NPTEL ONLINE CERTIFICATION COURSES

Course Name: Introduction to Environmental Engineering and Science – Fundamentals and Sustainability Concepts

Faculty Name: Dr. Brajesh Kumar Dubey

Department : Civil engineering

Topic Water Treatment Basics

Lecture 36: Plain sedimentation

CONCEPTS COVERED

Concepts to be Covered

- ❑ Plain sedimentation
- ❑ Coagulation
- ❑ Filtration
- ❑ Disinfection
- ❑ Distribution

Water supply scheme

- Source
- Collect water from source
- Transport the collected water
- Treatment
- Distribute
- Consumer

Water treatment units

Purpose of unit — Intake

Suspended particles — Plain sedimentation

Colloidal particles — Coagulation

Dissolved particles — Filtration

Pathogens — Disinfection

Aeration

If the source is ground water aeration is provided before sedimentation to remove undesirable gases

Source: http://www.govisitcostarica.com/images/photos/full-cano-negro-brown-river.jpg [Accessed: 21.02.2012]

Source: http://headlinenewsstories.com/wp-content/uploads/2010/06/india.jpg [Accessed: 21.02.2012]

Source: http://sinkhomes1.com/wp-content/uploads/2011/07/Old-Sink.jpg [Accessed: 21.02.2012]

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Source: http://www.govisitcostarica.com/images/photos/full-cano-negro-brown-river.jpg [Accessed: 21.08.2019]

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Source: http://sinkhomes1.com/wp-content/uploads/2011/07/Old-Sink.jpg [Accessed: 21.08.2019]

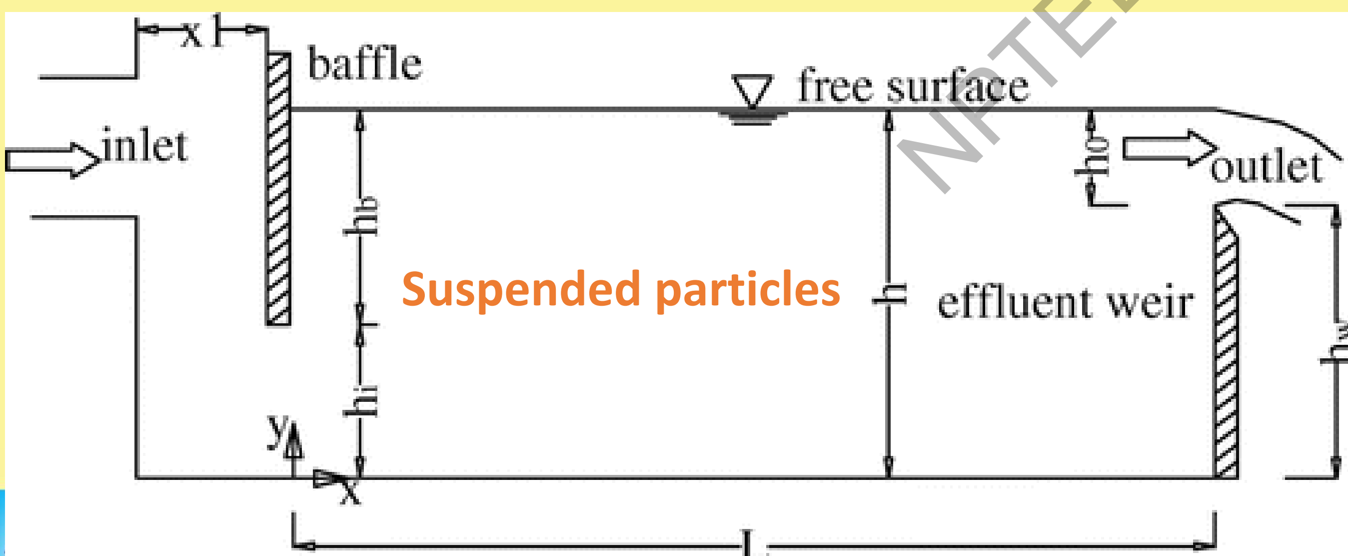
Pre-Treatment		Rapid Sand Filtration		Post-Treatment
Coagulation-Flocculation	→	**Rapid Sand Filtration**	→	Chlorination

Plain sedimentation

Plain sedimentation Tank: Theory

Solid liquid separation process in which a suspension is separated into two phases –

- ❑ Clarified supernatant leaving the top of the sedimentation tank (overflow).
- ❑ Concentrated sludge leaving the bottom of the sedimentation tank (underflow).



Overflow

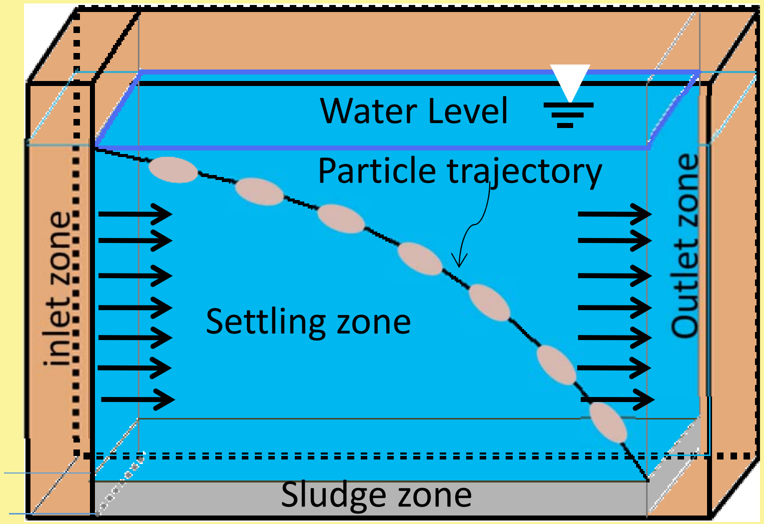
Underflow

Plain sedimentation Tank: Theory

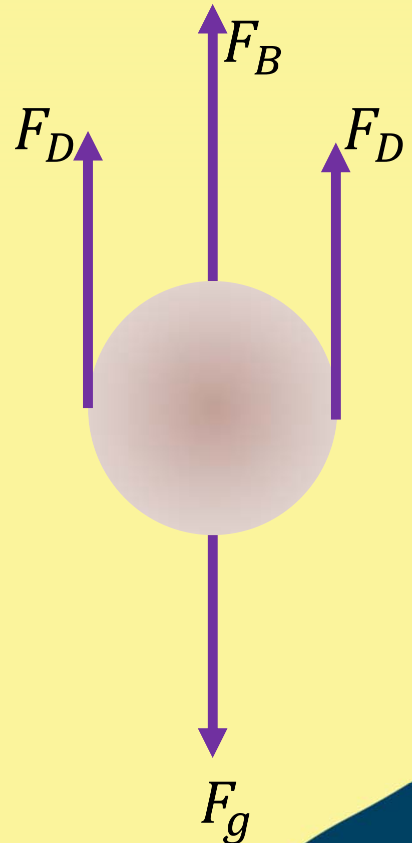
Also referred as 'SEDIMENTATION TANKS'.

Settling- process by which particulates settle to the bottom of a liquid and form a sediment.

Particles experience a force, either due to gravity or due to centrifugal motion; tend to move in a uniform manner in the direction exerted by that force.



Water Level
Particle trajectory
inlet zone
Settling zone
Outlet zone
Sludge zone

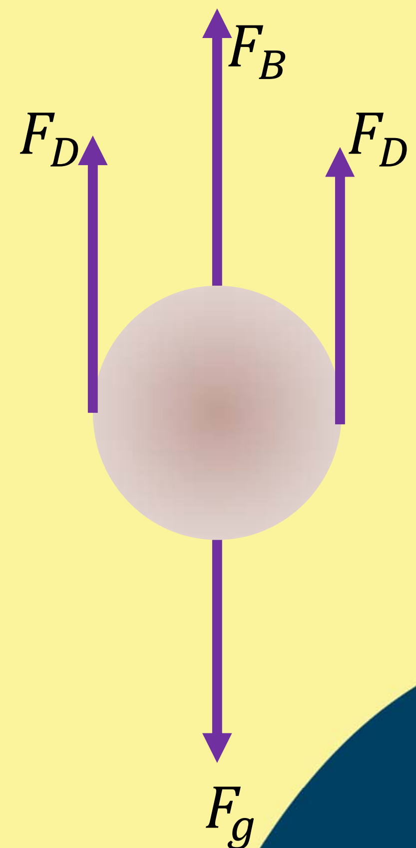


F_B
F_D
F_D
F_g

Plain sedimentation Tank: Theory

The movement of a particle in a fluid is determined by a balance of the viscous drag forces resisting the particle movement with gravitational or other forces that cause the movement.

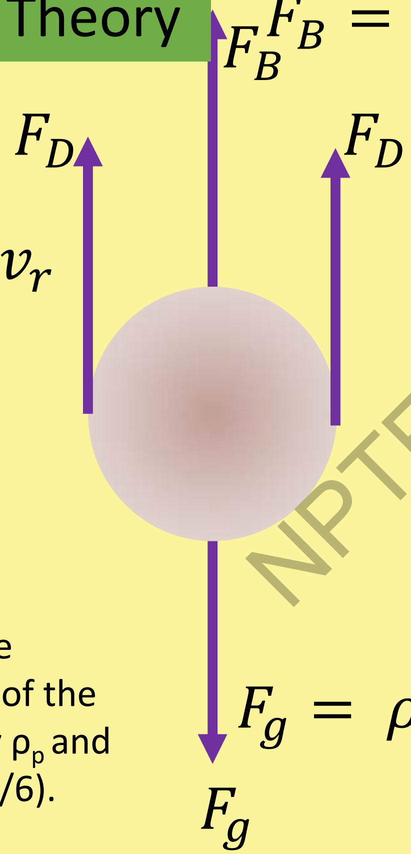
A force balance called stokes law is used to determine the relationship between particle size and its settling velocity.



Plain sedimentation Tank: Theory

$$F_B = \rho_f \frac{\pi}{6} D_p^3 \mathrm{g}$$

$$F_D = 3\pi\mu D_p v_r$$



The buoyancy force F_B is a net upward force that results from the increase of pressure with depth within the fluid. The buoyancy force is equal to gravitational constant times the mass of the fluid displaced by the particle.

$$F_B = \rho_f \frac{\pi}{6} D_p^3 \mathrm{g}$$

Where ρ_f is the fluid density.

The gravitational force F_g, is equal to the gravitational constant g times the mass of the particle, m_p. In terms of particle density ρ_p and the diameter D_p, m_p is equal to $(\rho_p \pi D_p^3/6)$.

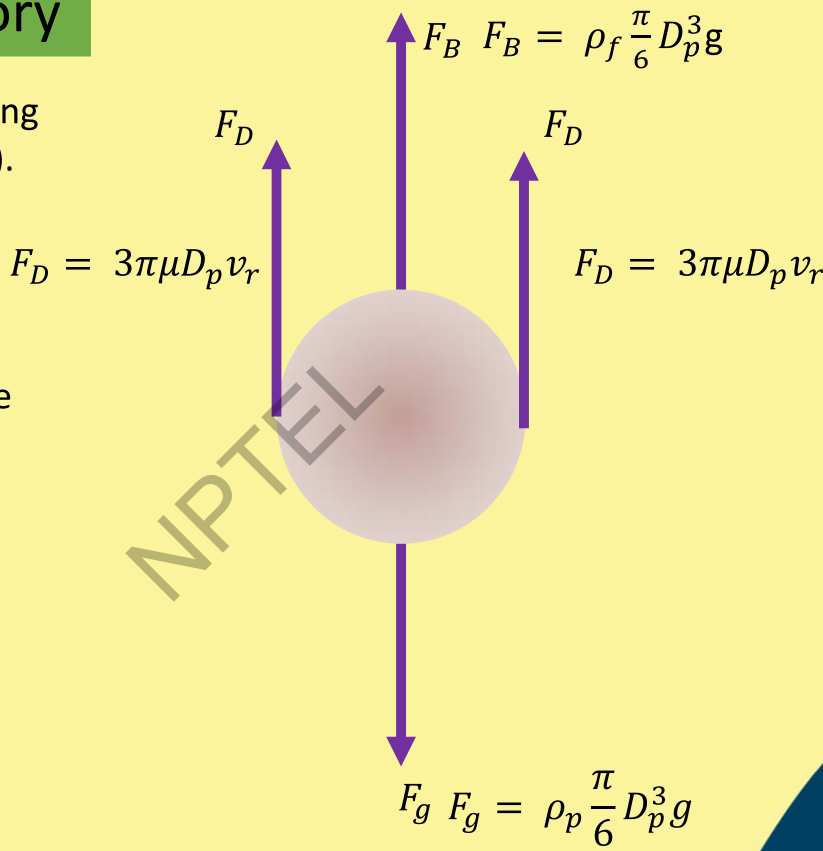
$$F_g = \rho_p \frac{\pi}{6} D_p^3 g$$

Plain sedimentation Tank: Theory

Most particle settling situations involve creeping flow conditions (Reynolds number less than 1). In this case stoke's drag force can be used as:

$$F_D = 3\pi\mu D_p v_r$$

Where μ is the fluid viscosity (units of g/cm-s) and Vr is the downward velocity of the particle relative to the fluid.



Plain sedimentation Tank: Theory

The net downward force acting on the particle is equal to the vector sum of all forces acting on the particle:

$$F_{down} = F_g - F_B - F_D$$

$$= \rho_p \frac{\pi}{6} D_p^3 g - \rho_f \frac{\pi}{6} D_p^3 g - 3\pi\mu D_p v_r$$

$$= (\rho_p - \rho_f) \frac{\pi}{6} D_p^3 g - 3\pi\mu D_p v_r$$

The particle will respond to this force according to the newton's second law. Thus,

$$F_{down} = m_p \times acceleration$$

$$= m_p \times \frac{dv_r}{dt}$$

Plain sedimentation Tank: Theory

When the particle terminal velocity is reached, it is no longer accelerating so (dv/dt=0). Thus F_{down}=0 and noting that V_r is equal to the settling velocity at terminal velocity.

