Industrial Wastewater Treatment

Eng/ Marwa M.Saad

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- Wastewater type
- Characteristics Of Wastewater
- Wastewater Treatment Market
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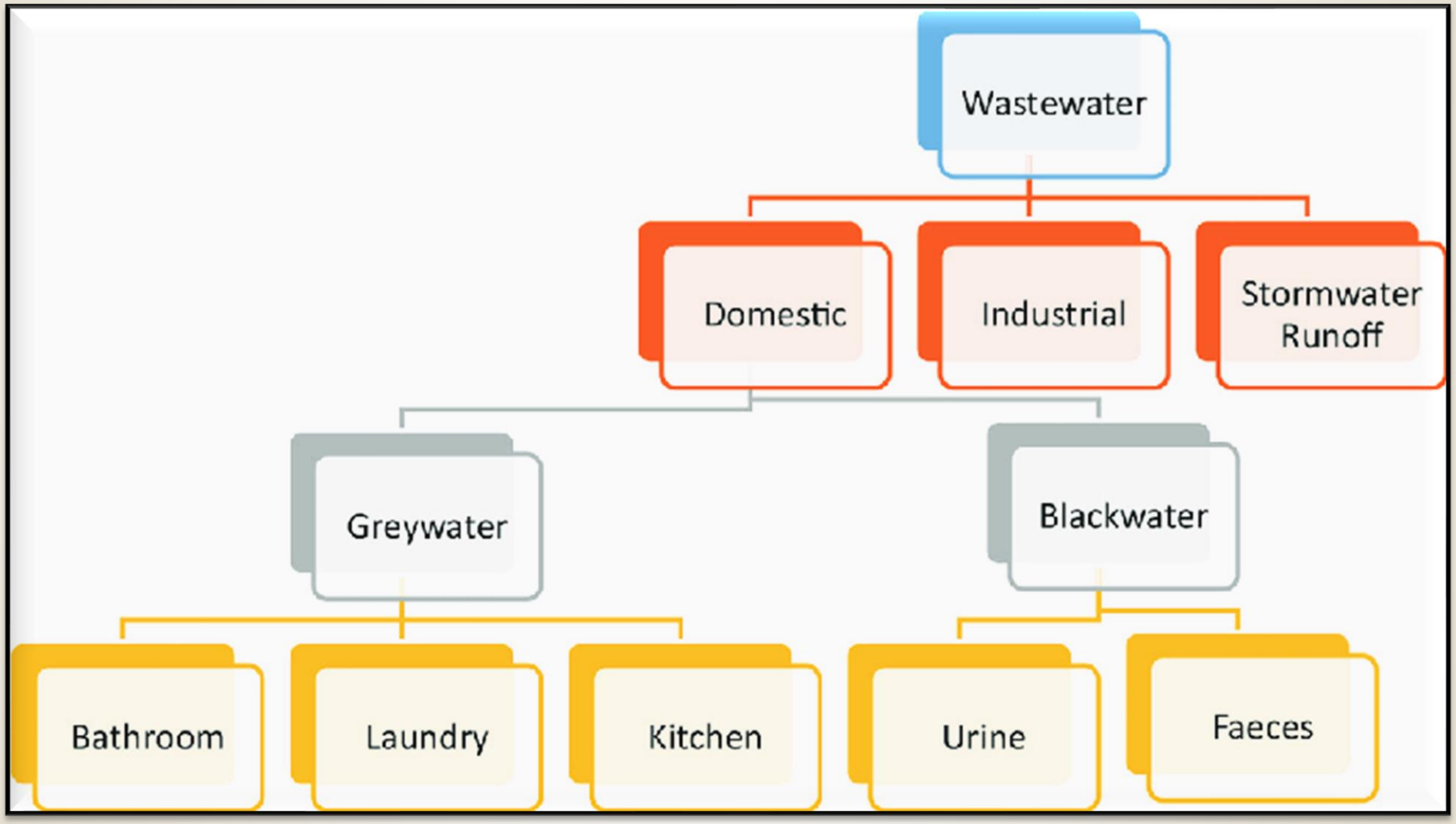
- Characteristics Industrial Of Wastewater
- New Borg El-Arab City factories
- Wastewater Treatment Methods
- 1- Physical Treatment
- 2-Chemical Treatment
- 3- Biological Treatment
- Wastewater Treatment Stages
- Wastewater Treatment plants
- Wastewater Management

