

Water Treatment Processes and Ozone Treatment of the Source

WQT 131

**Water Works Operation III
Water Treatment**

**Chapter 1 Water Treatment Processes
Chapter 2 Treatment of Water at the Source
OZONE**

Lecture 1

Week 1 Objectives

Reading assignment:

AWWA 2003. Water Treatment, Principles and Practices of Water Supply Operation, Third Edition, American Waterworks Association, ISBN 1-58321-230-2

Chapter 1 Water Treatment Processes

Chapter 2 Treatment of Water at the Source

Chapter 7 Disinfection and OZONE FACT SHEET

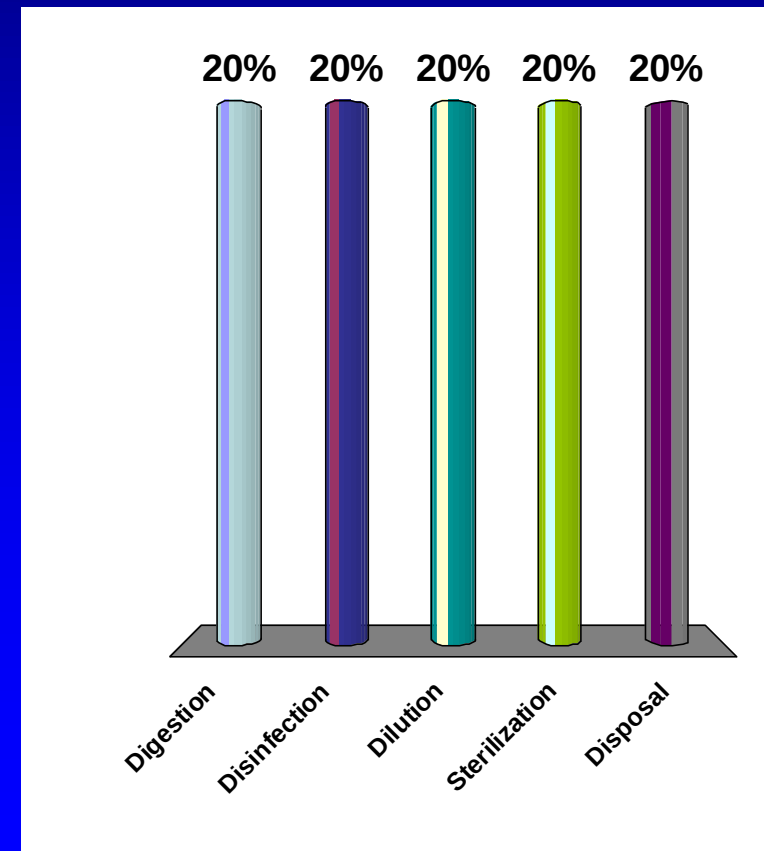
1. Understand common water treatment processes
2. Understand ways to control biological growth and maintain clean water at the source
3. OZONE

Key Words

- Disinfectants: kill unwanted microorganisms in water.
- Algaecides: chemicals that kill blue or green algae, when added to water.
- Coagulants: used to remove clay, organic matter, small suspended particles, iron, and manganese from water
- Surface Water Systems: Treatment and use of surface water to supply industries and domestic residences.
- Groundwater Systems: Groundwater extracted for the sole purpose of supply.

The destruction of the larger portion of microorganisms with the probability that all pathogens are killed is called ?

1. Digestion
- 😊 2. Disinfection
3. Dilution
4. Sterilization
5. Disposal



CH 1 Water Treatment Processes

**WQT 131
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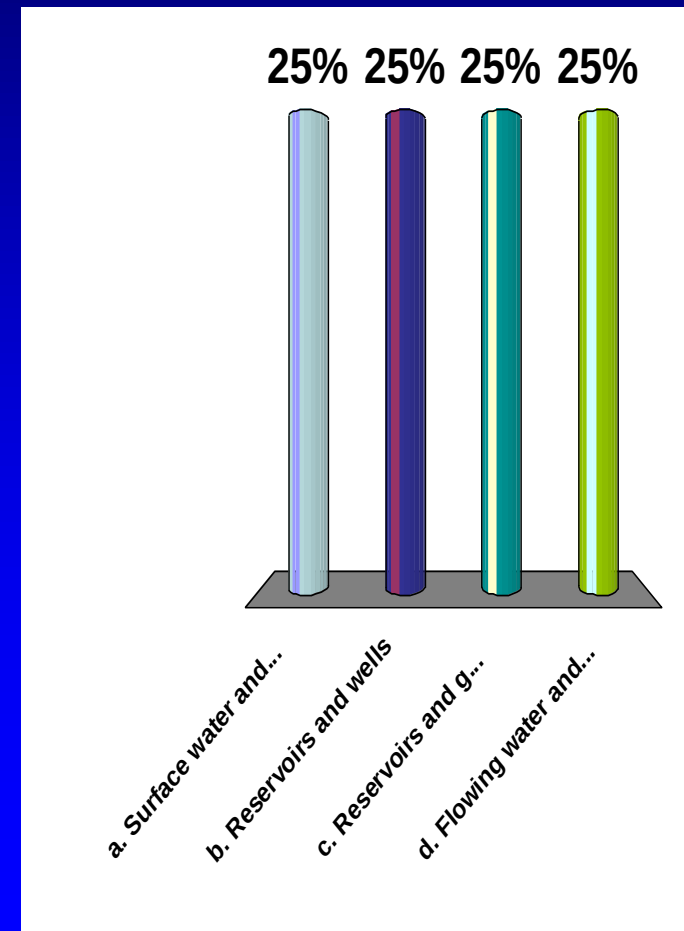
Chapter 1 Water Treatment Processes

Surface Water Systems

- Surface water sources are open to contamination from human and animal waste and other pollution.
- *Must comply with the Federal Surface Water Treatment Rule (SWTR) and include filtration, disinfection, operating, monitoring, and reporting requirements.*
- Water is always treated prior to distribution
- Treatment for microorganisms, low turbidity, and must have a minimum disinfectant residual.

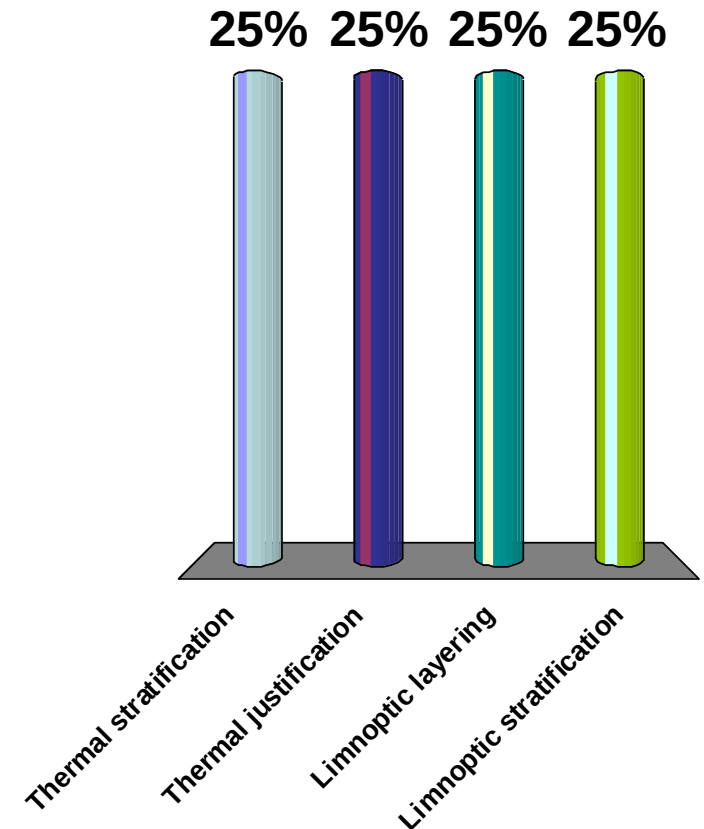
Source waters include these two broad categories

