

What is physical treatment?

What is chemical treatment?

Physical : having material existence and subject to the laws of nature.

Chemical : any material used in, or produced by chemistry.

Chemistry : is the study of matter (composition, structure, and properties) and the changes it undergoes.

The key is the **change** that the matter undergoes.

In chemical transformation, the original substance turns into an entirely different substance after the transformation.

In physical transformation, the change is only in appearance but not in substance.

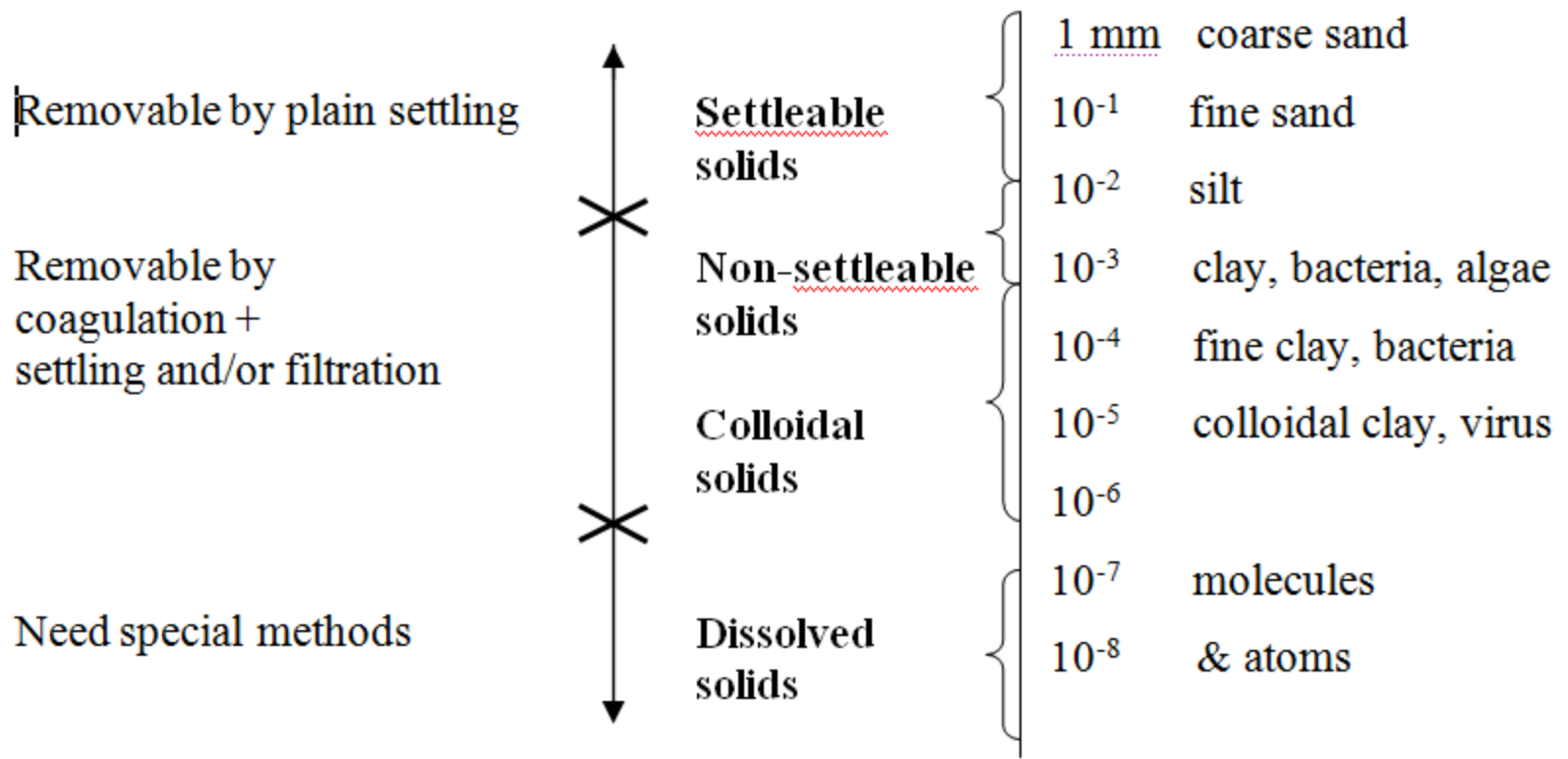
❑ **Physical treatment** of water and wastewater is a process applied to water and wastewater in which **no chemical changes** occur.

❑ **Chemical treatment** of water and wastewater is a process applied to water and wastewater in which **chemical changes** occur.

