ENVIRONMENTAL ENGINEERING -1

Lecture 17 – Disinfection

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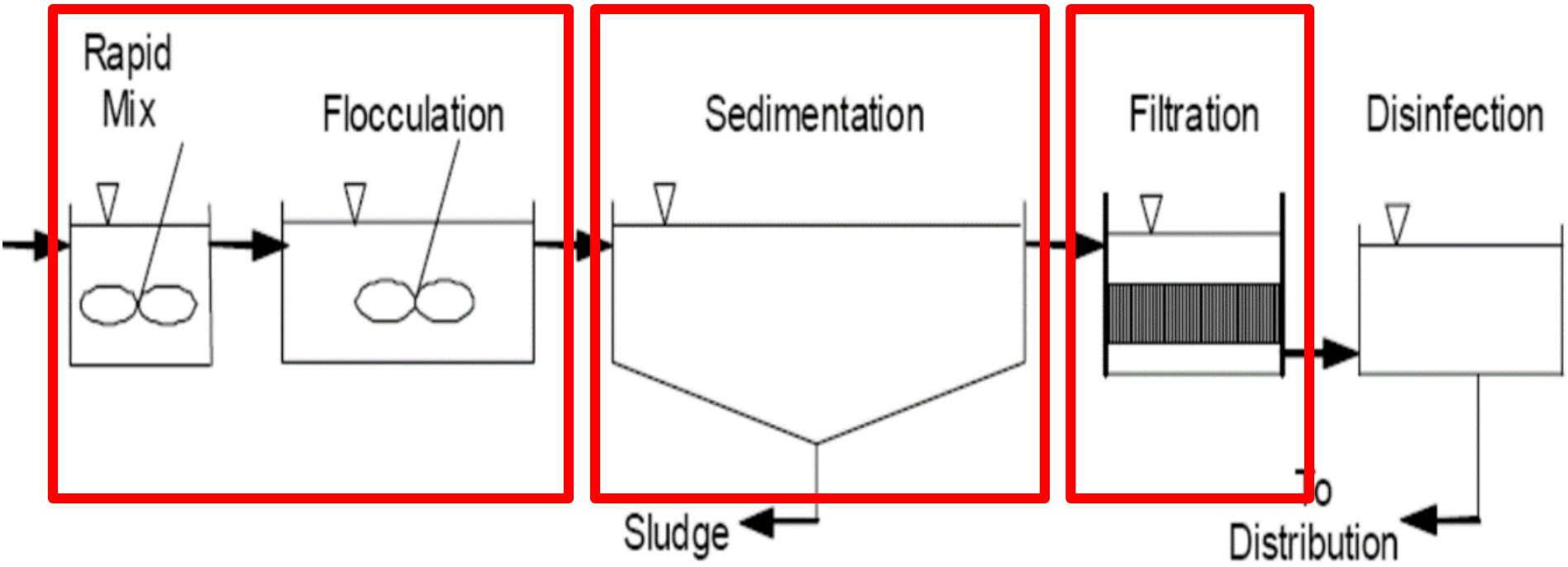

Rapid
Mix
Flocculation
Sedimentation
Filtration
Disinfection
Sludge
To
Distribution

Definition

"It is the destruction of disease causing micro-organisms (Pathogens)" .

*Sterilization is the destruction of all micro-organisms whether disease causing or not.

Methods of Disinfection

- Different methods of disinfection are:

1. **Physical** (Heat , Sunlight , UV rays)
2. **Chemical** (Chemical agents used are chlorine, iodine, ozone and bromine etc.)
3. **Mechanical** (Coagulation + Sedimentation + Filtration)

- 98-99% bacteria are removed by using mechanical methods

Chlorination

Most commonly used methods of disinfection in case of public water supply is by using chlorine and its various compounds. This process is known as chlorination

Why it is most commonly used?

→Cheap ,

→ More reliable ,

→No difficulty in handling

Different Forms of Chlorine used for Disinfection

1. Chlorine Gas

$Cl_2 + H_2O \rightarrow HOCl$(hypo-chlorous acid) $+ H^+ + Cl^-$

Disinfection is generally caused by HOCl rather than other species as it is neutral where as bacteria is negative in nature.

