Environmental Quality & Pollution Monitoring Techniques

Water Environment

Water Characteristics & Water Quality

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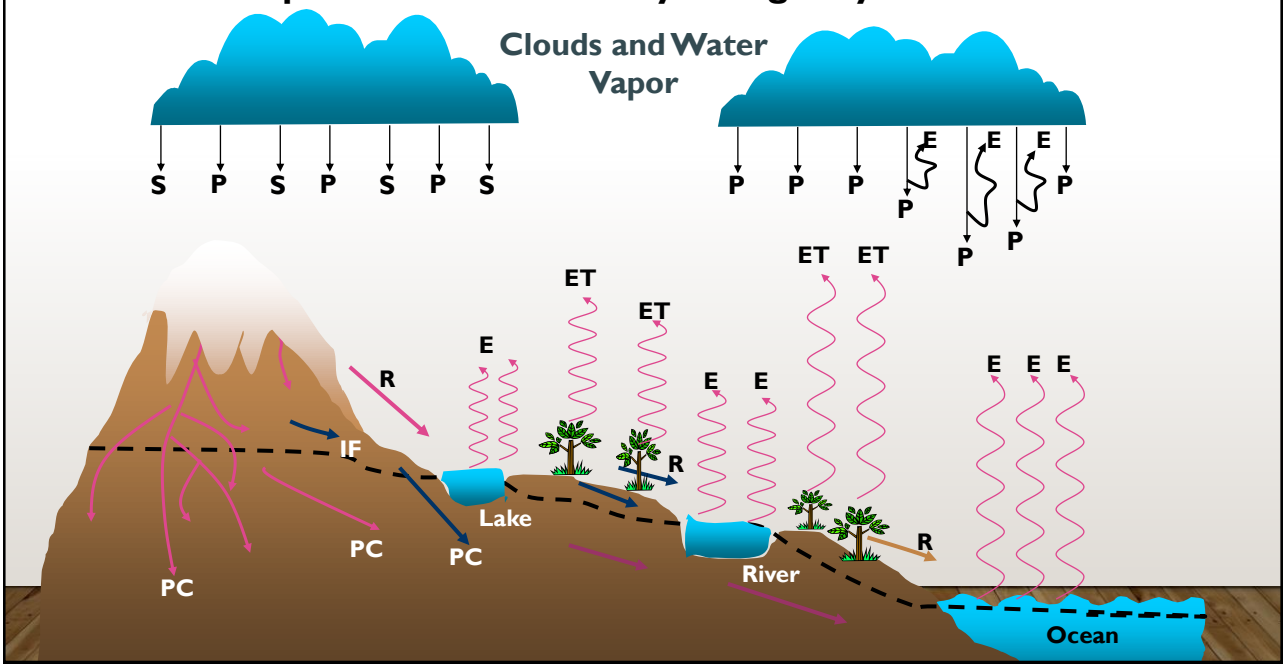
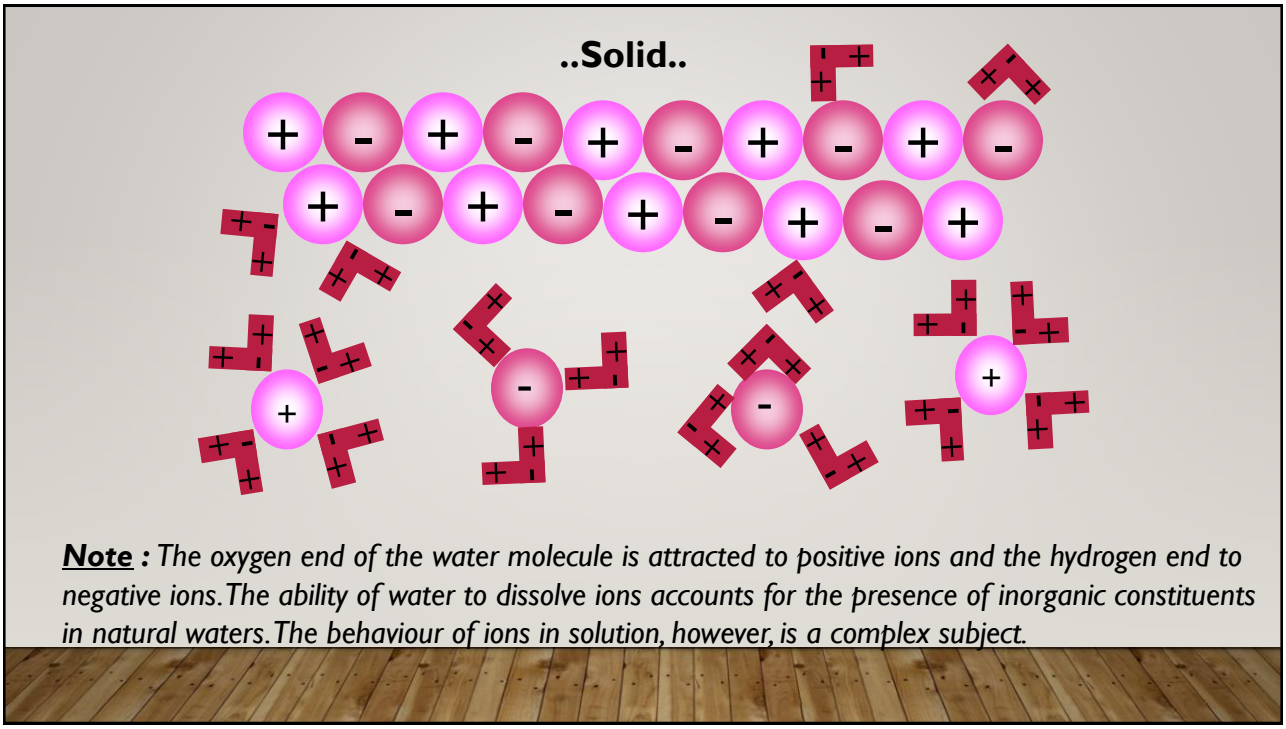
Water – Pure/Impure and Contaminated/Polluted