Process versus Operation?

In **PROCESS** chemical and biological forces are active. (e.g. adsorption, oxidation, activated sludge treatment)

In **OPERATION**, physical forces are active (e.g. mixing, filtration, aeration). Physical treatments are called unit operations.



- ❖ 10⁻² : naked eye limit
- ❖ 10⁻⁴ : ordinary microscope limit
- ❖ 10⁻⁶ : ultra microscope limit

WATER TREATMENT PROBLEMS

1. Turbidity

Importance : Less attractive for drinking, swimming, etc. particles protect microorganisms from the effect of disinfectants.

Characteristics : Colloidal particles, e.g. clay, silt, metal oxides, plant fibers, algal cells.

Treatment : Coagulation, sedimentation, filtration.

2. Algae (*colloidal size plants*)

Importance : Cause taste and odor and turbidity.

Characteristics : Non-settleable, colloidal microscopic plants.

Treatment : Coagulation, sedimentation, filtration, disinfection.

3. Pathogenic Microorganisms

Importance : Transmission of diseases through water.

Characteristics : Colloidal, bacteria, viruses, protozoa.

Treatment : Disinfection, coagulation, filtration.

4. Iron and Manganese

Importance : Staining, taste.

Characteristics : Dissolved solids.

Treatment : Chemical oxidation by O_2 (aeration), O_3 , Cl_2 , $KMnO_4$, etc.

5. Sulfides → H_2S , Mercaptanes (organic S containing comp.)

Importance : Odor, taste, corrosion.

Characteristics : Dissolved solids (usually in groundwater).

Treatment : Stripping (aeration), chemical oxidation to break the bonds and make it a smaller compound.

6. Salts

Importance : Taste, SO_4 – laxative.

Characteristics : Dissolved solids (Cl^- , $SO_4^{=}$, HCO_3^- , etc).

Treatment : Ion exchange, membrane processes.

7. Hardness → if H₂O is needed for industrial purposes such as boilers or cooling H₂O you have to remove them. For tap water it is not very important.

Importance : Scaling, soap precipitation.

Characteristics : Dissolved solids (Ca⁺⁺ & Mg⁺⁺).

Treatment : Precipitation, ion exchange, membrane processes.

You can bring them down to the solubility of those compounds.

8. Heavy Metals

Importance : Toxic, damage nervous system (Hg) brittle bones

Characteristics : Dissolved solids.

Treatment : Precipitation, oxidation/ppt., ion exchange, magnetic separation, adsorption.

9. Organic Chemicals

Importance : Carcinogenic, toxic, mutagenic.

Characteristics : have low solubilities and accumulate in the fatty acids of the body.

- synthetic (pesticides, herbicides, PCBs, PAH, etc.) solvents and other chlorinated organics

- THMs produced in the treatment plant upon chlorination.

- Natural humic substances (association with metals & synthetic organics is of concern). They form complexes. All are dissolved solids except some colloidal humic.

Treatment : Adsorption (up to 60% can be removed through adsorption), chemical oxidation, coagulation, stripping, biological removal

10. Nitrate

Importance : Interferes with oxygen-carrying capability of blood causing oxygen starvation of cells in infants → “blue babies”

Characteristics : Ion

Treatment : Ion exchange, membrane processes, denitrification (being researched).

11. Sludge

Importance : Created in the treatment plant from coagulation and precipitation processes
Needs further treatment.

Characteristics : Settleable and colloidal particles.

Treatment : Thickening, dewatering by centrifuge or filter press.

WASTE WATER TREATMENT PROBLEMS

1. Settleable Solids

Grit chambers, sedimentation, during primary treatment.

2. Dissolved & Colloidal Organics

Secondary Treatment until biological treatment.

Exert oxygen demand in receiving waters.

Biological oxidation (aerobic or anaerobic)

If you have non-biodegradables apply chemical oxidation such as (O_3 , Cl_2 , $KMnO_4$, UV)

Coagulation, adsorption.

3. Nitrogen Compounds

Advanced or Tertiary Treatment

Nutrient (NH_3 , NO_3^- , amines, amino acids, etc.). Dissolved solids.

Removal by nitrification/denitrification, NH_3 stripping, breakpoint chlorination, ion exchange → in the form of NH_4^+ (below pH 9).

4. Phosphorus Compounds

Nutrient (ortho and polyphosphates, org-P). Dissolved solids.
Removal by chemical precipitaton, ion exchange → very expensive.

5. Pathogens, Heavy Metals, Synthetic Organics

Same as in water treatment.

6. Sludge → mostly biological sludge

Further treatment thermally or digestion before dewatering.