EWCE 331
Water Supply Engineering

Lecture 7

Instructor

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Lecture outline

Water Treatment Methods

Topics	References
• **Preliminary Treatment methods** ✓ **Plain Sedimentation** ✓ **Coagulation** ✓ **Flocculation** ✓ **Filtration** ✓ **Disinfection**	**1. Water and Environmental Engineering** Authors: M. Habibur Rahman, Abdullah Al-Muyeed 1st ed., ITN-BUET **2. Environmental Engineering** Authors: Howard S. Peavy, Donald R. Rowe and George Tchobanoglous International Edition, McGraw Hill Companies **2. Water Supply and Sanitation** Authors: M. Feroz Ahmed, Md. Mujibur Rahman 1st ed., ITN-BUET

Objectives of Water Treatment

- To produce an adequate and continuous supply of water that is chemically, bacteriologically and aesthetically pleasing.

- More specifically, water treatment must produce water that is:
  - ✓ Palatable – having no unpleasant taste
  - ✓ Safe – not containing any pathogenic organisms or chemical that could be harmful to the users.
  - ✓ Clear – be free from suspended matter and turbidity
  - ✓ Colorless and odorless

Objectives of Water Treatment

✓ Reasonably soft – to allow consumers to wash clothes, dishes and themselves without excessive use of detergent or soap.

✓ Non-corrosive



✓ Low in organic content – a high organic content will encourage unwanted biological growth in pipe or storage tanks, which can affect the quality of the water supplied.

Objectives of Conventional Drinking Water Treatment

Primary objectives are removal of –

- Microbial pathogens (coliforms) – health concerns
- Particles (color and turbidity) – health and aesthetic concerns
- Total dissolved solids removal (hard waters) – health and aesthetic concerns

Objectives of Conventional Drinking Water Treatment

Secondary objectives are removal of dissolved pollutants – health concerns

- **General**: Odor, taste, pH

- **Inorganic** - Hardness, Alkalinity, Fe, Cl, F, Ca, Mg, Cu, Mn, SO_4^{2-},NO_3^-, Hg, Cd, Se, As, CN, Pb, Zn, Cr(VI), Al, B, radioactive materials, residual free chlorine, TDS

- **Organic** - Natural Organic Matter (NOM), Pesticides, Oils, PAHs, Anionic detergents, Phenols

Consideration for Water Treatment – **Surface Water Source**

General characteristics of surface water



- High turbidity and microbial concentrations

- Dissolved oxygen concentrations vary depending on organic matter concentrations





Consideration for Water Treatment – **Ground Water Source**

Characteristics of GW water compared to SW

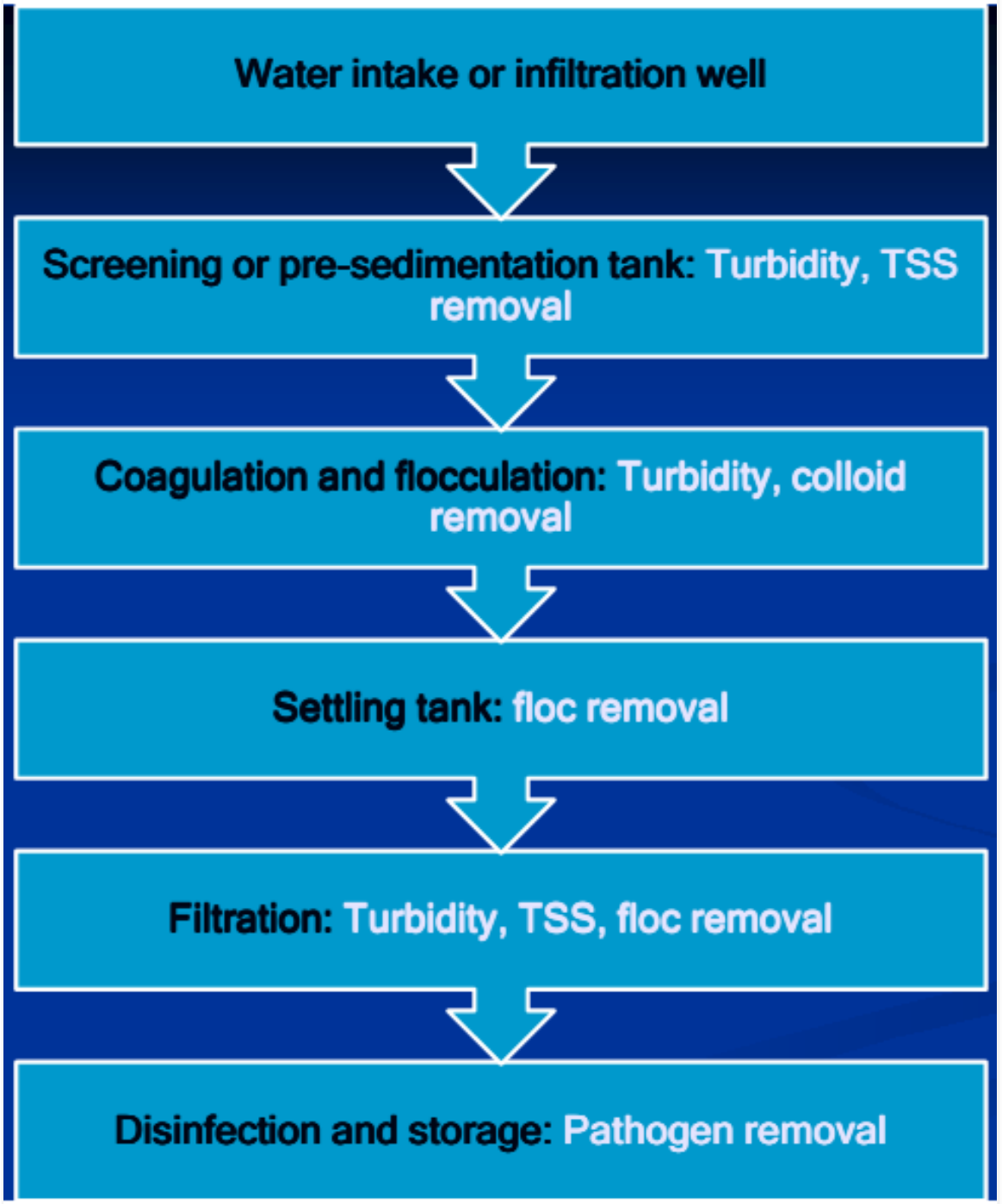
- Lower dissolved oxygen compared to waters.
- Can have very little microbial contamination especially if GW is from a deep aquifer.
- Much higher concentrations of inorganic compounds (or ions).
- **Anions**: chloride, carbonates, sulfates (or sulfides), bromide, nitrates, fluorides, arsenite [As(III)] and arsenate [As(V)]
- **Cations**: Ca, Mg, Fe, Mn, Al, As, (Hardness is the concentration of Ca and Mg in GW)

Consideration for **Water Source Characteristics**

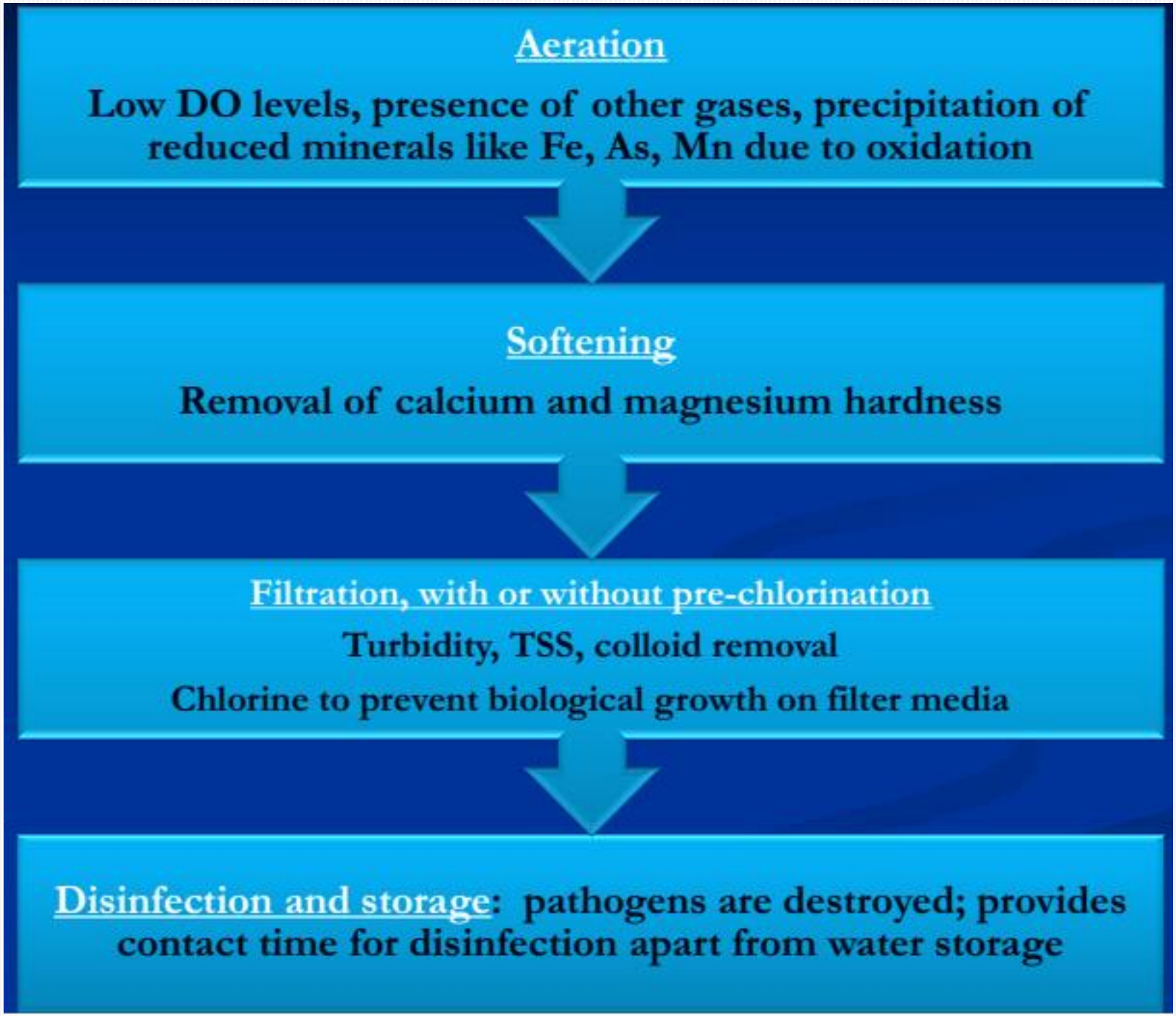
Groundwater	Surface water
• constant composition	• variable composition
• high mineral content	• low mineral content
• low turbidity	• high turbidity
• low color	• colored
• low or no D.O.	• D.O. present
• high hardness	• low hardness
• high Fe, Mn	• taste and odor

