# WATER TREATMENT

- The objective of the municipal water treatment is to provide a potable supply: one that is chemically and microbiologically safe for human consumption.

- For domestic uses, treated water must be aesthetically acceptable-free from apparent turbidity, color, odor and objectionable taste.

- Quality requirements for industrial uses are frequently more stringent than for domestic water supplies. Thus additional treatment may be required by the industry.

- Water quality can be improved both by reducing the number of contaminants that go into the water supply and by cleaning up wastewater –water that already contains contaminants.

- The techniques employed in making water safe for household use and drinking depend strongly on the initial water quality.

- Common treatment methods include advanced oxidation, ion exchange, sedimentation, carbon filtration, sand filtration and disinfection.

# TREATMENT OF WATER AND WASTEWATER

## A. Drinking Water Quality Standards

Water is evaluated for quality in terms of its:

(1) Physical Properties

- turbidity --- suspended particles
- tastes due to VOC, decomposing organics
- odors
- color --- ions, minerals

(2) Chemical Properties

- Inorganic and organic compounds dissolved in water which are harmful

(3) Microbiological properties

- pathogens (Coliform bacteria)

- Two categories
  - * primary standards : based on health criteria
  - * secondary standards : based on aesthetic and non-aesthetic characteristics

## B. Water Treatment Systems

Purpose : to reduce any risks to human health and to bring raw water up to drinking quality standard

How a water treatment plant be designed depends very much on the quality of the source water!

e.g. River/stream

- solids — Settleable
  Nonsettleable
- bacteria

Lake/Reservoir

- algae
- solids
- bacteria

Groundwater (well water)

- particle free
- lack of fluoride
- bacteria
- hardness

**An Overall View of Water Treatment Processes**

I. *Schematic for Treating River or Stream Water*

River or Stream Water → Low Lift Pumping → Plain Sedimentation → Chemical Coagulation & Flocculation → Sedimentation → Rapid Sand Filtration → Chlorination → Clearwater Storage Well → High Lift Pumping → Transmission Line → Distribution Network

II. *Treatment Schematic for Lake or Reservoir Water*

Lake or Reservoir Water → Low Lift Pumping → Possibly Prechlorination for Taste & Odor Control → Chemical Coagulation & Flocculation → Rapid Sand Filtration → Chlorination Disinfection → Clearwater Storage Tank → High Lift Pumping to Transmission Line → Distribution Network

III. *Schematic for Treating Well Water*

Well Water (pumps) → Chlorine Disinfection → Possibly Fluoridation → Clearwater Storage Tank → High Lift Pumping to Distribution System →

OR

Well Water (pumps) → Water Softening → Chlorination → Fluoridation → Clearwater Storage Tank → High Lift Pumping to Distribution System

**General setting :**

Low lift pumping --- to take raw water from the intake structure to the site of water treatment plant

Clearwater storage tank --- to allow the treated water to be temporarily stored at the treatment site to equalize the supply and demand for the community

High lift pumping --- to deliver the finish water to the community's distribution system by a large water head (~60 to 85 psi pressure)

**Water Treatment Processes:**

*Plain sedimentation*: to allow raw water to settle in a rectangular sedimentation tank for a period of 6-8 hours so that large and settleable suspended solids will be removed. Most of the settled solids are inorganic matter.

Screening: to remove relatively large floating and suspended solids/debris.

*Chemical coagulation (in a mixing tank)*: addition of chemicals (coagulant) in a mixing tank to encourage the small and non-settleable solids (suspended solids) to coagulate into large particles (chemical flocs) that will more easily settle.

*Flocculation*: a gently mixing process which induces particle collision and allows the formation of large particles of floc. It takes about 15-20 minutes to complete.

*Sedimentation or settling tank*: to settle out the produced chemical flocs by gravity.

*Rapid sand filtration*: to filter out those broken chemical flocs which fail to settle in the previous sedimentation tank. The filtered water is normally particle- and turbidity-free.

**Water Treatment Processes (Contiuned)**

*Disinfection or chlorination*: to disinfect the filtered water so that all pathogenic bacteria will become killed. Chlorination using chlorine gas ($Cl_2$), sodium hypochlorite (NaOCl) or calcium hypochlorite [$Ca(OCl)_2$] is the most commonly used method of disinfection.

*Prechlorination*: to add a relatively large dose of chlorine (3 to 5 ppm) to water to oxide the taste- and odor-causing chemicals which are produced by the presence of algae, and to kill algae cells.

*Fluoridation*: Normally groundwater (or well water) is particle free, thus not requiring for coagulation & flocculation process. However, the fluoride may be absent and it is desirable to add fluoride for strengthening the dental care of baby infants.

*Water softening*: If groundwater contains a high concentration of divalent metal ions (which cause hardness in water), lime (CaO) and soda ash ($Na_2CO_3$) are used to remove calcium and magnesium from water.