- 😊 a. Surface water and ground water
- b. Reservoirs and wells
- c. Reservoirs and ground water
- d. Flowing water and stagnant water



The formation of layers of different temperature in a body of water is called what?

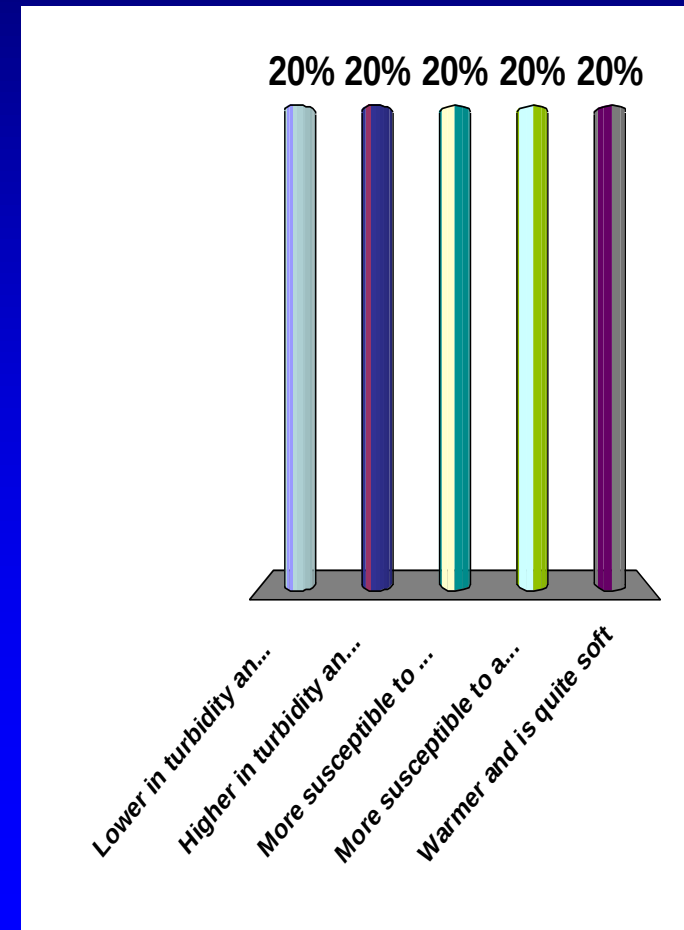
- 😊 1. Thermal stratification
- 2. Thermal justification
- 3. Limnoptic layering
- 4. Limnoptic stratification



Groundwater in comparison to surface water is generally:



1. Lower in turbidity and higher in mineral content
2. Higher in turbidity and lower in mineral content
3. More susceptible to seasonal changes
4. More susceptible to algal blooms
5. Warmer and is quite soft

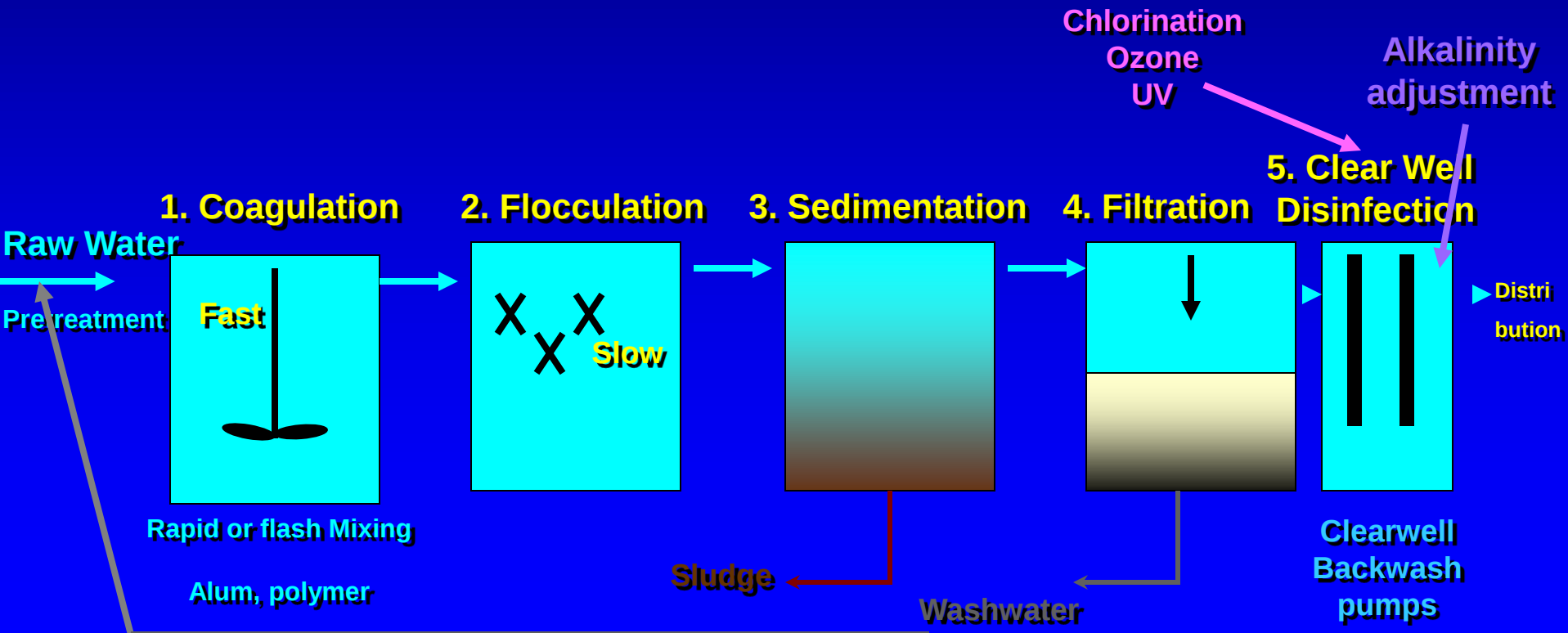


Water Treatment Steps

1. Pretreatment – At the Source
2. Coagulation and Flocculation
3. Sedimentation
4. Filtration-Sand filters or Ultra Filtration Membranes
5. Disinfection-chlorine, Ozone, UV
6. Corrosion control- caustic soda or lye NaOH
Soda ash Na_2CO_3
Sodium bicarbonate (baking soda) NaHCO_3