Source: Davis and Cornwell, 2008

Surface Water Treatment Scheme

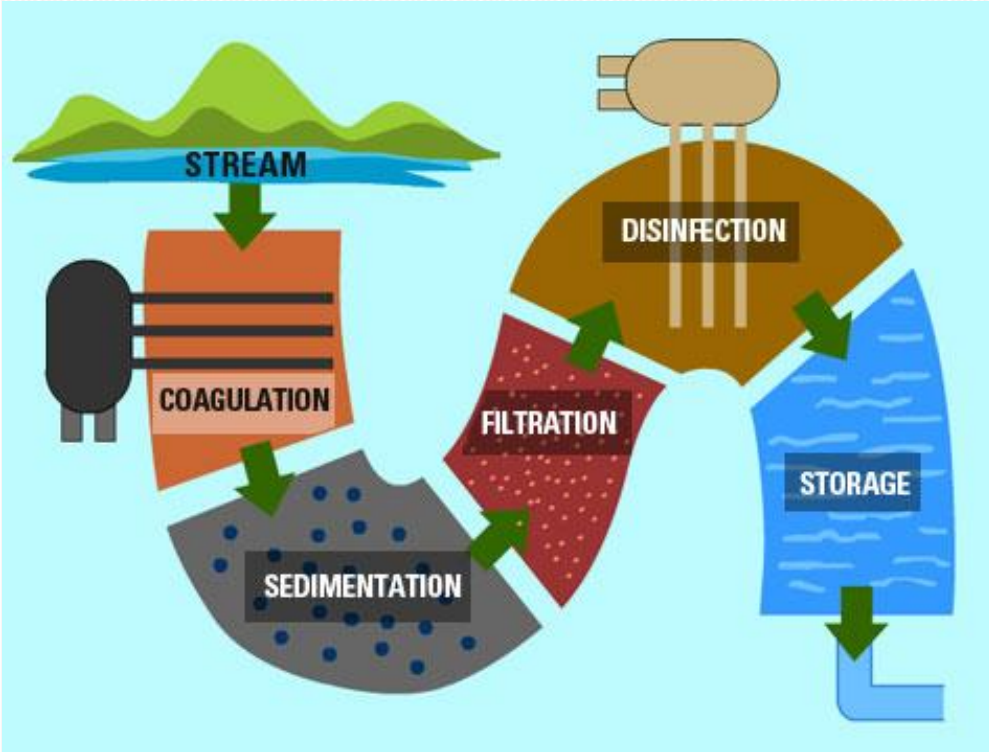


Ground Water Treatment Scheme



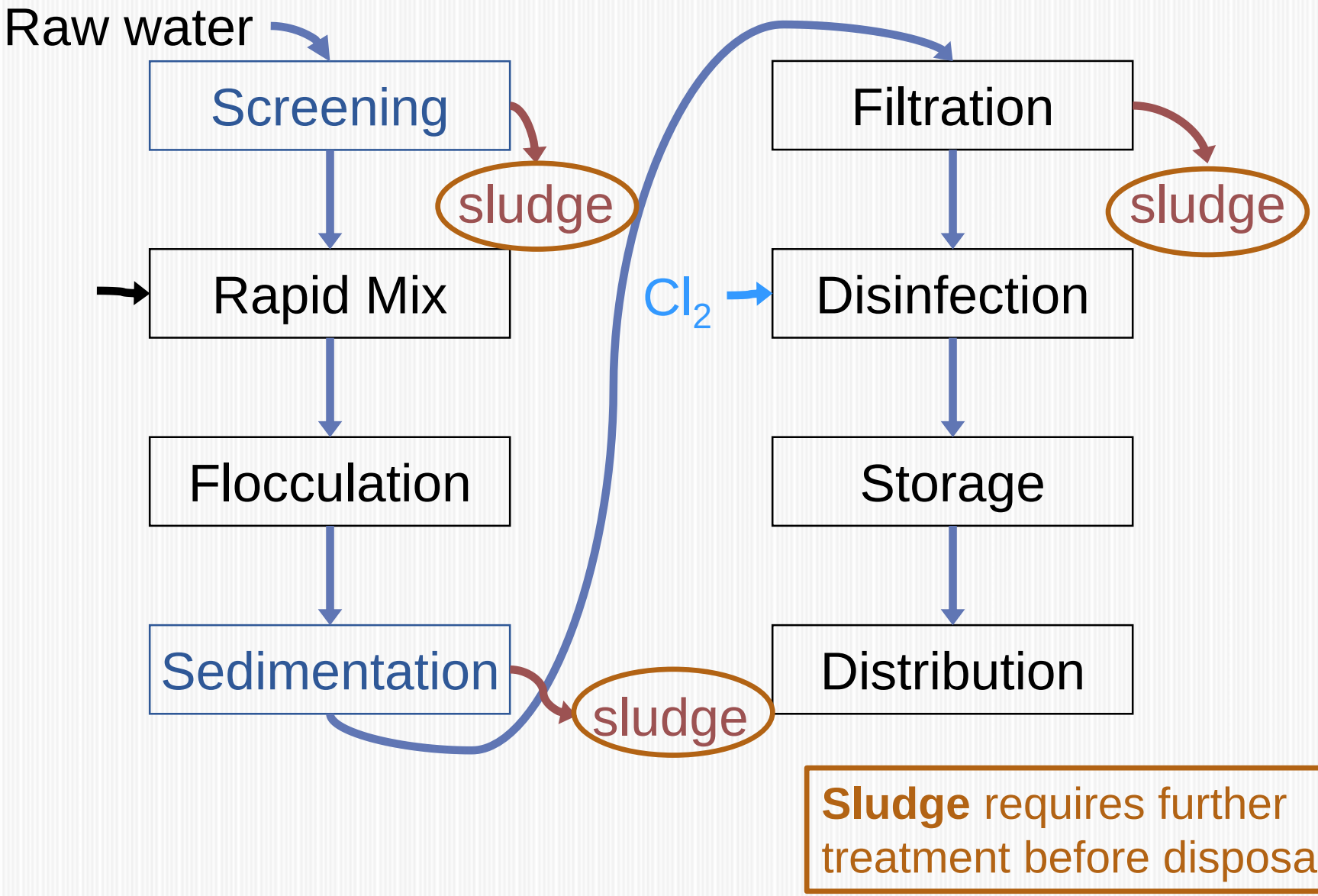
Conventional Water Treatment Unit Processes

Unit process: a process that is used in similar ways in many different applications



- **Preliminary Treatment**
  - ✓ Screening
  - ✓ Pre-sedimentation
  - ✓ Aeration
  - ✓ Monitoring (pH, temperature correction)
- **Primary Treatment**
  - ✓Coagulation and flocculation
  - ✓ Primary Sedimentation
  - ✓ Pre-chlorination and de-chlorination
  - ✓ Filtration
  - ✓ Disinfection
  - ✓ pH adjustment

Conventional Surface Water Treatment & Supply



Preliminary Water Treatment

- Preliminary treatment is **any physical, chemical or mechanical process** used on water before it undergoes the main treatment process.

- The purpose of preliminary treatment processes is **to remove any materials which will interfere with further treatment**.

- **Pretreatment** may include **screening, presedimentation, chemical addition, flow measurement, and aeration**.

Preliminary Water Treatment - **Screening**

- The screens are used **to remove rocks, sticks, leaves, and other debris.**

- Very small screens can be used to **screen out algae in the water**.

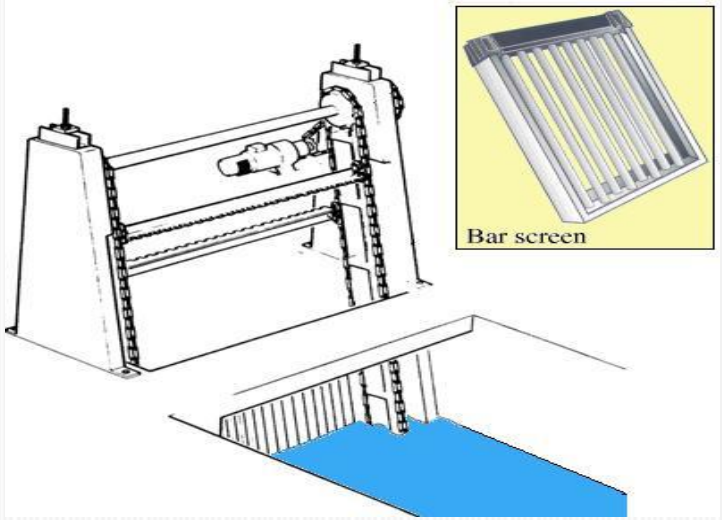
- All objects are removed by physical size separation.

- Screens on the outside of intakes are often cleaned by flushing water from the treatment plant backwards.

- There are two primary types of screens - bar screens and wire-mesh screens.

Preliminary Water Treatment - **Screening**

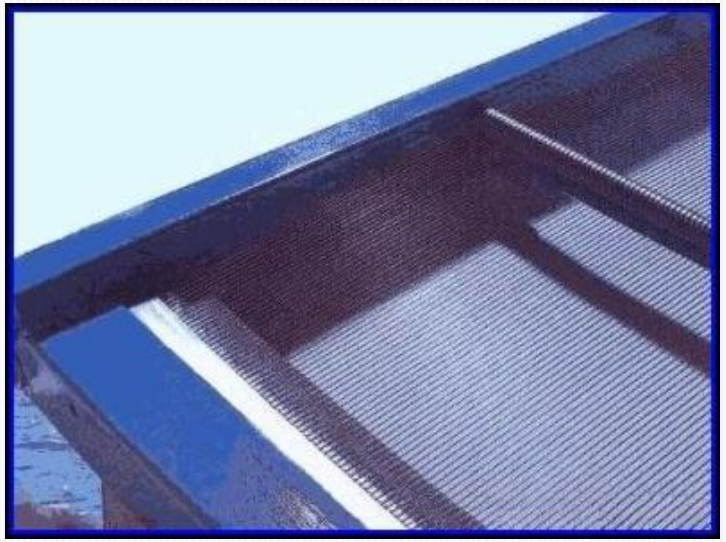
• A bar screen is used to remove large debris. The spaces between the bars are 2"- 4" inches wide.



A bar screen

• A wire-mesh screen is used to remove smaller debris. The gaps are about 1/2" wide.

• Water must be flowing slowly in order to pass through a wire-mesh screen - velocities should be no greater than 3.5 inches per second.



A wire-mesh screen

Preliminary Water Treatment - **Screening**



Bar screen



Fine screens

Preliminary Water Treatment – **Pre-sedimentation**

• **Pre-sedimentation** is to settle out sand, grit, and gravel which will settle rapidly out of the water without the addition of chemicals at the beginning of the treatment process.

• It depends on gravity and includes no coagulation and flocculation.

• It will reduce the load on the coagulation/flocculation basin and on the sedimentation chamber, as well as reducing the volume of coagulant chemicals required to treat the water.

Preliminary Water Treatment – **Pre-sedimentation**

• Pre-sedimentation basins are useful because raw water entering the plant from such a basin is usually more uniform in quality than water entering the plant without such a holding basin.

• The purpose of this process is to make the chemical treatment phase of the water treatment process more efficient by removing sediment from the raw water.

• In pre-sedimentation basin, activated carbon may be added to the basin for taste, odor, and color problems, and some chemicals to control the growth of algae.

Preliminary Water Treatment – **Aeration**

- **Aeration** removes carbon dioxide and hydrogen sulfide from the water.

- It also oxidizes the iron and manganese.

- Aeration is necessary for GWs that are anoxic.

- Aeration causes oxidation of reduced forms of Fe(II) to Fe(III) and Mn(II) to Mn(IV)

- For As-contaminated water, it can result in substantial removal of As, too

- Types of aerators: cascade, fountain, tray, diffuser

Preliminary Water Treatment – **Aeration**

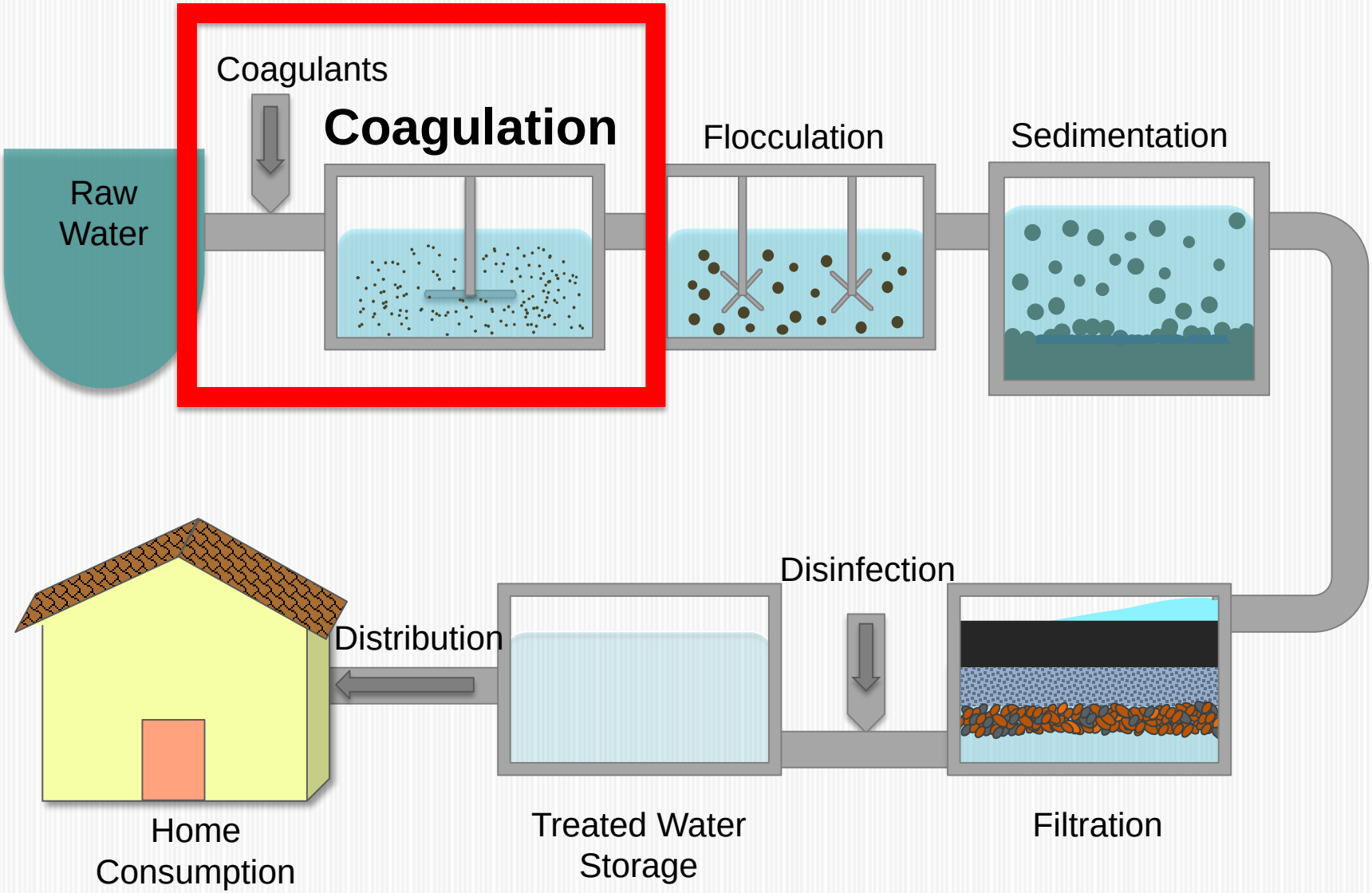
Aeration causes better dissolution of oxygen into the water which remove –

- ✓ smell and taste,
- ✓ promote helpful bacteria to grow,
- ✓ precipitate nuisance metals like iron and manganese.





Water Treatment Process - **Coagulation**



Water Treatment – **Coagulation**

Objectives of Coagulation process –

- The finest particles, such as colloidal minerals, bacteria, and pollen do not settle in the raw water.

- Removal of this colloidal particles is necessary:

✓ to give the finished water a clear appearance

✓ because they contain viruses and bacteria that are resistant to later disinfection process.