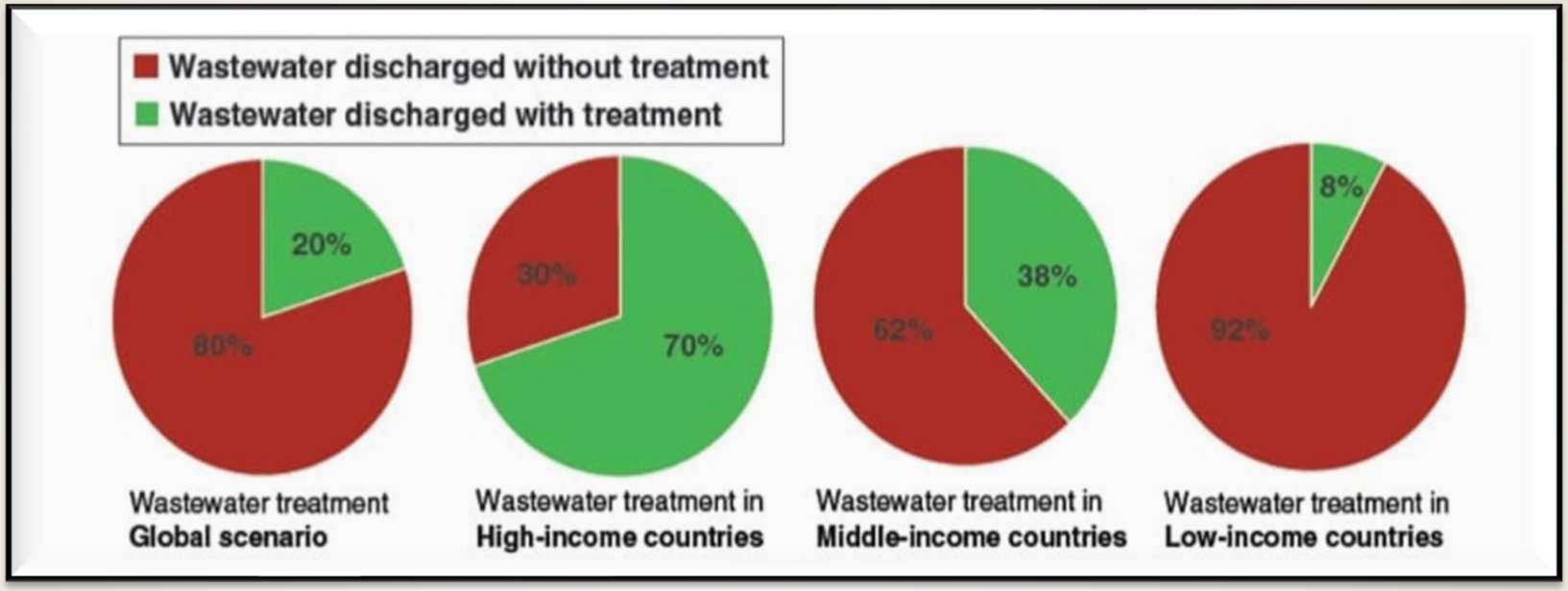
Wastewater type

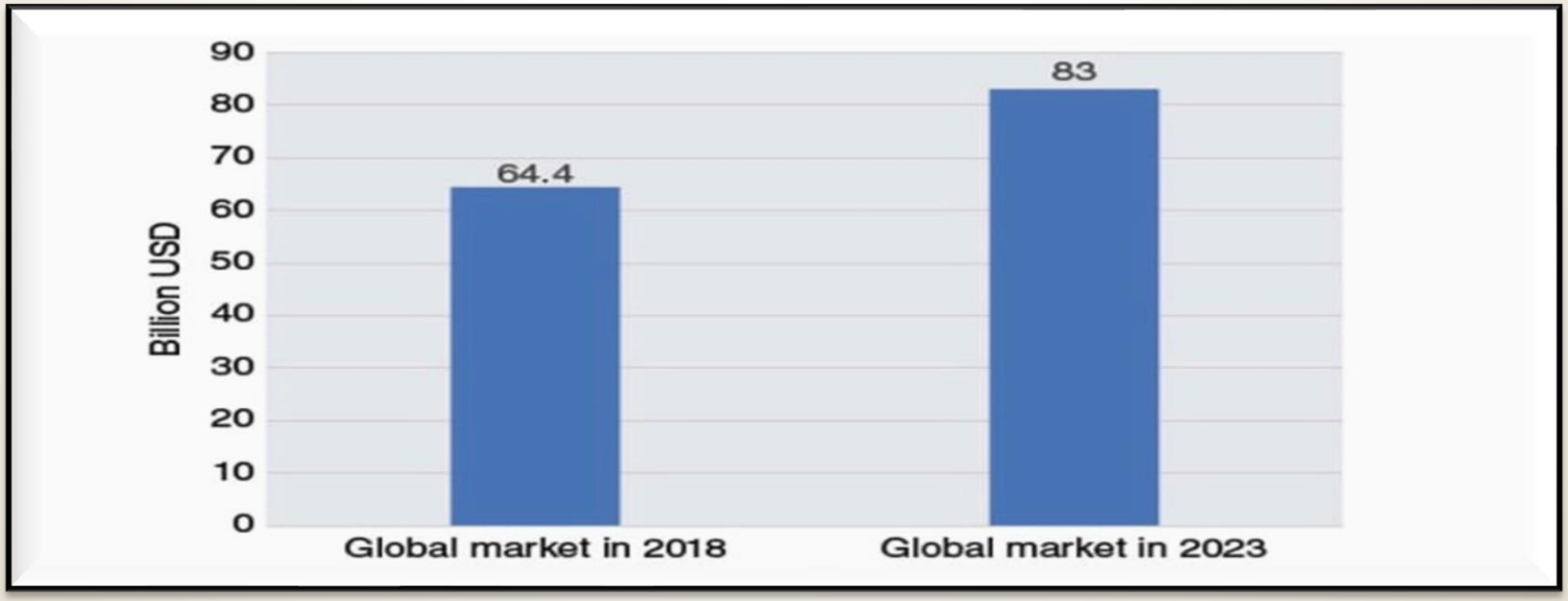


Characteristics Of Wastewater

Physical characteristics	*Chemical characteristics*	*Biological characteristics*
Solids Total, suspended and dissolved, volatile and fixed or mineral solids	*Organic contents* BOD, COD, fats, phenols, surfactants, oil and grease, etc.	Animals
Colour	*Inorganic contents* alkalinity, chlorides, nitrogen, sulphur, phosphorous, heavy metals, pH, carbohydrates, etc.	Plants
Odour	*Gases* oxygen, methane, hydrogen sulfide	Protista
Temperature		*Pathogenic organisms* Viruses

Wastewater Treatment Market





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Industrial Wastewater Treatment

Why ??