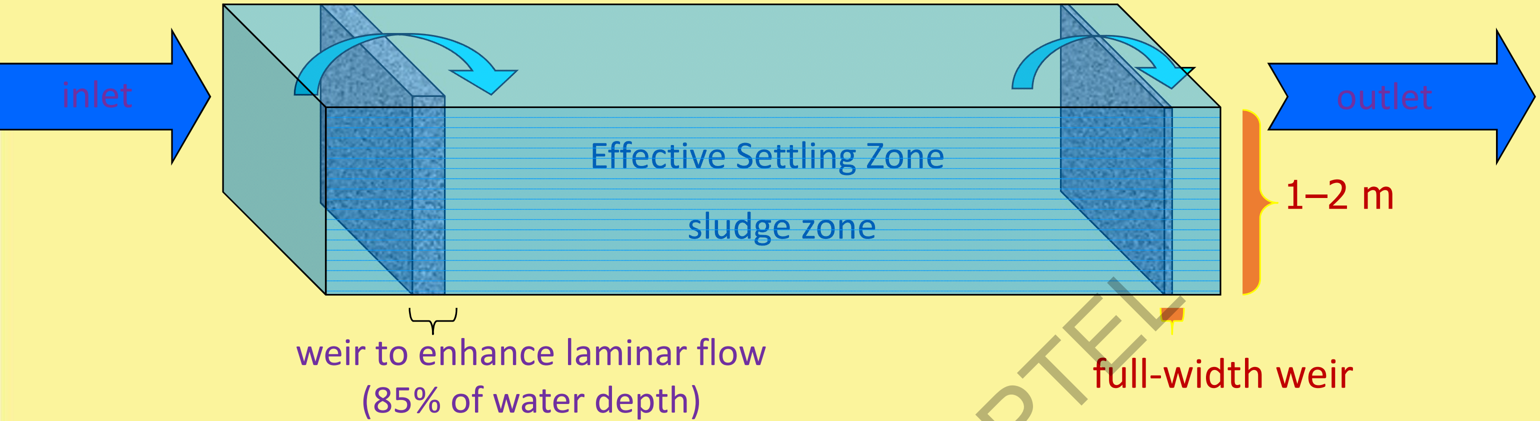
$$(\rho_p - \rho_f)\frac{\pi}{6}D_p^3 g = 3\pi\mu D_p v_s$$

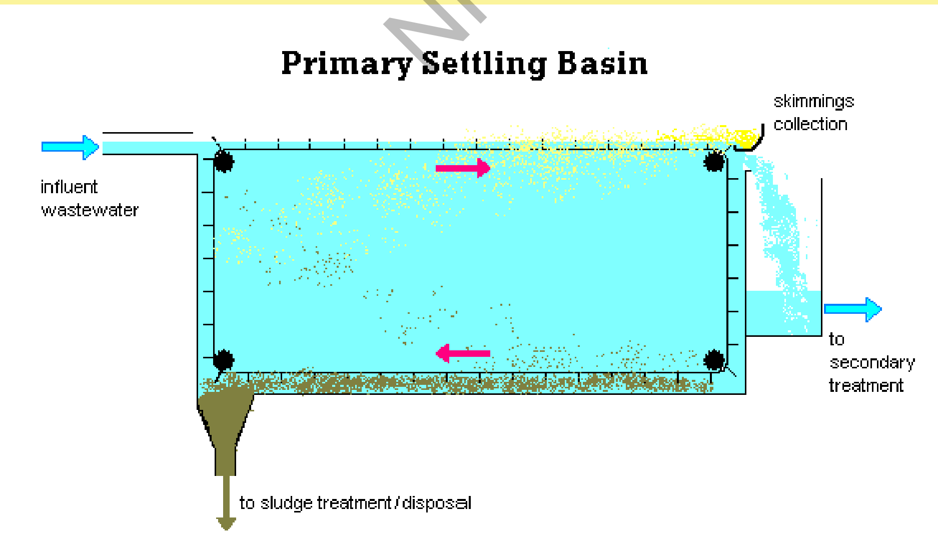
$$\boxed{v_s = \frac{g(\rho_p - \rho_f)}{18\mu}D_p^2}$$

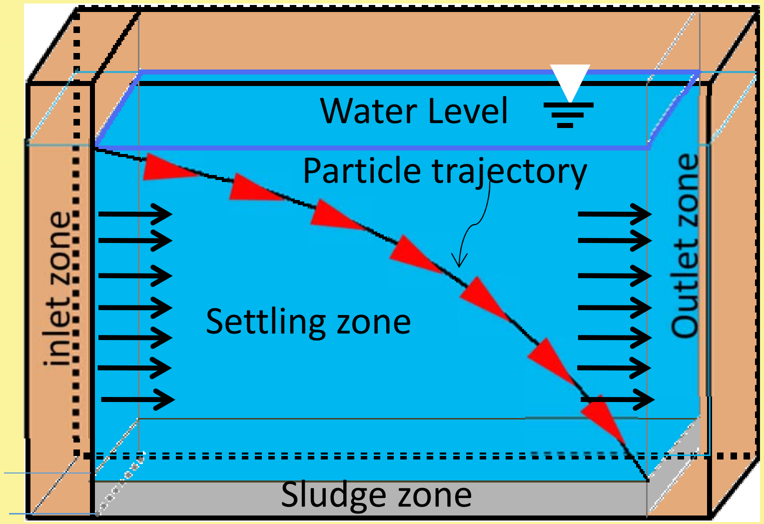
Stokes Law

Denser and large particles have a higher settling velocity

Plain sedimentation Tank







Theory of sedimentation

The particles which are heavier than water are naturally likely to settle down due to force of gravity. In water, there are mainly two types of impurities.

(1) Inorganic suspended solids having specific gravity of about 2.65; and

(2) Organic suspended solids having specific gravity of about 1.04

The particles having specific gravity of about 1.20 or so readily settle down at the bottom of tank.

Purpose of Settling

❖ To remove suspended particles present in water.

Principle of Settling

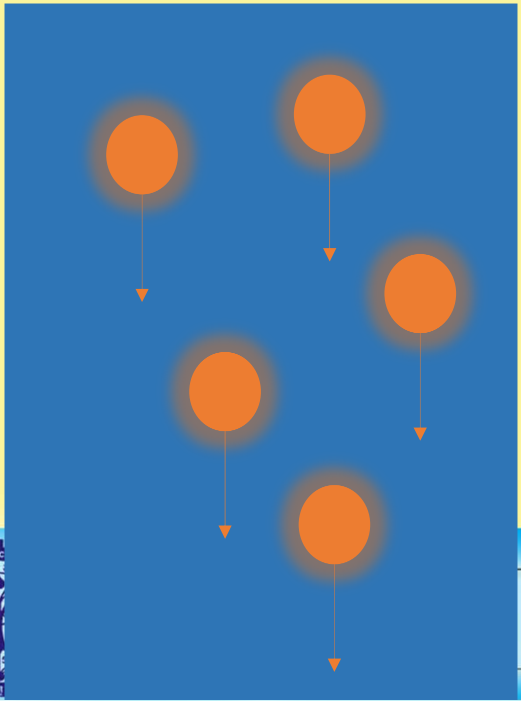
- Suspended solids present in water having specific gravity greater than that of water tend to settle down by gravity as soon as the turbulence is retarded by offering storage.
- Basin in which the flow is retarded is called ***settling tank***.
- Theoretical average time for which the water is retained in the settling tank is called the ***detention period***.

Types of Settling

Type I: Discrete particle settling - Particles settle individually without interaction with neighboring particles.

Type II: Flocculent Particle settlement
Type III: Hindered or Zone settling
Type IV: Compression settling

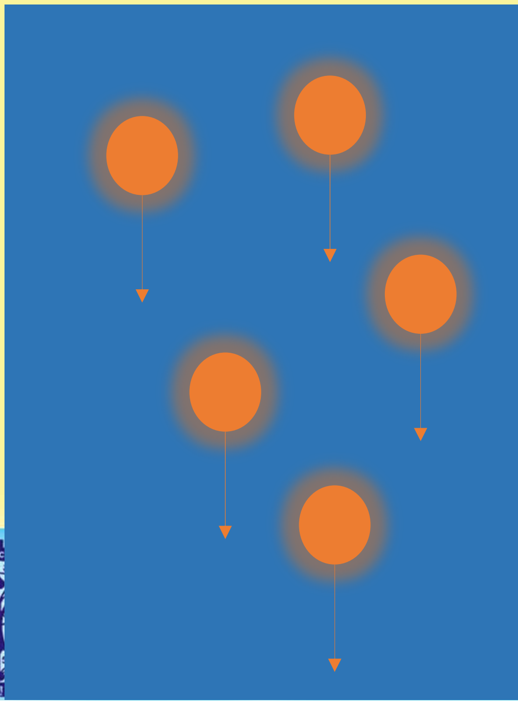
Will be discussed in coming slides



Discrete particle settlement

Discrete particle

- Size, shape and specific gravity of the particles do not change with time.
- Settling velocity remains constant.

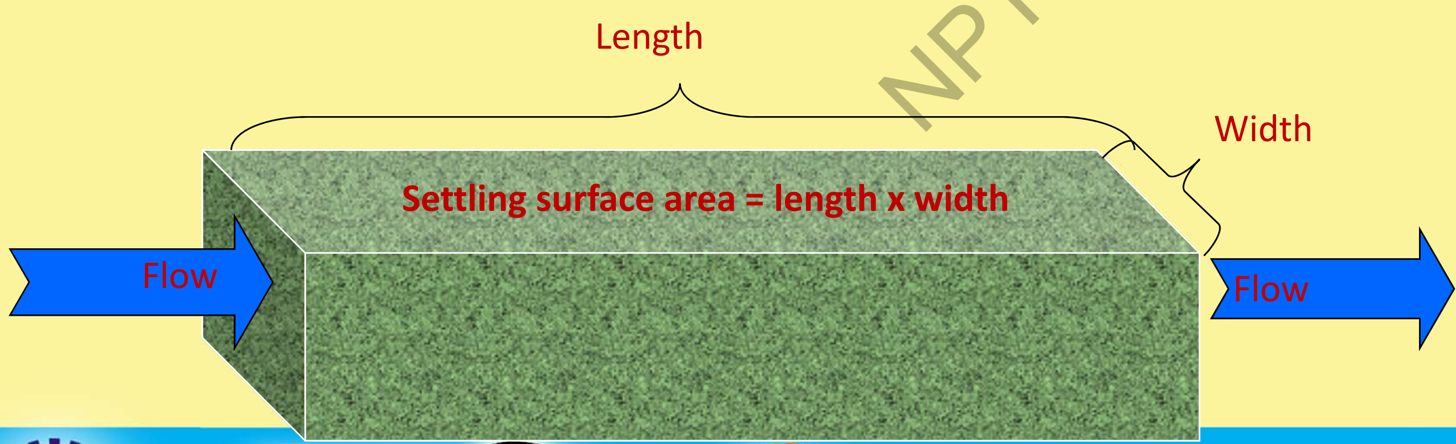


Discrete particle settlement

Settling Basin

Overflow rates are used for design: V_o

$$Overflow\ Rate = \frac{Flow\ Rate\,(m^3/s)}{settling\ \ surface\ area\,(m^2)}$$

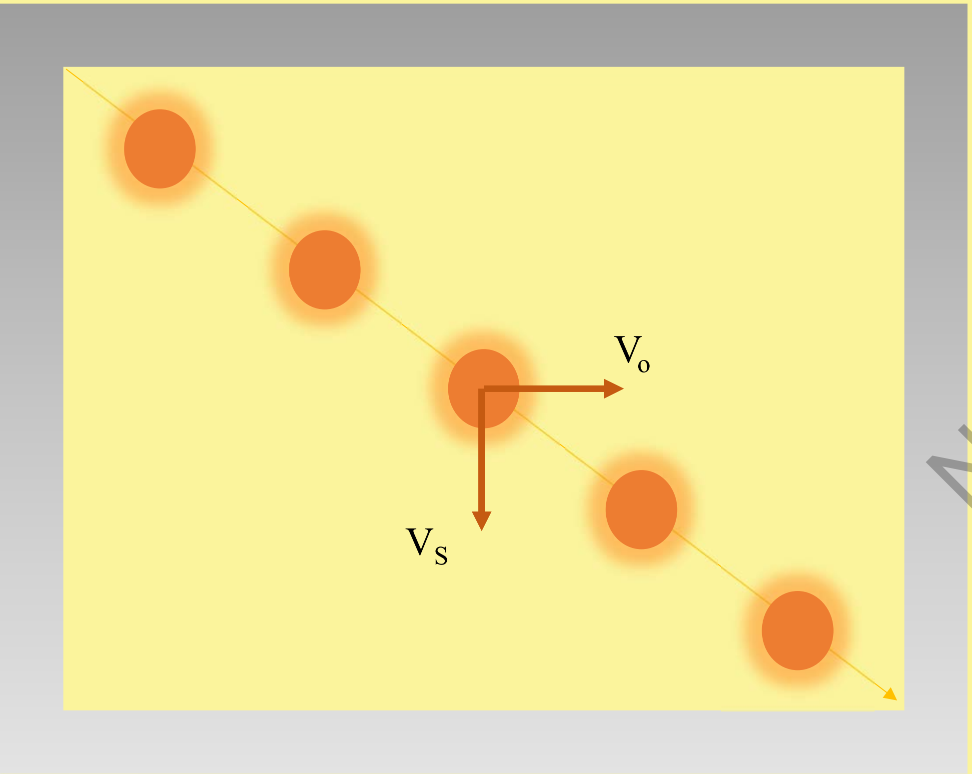


Horizontal velocity (V_H)

Overflow rates are used for design: V_H

$$V_H = \frac{Flow\ rate\ (\frac{m^3}{s})}{Cross\ sectional\ area\ (Height \times width)(m^2)}$$