Water Treatment – **Coagulation**

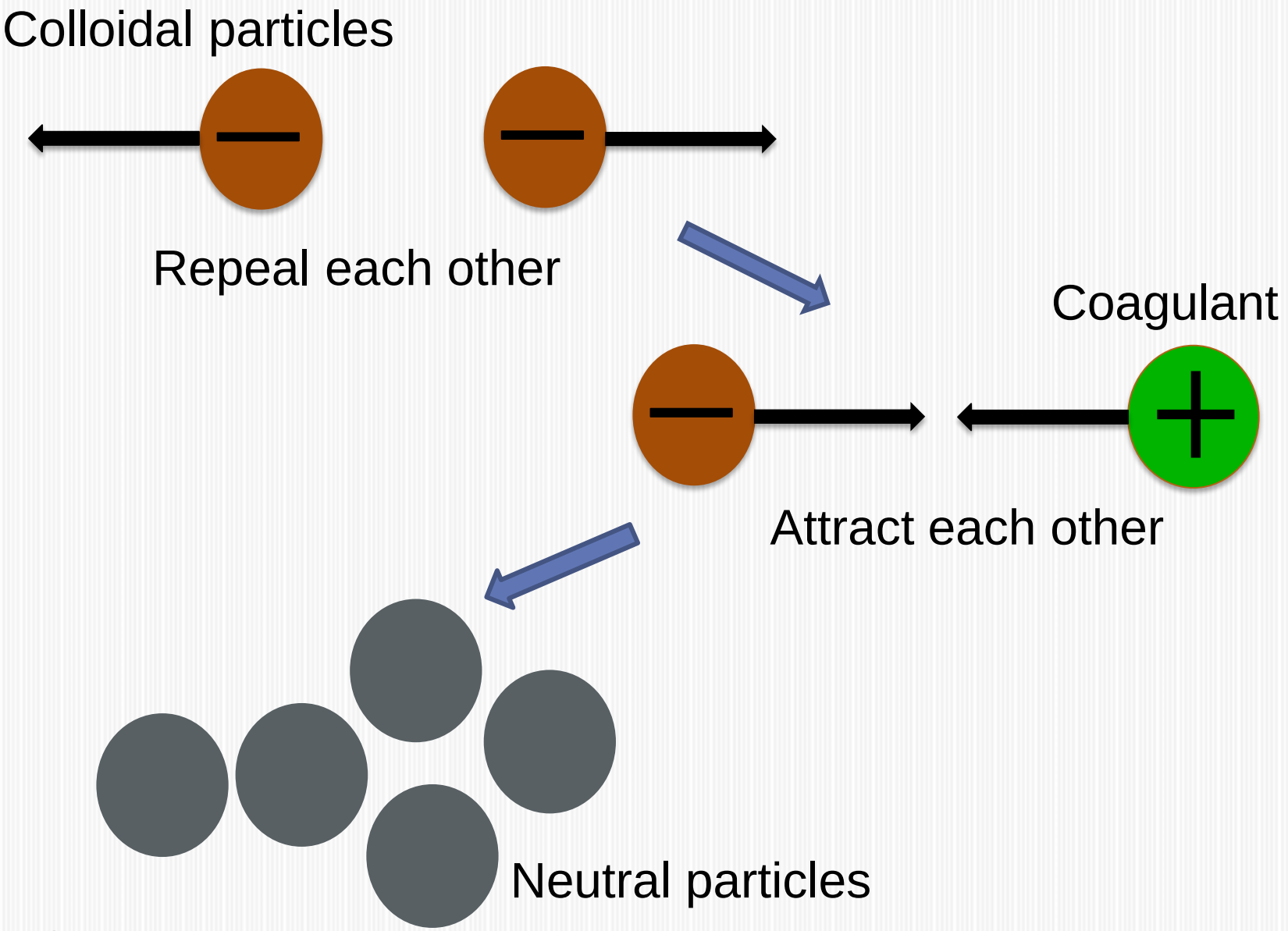
- Coagulation is the process of –

  ✓ addition of a salt that produces positive ions in water

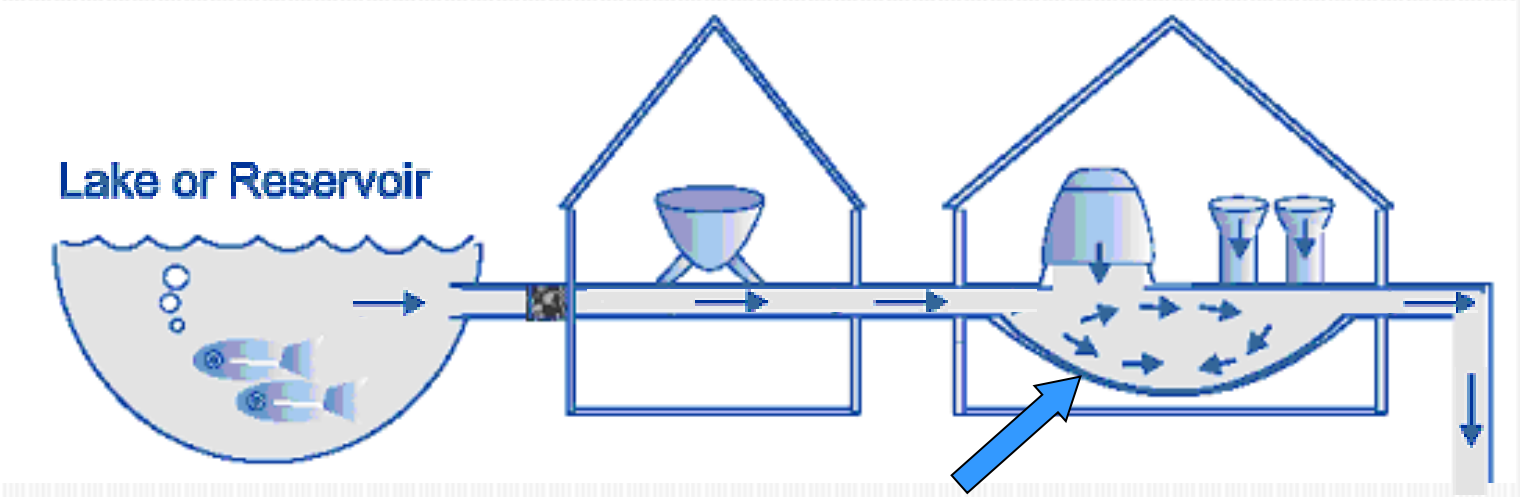
  ✓ rapid mixing leading to destabilization of colloids

  ✓ promotion of frequent contact among the particles.

Water Treatment – **Coagulation Principle**



Water Treatment – **Coagulation & Flocculation**



- **Coagulation** removes dirt and other particles suspended in water.

- Alum and other chemicals are added to water to form tiny sticky particles called "**floc**" which attract the dirt particles.

- The combined weight of the dirt and the alums (**floc**) becomes heavy enough to sink to the bottom during sedimentation.

Water Treatment – **Coagulation**

- Coagulants generally used are –
  - ✓ iron(III) sulfate, $Fe_2(SO_4)_3$
  - ✓ aluminum sulfate, $Al_2(SO_4)_3$

- In the case of aluminum sulfate, $Al(OH)_3$ is formed (in the pH range of 6-8):

$$Al^{3+}(aq) + 3\,HCO_3^-(aq) \rightarrow Al(OH)_3(s) + 3\,CO_2(aq)$$

- At this pH values, $Al(OH)_3$ is close to its minimum solubility and at equilibrium very little aluminum is left dissolved in the water.

Water Treatment – **Coagulation**

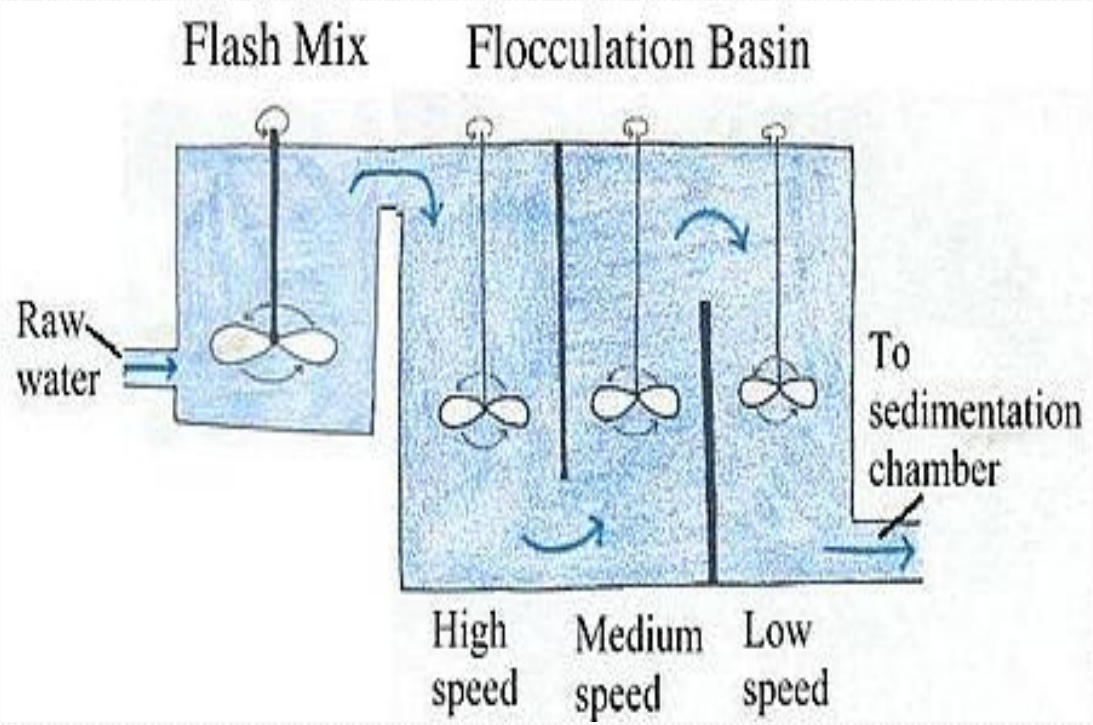
- Aluminum hydroxide forms a very gelatinous precipitate, which settles very slowly and which incorporate the colloidal particles.

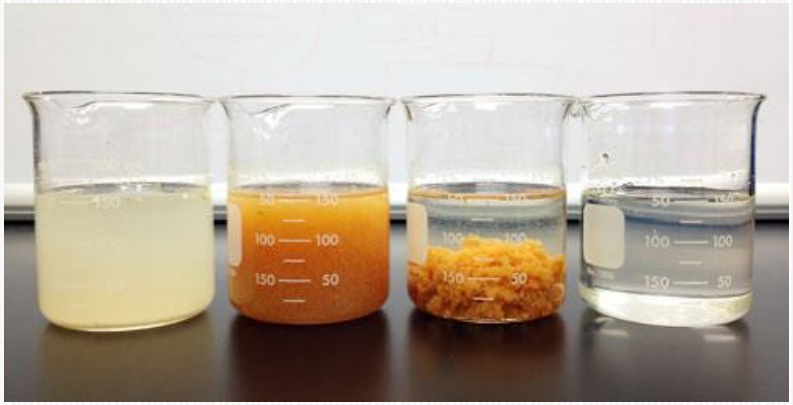
- With iron(III) sulfate the chemistry is analogous to aluminum (III) sulfate:
  - Fe^{3+} forms gelatinous iron hydroxide $Fe(OH)_3$.

$$\mathbf{Fe^{3+}(aq) + 3\,HCO_3^-(aq) \rightarrow Fe(OH)_3(s) + 3\,CO_2(aq)}$$

- These reactions consume hydroxide, hence pH decreases (neutralize alkaline water)

Water Treatment – **Coagulation**







Water Treatment – **Coagulation**

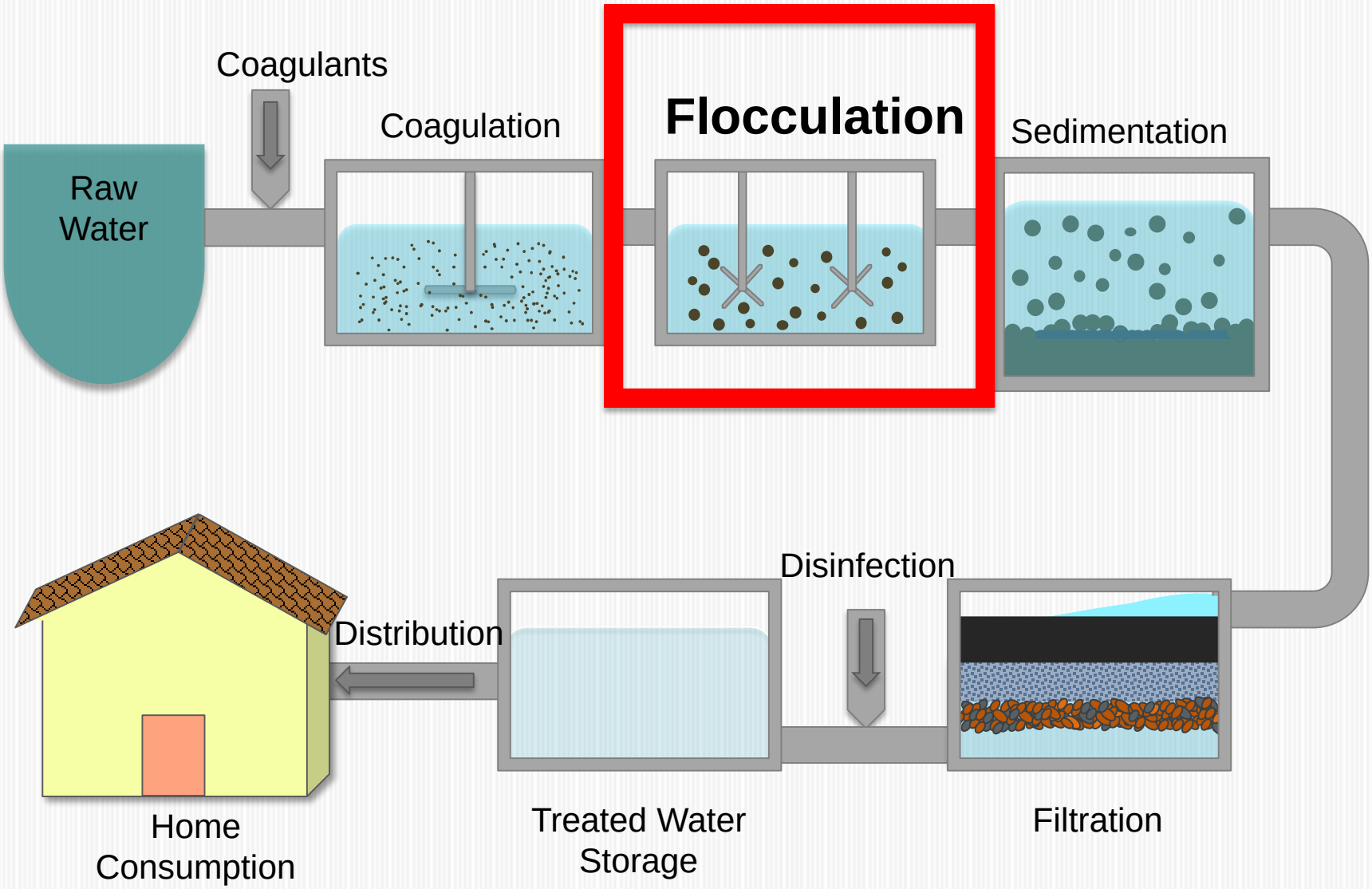






Addition of coagulant

Water Treatment Process - **Flocculation**



Water Treatment – **Flocculation**

• Flocculation is a process of gentle and continuous stirring for agglomeration of micro-flocs formed during the coagulation process.

•The stirring should be gentle, so that the microflocs formed do not disintegrate and can collide with each other to form even bigger particles, called flocs.

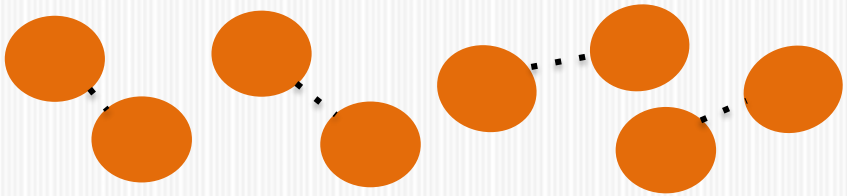
• Larger flocs are with good settling characteristics.

• It requires very slow and continuous mixing of water for frequent contact between fine particles and the hydrolyzed product of the coagulants.

Water Treatment – **Flocculation**

- The floc is generally a collection of most of the suspended load and bacteria in the water that caused its turbidity, and once it is formed the water will be clearer.

- The efficiency of the flocculation process largely depends on the number of random collisions among the coagulated particles per unit of time.



