakes and Streams	50-250

Impurities in water…Contd.

I) Temperature

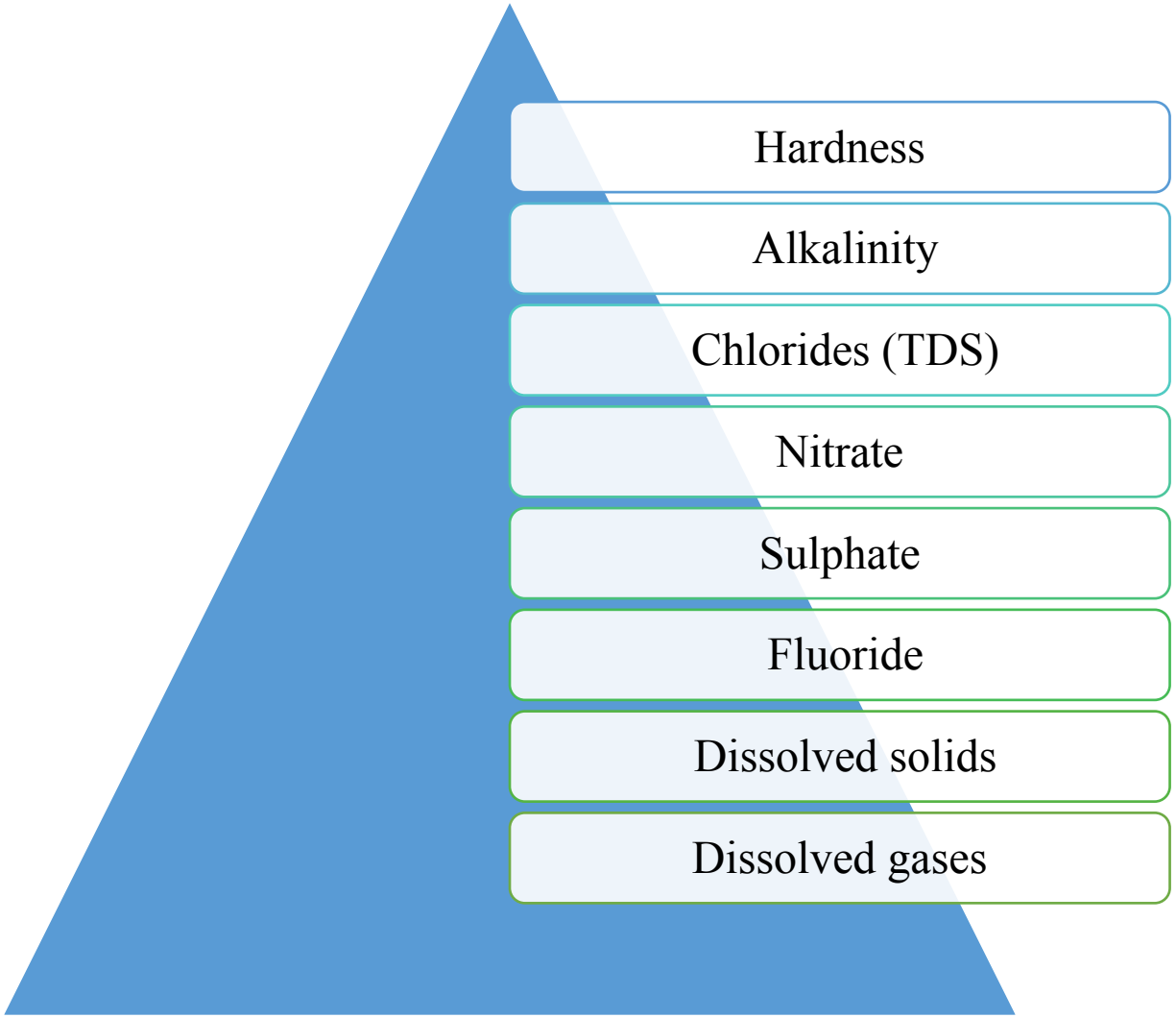
- Biological and chemical process depends on temperature.
- Affects the oxygen content of water.
- Rate of photosynthesis by aquatic plants.
- Thermal pollution-addition of warm water.