Settling Basin

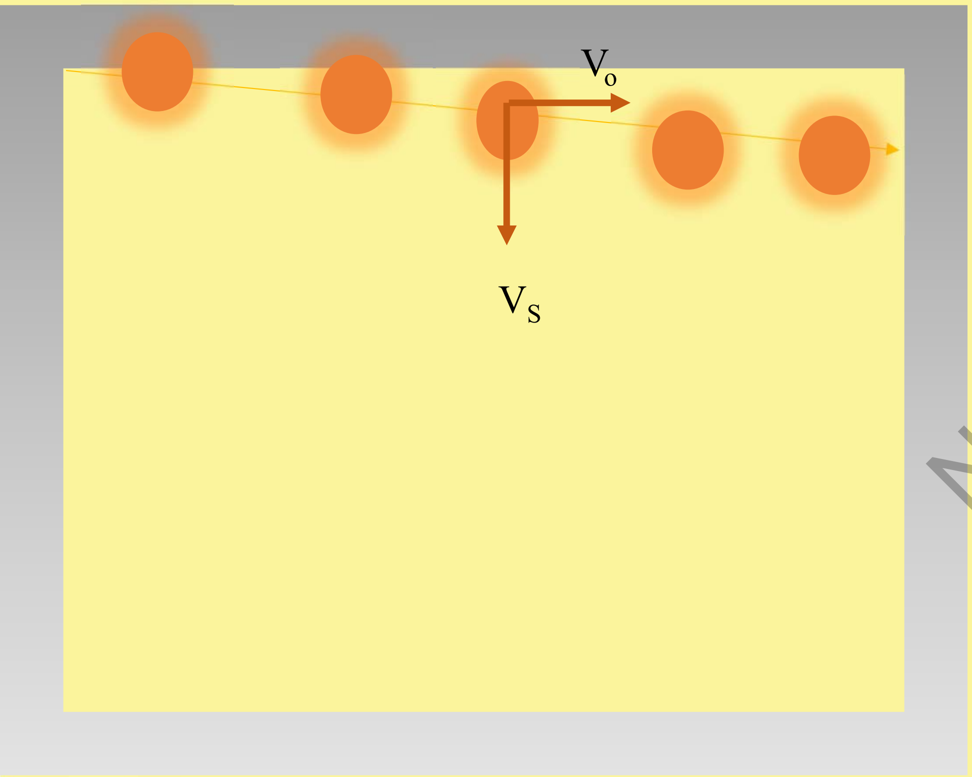


$V_s < V_o$ Particle escape

$V_s > V_o$ Particle captured

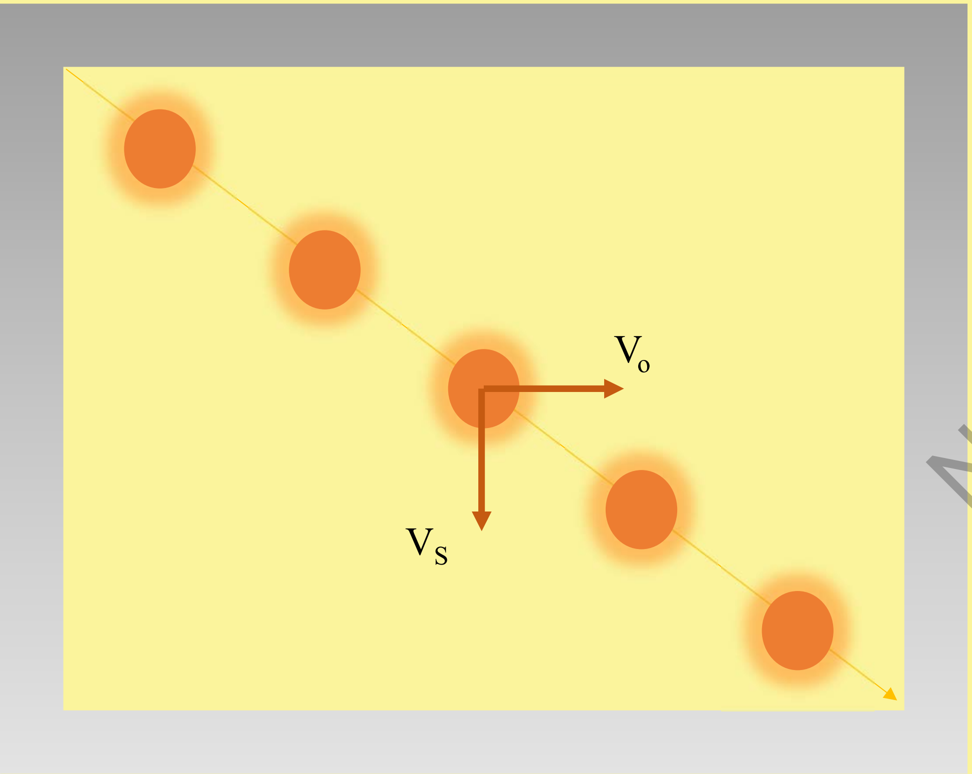
$V_s = V_o$ Particle captured

Settling Basin



$V_o > V_s$ Particle escape

Settling Basin



$V_o < V_S$ Particle captured

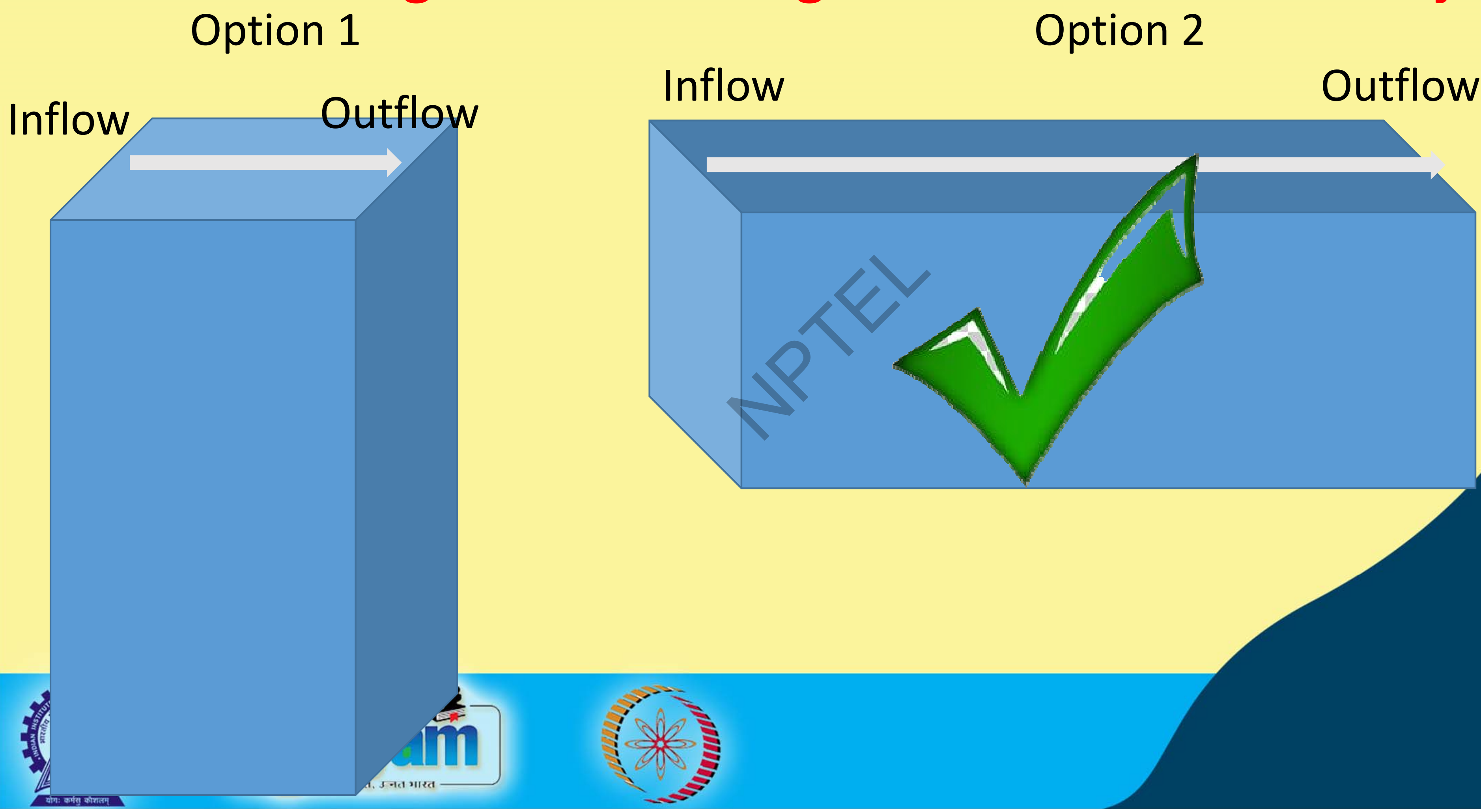
$V_o = V_S$ Particle captured

Sedimentation efficiency = η = $V_s/V_o \times 100$

Sedimentation efficiency = $\eta \propto 1/V_o$

Sedimentation efficiency = $\eta \propto$ Surface area

Which Settling Basin has higher removal efficiency



NPTEL ONLINE CERTIFICATION COURSES

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Faculty Name: Dr. Brajesh Kumar Dubey

Department : Civil engineering

Topic Water Treatment Basics

Lecture 37: Coagulation

A sedimentation tank designed to capture 0.01 mm diameter particles with specific gravity 2.65. If the sedimentation tank is designed for a surface over flow rate 20 $\frac{m^3}{day \times m^2}$. Find the efficiency of particle removal.
Take kinetic viscosity of water: 001 cm^2/sec.

Settling velocity $v_s = \frac{g(\rho_p - \rho_f)}{18\mu} D_p^2$

$$= \frac{9.81(2.65-1)}{18 \times 0.01 \times 10^{-4}} (0.01 \times 10^{-3})^2$$

$$= 8.99 \times 10^{-5}\ m/\sec = 7.769\ m/day$$

$$\eta = Vs/Vo \times 100 = \frac{7.769}{20} \times 100 = 38.85\ \%$$

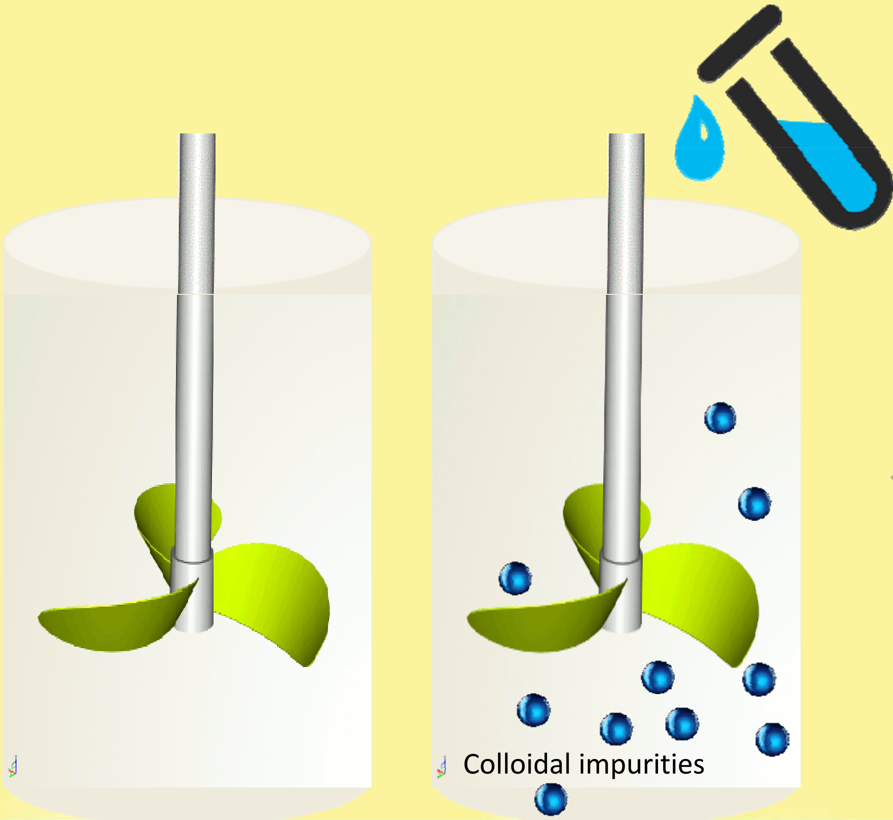
Coagulation

Sedimentation aided with coagulation is a practice used to remove suspended particles that escape from sedimentation tank and colloidal particles present in water.

Coagulation consist of three parts

1. Addition of coagulant
2. Flocculation
3. Clarification/Sedimentation

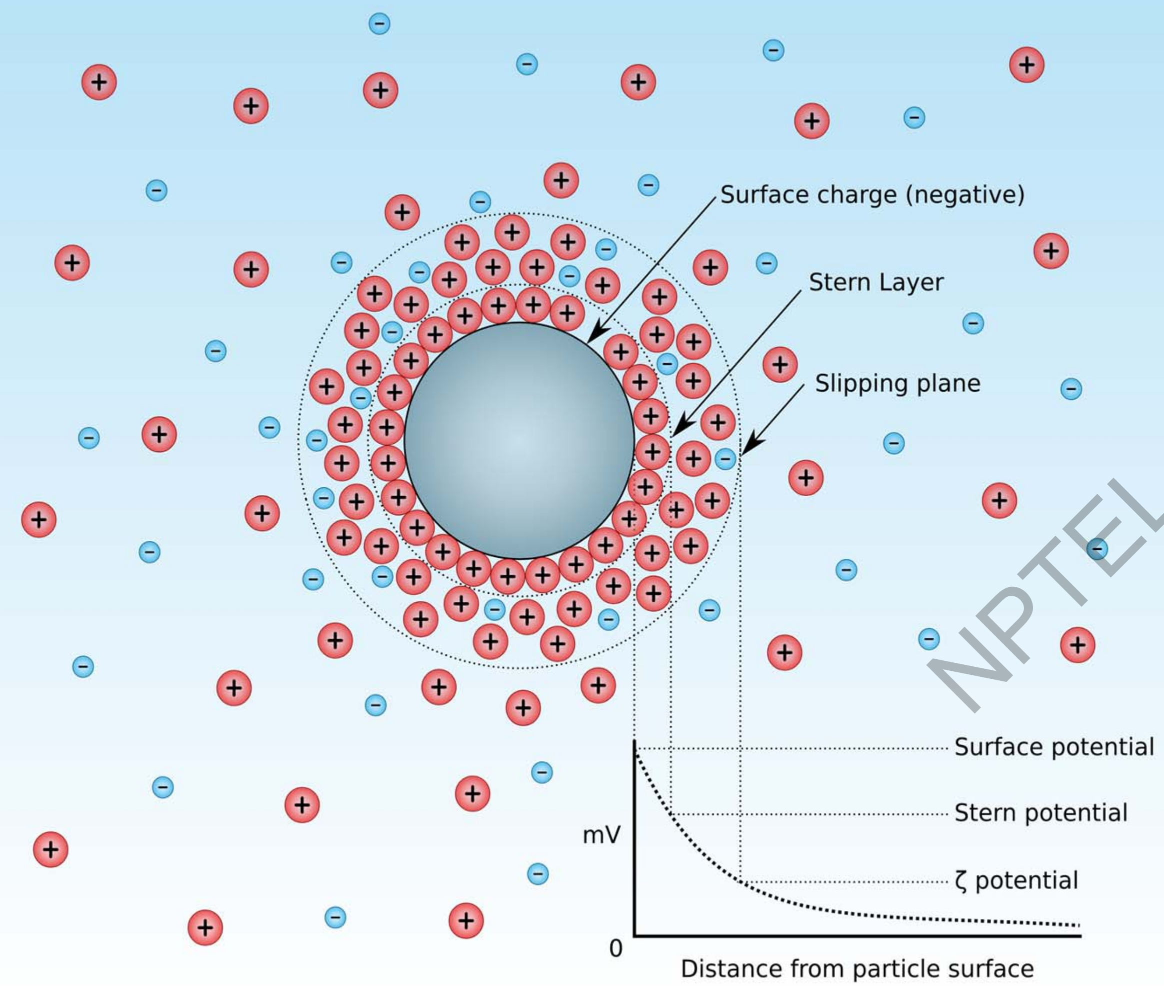
CE1



Commonly used coagulants:

Aluminium sulphate or alum
Ferrous Sulphate
Ferric sulphate
Sodium sulphate

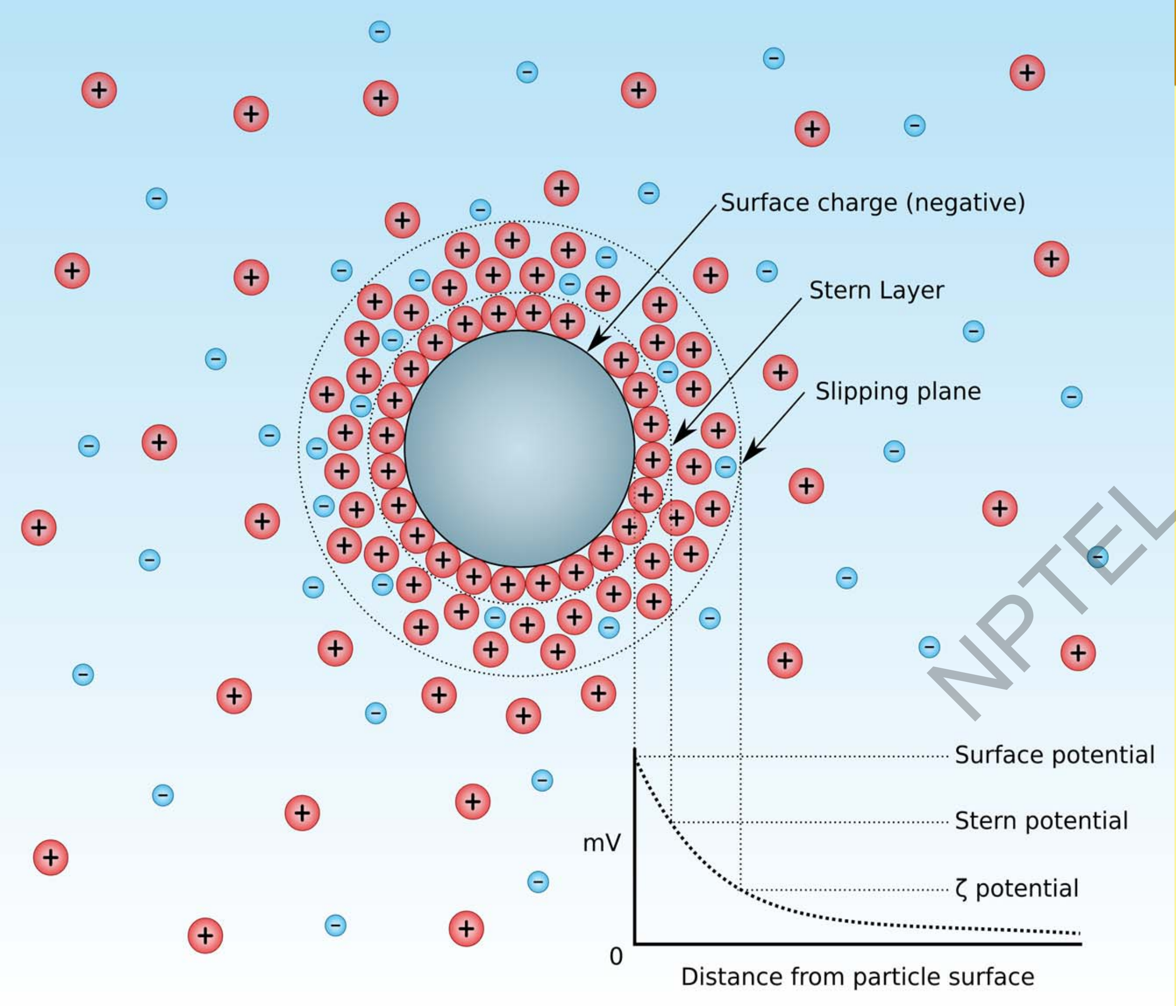
CE1 Civil Engg--11, 24-08-2019



ELECTRICAL DOUBLE LAYER (EDL):

If we put a charged particle in a suspension with ions, then the primary charge will attract counter ions (opposite charged ions) by electrostatic attraction. The primary charge cannot attract an equal amount of counter charge because a gradient of counter ions is established that drives the counter ions away from the surface.

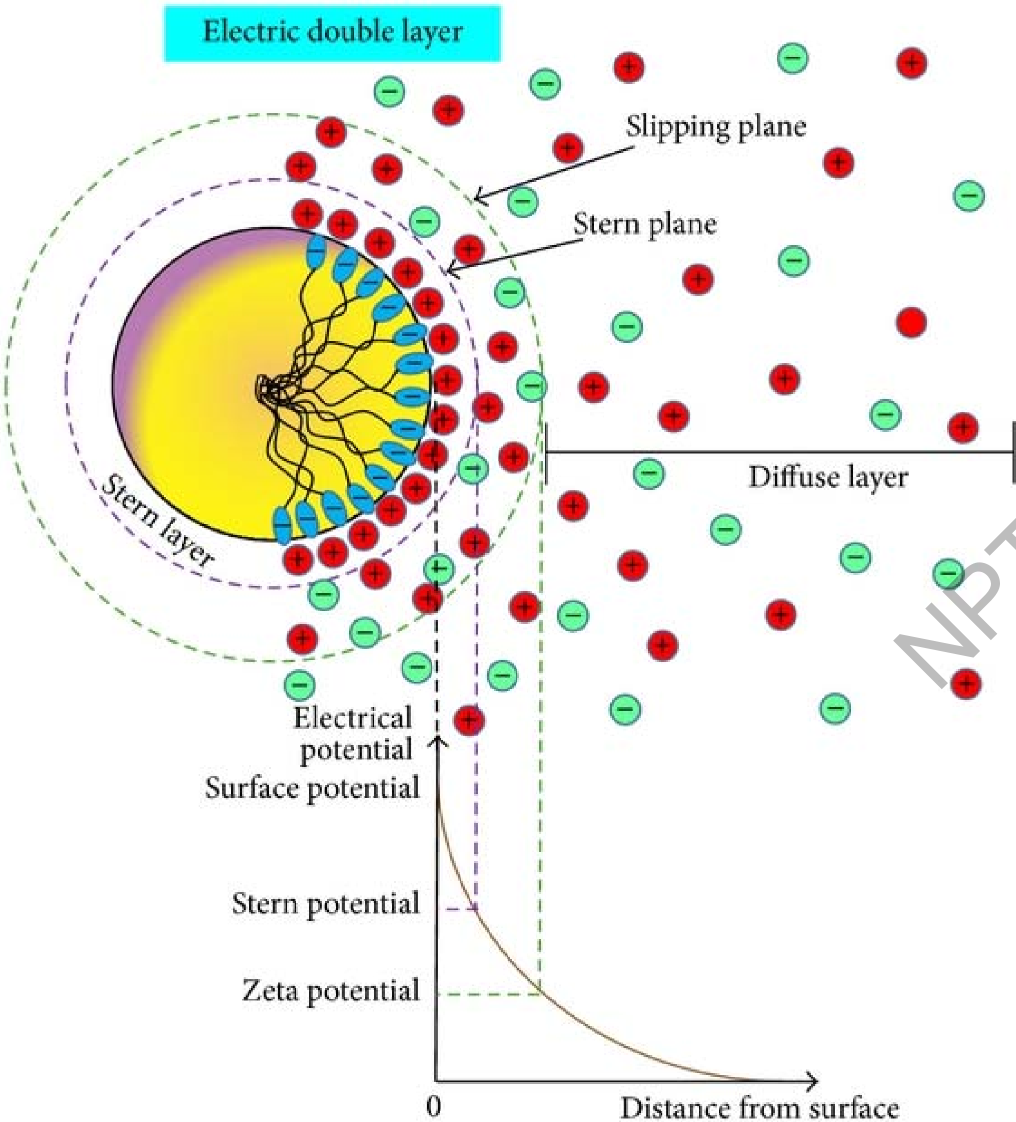
Source: https://en.wikipedia.org/wiki/Zeta_potential .



ELECTRICAL DOUBLE LAYER (EDL):

The formation of the electrical double layer (EDL) then occurs via attraction of oppositely charged counterions by the primary surface charge and then a diffusion of the counterions away from the surface. The counterions are mobile, the primary charge is not. The EDL development is schematically shown here:

Source: https://en.wikipedia.org/wiki/Zeta_potential .

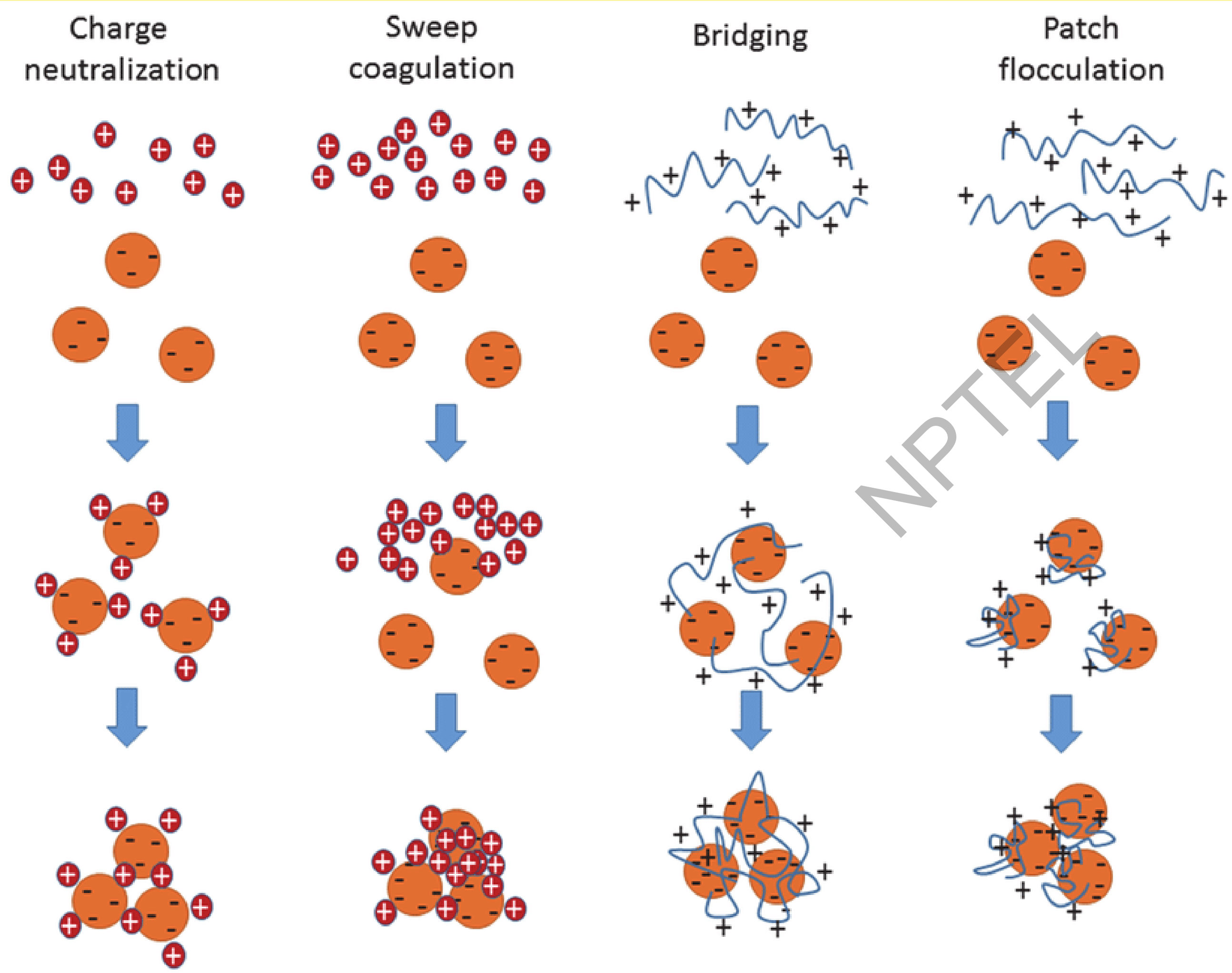


ELECTRICAL DOUBLE LAYER (EDL):

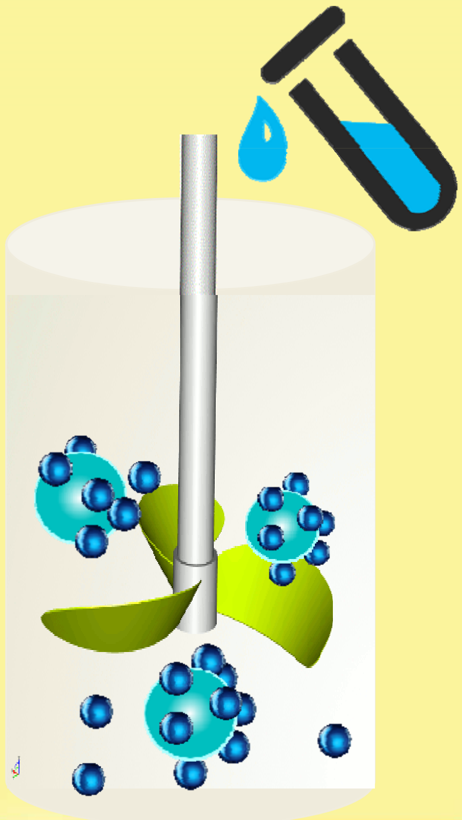
As a result of this EDL there is a net electrostatic repulsion/attraction developed between colloids. This net force is shown