Particles collide and link together through weak bonds

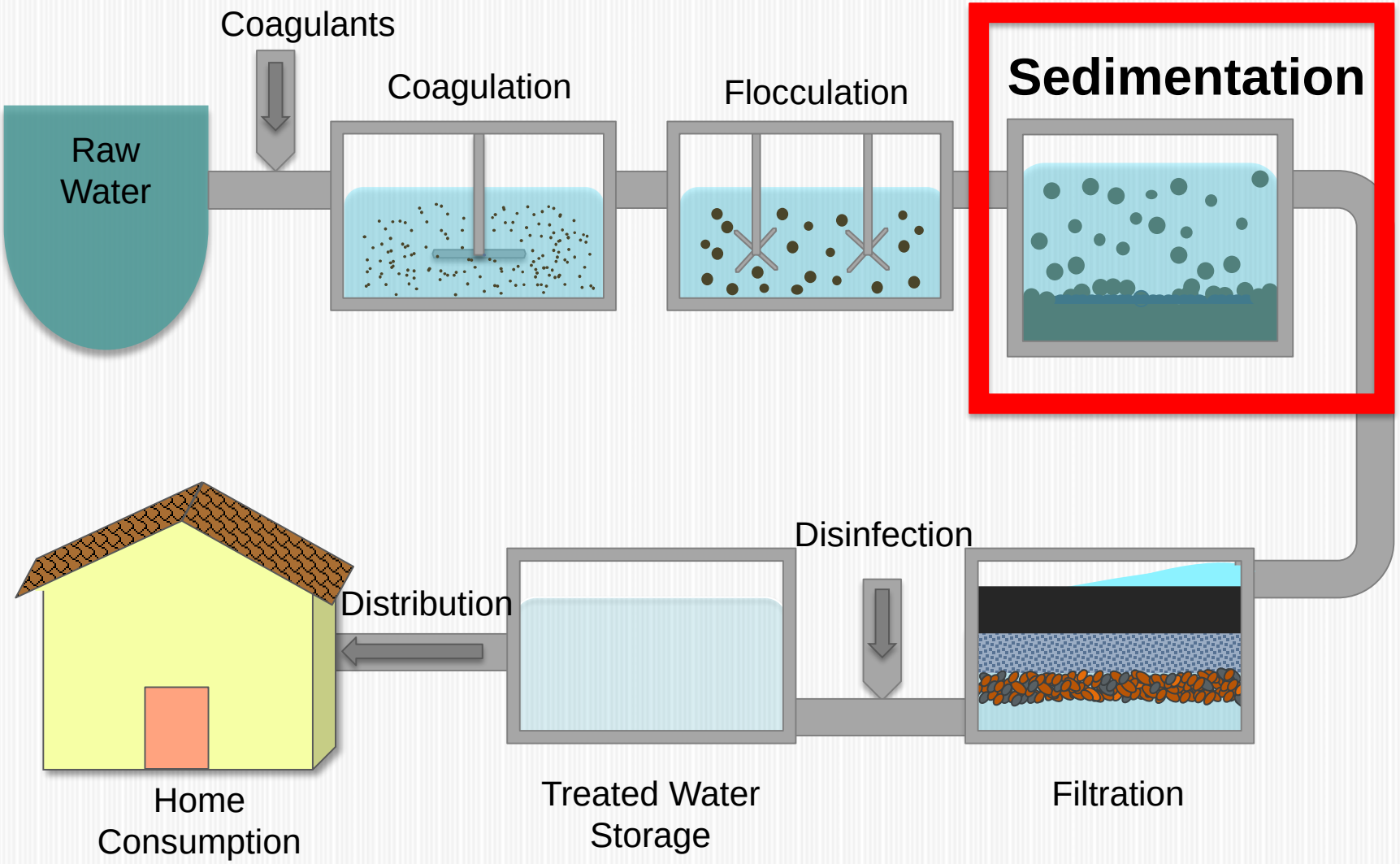


And form big clumps called **flocs**



Flocculation chamber

Water Treatment Process - **Sedimentation**



Water Treatment Process **– Sedimentation**

- Particles in water that will settle by gravity within a reasonable period of time can be removed by "sedimentation" in sedimentation basins (also known as "clarifiers").

- In sedimentation process, water velocity is lowered below the suspension velocity and the suspended particle settle out of the water due to gravity.

- The process is also known as settling or clarification

Water Treatment Process **– Sedimentation**

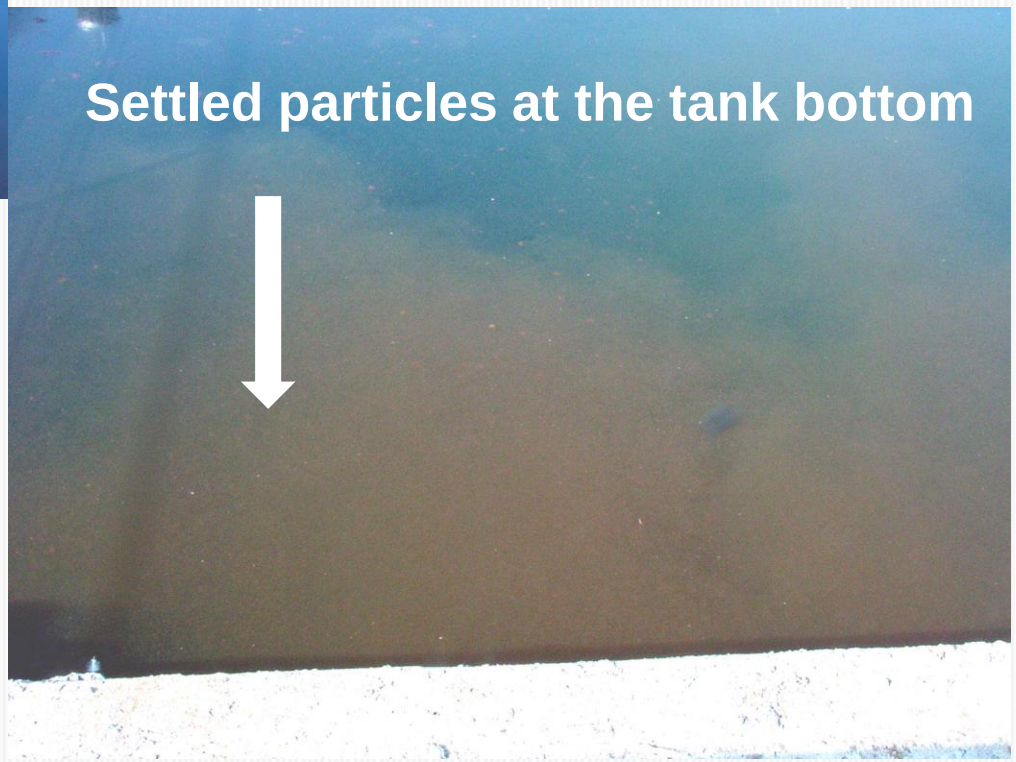
- Settled solids in the sedimentation basin are removed as sludge, and floating solids are removed as scum.

- Sedimentation basins are usually included as integrated units of treatment plants and are heavily dependent on sedimentation mechanism.

Water Treatment Process – Sedimentation



Rectangular Sedimentation Tank

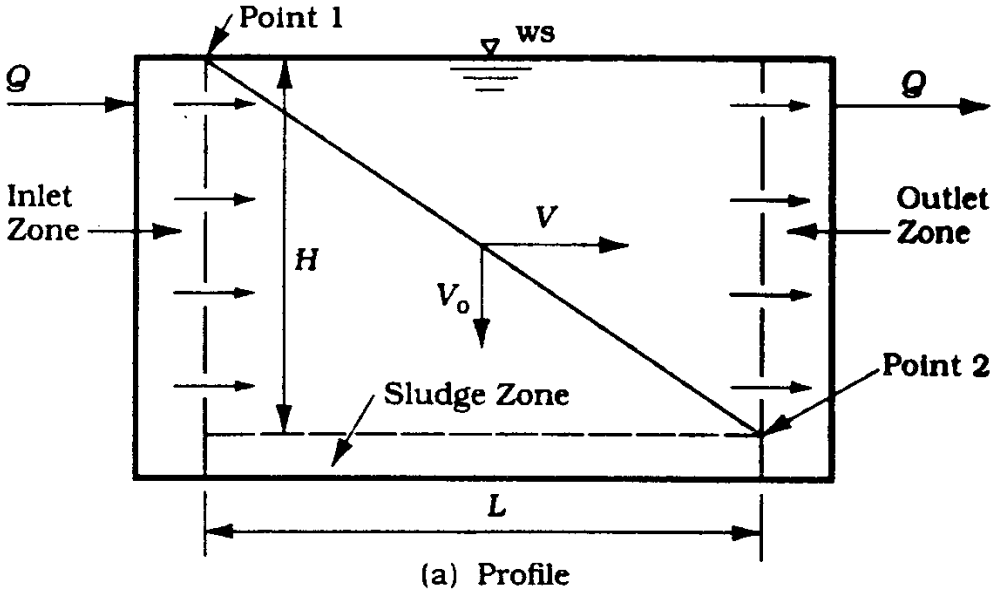


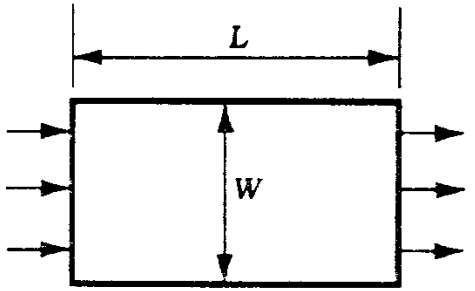
Water Treatment Process – Sedimentation

Objectives of Sedimentation

1) Producing a clarified (free of suspended solids) effluent.

2) Producing a highly concentrated solid sludge stream.





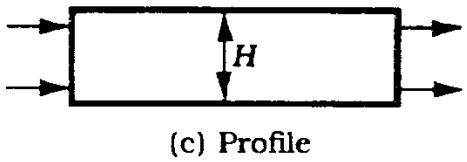


FIGURE 9.6 *Ideal Rectangular Settling Basin*

Water Treatment Process – **Sedimentation**

Mechanism of Sedimentation

- In this process, the organic and inorganic particles heavier than water settle by gravity in a tank or basin.

- These particles are held in suspension in natural water mainly by turbulence or current and when the current is slowed down, the suspended particles settle at the bottom of the basin.

Water Treatment Process – **Sedimentation**

Mechanism of Sedimentation

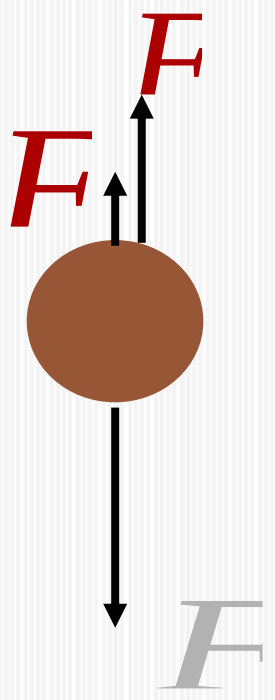
- Particle having specific gravity > 1, moves downward in relatively inactive water by the force of gravity, accelerating until the frictional resistance (‘drag’) of water equals the gravitational force acting upon the particle.

- Thereafter the particle travels with a constant velocity called the ‘*terminal velocity*’ or ‘*settling velocity*’ of the particle.

Water Treatment Process – Sedimentation

Mechanism of Sedimentation

• For a rigid particle of mass *m* moving in a fluid, there are three forces acting on the body:



(1) **Gravity force, F_g,** acting downward

$$F_g = mg$$

(2) **Buoyant force, F_b,** acting upward

$$F_b = \rho g V_s = \frac{m\rho g}{\rho_s}$$

where,

ρ= density of the fluid

ρ_s = density of the solid particle

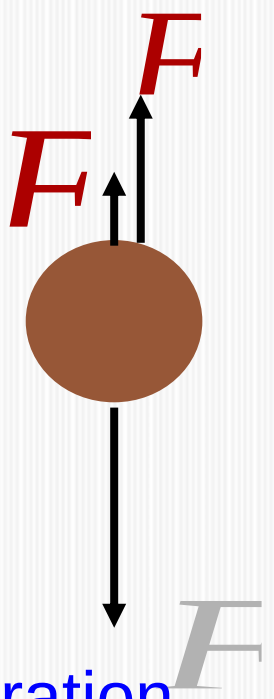
V_s = volume of the particle

Water Treatment Process – Sedimentation

Mechanism of Sedimentation

(3) **Drag force, F_D,** acting in opposite direction to the particle motion

$$F_D = C_D A \frac{\rho v^2}{2}$$



where, C_D = the drag coefficient

A = the projected area of the particle

The resultant force equals the force due to acceleration.

$$m\frac{dv}{dt} = mg - \frac{m\rho g}{\rho_s} - C_D A \frac{\rho v^2}{2}$$

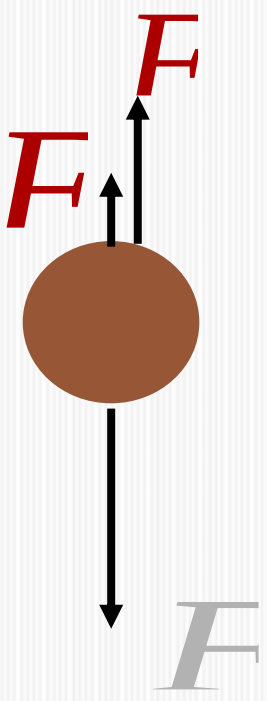
Water Treatment Process – Sedimentation

Mechanism of Sedimentation

The falling of the body consists of two periods:

(1) The period of accelerated fall

- The initial acceleration period is usually very short, of the order of a tenth of a second or so.



(2) The period of constant velocity fall

Set $\frac{dv}{dt} = 0$ and solve the above equation for v.

$$m\frac{dv}{dt} = mg - \frac{m\rho g}{\rho_s} - C_D A\frac{\rho v^2}{2} = 0$$

$$\Rightarrow \quad v = v_t = \sqrt{\frac{2(\rho_s - \rho)mg}{\rho_s \rho C_D A}}$$

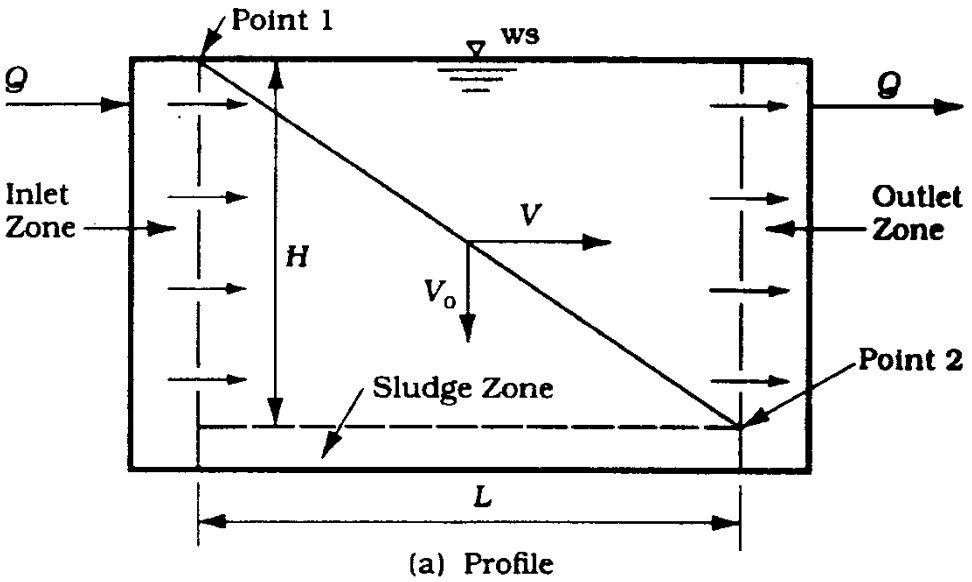
- * v_t is called the free settling velocity or terminal velocity.