- Water gains chemical characteristics of aesthetic, health, biological and economic importance by dissolving and suspending materials.
- The type, magnitude, and interactions of these materials determine whether water will have taste, odor, or in general potable or not, and whether it will be corrosive, or acceptable or harmful for a particular use, etc.

Schematic Representation of the Hydrologic Cycle





Note *: The oxygen end of the water molecule is attracted to positive ions and the hydrogen end to negative ions. The ability of water to dissolve ions accounts for the presence of inorganic constituents in natural waters. The behaviour of ions in solution, however, is a complex subject.*

Water – Origin and Sources of Impurities

Origin: Atmosphere

Ionic and Dissolved

Positive ions

Hydrogen (H^+)

Negative ions

Bicarbonate (HCO_3^-)

Chloride (Cl^-)

Sulfate (SO_4^{-2})

Gases

Carbon dioxide (CO_2)

Nitrogen (N_2)

Oxygen (O_2)

Sulfur dioxide (SO_2)

Suspended

Dust, pollen

Water – Important Chemical and Biological Impurities

Origin: Contact of Water with Soils, Rocks and Minerals

Ionic and Dissolved

Positive ions

Calcium (Ca^{+2})

Iron (Fe^{+2})

Magnesium (Mg^{+2})

Potassium (K^+)

Sodium (Na^+)

Zinc (Zn^{+2})

Negative ions

Bicarbonate (HCO_3^-)

Carbonate (CO_3^{-2})

Chloride (Cl^-)

Fluoride (F^-)

Nitrate (NO_3^-)

Phosphate (PO_4^{-3})

Hydroxide (OH^-)

Borates ($H_2BO_3^-$)

Silicates (H_3SiO_4)

Sulfate (SO_4^{-2})

Suspended

Clay, silt, sand and other inorganic soils

Colloidal

Clay

Silica

Ferric oxide

Aluminum oxide

Magnesium dioxide

Gases

Carbon dioxide (CO_2)

Water – Origin and Sources of Impurities

Origin: Decomposition of organic matter in the environment

Ionic and Dissolved

Positive ions

- Ammonium (NH_4^+)
- Hydrogen (H^+)
- Sodium (Na^+)

Negative ions

- Chloride (Cl^-)
- Bicarbonate (HCO_3^-)
- Hydroxide (OH^-)
- Nitrite (NO_2^-)
- Nitrate (NO_3^-)
- Sulfide (HS^-)
- Organic radicals

Suspended

Organic soils (topsoil), organic wastes

Colloidal

Vegetable coloring matter, organic wastes

Gases

- Ammonia (NH_3)
- Carbon dioxide (CO_2)
- Hydrogen sulfide (H_2S)
- Hydrogen (H_2)
- Methane (CH_4)
- Nitrogen (N_2)
- Oxygen (O_2)

Water – Origin and Sources of Impurities

Origin: Living organisms in the environment

Colloidal

Bacteria, algae, viruses, etc.

Suspended

Algae, diatoms, minute animals, fish, etc.

Gases

- Ammonia (NH_3)
- Carbon dioxide (CO_2)
- Methane (CH_4)

Water – Origin and Sources of Impurities

Origin: Municipal, industrial, and agricultural sources and other human activity

Ionic and Dissolved	
Positive ions	**Negative ions**
Inorganic ions, including a verity of heavy metals	Inorganic ions, organic molecules, color

Colloidal
Inorganic and organic solids, coloring matter, chlorinated organic compound, bacteria, worms, viruses

Suspended
Clay, silt, grit, and other inorganic solid; organic compounds; oil; corrosion products; etc.