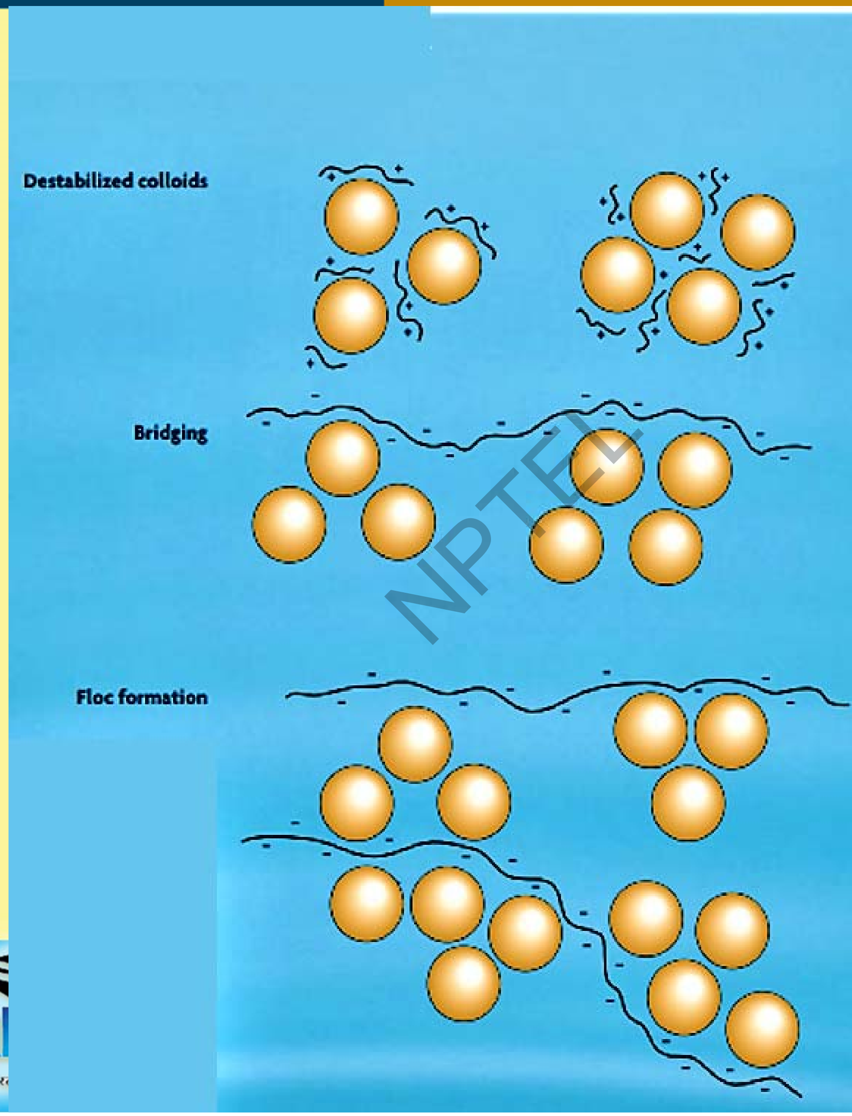
Source: https://www.researchgate.net/publication/288917890_Amphiphiles_SelfAssembly_Basic_Concepts_and_Future_Perspectives_of_Supramolecular_Approaches/figures?lo=1.

Methods to Destabilize Colloids (Coagulation Processes):



Source: https://www.researchgate.net/publication/275634703_Functionalized_Nanocelluloses_in_Wastewater_Treatment_Applications/figures?lo=1





Source: Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (1985). Environmental Engineering McGraw-Hill Book Co. *New York*.

Source: http://www.thewatertreatments.com/wp-content/uploads/2009/01/waste-water-treatment-clariflocculator.jpg [Accessed: 21.08.2019]

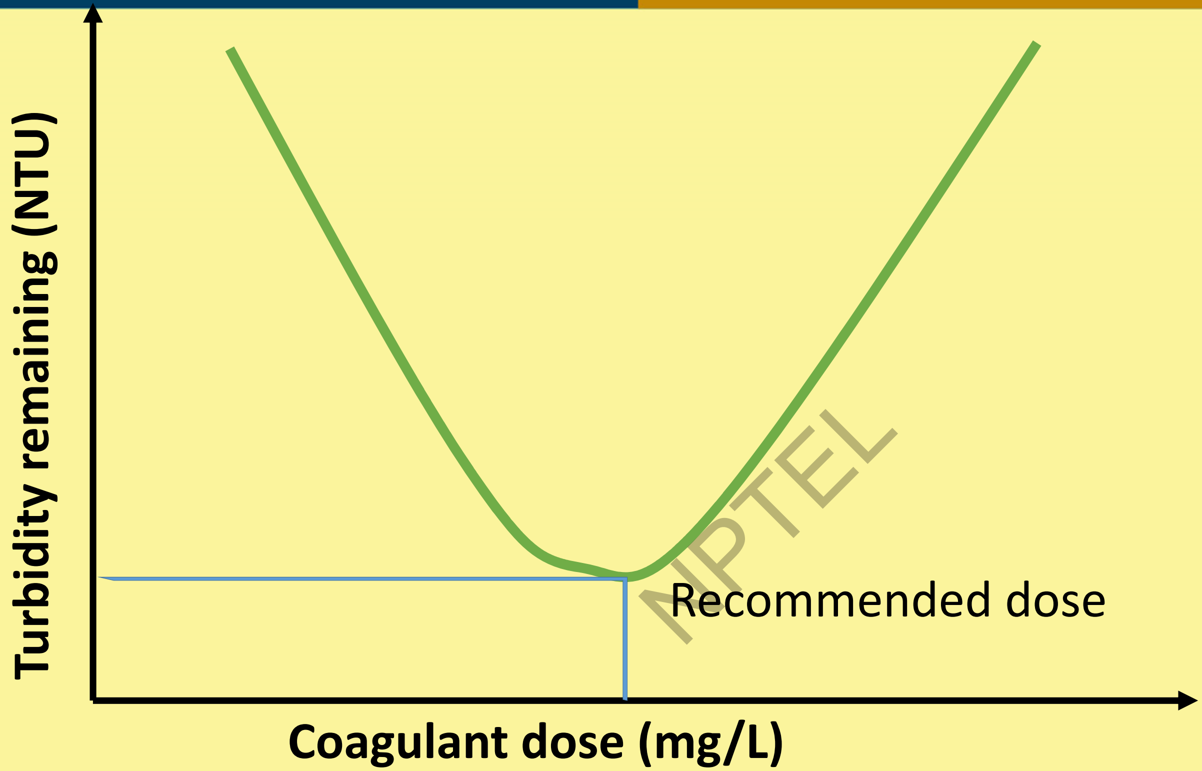
Type I: Discrete particle settling

Type II: Flocculent Particle settlement- - Particles settle with interaction with neighboring particles

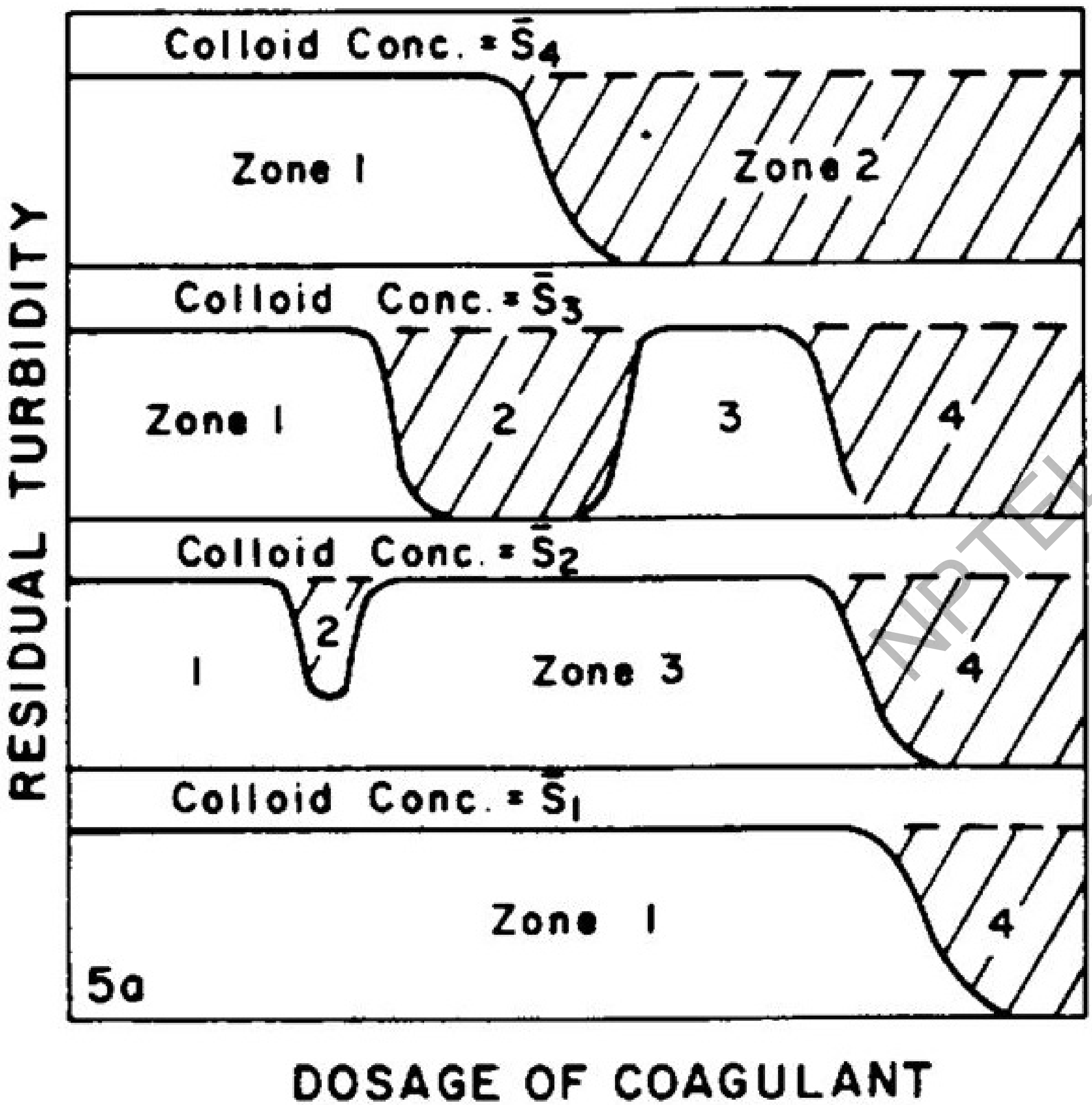
Type III: Hindered or Zone settling

Type IV: Compression settling

Source: https://ovan.es/productos/jar-test/



Turbidity remaining (NTU)
Recommended dose
Coagulant dose (mg/L)



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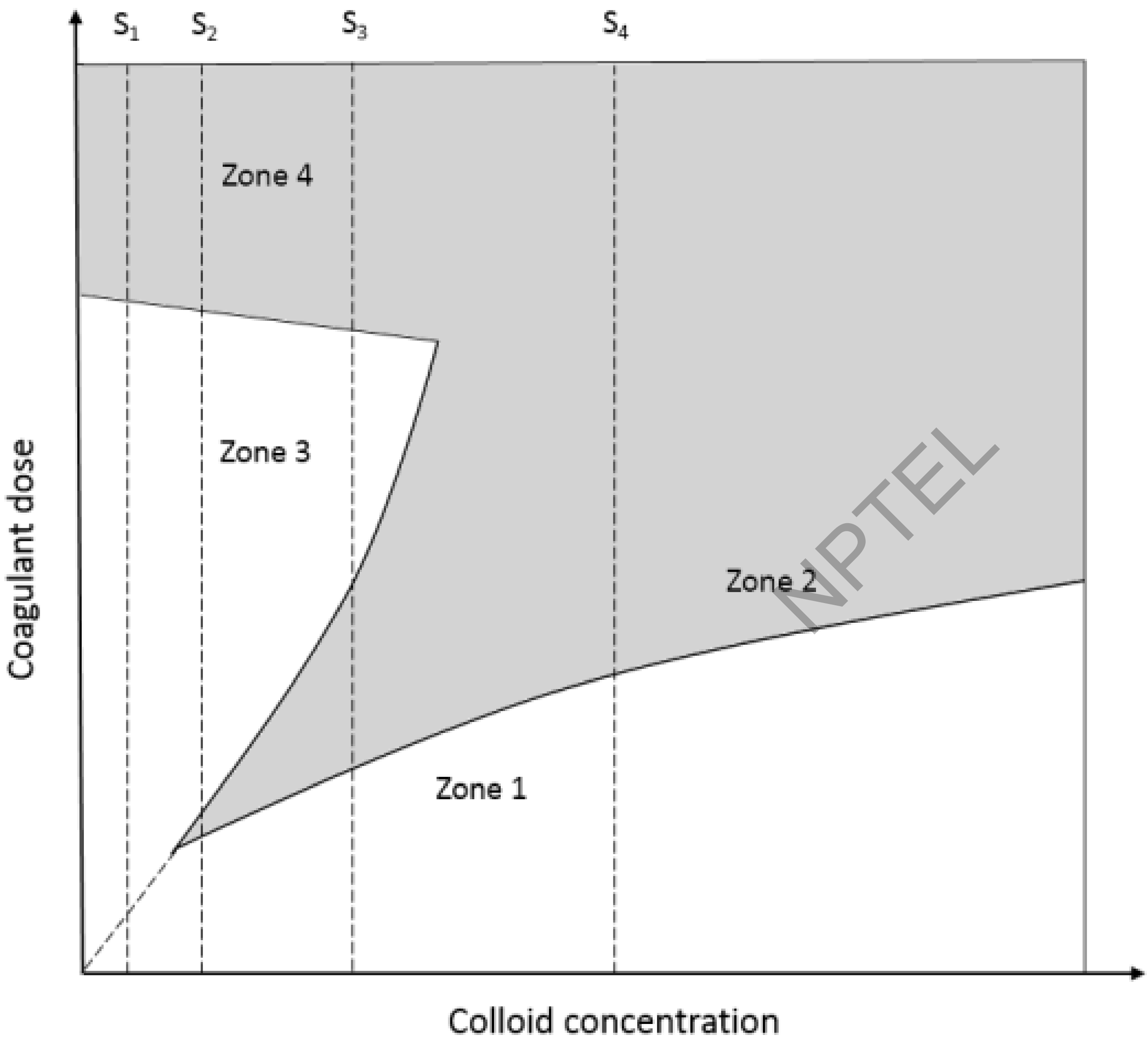

Zone 1 – Insufficient coagulant dose applied to suspension.

Zone 2 – Destabilization through charge neutralization.

Zone 3 – Restabilization due to coagulant overdose. Particle surfaces become positive.