Water Treatment Process – Sedimentation

Mechanism of Sedimentation

Terminal velocity of a particle moving in a fluid

$$v = v_t = \sqrt{\frac{2(\rho_s - \rho)mg}{\rho_s \rho C_D A}}$$



Terminal velocity for spherical particles of diameter *d*,

$$m = \frac{\rho_s \pi d^3}{6} \text{ and } A = \frac{\pi d^2}{4}$$

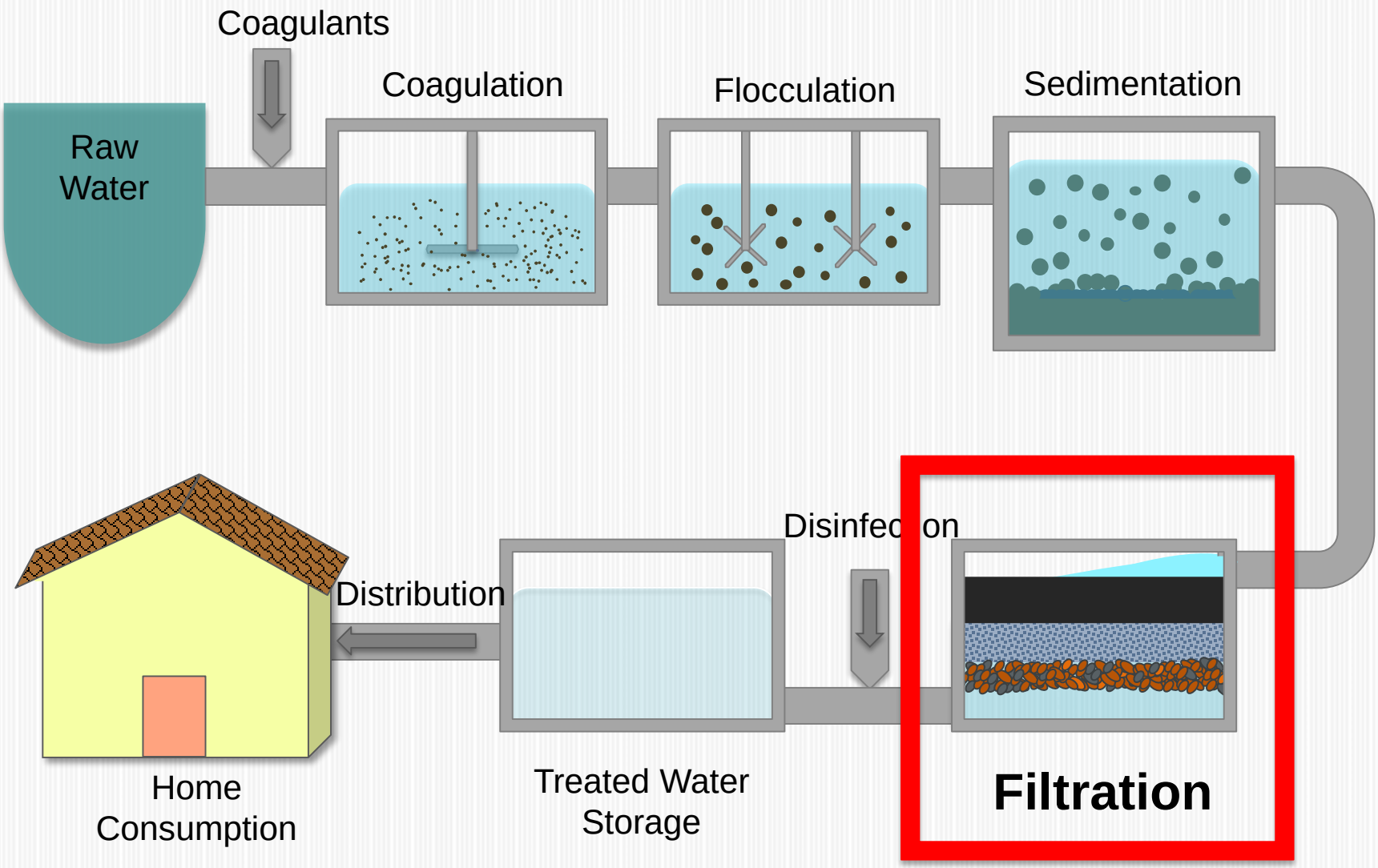
$$\Rightarrow \quad v_t = \sqrt{\frac{4(\rho_s - \rho)dg}{3\rho C_D}}$$

Water Treatment Process **– Sedimentation**

Factors affecting sedimentation and efficiency of sedimentation tank -

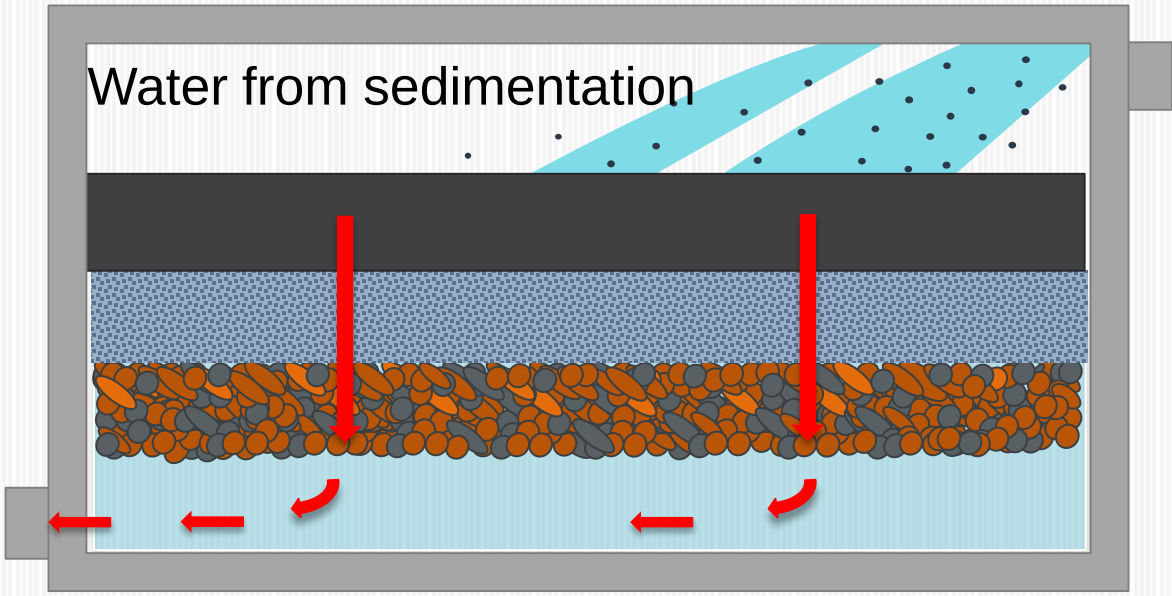
- Horizontal flow velocity of water
- Shape and size of the particle
- Specific gravity of the particle
- Viscosity of water
- Density of water
- Temperature of water

Water Treatment Process - **Filtration**

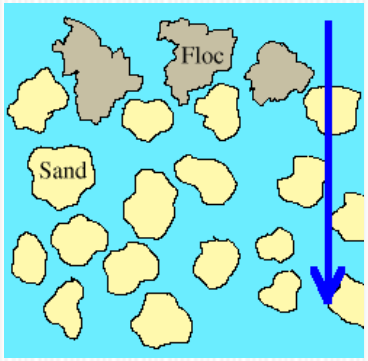


Water Treatment Process – Filtration

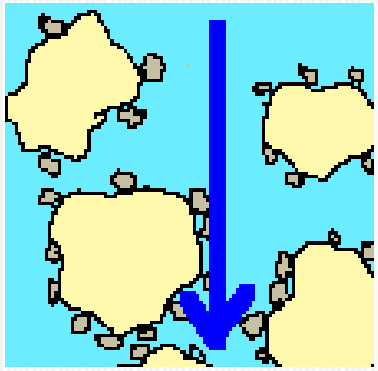
- Once most of the major particles are removed, the water is pushed through layers of activated carbon, sand and gravel to filter out any remaining fine particles and microorganisms.



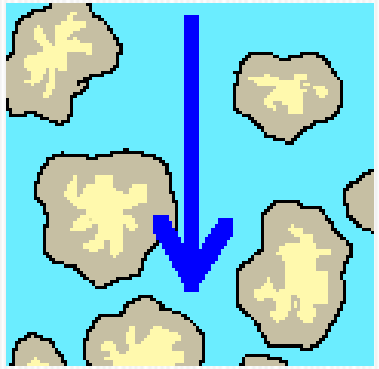
Water Treatment Process – Filtration



Straining



Adsorption

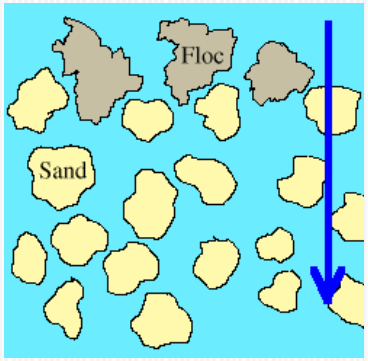


Absorption

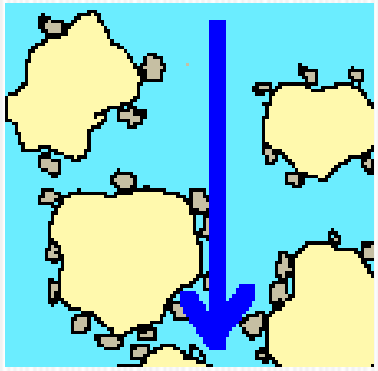
- The primary filtration process used is adsorption, where the particles are attracted to the filter material, such as activated carbon, and are gathered on its surface.

- The secondary process is the straining out of the remaining flocs in the water in a filter.

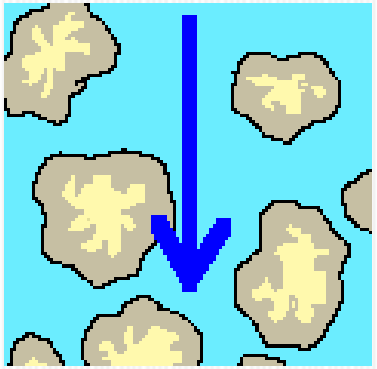
Water Treatment Process – Filtration



Straining



Adsorption



Absorption

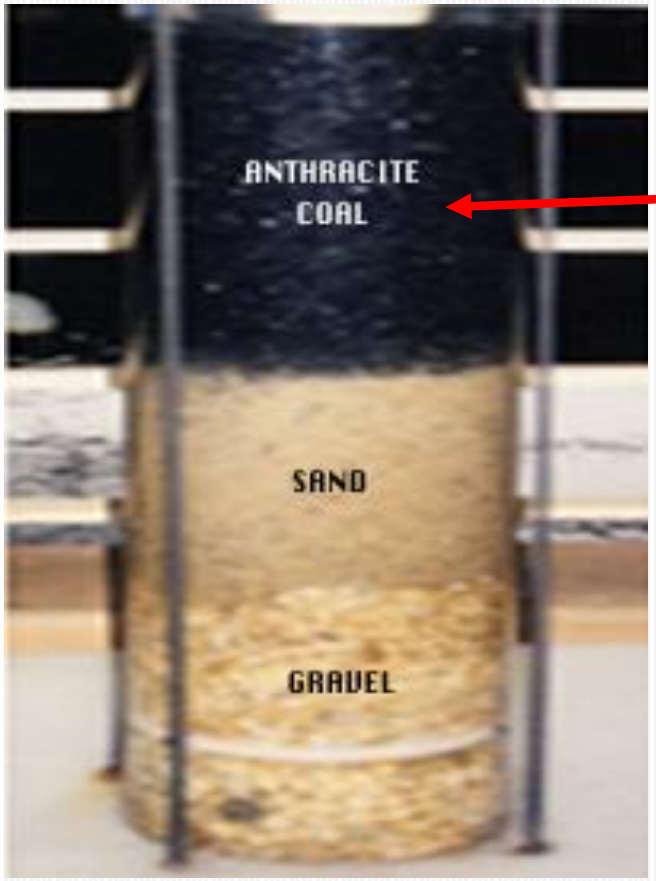
- The pores between the filter material, such as sand, are smaller than they are, straining cause trapping of the filter media and preventing them from flowing with the water.

- However, this water is still filled with bacteria, viruses, and other organic matter.

Water Treatment Process – Filtration

Filter Media

• Filter media is the part of the filter which actually removes the particles from the water being treated.



Applying the layer of anthracite (coal) provides a higher filtration rate and a longer filter run time than sand alone.

