

Theory of Water & Wastewater Treatment Solutions

Sedimentation (утворення осаду)

Sedimentation is the process of allowing particles in suspension in water to settle out of the **suspension** under the effect of gravity. The particles that settle out from the suspension become sediment, and in water treatment is known as **sludge**. When a thick layer of sediment continues to settle, this is known as **consolidation**. When consolidation of sediment, or sludge, is assisted by mechanical means then this is known as **thickening**.

Sedimentation is accomplished by decreasing the velocity of the water to a point which the particles will no longer remain in suspension. When the velocity no longer supports the particles, gravity will remove them from the water flow.

Suspension – зважений стан (суспензія)

Sludge – мул (осад)

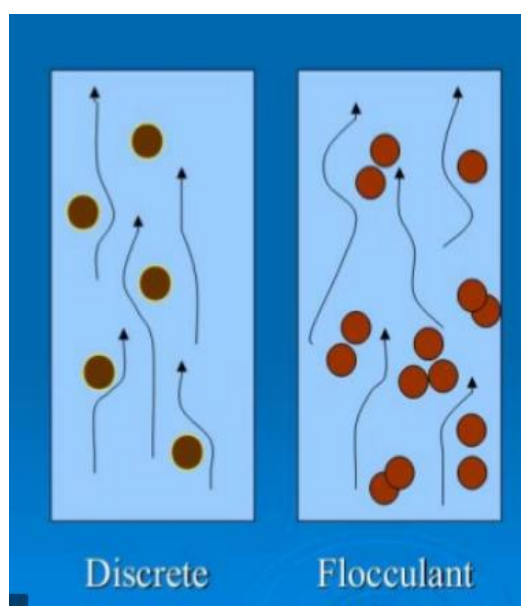
Consolidation – консолідація

Thickening – ущільнення (згущення)

Types of settling

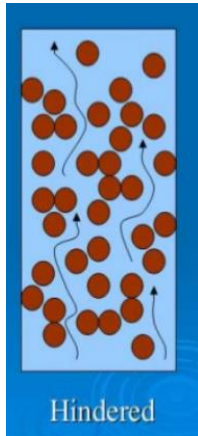
In **discrete settling**, particles settle as individual entities, and there is no significant interaction with neighbouring particles

In **flocculent settling**, particles flocculate or **coalesce** during settling. By flocculation or coalescing, the particles increase in mass and thus settle at a faster rate. Flocculent settling refers to the sedimentation of particles in a rather **dilute** suspension with concentration of solids usually less than 1000 mg/l.



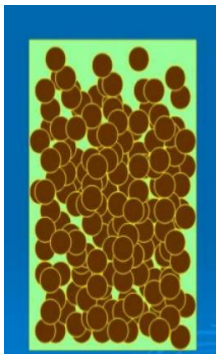
Hindered Settling

When concentration of flocculent particles is intermediate range, they are close enough together so that inter-particle forces are sufficient to hinder the settling of neighbouring particles resulting in hindered settling. The particles maintain their relative positions with respect to each other and the whole mass of particles settles as a unit or zone.



Compression Settling

This refers to settling in which the concentration of particles is so high that particles are in physical contact with each other resulting in the formation of a structure with lower layers supporting the weight of upper layers. Consequently, further settling occurs due to compression of the whole structure of particles and accompanied by squeezing out of water from the pores between the solid particles.



settling – осідання

discrete settling – вільне осадження

flocculent settling – флокулентне осідання (зв'язане)

coalesce – зливатися

dilute - розбавлений

Hindered Settling – утруднене осідання

Compression Settling – стисле осідання

Squeezing - віджимання

4. Sedimentation in water Treatment

- Settling velocity (v_s) must be determined to assure good sedimentation tank design.
- Overflow rate (v_o) must be set at some value LESS THAN or EQUAL to V_s

$$v_s = \frac{H}{t}$$

$$v_s = \frac{H}{t} = \frac{H}{\left[\frac{V}{Q} \right]} = \frac{HQ}{l * W * H} = \frac{Q}{A_s}$$

But $\rightarrow v_o = \frac{Q}{A_s}$

So $\rightarrow v_o = v_s$

Where

Q = flow rate (m³/h)
A_s = surface area (m²)
H = depth of water, m
W = tank width, m
L = tank length, m
t = detention time, hr