Zone 4 – Sweep flocculation due to oversaturation of coagulant.

Source: http://www.diva-portal.org/smash/get/diva2:839318/FULLTEXT01.pdf

Goal –

To remove non-settleable floc remaining after flocculation and sedimentation (i.e., reduce settled water turbidity of ~ 3 TU to below 0.3 TU)

Types

Slow sand filter

Rapid sand filter

Pressure filter

Mechanism of filtration

Mechanical straining

Sedimentation and adsorption

Biological metabolism

Electrolytic action

Item	Slow Sand Filter	Rapid Sand Filter
Pre treatment	Not required except plain sedimentation	Coagulation, Flocculation and Sedimentation
Base materials	Gravel base of 30 to 75 cm depth with 3 to 65mm size graded gravel.	Gravel base of 45 to 50 cm depth with gravel size varies from 3 to 50 mm in 4 or 5 layers
Filter sand ▪ Effective size ▪ Uniformity coefficient ▪ Thickness of sand bed	 ▪ 0.25 to 0.35 mm ▪ 3 to 5.0 ▪ 80 to 100 cm	 ▪ 0.45 to 0.70 mm ▪ 1.2 to 1.7 ▪ 60 to 75 cm
Under drainage system	Open jointed pipes or drains covered with perforated blocks	Perforated pipe laterals discharging into main header
Size of each unit	50 to 200 sq.m	10 to 100 sq.m
Rate of filtration	100 to 200 Lph/sq.m	4800 to 7200 Lph/sq.m
Cost ▪ Installation ▪ O&M	 ▪ High ▪ Low	 ▪ Low ▪ High
Efficiency ▪ Turbidity of feed water ▪ Removal of bacteria	 Low; < 30 NTU 98 to 99%	 Any level of turbidity of feed water; (with pre-treatment) 80 to 90%
Suitability	For water supply to rural areas and small town	For public water supply to towns and cities
Post treatment	Slight disinfection	Complete disinfection is a must
Ease of construction	Simple	Complicated;
Skilled supervision	Not essential	Essential
Loss of head ▪ Initial ▪ Final	 ▪ 10c m ▪ 80 to 120 cm	 ▪ 30 cm ▪ 250 to 350 cm
Method of cleaning	▪ Scrapping and removing *Schmutzedecke* and 1.5 to 3 cm thick sand layer ▪ Laborious	▪ Back washing with or without compressed air agitation ▪ Simple and easy
Quantity of wash water required	0.2 to 0.5% of total water filtered	1 to 5% of the total water filtered
Cleaning Interval	Three to four months	One to two days

What is slow sand filtration?

- Large scale community water treatment system
- Water filters through a layer of sand with gravel base
- Gravity is the driving force
- No chemicals added
- Small pore space traps and removes particles
- Formation of biofilm above the sand contributes to the reduction of bacteria, viruses, protozoa and colloidal particles

History of the Slow Sand Filter

- Slow Sand Filter dates back to 1790 in Lancashire, England
- Spread throughout Europe and United States by the mid and late 1800's
- By 1940, the United States had around 100 slow sand filters purifying a total of 52.6 million gallons a day
- According to the World Health Organization, "Under suitable circumstances, slow sand filtration may be not only the cheapest and simplest but also the most efficient method of water treatment."

Advantages of the Slow Sand Filter

- Long design life
- Can use local materials and labor
- Inexpensive and easy to construct
- Minimal sludge handling problems
- Close operator supervision is not necessary
- Viable for the 21st century
- Reduces bacteria, cloudiness, and organic levels
- Minimal power and chemical requirements

What will make the filter suitable for rural communities?

- Simple filtration technology
- Low construction and operation cost
- Excellent removal of pathogenic organisms
- Good removal of turbidity
- Low energy consumption
- Minimal sludge handling
- Does not need constant operator attention

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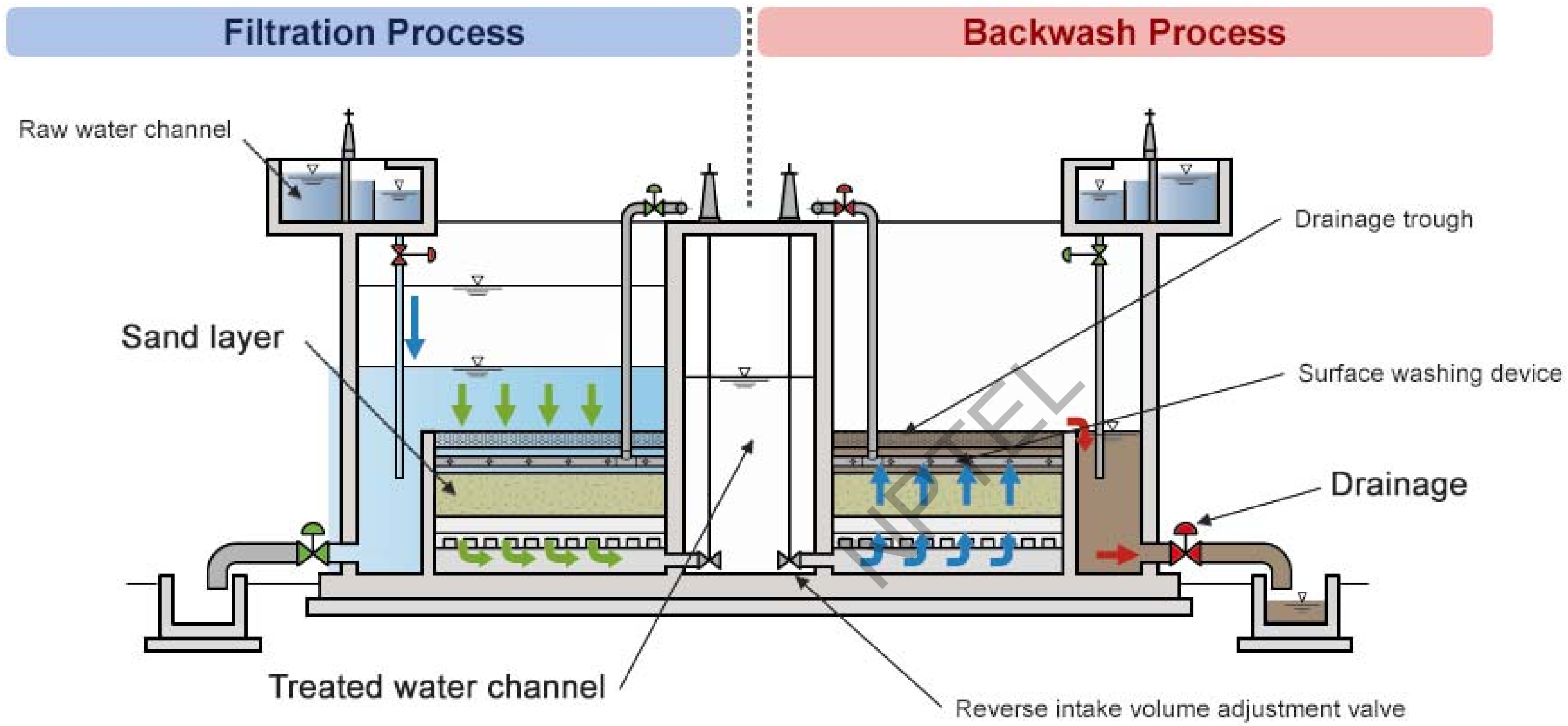
Lecture 38: Filtration

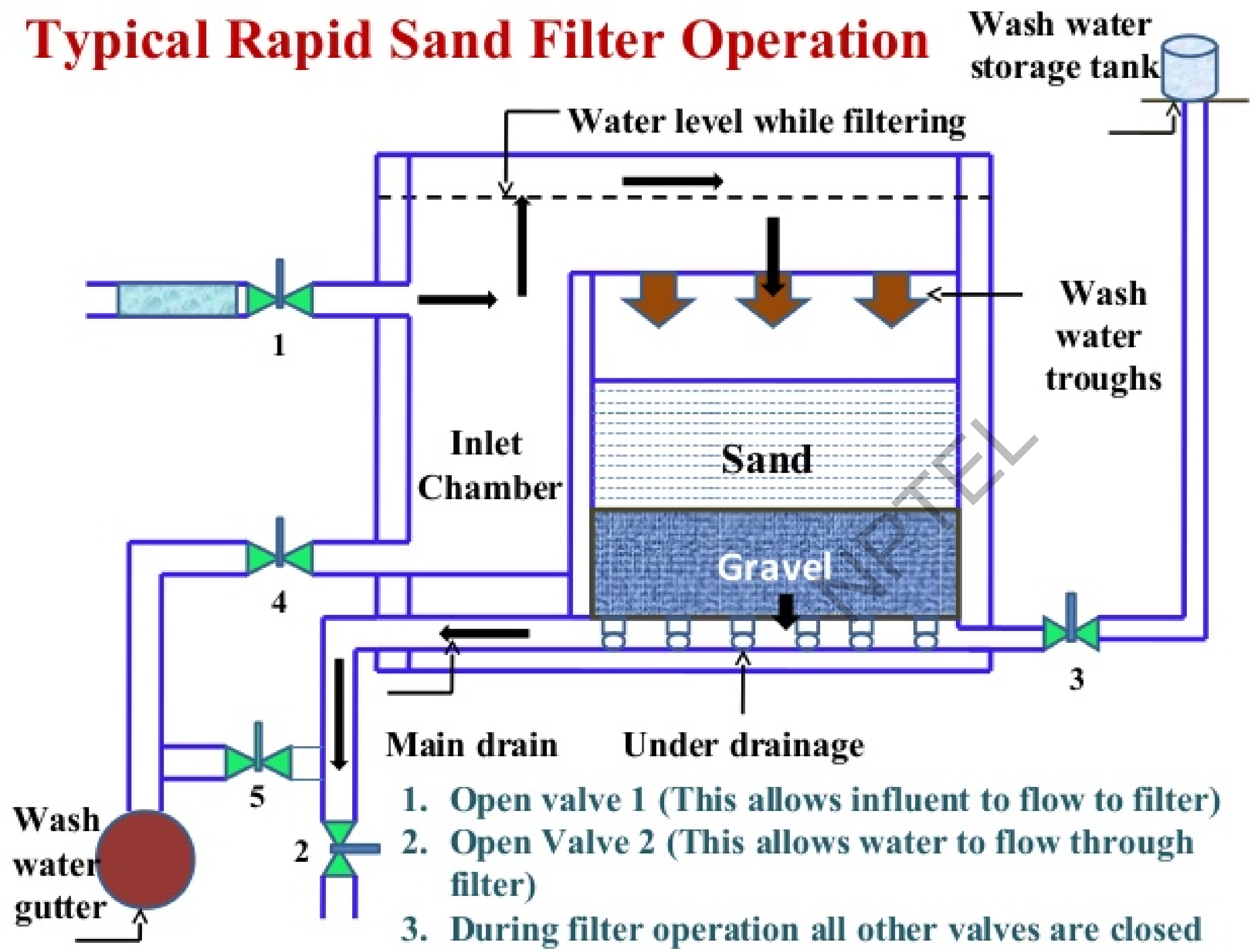
Rapid Sand Filter



Source: Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (1985). Environmental Engineering McGraw-Hill Book Co. *New York*.

Rapid Sand Filter

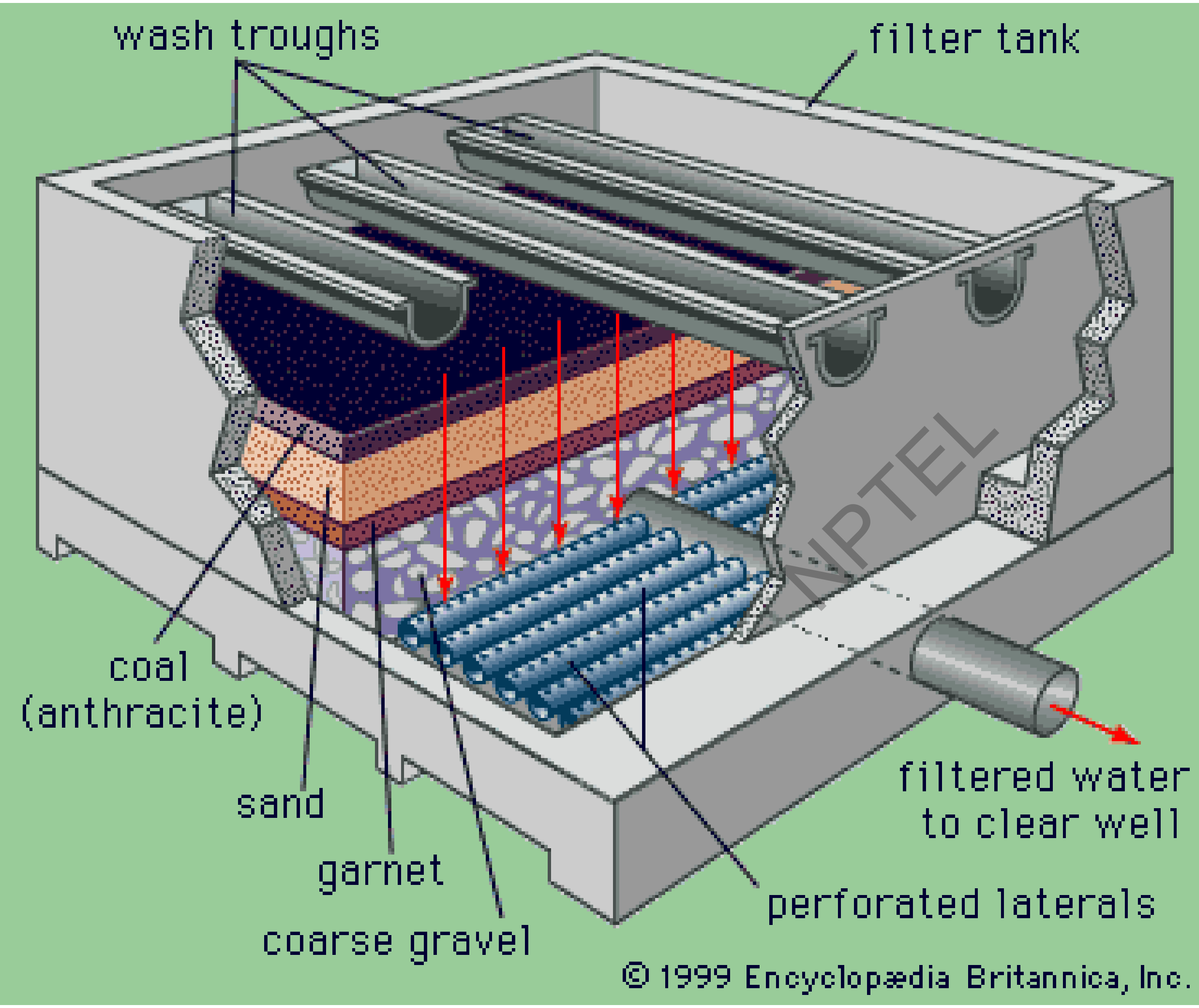
Typical Rapid Sand Filter Operation



1. Open valve 1 (This allows influent to flow to filter)
2. Open Valve 2 (This allows water to flow through filter)
3. During filter operation all other valves are closed

Source: https://www.britannica.com/technology/water-supply-system/Coagulation-and-flocculation

Sand Filter



Source:
https://www.britannica.com/technology/water-supply-system/Coagulation-and-flocculation

Characteristics of Urbanised Areas

Large water demand

Source: http://headlinenewsstories.com/wp-content/uploads/2010/06/india.jpg *[Accessed: 21.02.2012]*

High Land Prices

High population density

Limited Space

Rapid Sand Filter

Technical description

Rapid sand filtration is a technique common in developed countries for treating large quantities of drinking water.