Water Treatment Process – Filtration

Slow Sand Filters (SSF)/ Biological Filter

Elements of slow sand filter

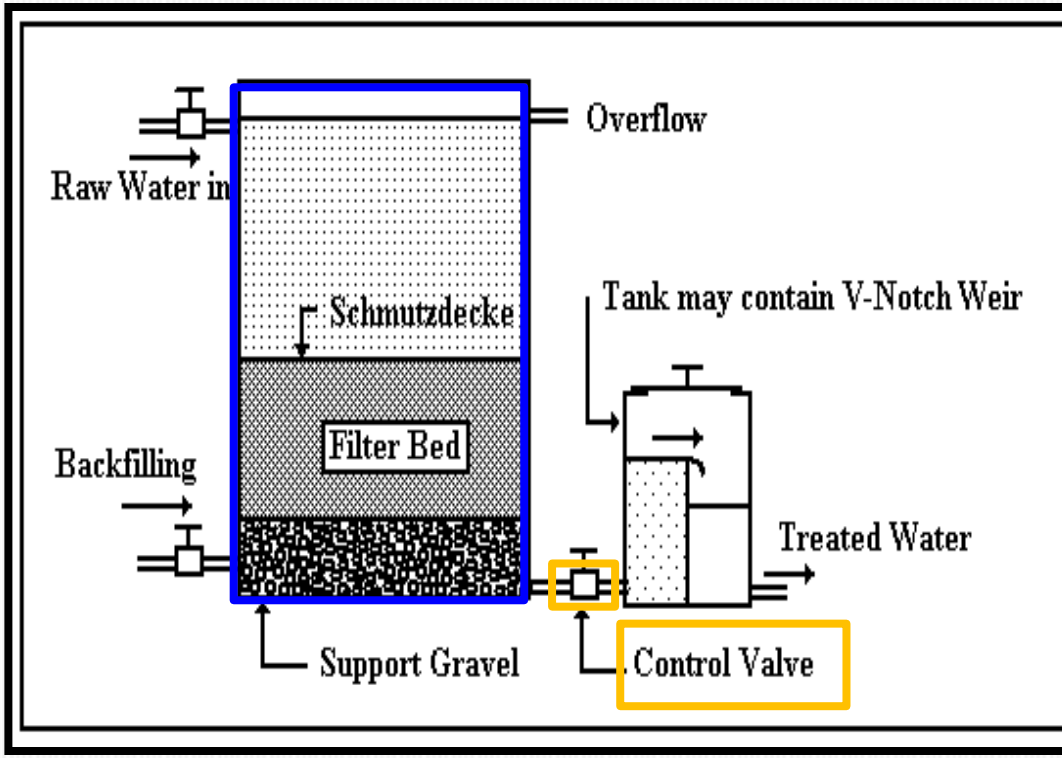
(1) Filter Box

(a) Supernatant water

(b) Sand bed (filter bed)

(c) Under drainage system

(2) Filter control valves



Water Treatment Process – SSF

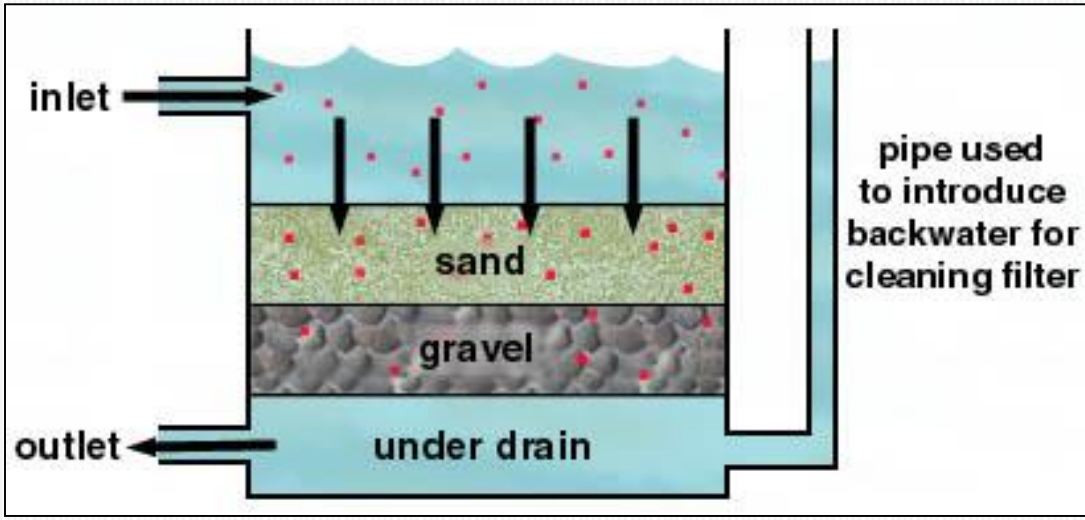
Filter Box Elements

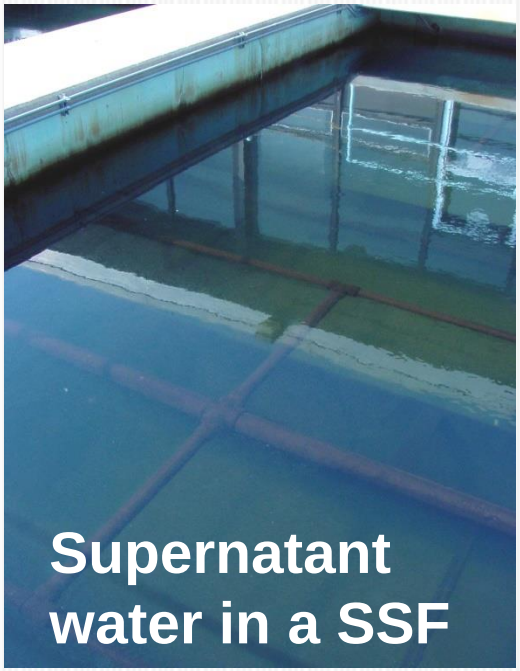
(a) **Supernatant water**

✓depth: 1-1.5 m

✓ promotes downward flow of water through the sand bed

✓ provide waiting time of 3-12 hours for raw water to undergo partial purification by sedimentation and oxidation




Supernatant water in a SSF

Water Treatment Process – SSF

Filter Box Elements

(b) <u>Sand bed supported by gravel:</u>

- ✓ Depth: 1 m, sand (0.2-0.3 mm diameter), supported with 0.3m gravel (0.2-1 cm diameter)



- ✓ Water percolates through the bed and gets filtered by - Mechanical straining, sedimentation, adsorption, oxidation and bacterial action

- ✓Rate of filtration: <u>0.1-0.4 m^3/hour/m^2</u>

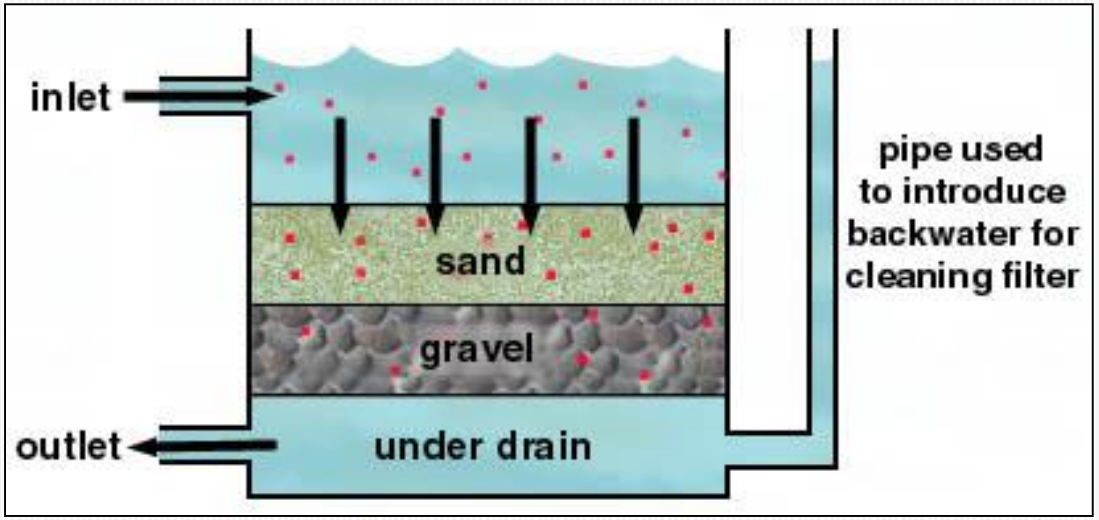
Water Treatment Process – SSF

Mechanism of action of slow sand filter:

1.Sedimentation:

- The supernatant water acts as a settling reservoir.
- Settleable particles sink to the sand surface.

2. Mechanical straining: Particles too big to pass through the interstices between the sand grains are retained.



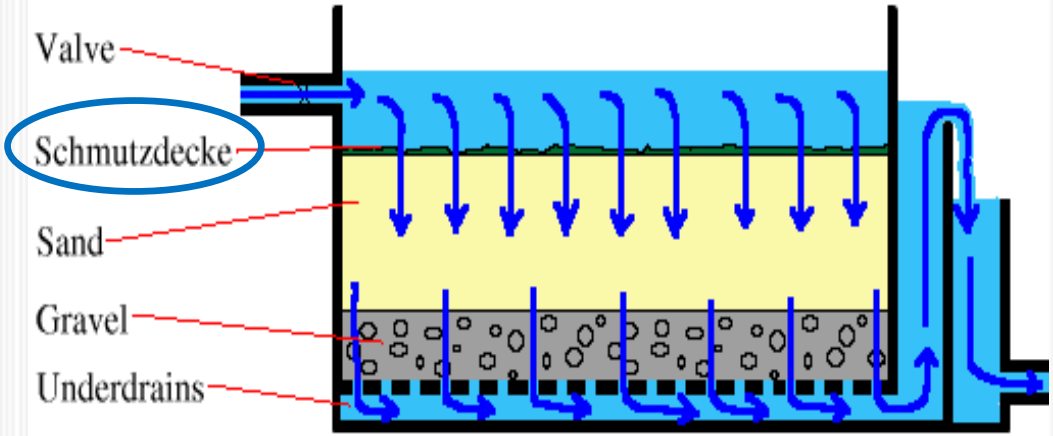
Water Treatment Process – SSF

Mechanism of action of slow sand filter:

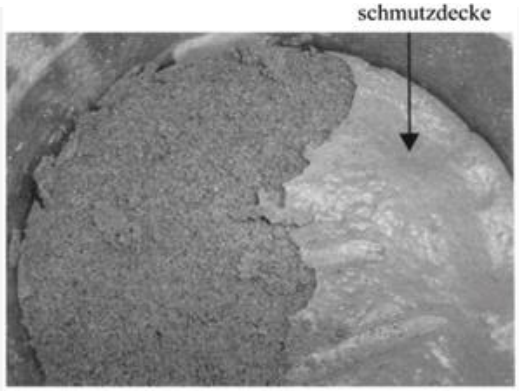
3. Formation of biological layer:

- Surface of the sand bed gets covered with a slimy growth known as vital layer or zoological layer or biological layer.

- It is slimy gelatinous, consists of algae, plankton, diatoms and bacteria.



- The formation of this layer is known as **RIPENING** of the filter, which may take several days to fully develop (2-3 cm)



Water Treatment Process – SSF

Mechanism of action of slow sand filter:

4. Adhesion: The suspended particles that come in contact with the surface of the sand grains are retained by adhesion to the biological layer/ vital layer.

5. Biochemical processes in the biological layer:

- Removes organic matter, holds back bacteria and oxidizes ammonia-nitrogen into nitrates.

Water Treatment Process – SSF

Mechanism of action of slow sand filter:

- Conversion of soluble iron and manganese compounds into insoluble hydroxides which attach themselves to the sand surfaces

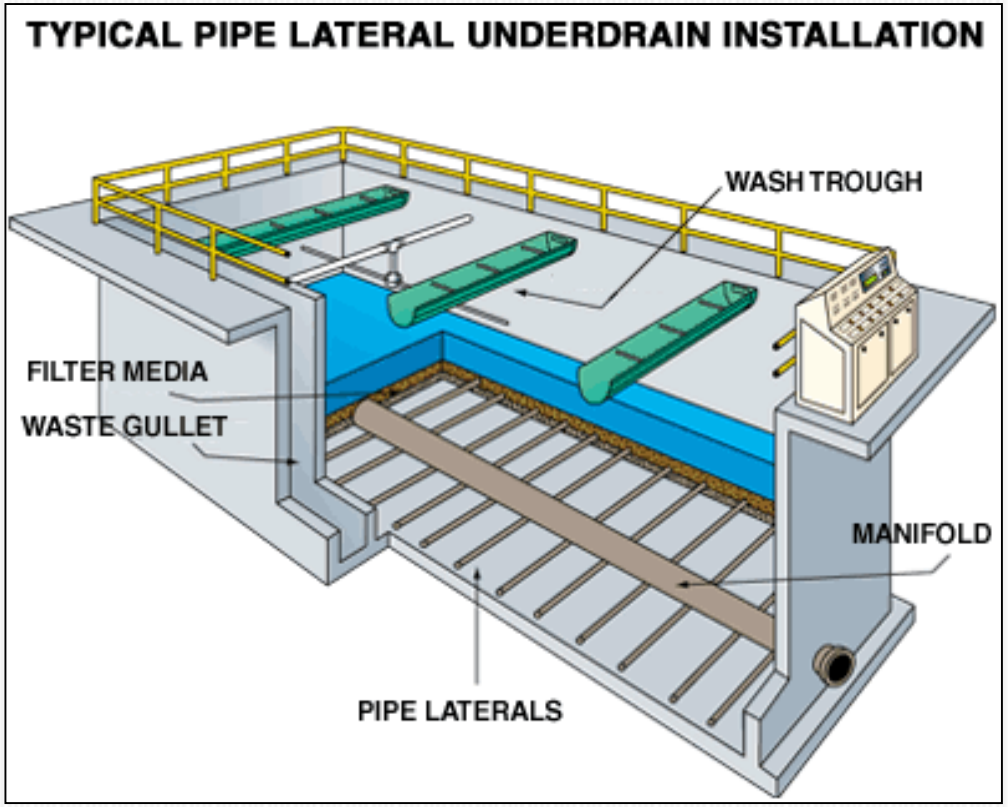
- Until the vital layer is fully formed, filter only worked as a mechanical strainer & so for the first few days filter water run to the waste.

Water Treatment Process – SSF

Filter Box Elements

(c) Underdrain System:

- ✓ Depth: 0.15 m
- ✓ At the bottom of filter bed
- ✓ Porous pipes: Outlet for filtered water as well as support to the filter media above



Filter Control Valve

- ✓ To regulate the flow of water in and out from the filter box.

Water Treatment Process – SSF

Filter Cleaning

- When the bed resistance increases to such an extent that the regulating valve has to be kept fully open, filter bed needs to be cleaned.


Removal of Vital Layer

- Cleaning is done by -

- Draining of supernatant water
- Scrapping of the top portion of the sand bed to a depth of 1-2 cm

- After 20-30 scrapings , new bed (filter) is required to be constructed

Water Treatment Process – SSF

Advantages

- Simple to construct and operate
- Cheaper
- Physical, Chemical & Bacteriological quality of water is very high
- Reduces bacterial count by 99.9% & E. coli by 99%.