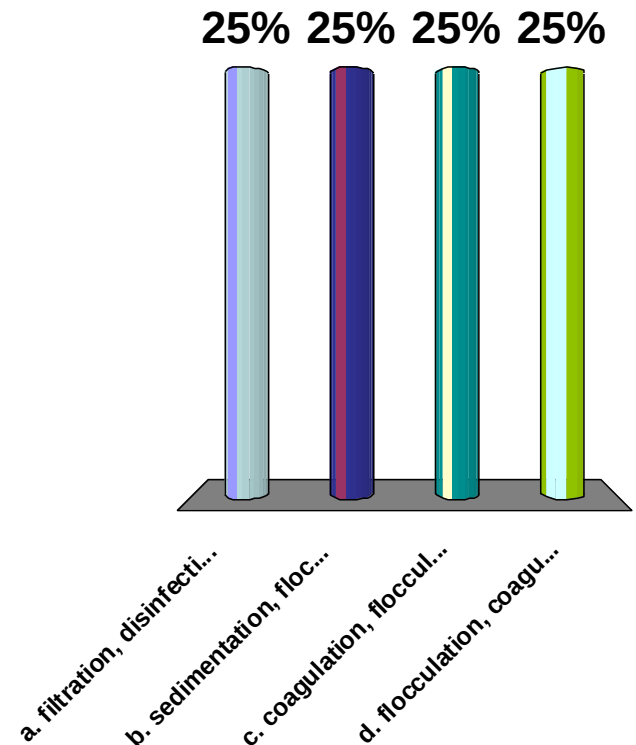
Conventional Treatment

- Conventional Treatment – Common treatment steps used to remove turbidity from the initial source water.



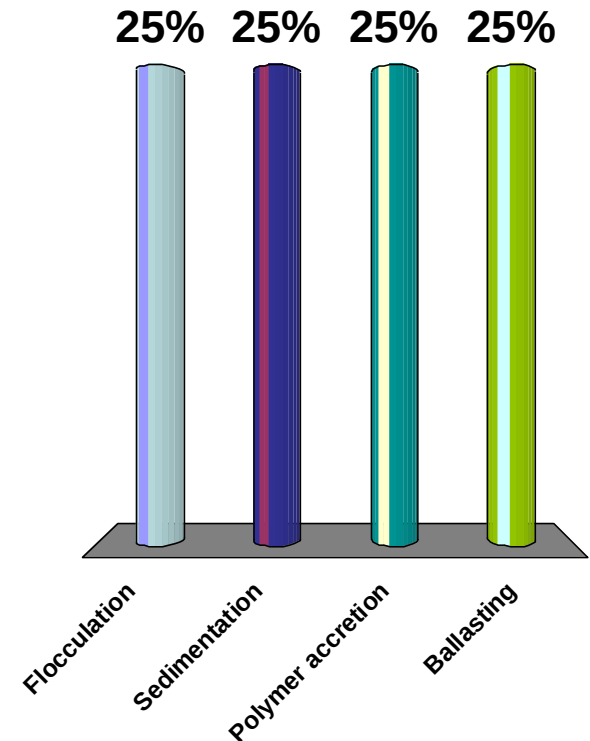
The correct order of treatment in a surface water plant is:

- a. filtration, disinfection, softening, and coagulation
- b. sedimentation, flocculation, softening, and coagulation
- 😊 c. coagulation, flocculation, sedimentation, and filtration
- d. flocculation, coagulation, filtration, and sedimentation



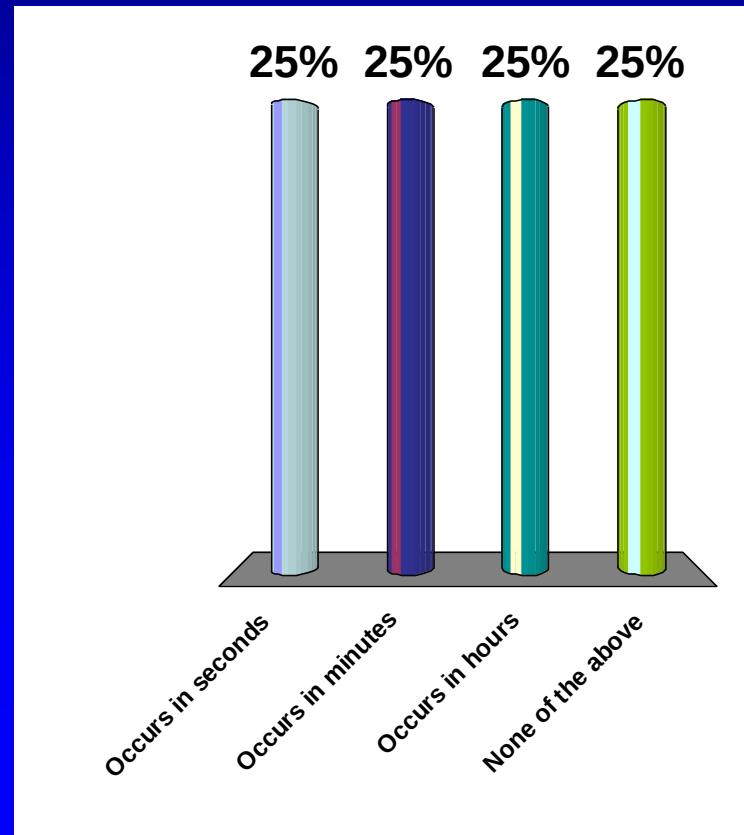
Agglomeration of colloidal and finely divided suspended matter after coagulation by gentle mixing is called what?

- 😊 1. Flocculation
- 2. Sedimentation
- 3. Polymer accretion
- 4. Ballasting



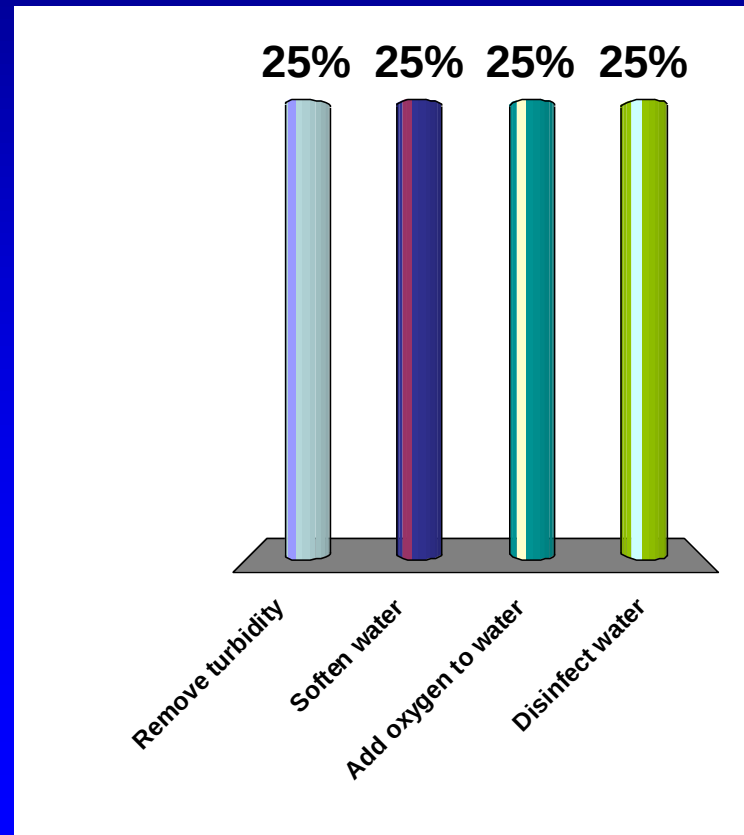
Under normal conditions, coagulation:

- 😊 1. Occurs in seconds
- 2. Occurs in minutes
- 3. Occurs in hours
- 4. None of the above



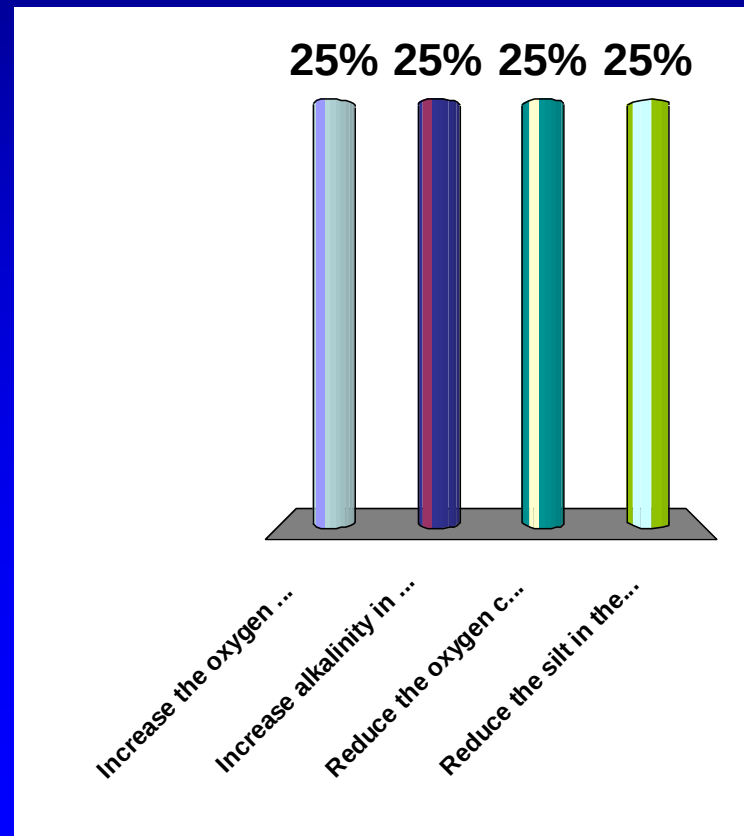
The main purpose of coagulation/flocculation is to:

- 😊 1. Remove turbidity
- 2. Soften water
- 3. Add oxygen to water
- 4. Disinfect water



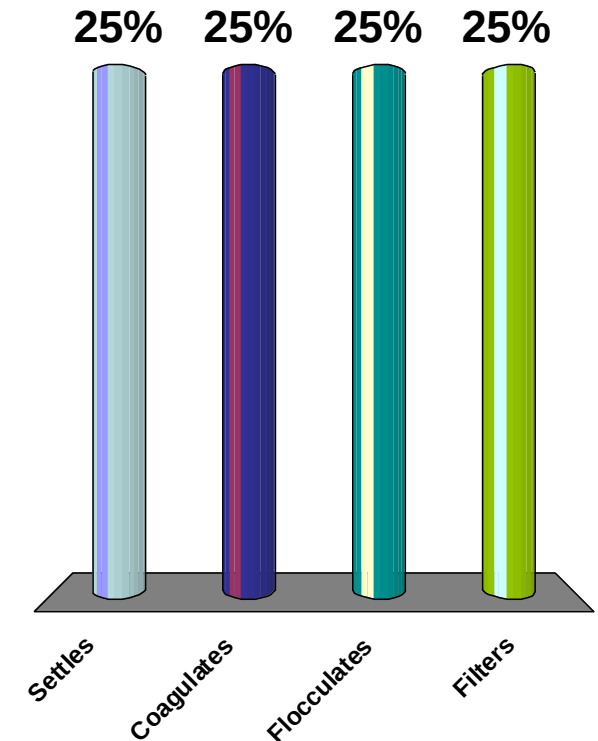
The main purpose of pre-sedimentation is to:

1. Increase the oxygen content of water
2. Increase alkalinity in the water
3. Reduce the oxygen content in the water
4. Reduce the silt in the water



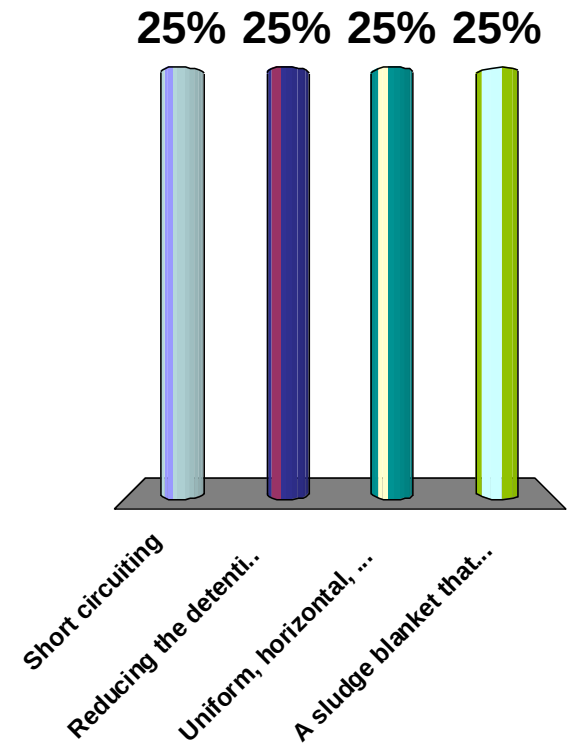
Sedimentation is a process that suspended matter.:

- 😊 1. Settles
2. Coagulates
3. Flocculates
4. Filters



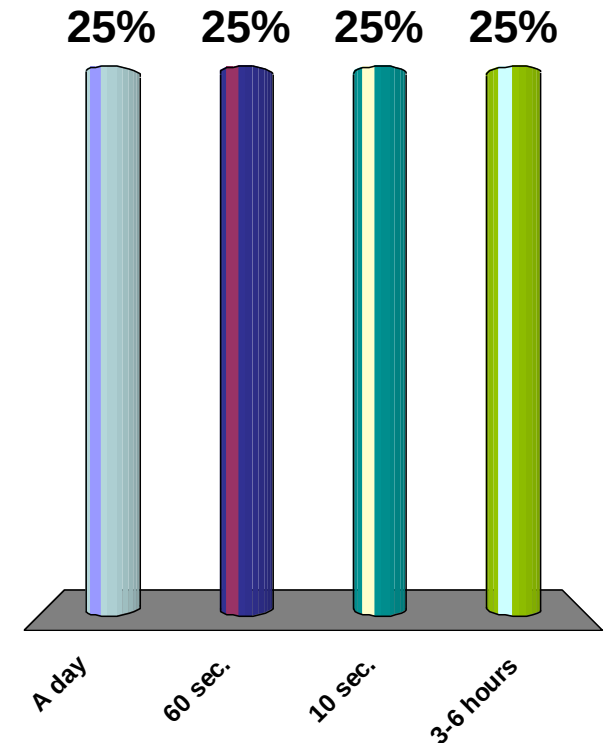
Sedimentation is improved by:

1. Short circuiting
2. Reducing the detention period
3. 😊 Uniform, horizontal, low-velocity flow across the basin
4. A sludge blanket that acts as a physical filter for incoming solids



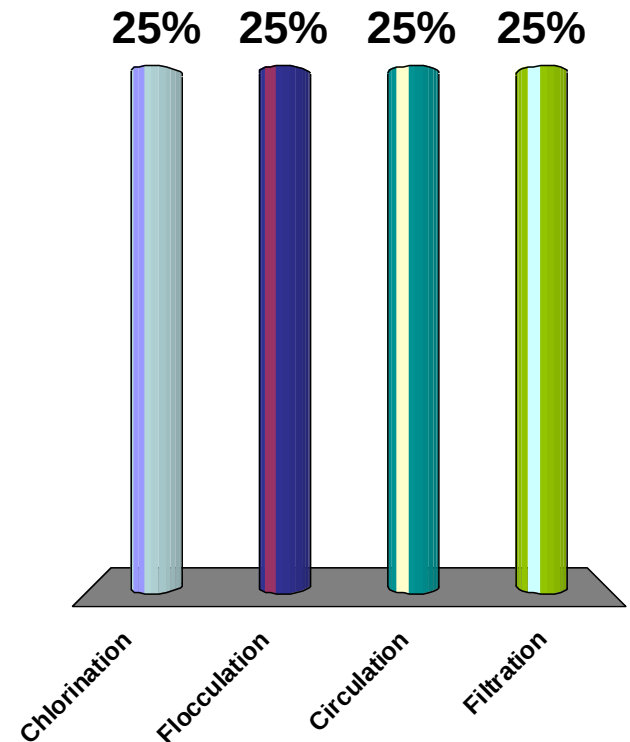
The normal range of detention times used in sedimentation basins in conventional water treatment plants is about:

1. A day
2. 60 sec.
3. 10 sec.
- 😊 4. 3-6 hours



In conventional water treatment practices, the final step in the removal of suspended matter is:

1. Chlorination
2. Flocculation
3. Circulation
- 😊 4. Filtration



Water Treatment

- Chemical Precipitation:

Chemical precipitation= coagulation, flocculation, oxidation. Various salts of aluminum (e.g., alum), iron, manganese, lime and other inorganic or organic chemicals are widely used processes to treat water for the removal of colloidal particles (turbidity) and microbes.

Water Treatment

- **Coagulation:** Clarification methods that work by using chemicals which effectively "glue" small suspended particles together, so that they settle out of the water or stick to sand or other granules in a granular media filter. Coagulation works by eliminating the natural electrical charge of the suspended particles so they attract and stick to each other. The joining of the particles so that they will form larger settleable particles is called flocculation.

(http://en.wikipedia.org/wiki/Water_purification).

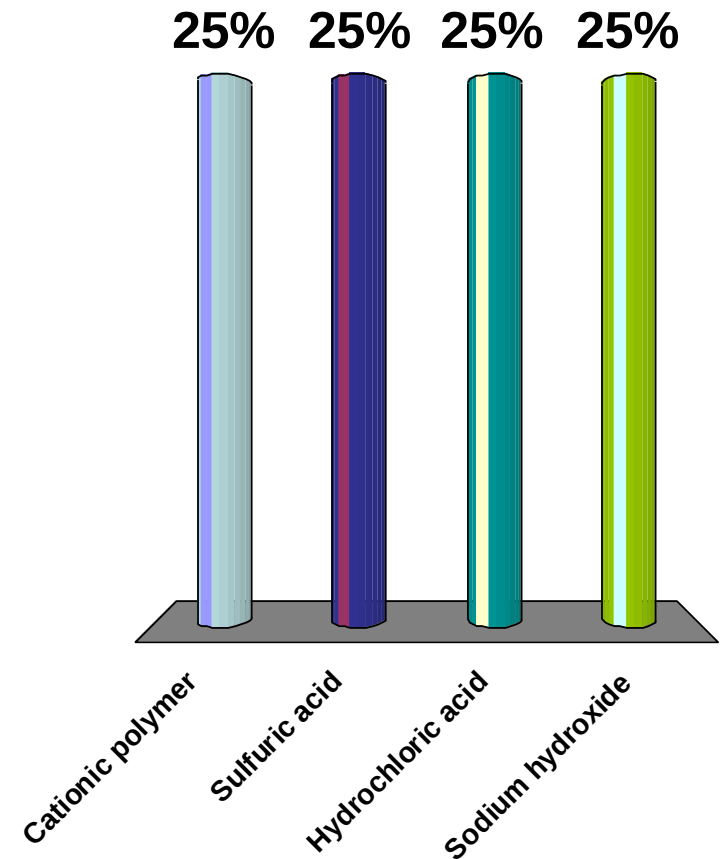






Which one of the following chemicals would you most likely use as a coagulant?:

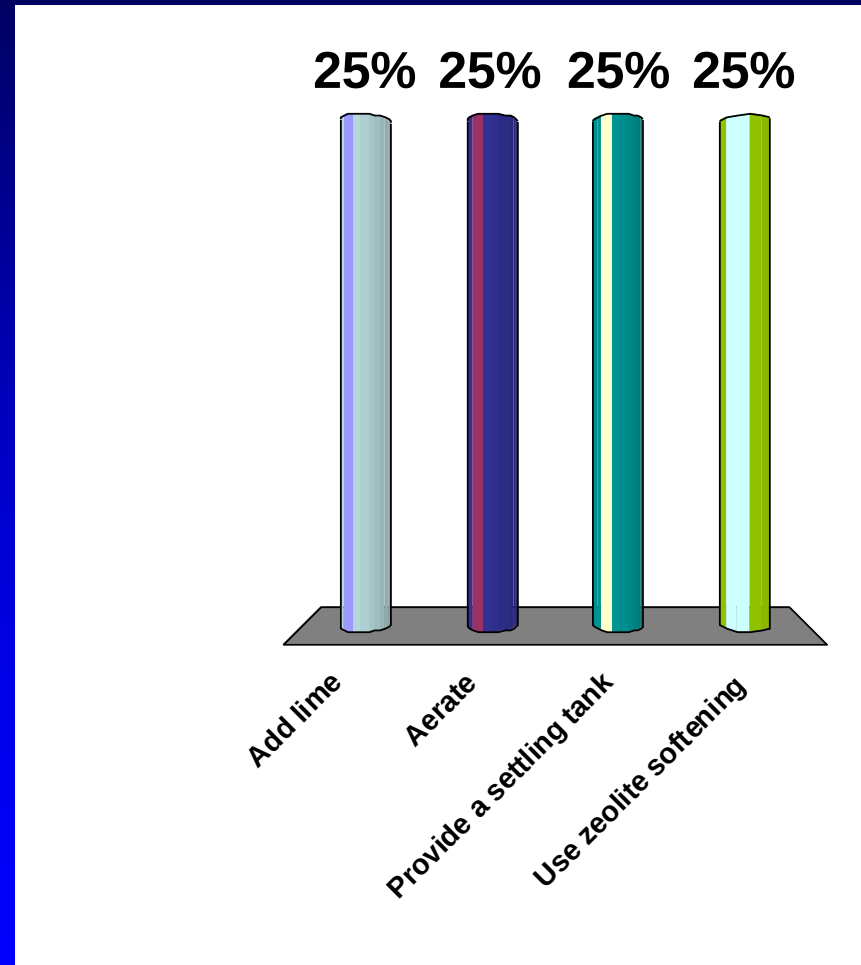
- 😊 1. Cationic polymer
- 2. Sulfuric acid
- 3. Hydrochloric acid
- 4. Sodium hydroxide