It is a relatively sophisticated process usually requiring power-operated pumps for backwashing or cleaning the filter bed, and flow control of the filter outlet.

A continuously operating filter will usually require backwashing about every two days when raw water of relatively low turbidity is used.

Rapid Sand Filter

Technical description

Pretreatment of the raw water, using chemical flocculation agents in combination with setting tanks, is common where turbidity is high.

Relatively large quantities of filter backwash water, as well as sludge from the settling process, may be generated and require some form of treatment before discharge to the environment.

Because of the higher filtration rates, the area requirement of a rapid filtration plant is about 20% of that required for the slow sand filters.

Rapid Sand Filter

Operation and Maintenance

Operation of a rapid sand filter consists of regular backwashing. The period between backwashes depends on the quality of the water being filtered. The purpose of backwashing is to remove the suspended material that has been deposited in the filter bed during the filtration cycle. Periodic repacking of the filter bed may be required at infrequent intervals to ensure efficient operation.

Level of Involvement

Operating a rapid sand filter requires trained personnel.

Rapid Sand Filter

Costs

The construction cost of rapid sand filters is determined primarily by the cost of materials such as cement, building sand, gravel, reinforcing steel, filter media, pipes, and valves. The cost of labor is usually of lesser importance. However, the cost of land and transport of materials could add substantially to the total cost. The cost of energy required to operate a rapid sand filter may also add significant costs.

Rapid Sand Filter

Effectiveness of the Technology

The technology is proven and is very effective in removing suspended materials from the water. However, the technology often requires that the water be pretreated, usually by sedimentation of particulates in the raw water supply. The water is normally disinfected after filtration.

Suitability

This technology is most suited for larger urban water supply systems with a surface water source. It is also suitable in areas where there is a scarcity of land available for public works.

Rapid Sand Filter

Advantages

The advantages of this technology are that it is a proven technology, effective in removing suspended solids, and that it requires a minimal land area for construction and operation compared to slow sand filters.

Disadvantages

Rapid sand filters have high capital and operation costs, which may be increased further if there is a need for pretreatment of the raw water. The technology uses energy for pumping, and requires a relatively high degree of training for the plant operator.

Further Development of the Technology

The technology is well developed. Improvements may result from better backwash control devices.

Find the length and width of slow sand filter required to handle 2 MLD of water with a rate of filtration of 200 lit/hr/m². Assume Length: Width = 1:2

Surface area of slow sand filter = Q/rate of filtration

$$L \times B = \frac{2 \times 10^6 \div 24}{200} = 416.66\, m^2$$

L = 2B

2B = 416.66

B= 14.43 m

L=28.86 m

Design a 5 rapid sand filter to treat 30 MLD of water with rate of filtration 3000 lit/hr/m^2. Also find the percentage of filtered water required to backwash filter, if backwashing rate is 6 times rate of filtration. Duration of backwash is 10 mins and it is carried out once in every 24 hours.

Surface area of rapid sand filter = Q/rate of filtration

$$L \times B = \frac{30 \times 10^6 \div 24}{3000} = 416.66\, m^2$$

Area of each filter = 416.66/5 = 83.32

L = 2B

L x B = 83.32

B= 6.45 m

L= 12.9 m

Volume of water used in backwash = ROB X DOB X Area of each filter

= 6 x 3000 x 10/60 x 83.32 = 249960 m^3

Design a 5 rapid sand filter to treat 30 MLD of water with rate of filtration 3000 lit/hr/m^2. Also find the percentage of filtered water required to backwash filter, if backwashing rate is 6 times rate of filtration. Duration of backwash is 10 mins and it is carried out once in every 24 hours.

Volume of water filtered = ROF X DOF X Area of each filter

$$= 3000 \times \left(24 - \frac{10}{60}\right) x\ 83.32$$

= 5957380 liters

% of water used in backwash = 2449960/5957380 x 100 = 4.195 %

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Thank you

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Course Name: Introduction to Environmental Engineering and Science – Fundamentals and Sustainability Concepts

Faculty Name: Dr. Brajesh Kumar Dubey

Department : Civil engineering

Topic Water Treatment Basics

Lecture 39: Disinfection

Disinfection

It is the process of killing pathogenic bacteria.

Methods
Boiling of water
Treatment with excess lime
Ozone
Iodine and bromine pills UV rays
$KMnO_4$
Silver or electro-katadyn process
Chlorination

Disinfection

Desired properties of disinfectants

1. Destroy pathogens within a reasonable time and in various temperatures
2. Must meet possible fluctuations in water quality
3. Must be non-toxic and palatable
4. Must be dispensable and storable
5. Must be able to easily measure concentration in water
6. Must provide residual
7. Cheaper

Chlorine Reactions in Water

- Chlorine is the most popular disinfectant [Cl_2, NaOCl, $Ca(OCl)_2$]
- $Cl_{2(g)} + H_2O \leftrightarrow HOCl + H^+ + Cl^-$

  → pH dependent
    - HOCL: 4 < pH > 6
    - OCl^-: pH > 7.5
    - Cl_2: pH < 1

  → Rapid reaction
- Free available chlorine – when chlorine exists in the form of HOCl and/or OCl^-

Strength of Disinfectants

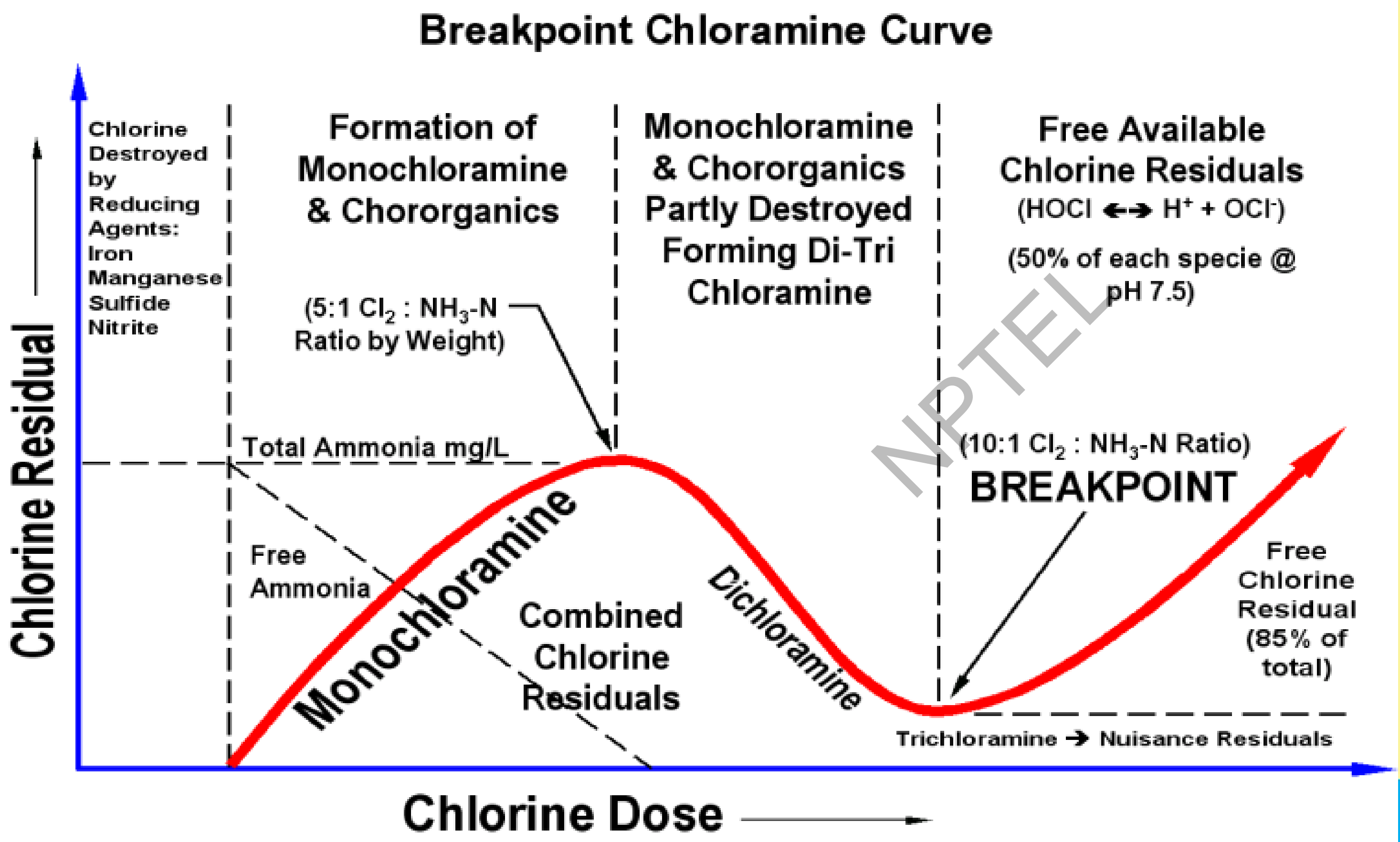
O_3 > ClO_2 > Free chlorines > Chloramines

- Little to zero residual for O_3 and ClO_2
- Free chlorine is cheaper that O_3 and ClO_2
- Chloramines offer longer residual and are less reactive
  - Combined chlorine
- What about Cl^- (chloride) and UV?

Combined Chlorine

- $NH_3 + HOCl \leftrightarrow NH_2Cl + H_2O$
  - Monochloramine: NH_2Cl
- $NH_2Cl + HOCl \leftrightarrow NHCl_2 + H_2O$
  - Dichloramine: $NHCl_2$
- $NHCl_2 + HOCl \leftrightarrow NCl_3 + H_2O$
  - Trichloramine: NCl_3
- 25 times more combined chlorine than free chlorine

Chloramine Breakpoint Curve



Source: https://springatewatercoop.myruralwater.com/documents/527/Chlorination_and_ammonia__Aaron_Jenzen_.pdf

Find Cl_2 demand, if Cl_2 dose of 0.6 mg/L is added to have Cl_2 residual of 0.2 mg/L. Find dose of bleaching powder required, if it contains only 30% of Cl_2. Also find monthly bleaching powder requirement in kg to treat 10 MLD of water.

Cl_2 demand = Cl_2 dose – Cl_2 residual = 0.6-0.2 = 0.4 mg/L

Bleaching powder = Cl_2 dose/% of Cl_2 in bleaching powder

= 0.6/(30/100) = 2 mg/L

Total bleaching powder required in kg/day = Flow rate (MLD) x dose of bleaching powder (mg/L)

= 10 x 2 = 20 kg/day

Monthly requirement = 20 x 30 = 600 kg

WATER SUPPLY

WATER SUPPLY SYSTEM

Water distribution systems are designed to adequately satisfy the water requirements for a combinations of the following demands:

- Domestic
- Commercial
- Industrial
- Fire-fighting

The system should be capable of meeting the demands at all times and at satisfactory pressure

COMPONENTS OF WATER SUPPLY SYSTEM

The main elements of the distribution system are:

- Pipe systems
- Pumping stations
- Storage facilities
- Fire hydrants
- House service connections
- Meters
- Other appurtenances

System Configurations

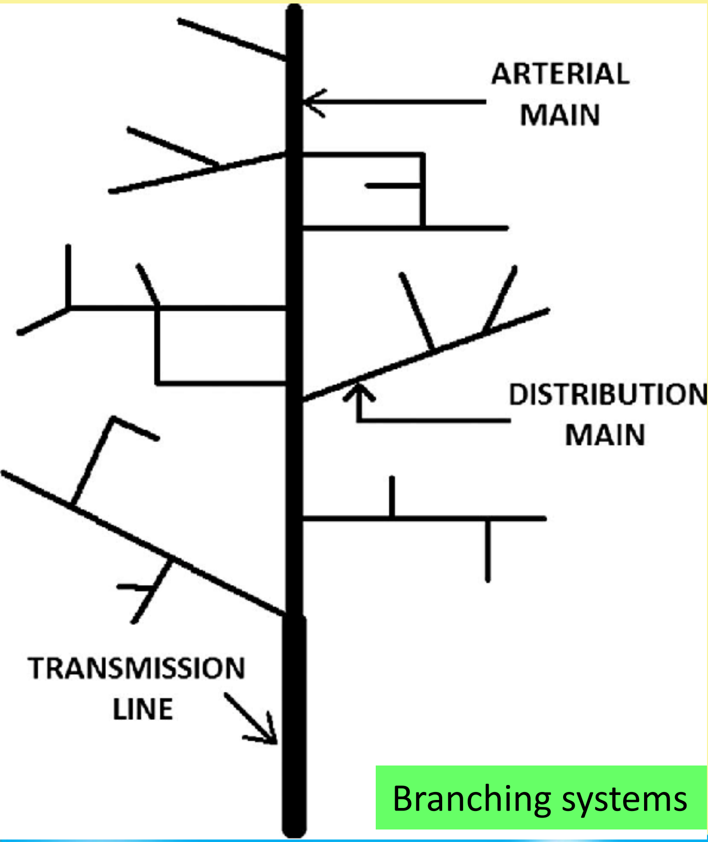
Distribution systems may be classified as:

- Branching systems
- Grid systems
- A combination of the above two systems

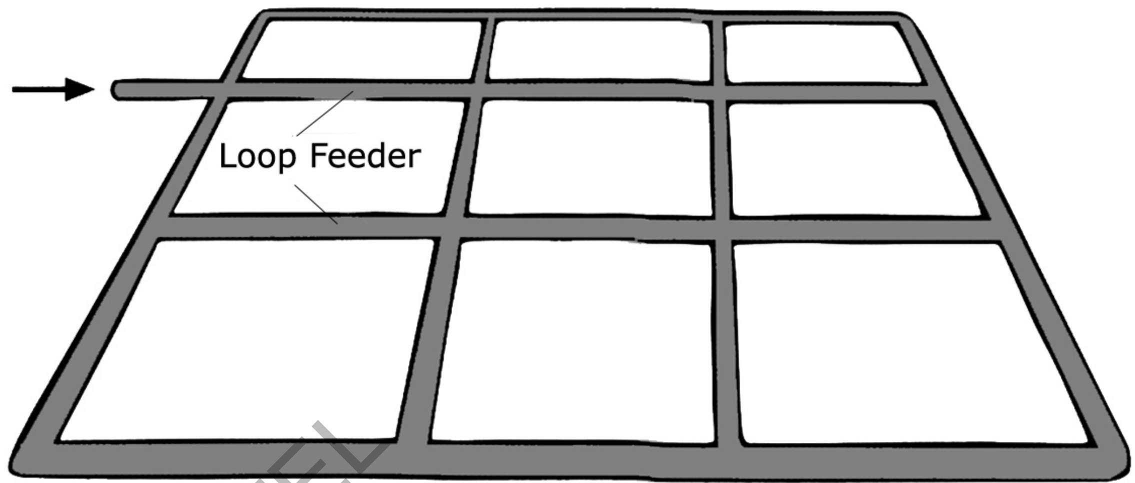
The configuration of the system is dictated by:

- Street patterns
- Topography
- Degree and type of development of the area
- Location of the treatment and storage works.