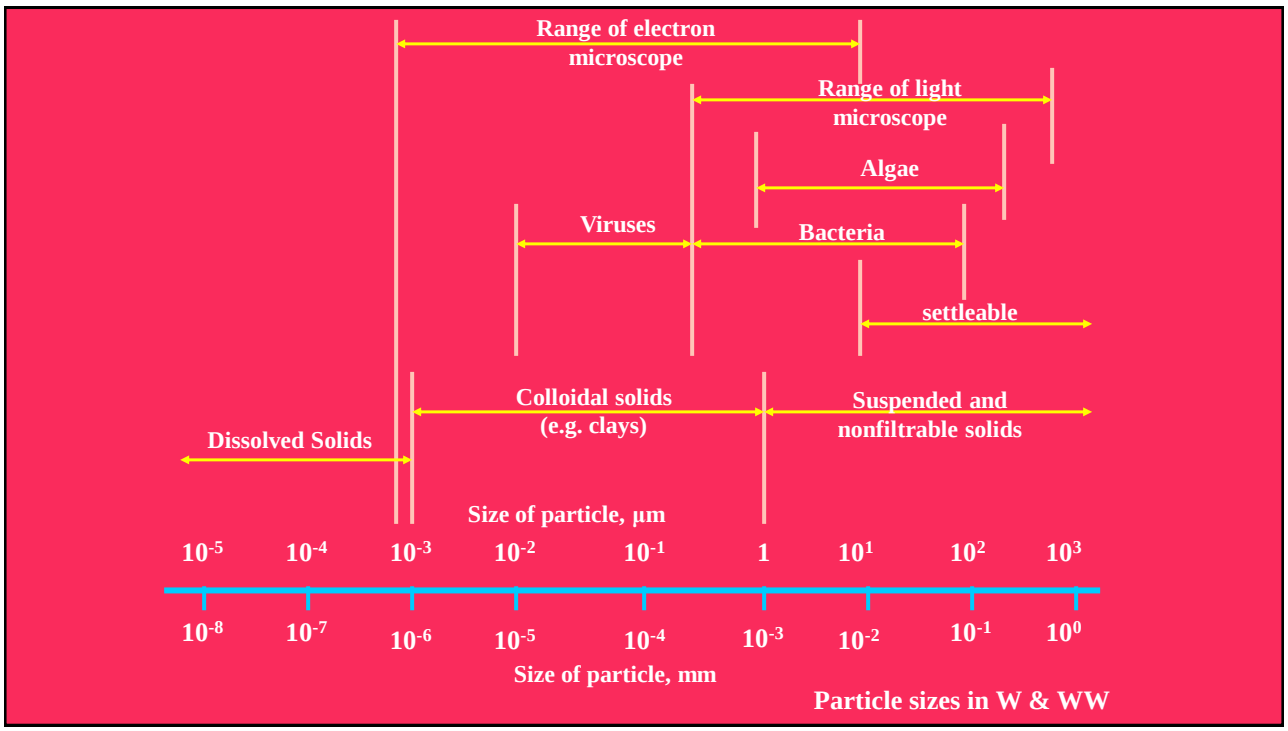
Gases
Chloride (Cl_2)
Sulfur dioxide (SO_2)

Sources of Bicarbonates, Sulfates, and Chlorides of Calcium, Magnesium, and Sodium Found in Natural Waters

Constituent	Source
Calcium Bicarbonate $Ca(HCO_3)_2$	Dissolution of limestone, marble, chalk, calcite, dolomite, and other minerals containing calcium carbonate
Magnesium Bicarbonate $Mg(HCO_3)_2$	Dissolution of magnesite, dolomite and dolomitic limestone, and other minerals containing magnesium carbonate
Sodium Bicarbonate $Na(HCO_3)_2$	White salt commonly known as baking soda, typically a manufactured product; also present in some natural waters
Calcium Sulfate $CaSO_4$	Minerals such as gypsum, alabaster, and selenite

Sources of Bicarbonates, Sulfates, and Chlorides of Calcium, Magnesium, and Sodium Found in Natural Waters

Constituent	Source
Magnesium Sulfate $MgSO_4$	Heptahydrate from ($MgSO_4 . 7H_2O$) commonly known as Epsom salt or when found in the salt beds or mines, as epsomite; monohydrate from ($MgSO_4 H_2O$) occurs in a verity of minerals as a double salt with potassium chloride, potassium sulfate, etc.
Sodium Sulfate Na_2SO_4	Salt lakes, salt beds, caverns, etc., decahydrate from ($Na_2SO_4 . 10H_2O$) is known as Glauber's salt
Calcium Chloride $CaCl_2$	Natural brines, salt beds, etc., and a by product of the chemical industry
Magnesium Chloride $MgCl_2$	Anhydrous forms found in natural brines, salt beds, etc.
Sodium Chloride NaCl	Salt beds, Salt lakes, connate waters, other natural brine



Water or Aqueous Systems

Solid Dispersed phase can be classified into three groups

Soluble or Dissolved (Solution or Molecular Dispersion)

- Size < 10^{-9} m (1 nm)
- Molecules or atoms
- Optically non- resolvable
- Stable Dispersed Phase

Colloidal (Colloidal Suspension)

- Size: 1 –500 nm
- Ultra microscopically resolvable
  - Electron microscope size < 0.5 μm
  - Microscopically resolvable
    Size: 0.5 – 20 μm
- Stable Dispersed Phase

Coarse (Coarse Suspension)

- Size > 20 μm
- Can be seen
- Can be easily separated/filtered
- Unstable Dispersed Phase or Unstable Dispersion

Dispersed phase can't be separated from dispersion phase easily, say be settling, filtration, etc.