Water Treatment Process – SSF

Disadvantages

- Old fashioned and outdated method of water purification (but still in use)
- Initial cost is low but maintenance cost is much more than rapid sand filter
- These filters need a lot of space

Water Treatment Process – Rapid Sand Filter

Types of RSF

- Open/gravity type — **PATERSON FILTER**
- Closed/presure type — Candy's Filter





Water Treatment Process – RSF

Steps of Filtration

- Coagulation
- Rapid Mixing
- Flocculation
- Sedimentation
- Filtration

Coagulation

- Alum is added – 5-40 mg/liter depending upon turbidity, color, pH & temperature

Rapid mixing of Alum

- By violent agitation in a mixing chamber for few minutes

Water Treatment Process – RSF

Flocculation

- Slow & gentle stirring of the treated water for about 30 minutes
- Results in formation of thick, copious, white flocculent precipitate of aluminium hydroxide

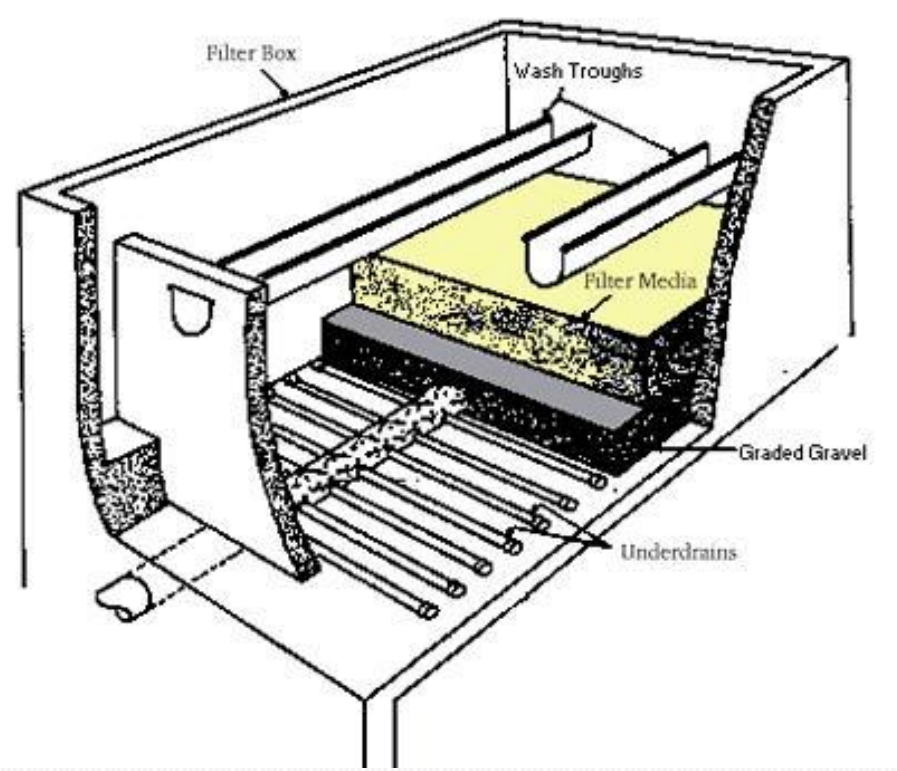
Sedimentation

- For 2-6 hours
- Flocculent precipitate together with impurities and bacteria
- 95% of the flocculent needs to be removed before the water enters the rapid sand filter

Water Treatment Process – RSF

Filter Bed

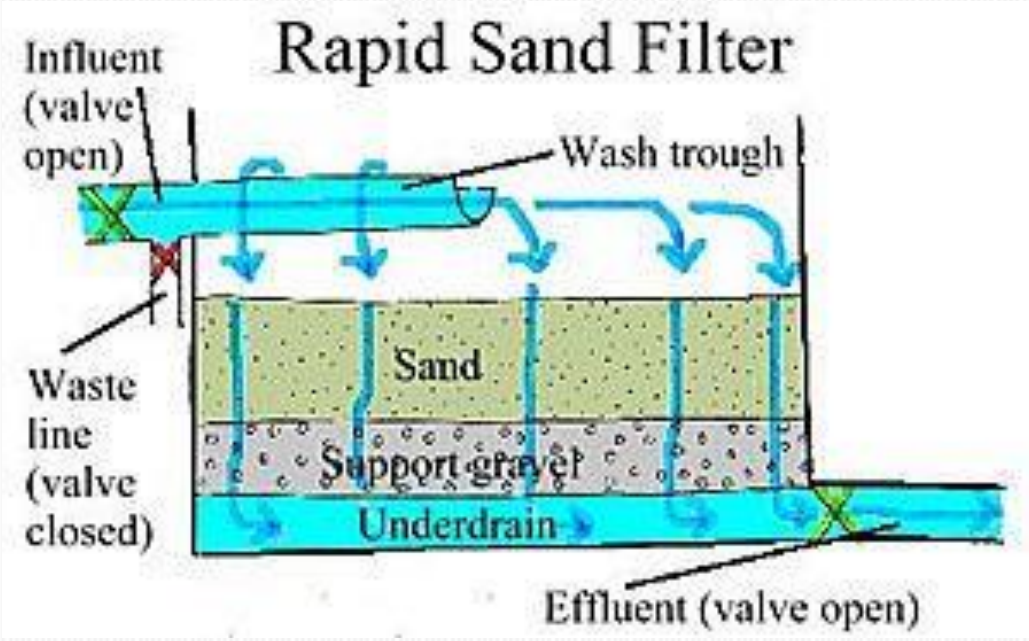
- Each unit has a surface of 80-90 m^2
- Supernatant water – 1 to 1.5 m
- Depth of sand bed – 1 m
- Effective size of sand particle is 0.4-0.7 mm
- Supported graded gravel – 30-40 cm
- Filtration rate – 5-15 m^3 / m^2/ hr



Water Treatment Process – RSF

Filtration

- Retained alum- flocs is held back on sand bed
- Forms a slimy layer [comparable to the zoological layer in slow sand filter]
- adsorbs bacteria from water
- Oxidation of ammonia also takes place during the passage of water



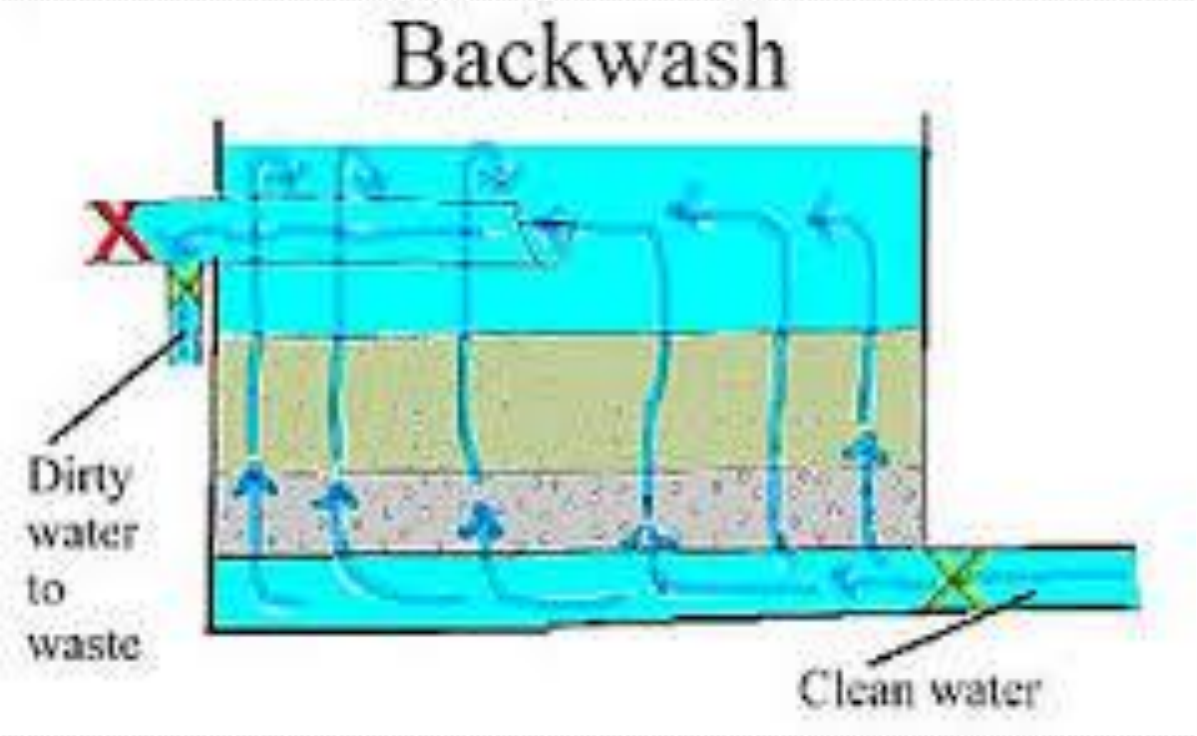


Water Treatment Process – RSF

Cleaning & Maintenance

- When the loss of head reaches 7-8 ft, it needs to be cleaned

- Cleaned by Backwashing.



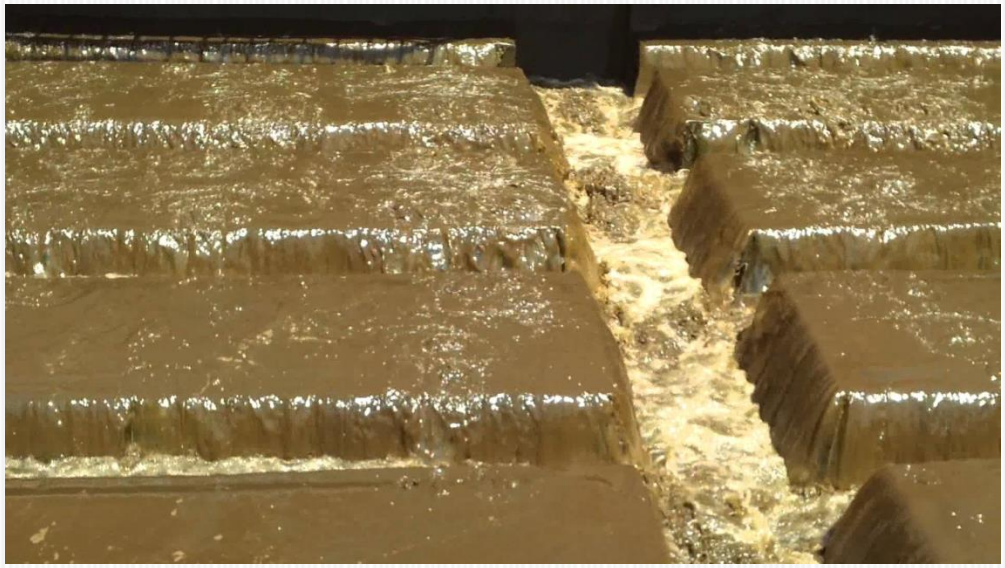
Water Treatment Process – RSF

Cleaning & Maintenance

- Backwashing is done by reversing the flow of water through the sand bed.

- Upward flow dislodges the impurities trapped in the sand layer and cleans up sand bed.

- Compressed air can be used in back washing



Water Treatment Process – RSF

Advantages

- Deal with raw water directly
- Occupies less space
- Filtration is rapid
- Washing of filter is easy
- More flexibility in operation

Water Treatment Process – RSF

Disadvantages

- Relatively high skill operation
- Costlier
- Removes bacteria by 98-99% (less compared to SSF)

Water Treatment Process – Disinfection

Current Methods

Large-Scale:

- Chlorination
- Ozone
- UV irradiation

Small Scale:

- Boiling
- Iodine tablets
- Filters

Water Treatment Process – Disinfection

Criteria for satisfactory disinfectant

- Not influenced from properties of water within short time
- Should not be toxic and color imparting or leave the water impotable
- Available, cheap, easy to use
- Residual concentration to deal with recontamination
- Detectable by rapid, simple techniques in small concentration

Water Treatment Process – Disinfection

Factors affecting disinfectant efficiency

- Duration
- pH
- Temperature
- Concentration of the disinfectant
- Concentration of organisms
- Nature of the disinfectant
- Nature of the organisms to be inactivated
- Nature of the suspending medium

Water Treatment Process – Disinfection

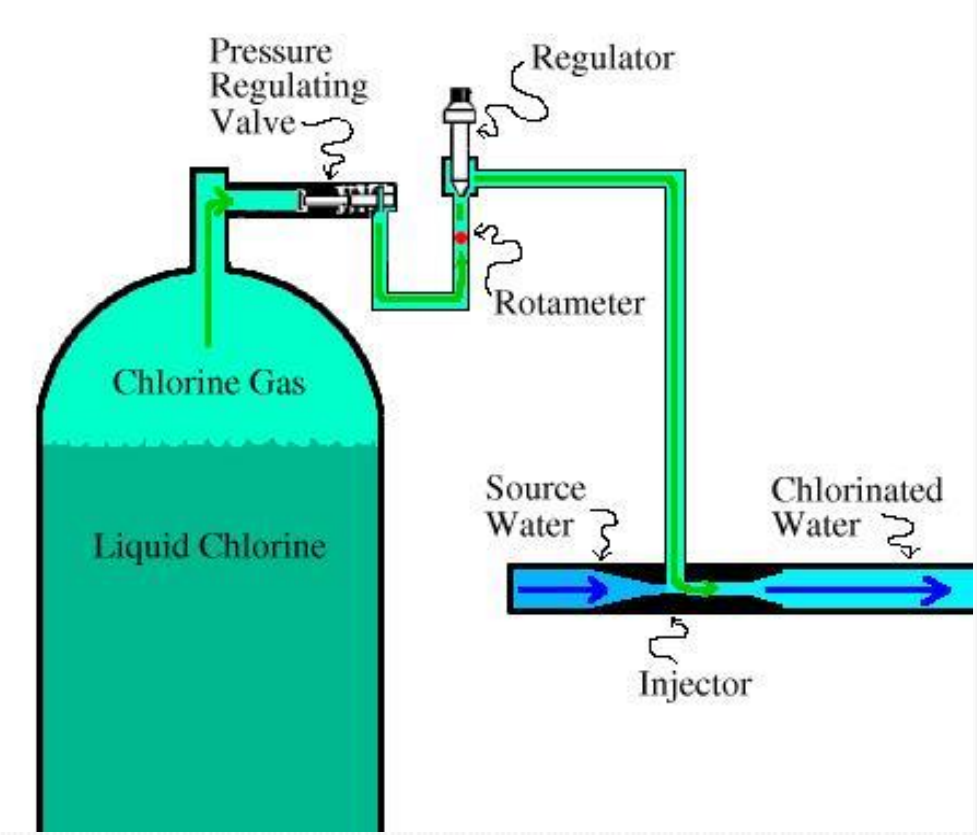
Chlorination

- It is easy to apply chlorine due to its relatively high solubility of about 7000 mg per liter.
- Readily available as gas, liquid or powder.
- Very toxic to most of the micro-organisms.
- Cheap and reliable.
- Chlorine can be applied in water in one of the following ways:
  - as bleaching powder,
  - as chloramines, or
  - as free chlorine gas.