System Configurations



Branching systems



Grid systems

System Configurations

Branching vs. grid systems:

- A grid system is usually preferred over a branching system, since it can furnish a supply to any point from at least two directions
- The branching system has dead ends, therefore, does not permit supply from more than one direction. Should be avoided where possible.
- In locations where sharp changes in topography occur (hilly or mountainous areas), it is common practice to divide the distribution system into two or more service areas.

Basic System Requirements

Pressure:

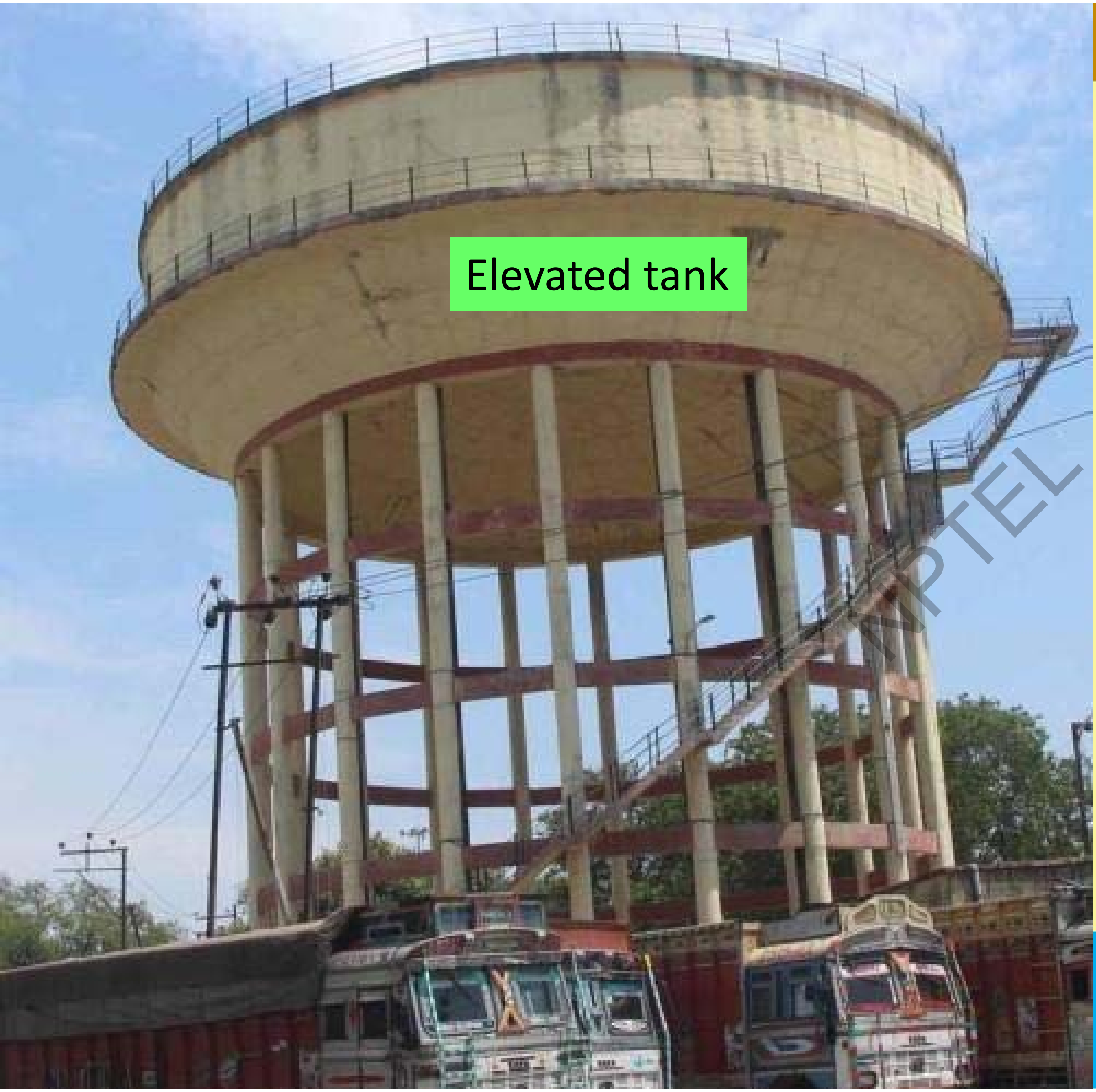
- Pressure should be great enough to adequately meet consumer and fire-fighting needs.
- Pressure should not be excessive: – Cost consideration – Leakage and maintenance increase

Capacity:

- The capacity is determined on the bases of local water needs plus fire-fighting demand.
- Pipe sizes should be selected to avoid high velocities:
  - Pipe sizes should selected based on flow velocity
  - Where fire-fighting is required, minimum pipe diameter is 6 in.

Hydraulic Design

- ❑ The design flowrate is based on the maximum of the following two rates:
- • Maximum day demand plus fire demand
- • Maximum hourly rate
- ❑ Analysis of distribution system:
- • Distribution system have series of pipes of different diameters. In order to simplify the analysis, skeletonizing is used.
- • Skeletonizing is the replacement of a series of pipes of varying diameters with one equivalent pipe or replacing a system of pipes with one equivalent pipe.



Distribution Reservoirs

Source: https://www.indiamart.com/proddetail/elevated-tank-14026362088.html

Distribution Reservoirs

❑ Location

- Distribution reservoirs should be located strategically for maximum benefits.
- Normally the reservoir should be near the center of use.
- For large areas, a number of reservoirs may be located at key locations
- A central location decreases the friction losses by reducing the distance to the serviced area.

❑ Storage function

- To provide head required head.
- To provide excess demand such as:

– fire-fighting: should be sufficient to provide flow for 10-12 hours.

– emergency demands: to sustain the demand during failure of the supply system and times of maintenance.

❑ To provide equalization storage.

Pumping

❑ Introduction

• Pumping is an important part of the transportation and distribution system.

• Requirements vary from small units (few gallons per minute) to large units (several hundred cubic feet per second)

• Two kinds of pumping equipment are mainly used; centrifugal and displacement pumps.

❑ Types of pumps

• Low-lift pumps: used to lift water from a source to the treatment plant

• High-service pumps: used to discharge water under pressure to the distribution system

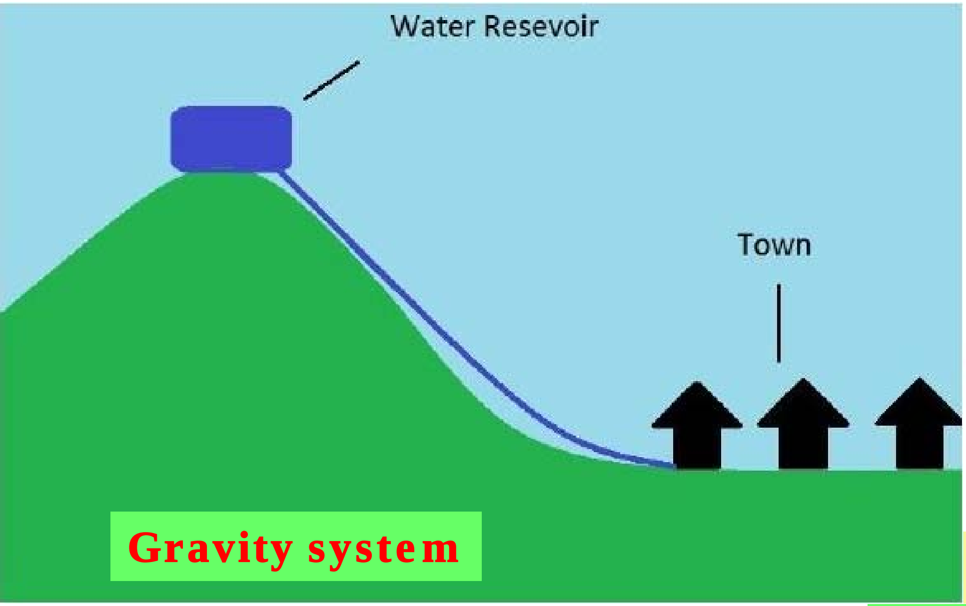
• Booster pumps: used to increase pressure in the distribution system.

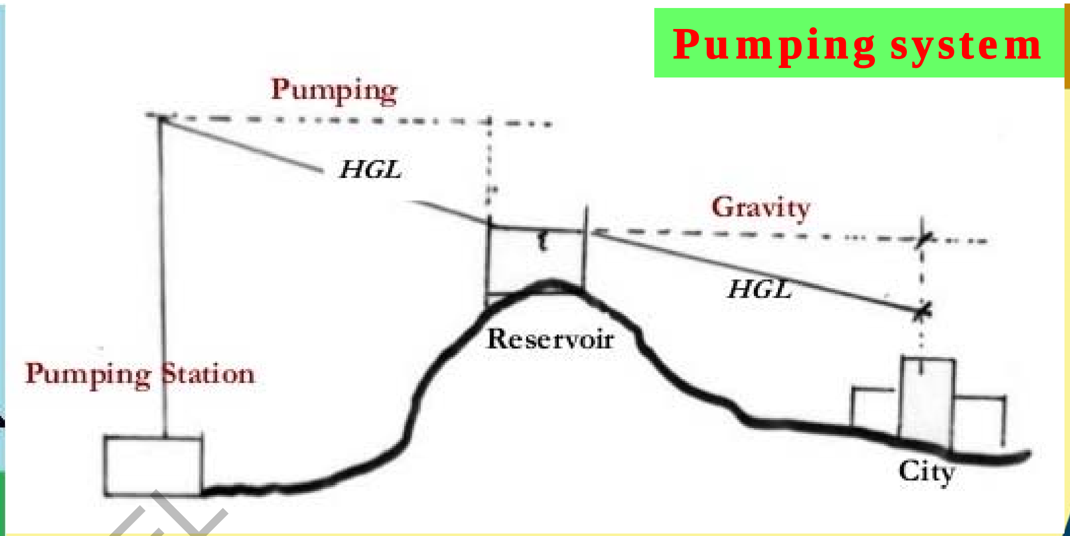
• Recirculation pumps: used within a treatment plant.

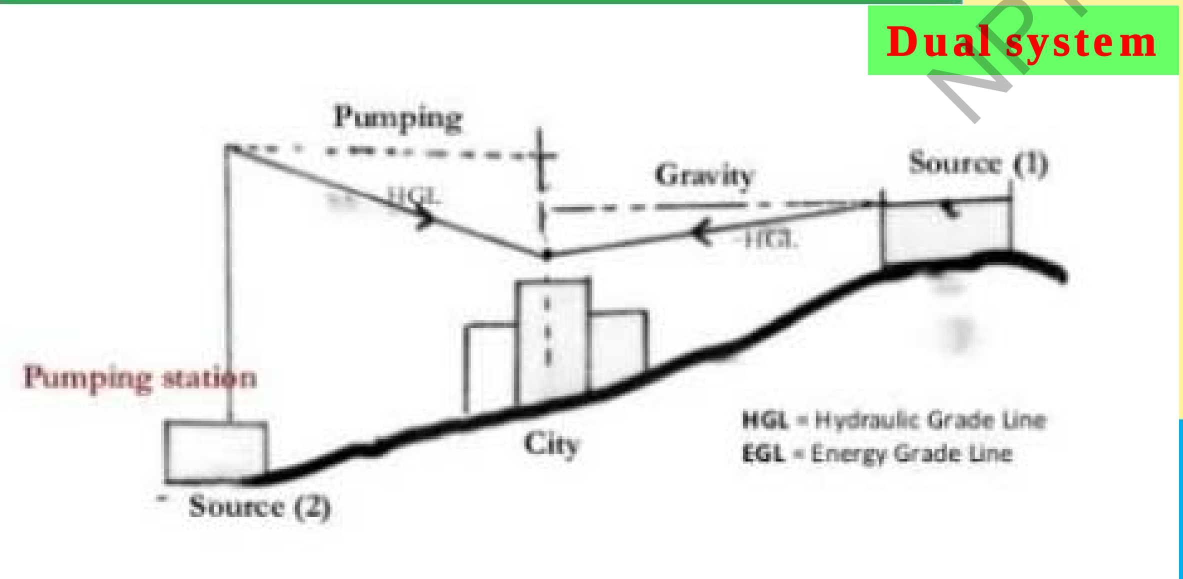
• Well pumps: used to left water from wells.

Source: https://www.indiamart.com/proddetail/centrifugal-pump-11508415397.html

Centrifugal pump


Water Resevoir
Town
Gravity system


Pumping system
Pumping
HGL
Gravity
HGL
Reservoir
Pumping Station
City


Dual system
Pumping
Gravity
Source (1)
HGL
HGL
Pumping station
City
HGL = Hydraulic Grade Line
EGL = Energy Grade Line
Source (2)

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Thank you