J) Salinity

- Concentration of dissolved salts in water,
- Salinity depends on weather.
- Expressed in parts per thousand (ppt)

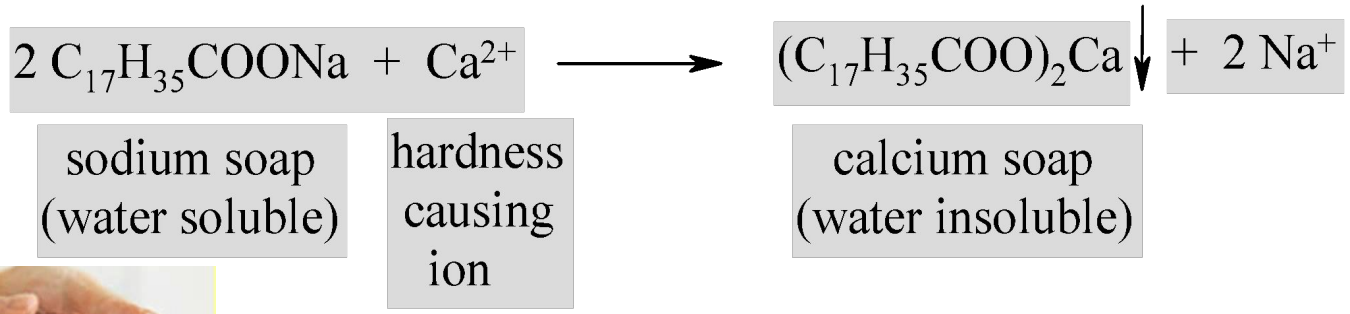
Water analysis

Chemical analysis of water will usually cover following parameters:



Hardness Of Water

- Hardness in Water is characteristic that prevents the ‘lathering of soap’
- Soap consuming capacity of the water sample.
- Due to presence of salts of Ca, Mg and other metal ions such as Al^{+3}, Fe^{+3}, and Mn^{+2}
- Hard water does not produce lather with soap solution readily, but forms a white scum precipitate.



Hardness Of Water …Contd.

Soft water

- Water which lathers easily on shaking with soap solution is called “Soft water.”
- Very low concentrations of minerals and dissolved salts.
- Cleaning action of soap not hampered and no wastage of soap.
- Less fuel and time is required for cooking.


Soap lather with soft water

Type of Hardness

1. Temporary Hardness (Alkaline Hardness)

- Due to presence of dissolved bicarbonate of calcium, magnesium and other heavy metals and the carbonate of iron.
- Destroyed by more boiling of water, when bicarbonates are decomposed yielding insoluble carbonates.

$$\underset{\text{Calcium bicarbonate}}{Ca(HCO_3)_2} \xrightarrow{\text{Heat}} \underset{\text{Calcium Carbonate}}{CaCO_3} + H_2O + CO_2$$

$$\underset{\text{Magnesium Bicarbonate}}{Mg(HCO_3)_2} \xrightarrow{\text{Heat}} \underset{\text{Magnesium hydroxide}}{Mg(OH)_2} + 2CO_2$$

- Calcium/Magnesium Carbonates thus formed being almost insoluble, are deposited as a scale at the bottom of vessel, while carbon dioxide escapes out.

Type of Hardness… Contd.

2.Permanent Hardness (Non Alkaline Hardness)

- Non Carbonate Hardness is due to the presence of chlorides, sulfates of calcium, magnesium, iron and other heavy metals.

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

Sodium stearate (sodium soap) — **Hardness** — **Calcium stearate (Insoluble)**

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

Sodium stearate (sodium soap) — **Hardness** — **Magnesium stearate (Insoluble)**

Total hardness – the sum of temporary hardness and permanent hardness.

Summary

- Water several contaminants such as suspended particles, inorganic salts, organic compounds, microorganisms, dissolved gases etc.
- Raw water can be analyzed based on hardness, alkalinity, TDS, fluorides, chlorides and dissolved gases.
- Hard water does not produce lather with soap
- Salts of Ca, Mg, Fe, and heavy metal ions mainly responsible
- Soft water lathers easily with soap.


भारतीय सूचना प्रौद्योगिकी संस्थान, ऊना
INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, UNA
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Thank You!