Water Treatment Process – Disinfection

Mechanism of Action of Chlorination

- H_2O+Cl_2 (**at pH 7**) → HCl + HOCl (main disinfectant)
- HOCl (**at pH > 8.5**) → H^+ + OCl^- (minor action)
- $NH_3 + Cl_2$ → NH_2Cl/ $NHCl_2$/ NCl_3+ H_2O (Mono, Di, Tri Chloramines)



Water Treatment Process – Disinfection

Commonly used Chlorine Sources

- Sodium Hypochlorite, NaOCl (common household bleach)

$$NaOCl + H_2O \Rightarrow HOCl + Na^+ + OH^-$$

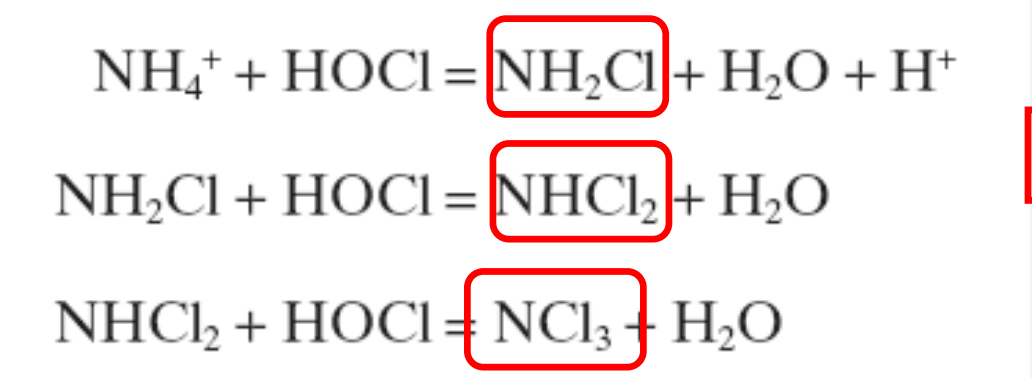
- Calcium Hypochlorite, $Ca(OCl)_2$

$$Ca(OCl)_2 + 2H_2O \Rightarrow 2HOCl + Ca^{++} + 2OH^-$$

Water Treatment Process – Disinfection

Disinfectant Demand Reactions

- In the presence of ammonium ion, free chlorine reacts in a stepwise manner to form chloramines -



Combined Chlorine

- Monochloramine (NH_2Cl), dichloramine ($NHCl_2$), and trichloramine (NCl_3), each contribute to the total (or combined) chlorine residual in a water.

Water Treatment Process – Disinfection

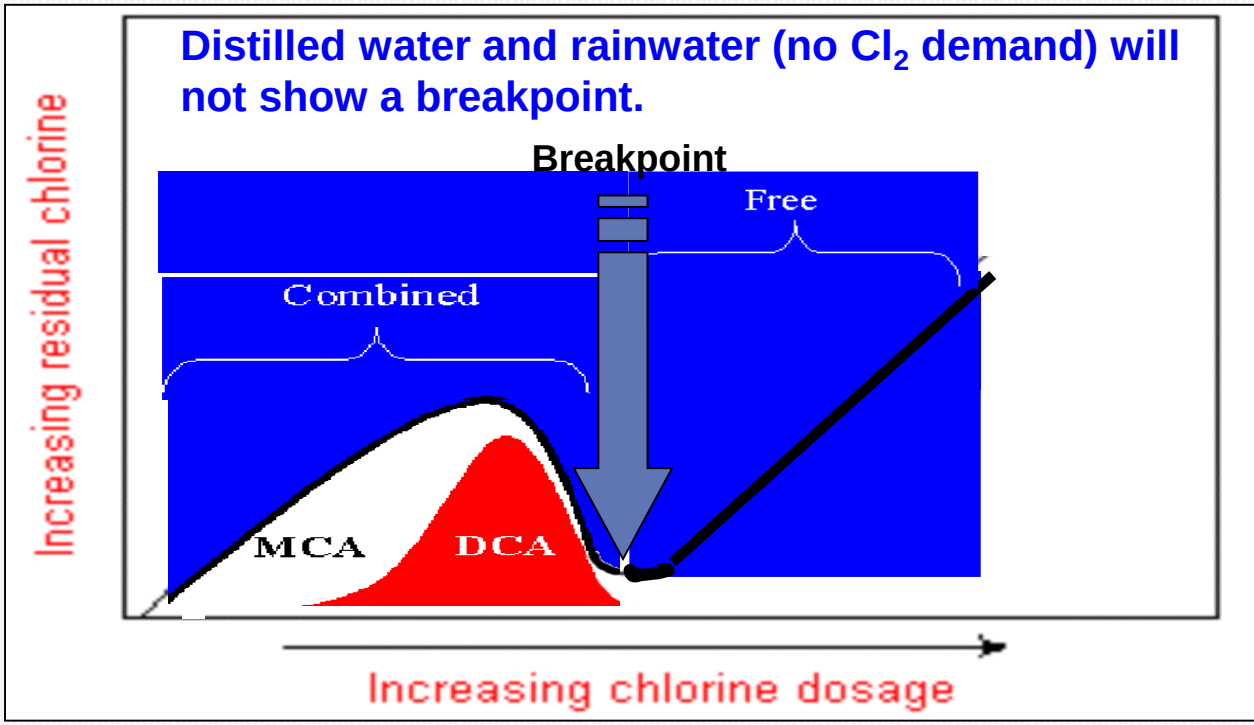
Disinfectant Demand Reactions

- The terms total available chlorine and total oxidants refer, respectively, to the sum of free chlorine compounds and reactive chloramines, or total oxidating agents.

- Under normal conditions of water treatment, if any excess ammonia is present, at equilibrium the amount of free chlorine will be much less than 1 percent of total residual chlorine.

Water Treatment Process – Disinfection

Breakpoint Chlorination



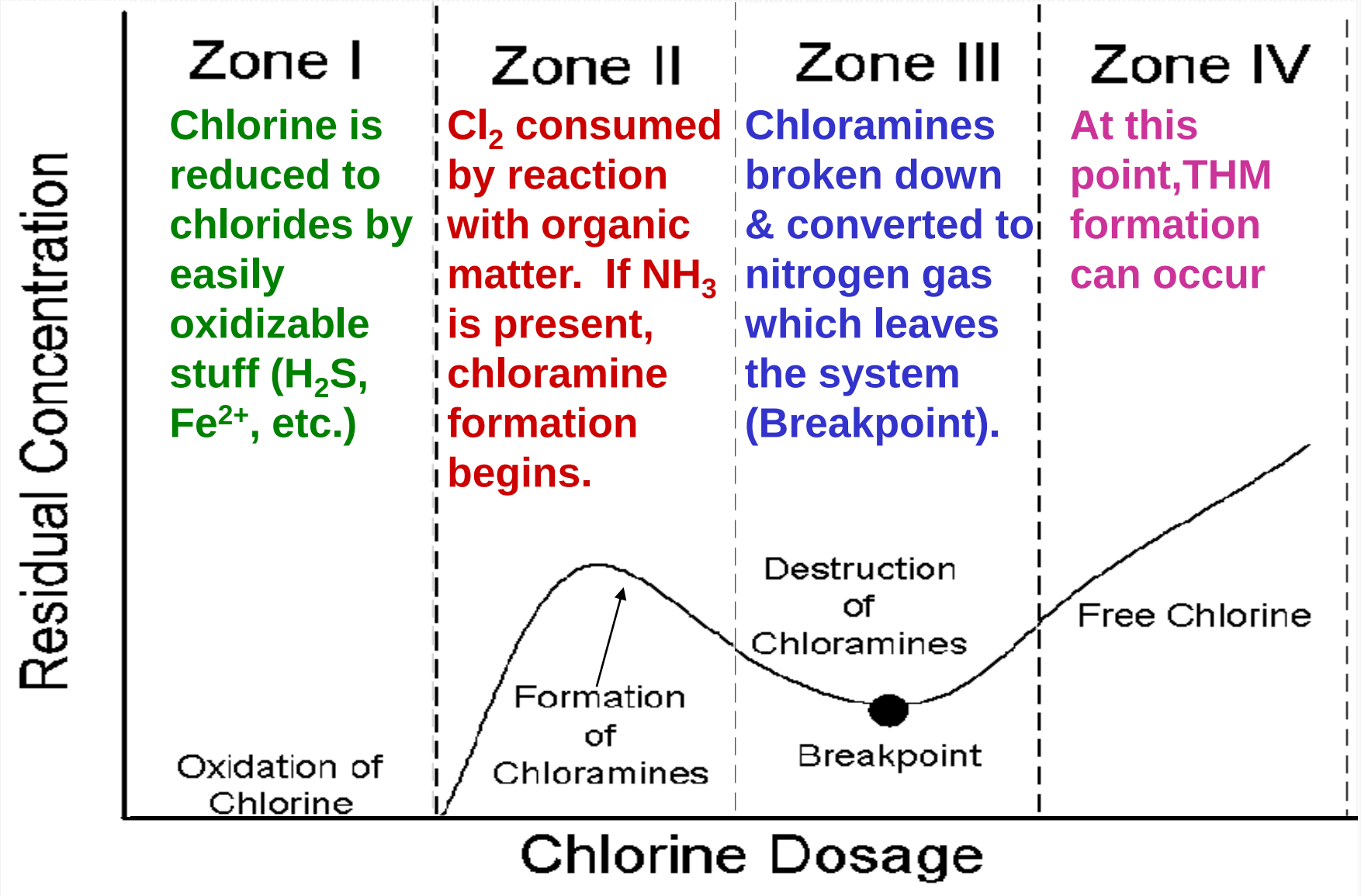
MCA – Mono Chloramine
DCA – Di Chloramine

- The type of chlorine dosing normally applied to piped water supply systems is referred to as breakpoint chlorination.

- Sufficient chlorine is added to satisfy all of the chlorine demand and then sufficient extra chlorine is added for the purposes of disinfection.

Water Treatment Process – Disinfection

Breakpoint Chlorination



Water Treatment Process – Disinfection

Super Chlorination

- Method of choice for highly polluted waters
- High dose of chlorine is added
- After 20 minutes of contact, dechlorination is done with sodium sulphate/ sodium thiosulphate to reduce the taste of excess chlorine

Water Treatment Process – Disinfection

Advantages of Chlorination

- Chloramines are not as reactive with organics as free chlorine in forming DBPs.

- The monochloramine residual is more stable and longer lasting than free chlorine or chlorine dioxide, thereby providing better protection against bacterial regrowth in systems with large storage tanks and dead end water mains. However excess ammonia in the network may cause biofilming.

Water Treatment Process – Disinfection

Advantages of Chlorination

- Because chloramines do not tend to react with organic compounds, many systems will experience less incidence of taste and odor complaints when using chloramines.

- Chloramines are inexpensive.

- Chloramines are easy to make.

Water Treatment Process – Disinfection

Disadvantages of Chlorination

- The disinfecting properties of chloramines are not as strong as other disinfectants, such as chlorine, ozone, and chlorine dioxide.

- Chloramines cannot oxidize iron, manganese, and sulfides.

- When using chloramine as the secondary disinfectant, it may be necessary to periodically convert it to free chlorine for biofilm control in the water distribution system.

Water Treatment Process – Disinfection

Disadvantages of Chlorination

- Excess ammonia in the distribution system may lead to nitrification problems, especially in dead ends and other locations with low disinfectant residual.
- Monochloramines are less effective as disinfectants at high pH than at low pH.
- Dichloramines have treatment and operation problems.
- Chloramines must be made on-site.

Water Treatment Process – Disinfection

Other Disinfection Methods

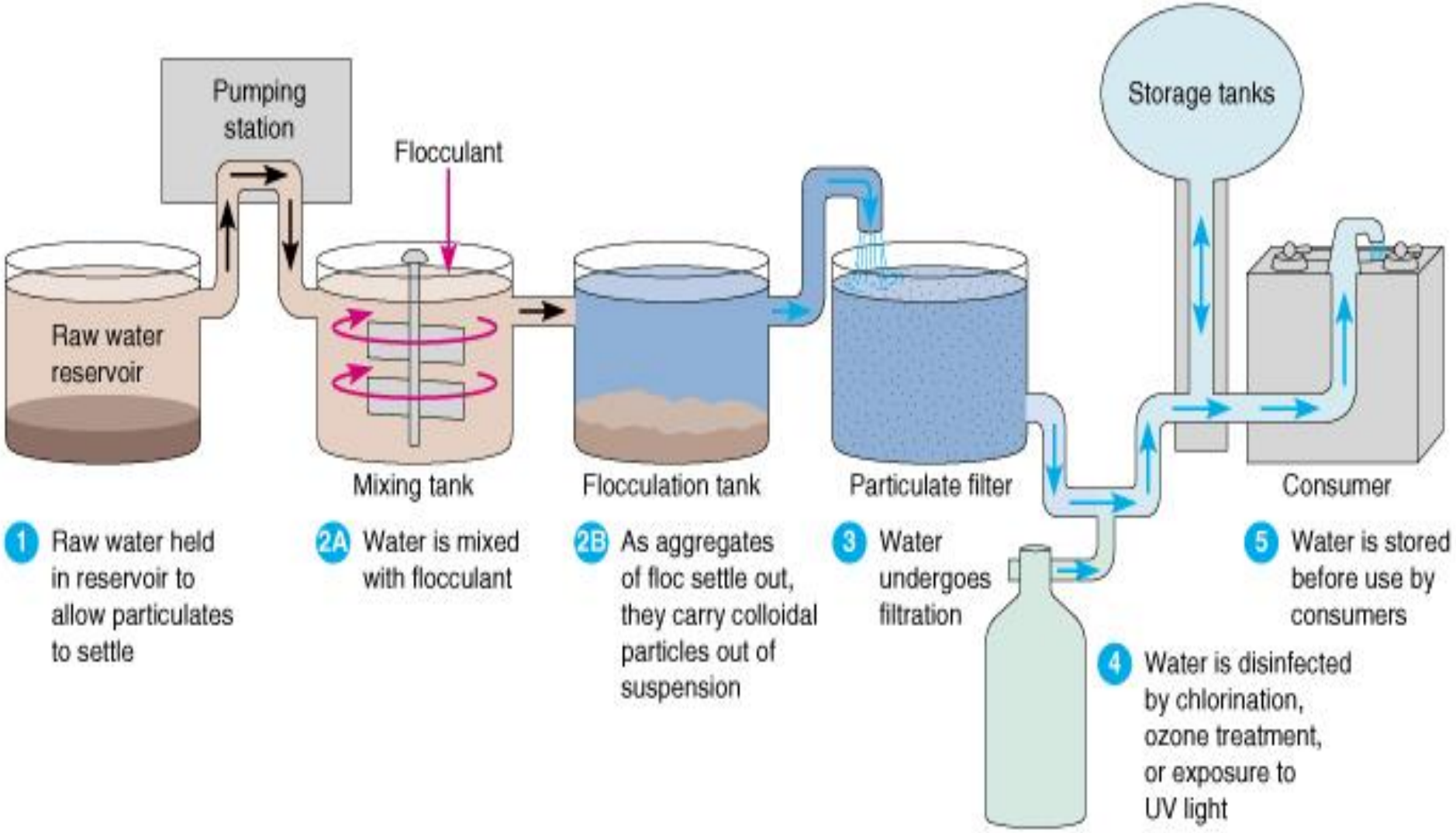
Ozone

- Used in Europe and Canada
- Strong oxidizing agent
- Strong virucidal
- No residual effect
- Should be used with chlorination

UV Rays

- Used in UK
- Water should be clear
- No residual effect
- Expensive

Municipal Water Treatment Plant (WTP)



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