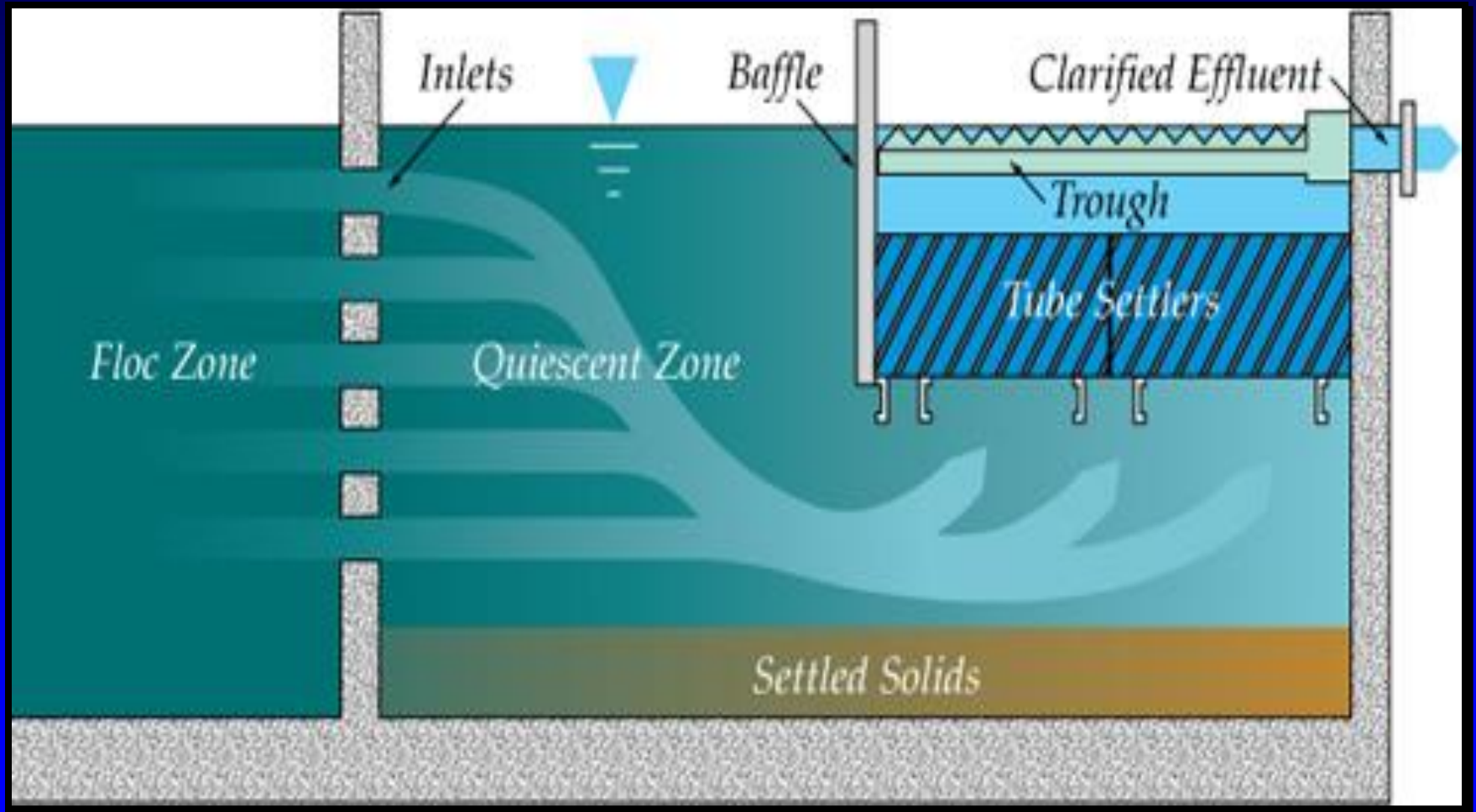


Which is the best method to remove sand from water?