2. Calcium Hypo-chlorite $Ca(OCl)_2$

Contains about 40-50% of available chlorine can be obtained either in powdered or in liquid form

3. Sodium Hypo-chlorite NaOCl

Contains about 12-15% available chlorine. It is in liquid form

4. Chlorinated Lime

Contains about 30-35% of available chlorine

Disadvantage is that it looses its chlorine content while storage (now it is not used)

Mechanism of Disinfection

The mechanism is still uncertain but it is suspected that it kills the pathogen by entering through cell walls of bacteria . Then it disturbs the enzymes activity and attack the nucleus, causing the death of pathogens.

Forms of Chlorine in Water

1-Free available Chlorine → chlorine existing in water as HOCl , OCl^- or molecular chlorine Cl2 is defined as free available chlorine

2- Combine available chlorine → chlorine in water in chemical combination of ammonia or other compounds in know as combine available.(e.g. Monochloramine (NH2Cl), Dichloramine (NHCl2), Trichloramine (NCl3))

Note→ Combine available chlorine is less effective than free available chlorine

Combined available Chlorine

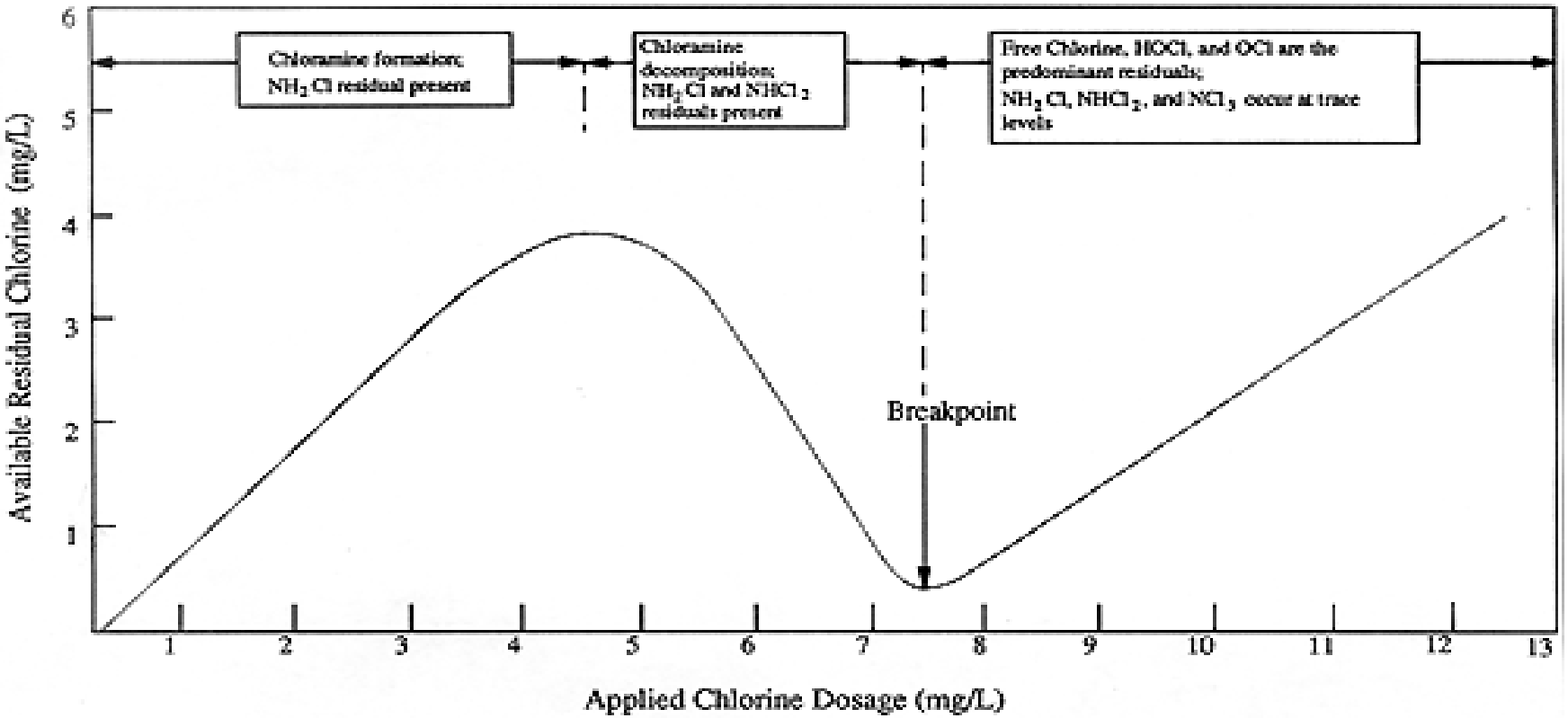
- NH3 containing compounds are available in water so chlorine will react with it to form compounds like monochloramine, dichloroamine and trichloroamine and collectively called combined residual chlorine.