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Settling velocity – швидкість осідання

Detention time – час контакту

Dissolved air flotation (DAF) (флотація розчинним киснем)

Flotation is known as a **separation** process, based on the introduction of gas bubbles as the transport medium. Suspended particulate matter, being hydrophobic or conditioned to be so, is then attach to the bubbles and moves toward the water solution surface—i.e., contrary to the direction of gravity

Flotation – флотація

Separation - розділення

Filtration

Filtration is the separation process of removing solid particles, microorganisms or droplets from a liquid or a gas by depositing them on a **filter medium**, which is essentially permeable to only the fluid phase of the mixture being separated.

The liquid more or less thoroughly separated from the solids is called the **filtrate**, effluent, permeate or, in case of water treatment, clean water.

Effluent almost always means wastes that pour into our water.

Permeate is the filtered fluid allowed to flow through a membrane.

Filtration processes can be classified in accordance with different criteria:

Generation of the pressure difference Pressure filtration, vacuum filtration, gravity filtration, centrifugal filtration;

BACKWASH CYCLE

The media must be expanded to clean the filter media during the backwash.

discontinuous, continuous

Filtration – фільтрація

Droplets – краплі

filter medium – фільтраційне завантаження

filtrate – фільтрат

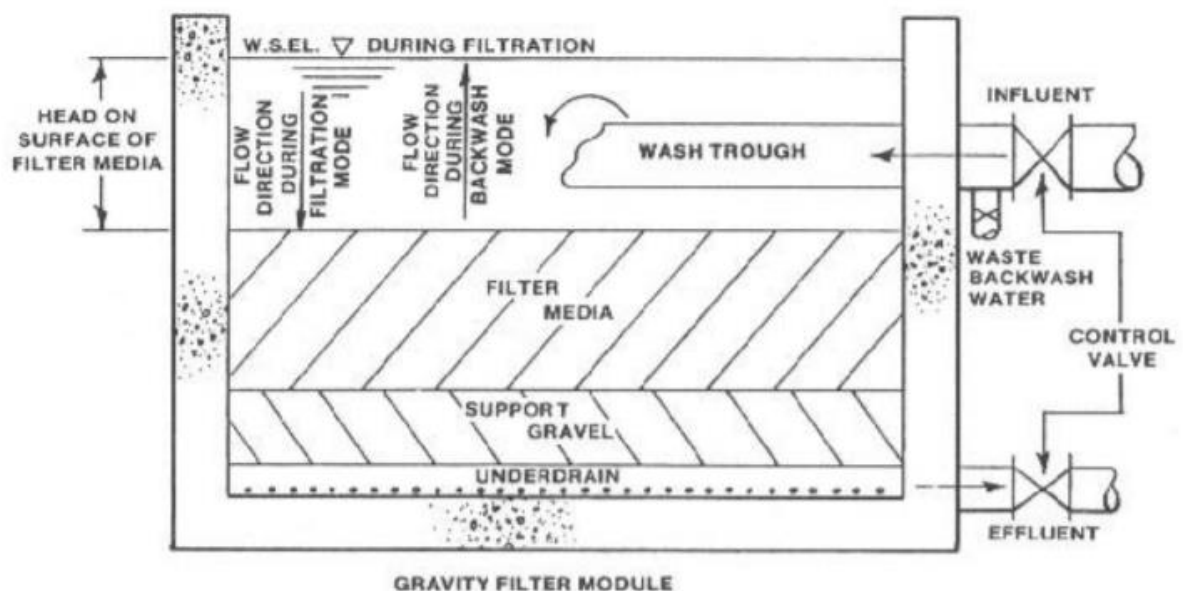
effluent – очищені стічні води

permeate – перміат (вода що профільтрувалась крізь мембрану)