1. Add lime
2. Aerate
- 😊 3. Provide a settling tank
4. Use zeolite softening

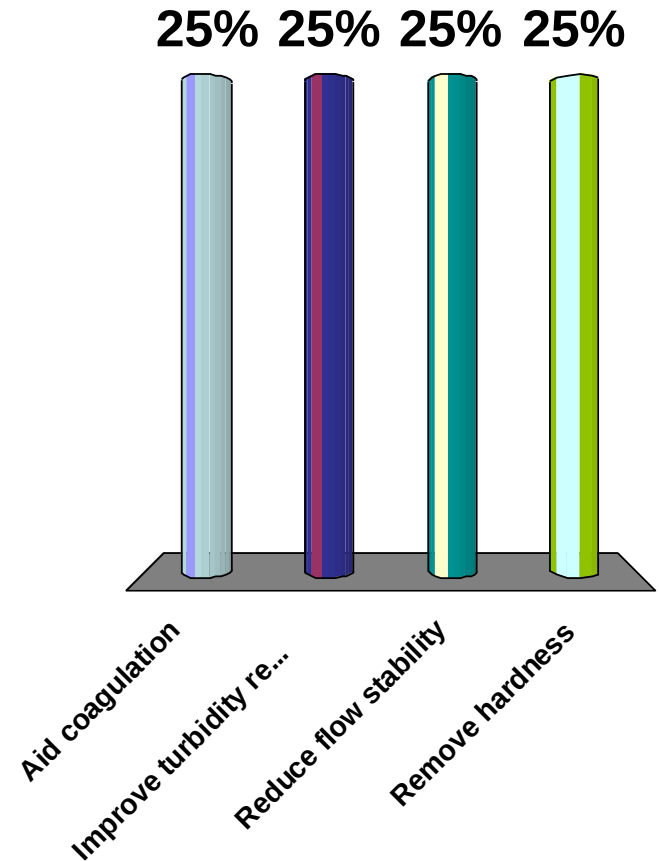


Lamella Tubular Settlers



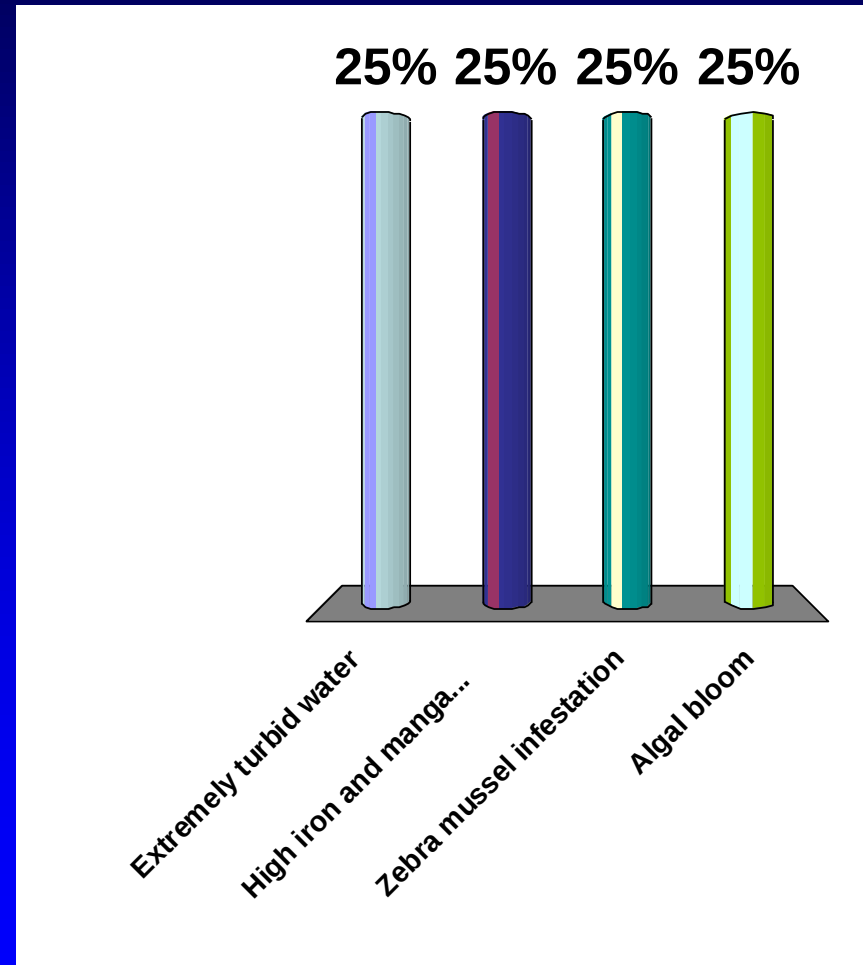
Tube settlers are used to:

1. Aid coagulation
2. Improve turbidity removal
3. Reduce flow stability
4. Remove hardness



What conditions call for the use of plate or tube settlers?:

- 😊 1. Extremely turbid water
- 2. High iron and manganese
- 3. Zebra mussel infestation
- 4. Algal bloom



Water Treatment

- Air Stripping: Air stripping is a full-scale technology in which volatile organics are partitioned from ground water by greatly increasing the surface area of the contaminated water exposed to air. (http://www.frtr.gov/matrix2/section4/4_50.html).



Water Treatment

- Ion exchange: Ion exchange is a reversible chemical reaction wherein an ion (an atom or molecule that has lost or gained an electron and thus acquired an electrical charge) from solution is exchanged for a similarly charged ion attached to an immobile solid particle (<http://www.remco.com/ix.htm>).



Water Treatment

- Ultrafiltration (UF) Membrane Processes: **Membrane filtration in which hydrostatic pressure forces a liquid against a semipermeable membrane. Suspended solids and solutes of high molecular weight are retained, while water and low molecular weight solutes pass through the membrane** (<http://en.wikipedia.org/wiki/Ultrafiltration>).



CH 2 Treatment of Water at the Source

WQT 131

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Aquatic Plants

Algae: encompass several groups of relatively simple, eukaryotic, living aquatic organisms that capture light energy through photosynthesis, using it to convert inorganic substances into organic substances.

~17,500 species

Blue green, green, diatoms, and pigmented flagellates

Aquatic Plants

Emergent Plant: shallow water near shoreline (cattails)



Floating Plant: have leaves floating on surface (Water lilies)



Submerged Plant: completely underwater (Coontail)



Algae Problems

- Taste, Odor, Color-metabolic by products
- Toxicity-some species toxic
- Filter Clogging-blind the filter
- Slime Accumulation:algae=light; bacteria=dark
- Corrosion-alter pH
- Interference-alter pH, alkalinity, DO, OM
- THM-react with Cl_2 produce THM

Aquatic Plants Control

Physical (removal)-harvesting, digging, dewatering, dredging, shading, lining.

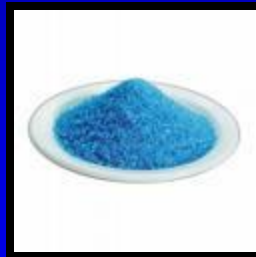
Biological-crayfish, snails, fish

Chemical-algaecides, herbicides

Algaecides

Ex: Copper sulfate, iron salts, rosin amine salts and benzalkonium chloride

Algaecides are effective against algae, but are not very usable for algal blooms. Kill all present algae, but they do not remove the toxins that are released by the algae prior to death.



Copper Sulfate



Copper sulfate application

- *pH, *Alkalinity, Temp, Suspended Solids, Organic Content
- 1.3 mg/L EPA DWS at the tap
- Not all algae killed by CuSO_4
- Ideal: pH 8-9 and CaCO_3 50 mg/L
- Safe dosage to fish: 0.5 mg/L, Trout Sensitive at 0.14 mg/L
- Pesticide regulated by EPA under Federal Insecticide, Fungicide, and Rodenticide act (FIFRA)