$$NH_3 + HOCl \rightarrow NH_2Cl + H_2O$$

$$NH_2Cl + HOCl \rightarrow NHCl_2 + H_2O$$

$$NHCl_2 + HOCl \rightarrow NCl_3 + H_2O$$

Break point Chlorination



Source: Wolfe et al. 1984

Figure 3.6 Theoretical breakpoint chlorination scheme (1.0 mg/L ammonia-nitrogen; pH 7; temperature 25°C; contact time 2 hours)

- Chlorination of the water to the extent that a NH3 present in water is converted to trichloramine or oxidized to free N2 or other gases is called Break point chlorination.
- Beyond break point almost all chlorine in water exists as free available chlorine.

Residual chlorine

It is the amount of chlorine , no matter whether in combined or free state, in mg/l , present in a given sample after a specified time.

Chlorine Demand

- Chlorine demand of water is difference between the amount of chlorine added and amount of chlorine present as residual (either free or combine) after some time period (usually 30 minutes)

$$Cl_{Demand} = Cl_{Applied} - Cl_{Residual}$$

Classification of Chlorination

- It is classified according to its

➢ Point of application

➢ End Results

1. **Plain Chlorination→** If the water is relatively free from suspended matter, chlorination can be done without any other treatment. This is know as plain chlorination.

Dosage of 0.5-1mg/l to obtain residual of 0.1mg/l at consumer end.

Classification of Chlorination

2. Pre-Chlorination → This is application of chlorine to raw water before applying any other treatment , it has some advantages

1. Improve the coagulation process thus reducing coagulation doses
2. Reduce taste and odor present in water

- **Depending upon condition of raw water dosage should be such that it gives a residual of 0.1mg/L at filter end.**

Classification of Chlorination

3. Post-Chlorination → It refers to addition of chlorine to water after all other treatment some sort of residual is always needed in distribution system

1. To fight against contamination caused due to cross connection
2. To prevent organic growth of pipe

- **Dosage→ 0.25-0.5 mg/L to obtain a residual of 0.1-0.2 mg/L as treated water leaves the plant.**

Classification of Chlorination

4. Super Chlorination → In order to remove taste and odor sometimes it is necessary to super-chlorinated water to oxidize all such compounds

5. De-Chlorination → After super-chlorination it is necessary to level-off chlorine in water and is termed as de-chlorination

- **Methods of De-Chlorination**

1. Aeration
2. Addition of sodium thaio-suphate and sodium bi-sulphate

Factors Effecting disinfection by chlorine

1. Time of Contact → more time more will be the disinfection
2. Type of Residual→ Free available chlorine is 20 times more effective than combine available chlorine
3. Turbidity→ Greater is the turbidity, lower is efficiency of chlorine. Turbidity should be less than 1 NTU
4. pH → At low pH chlorine is more effective almost 150 times more dose is req. at pH 10 than at pH of 5 (why??)

Factors Effecting disinfection by chlorine

5. Temperature→ disinfection is more effective at higher temp. like at 35-40 F chlorine is half effective as compared to that as 70-75F

6. Amount of Organic Matter→ Organic matter present in water will be oxidized by chlorine so we req. excessive amount of chlorine for disinfection

7 Types of organic matter→ For viruses etc. it is not effective where as for bacteria it is very effective

Numericals

- The Chlorine demand of a secondary effluent is 8.7mg/L and desired residual is 0.8mg/L. If daily plant flow is 7000m3/day and the Calcium Hypochlorite dose of 200kg. What is the % of available chlorine of calcium hypochlorite solution?
- The chlorine demand of a water under given condition is 7mg/L as Cl2 after a contact period of 30min. Calculate the amount of Ca(OCl)2 with available Cl2 to treat 30000m3/day of water so that the free residual chlorine is 0.2mg/l.

Numericals

- The chlorination demand for a water has been determined to be 1.2 mg/l after a contact time of 30 minutes. Calculate daily requirement of Cl2 to disinfect 5000 m3/day of water.