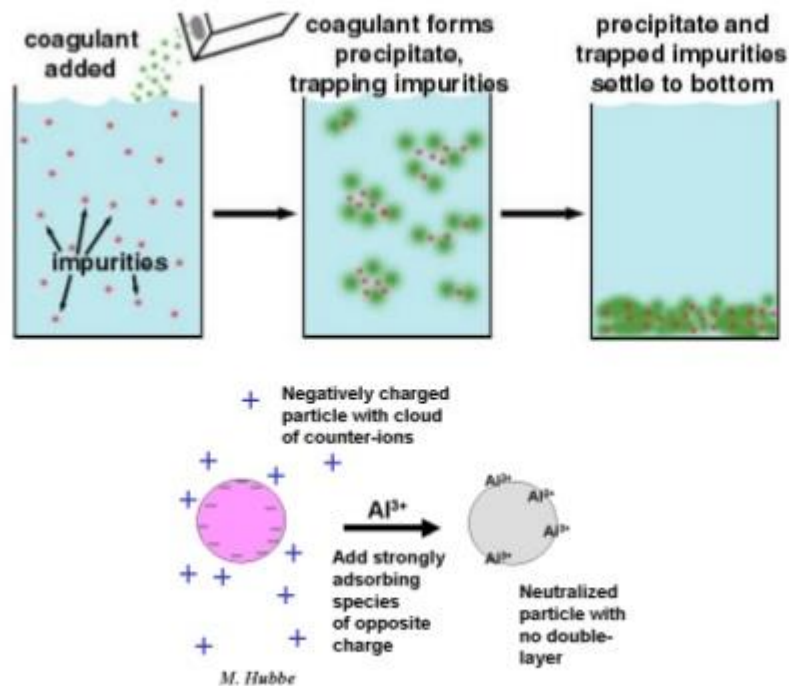
discontinuous – періодичний

continuous – безперервний

backwash – зворотня промивка



Coagulation aim



04/27/16

water treatment

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Video Flocculation and coagulation

https://www.youtube.com/watch?v=JkpMWjW3wbE&t=76s&ab_channel=Karl-UweSchmitz

Flocculation and coagulation are fundamental for wastewater treatment and were already used by the ancient Egyptians in 1300 BC. This sample of muddy looking water from a paper mill has a very high turbidity due to the presence of many suspended particles. Adding flocculants will cause that the small particles clump together to bigger **flocks** that settle down. So, let's have a closer look how flocculation and coagulation work in detail.

Turbidity of muddy looking water is caused by two types of particles organic and inorganic. **Organic particles** are for example algae and bacteria. Whereas inorganic particles are for example clay and silt. Both particle types in common are able to float because they are too small to settle by gravity. Suspended particles that are too light to settle down are called **colloids**. Almost all colloids have negatively charged surfaces. The negatively charged surface will attract positively charged ions in the water. So, the colloids form a first layer. The effect is very similar to magnets like poles repel but opposite poles attract each other. Over time colloids form a second diffused layer with positively and negatively charged ions called a **double layer**. The double layer creates a repulsive force which prevents two colloids from stacking to

each other. The colloids stay suspended in water and move around to avoid collision with other colloids. To overcome this behavior and to clump colloids together for particle settling flocculants are used. Typical used flocculants for particle settling are alum and Ferric. Alum and Ferric are ideal as flocculants because they form a high number of ions when they get in contact with water. These ions will bind together with the colloids and neutralize **repulsive forces**. Mixing the water allows the colloids to stick together to form bigger flocs and settle down to the **tank** bottom. Within wastewater treatment plants the flocculation process is normally separated from sedimentation. Under gentle **agitation** flocculants are added in the mixing tank before water is entering the **sedimentation tank**. Here particles are settling down until they build up a sludge blanket which is then removed.

Flocs – пластівці

Organic particles – органічні частинки

Colloids – колоїди

double layer – подвійний шар

repulsive forces – сили протидії

tank – ємність (резервуар)

agitation – перемішування

mixing tank – змішувач

sedimentation tank - відстійник

Adsorption

Adsorption takes place when molecules in a liquid bind themselves to the surface of a solid substance. **Adsorbents** have a very high internal surface area that permits adsorption.

Active carbon is by far the most commonly used adsorbent.