Copper Sulfate

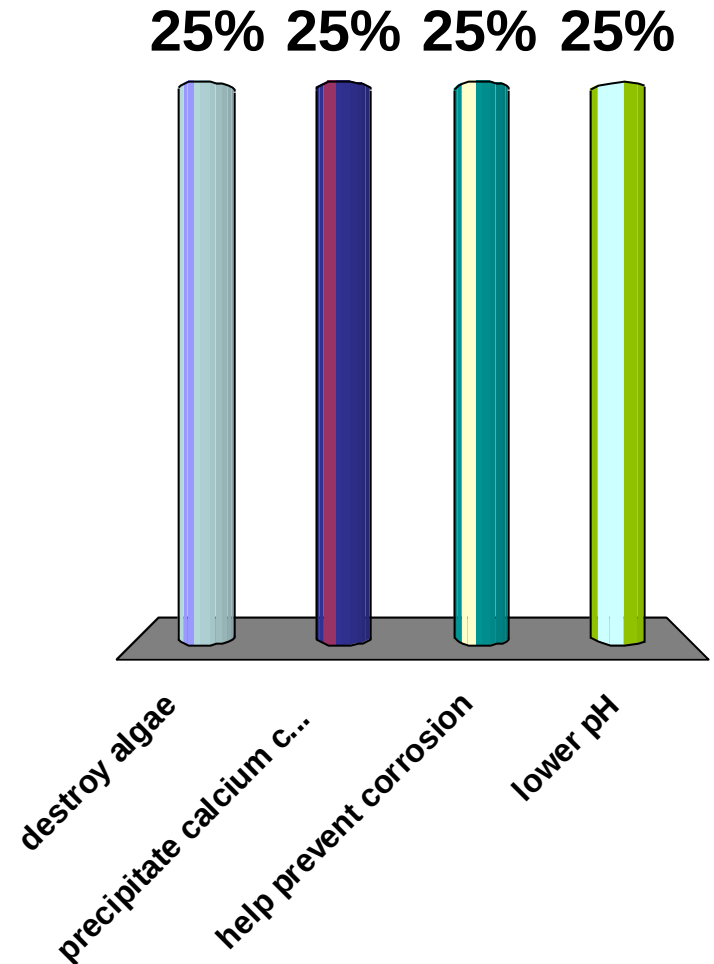
Copper sulfate application

- Turns water greyish white, apply every 10-14 days
- Tow bag or spray



Copper sulfate is used primarily to:

- 😊 1. destroy algae
2. precipitate calcium carbonate
3. help prevent corrosion
4. lower pH



Potassium Permanganate

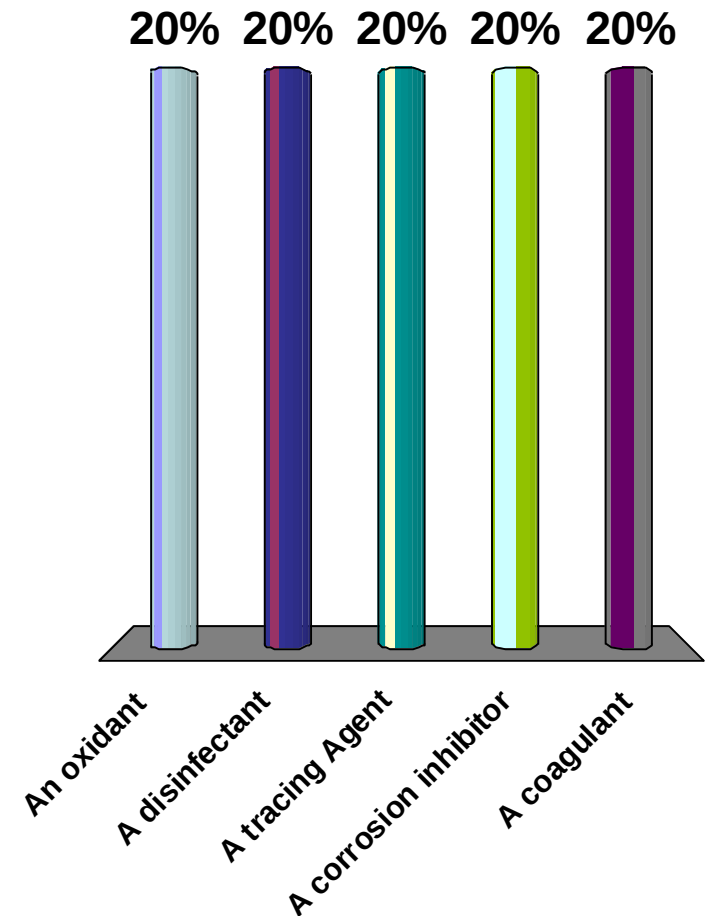
Potassium Permanganate application

- Oxidizes iron which is needed for photosynthesis=plants die
- Tow bag or spray
- Strong Oxidizer



In water treatment, potassium permanganate is used primarily as:

- 😊 1. An oxidant
2. A disinfectant
3. A tracing Agent
4. A corrosion inhibitor
5. A coagulant



Powdered Activated Carbon

Powdered Activated Carbon

- Block sunlight thus no photosynthesis=plants die

Pond Covers

- Block sunlight



CH 7 Disinfection Ozone

WQT 131

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Water Treatment**

**Chapter 7 Disinfection Ozone
OZONE FACT SHEET**

Water Treatment Disinfectants

Ozone



Ozone (O_3)

Factoids

- Colorless gas (thunderstorm smell)
- Greenhouse gas
- Highly unstable
- **STRONGEST OXIDANT!!**
- Corrosive!



Ozone (O_3)

Water Industry

- Discovered in 1783 Van Marcum
- First Ozonator = 1857
- Commercial Ozonator = 1893
- Widely used in Europe (France)
- Start with air, oxygen, or even liquid oxygen



Ozone (O₃)

How is it produced?

- Start with air, oxygen, or even liquid oxygen
- The higher the purity of air/oxygen the better the quality of ozone!
- Low moisture and dry air
- Bubbled into a ozone contactor

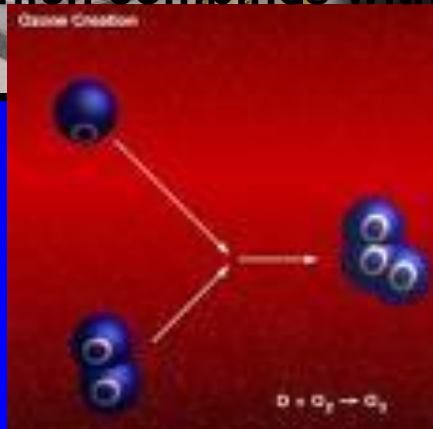
Ozone (O_3)

How is it produced?

Liquid oxygen goes to oxygen gas



oxygen gas gets ruptured by high volt arc into free oxygen radical which combines with oxygen gas to form ozone



Ozone (O₃)

How does it work?

- Kills by oxidation
- reacts with components of cell wall: phospholipids
- Causes cell leakage and lysis of glycoprotein
- Breaks H bonds in DNA

Ozone Production

- Corona-discharge method is used at WRWTP. A 15,000 volt arc ruptures the O_2 into two free oxygen radicals.
- The oxygen atoms want to be stable so the atoms recombine into a combination of oxygen gas (90%) and ozone or O_3 (10%).
- Ozone production is very energy intensive and creates a lot of heat.
- Calcium thiosulfate is added as a catalyst to decrease the half life of the ozone (to deozone or remove it).

Ozone (O₃)

Advantages

- No chemicals
- No taste, color, or odor problems
- Takes care of algae, organics, Fe, and Mn in water
- No toxic residual!
- Increases dissolved oxygen levels
- No ammonia demand at pH > 9
- Instantaneous disinfection= low contact time
- No DBP or THM
- Effective disinfection over wide range of pH and Temp

Ozone (O₃)

Disadvantages

- Higher initial capital cost than chlorine or UV!
- Ozone exposure=serious hazard (0.1 mg/L work area)
- On site generation
- Some ozone byproducts (aldehydes and ketones)
- Can react with bromide
- No residual so you still need chlorine
- Short half life
- Corrosive (need calcium thiosulfate)
- Equipment malfunctions
- Lots of electricity
- Short lived/no residual still may need chlorine

Tonight's Lecture Objectives: To understand basic water treatment processes and using ozone for disinfection has been met?

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree