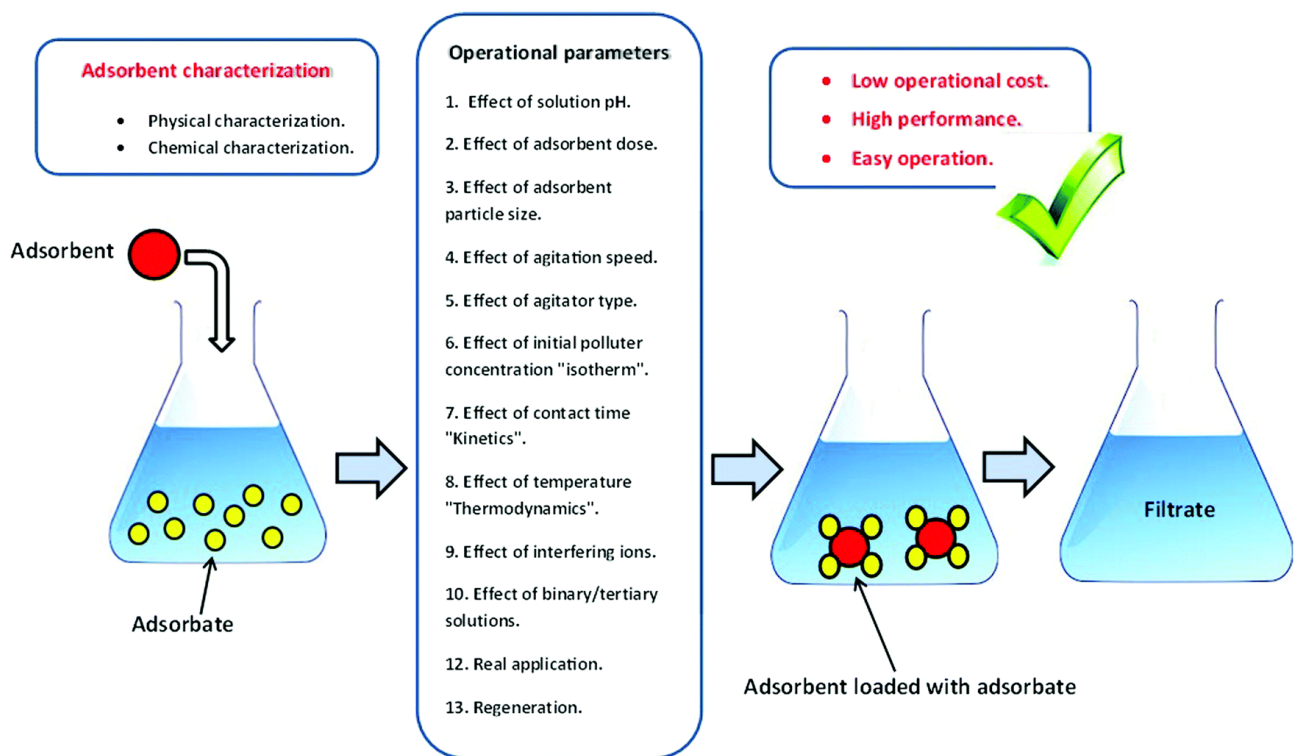
Adsorption – адсорбція

Bind – зв'язувати

Adsorbents – адсорбент

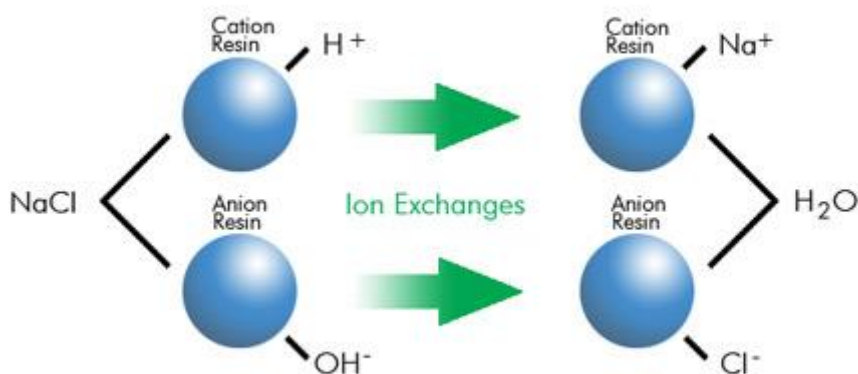
Adsorbate – абсорбат (a substance that is adsorbed)

Regeneration - регенерація



Ion exchange

Ion exchange is a **water treatment** method where one or more undesirable **ionic contaminants** are removed from water by exchange with another non-objectionable, or less objectionable ionic substance



Ion exchange - іонний обмін

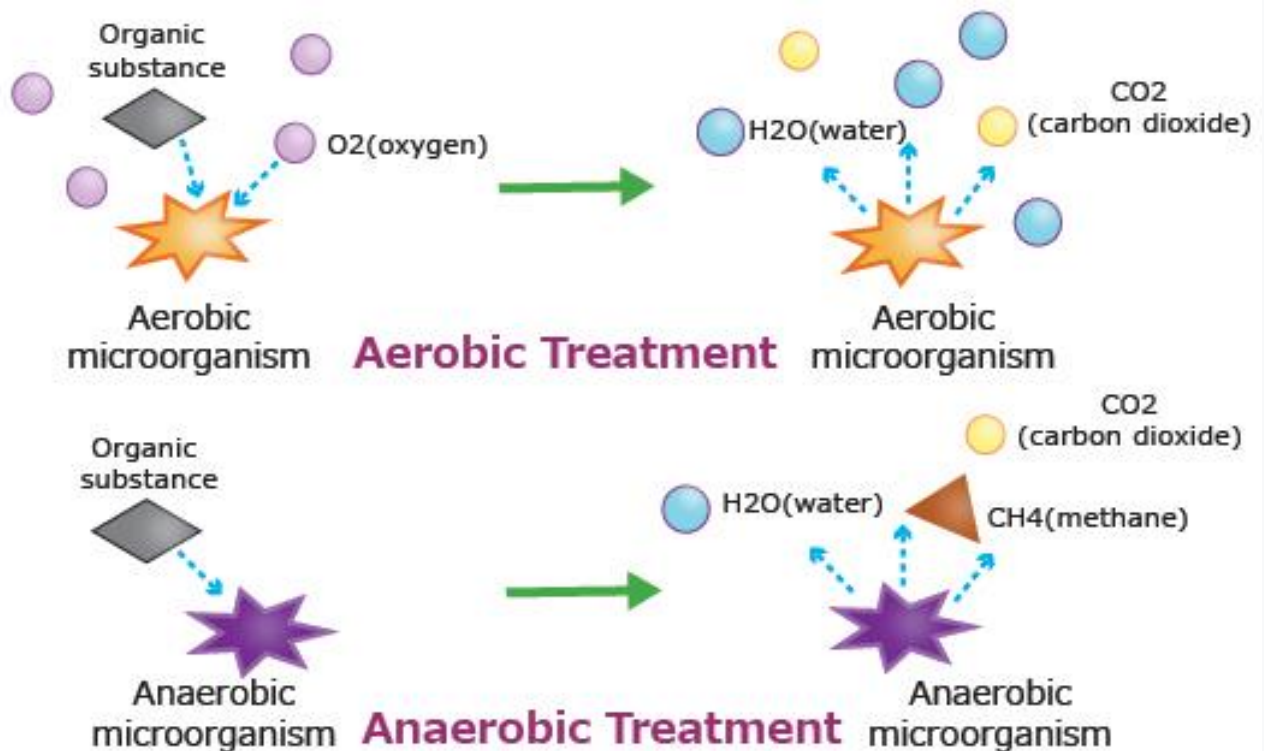
ionic contaminants – іонні забруднення

Biological treatments

Biological treatments rely on bacteria, nematodes, or other small organisms to break down organic wastes using normal **cellular** processes.

In biological wastewater treatment organic material is **oxidized** by microbial communities maintained in either a **suspended growth** or an **attached**

growth reactor. **Aerobic treatment** works on the basis that microorganisms multiply by using the oxygen dissolved in water to break organic matter down into carbon dioxide and water. **Anaerobic treatment** works on the basis that, in aquatic environments lacking dissolved oxygen, microorganisms multiply by breaking organic matter down into methane gas, carbon dioxide and water



Biological treatment – біологічне очищення

Cellular - клітковий

Oxidize - окислення

suspended growth - зважене розмноження

attached growth - прикріплене розмноження

Aerobic – аеробний

Anaerobic - анаеробний