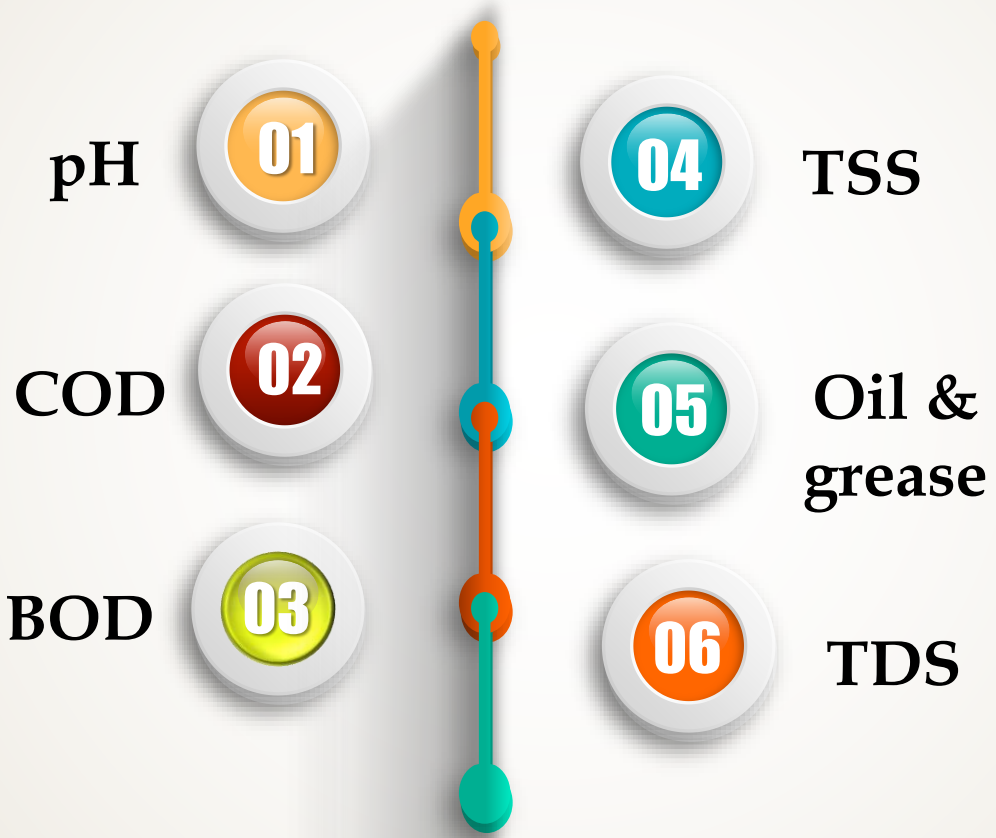
- Protecting the environment
- Protecting public health
- Meeting regulatory requirements
- Conserving water resources
- Improving economic efficiency

Industrial Wastewater

Nature Of Industrial Wastewater depends on The quality and quantity of pollutants produced by the industry vary widely from one industry to another and depend on several factors:

- Type of industry.
- Plant size, age and maintenance system.
- Factory work system, production volume and quality.
- Techniques used in industrial processes.
- The quality of fuel and raw materials used.

Characteristics Of Industrial Wastewater



Characteristics Industrial Of Wastewater

TOC

Total organic carbon (TOC) is the amount of carbon found in water.

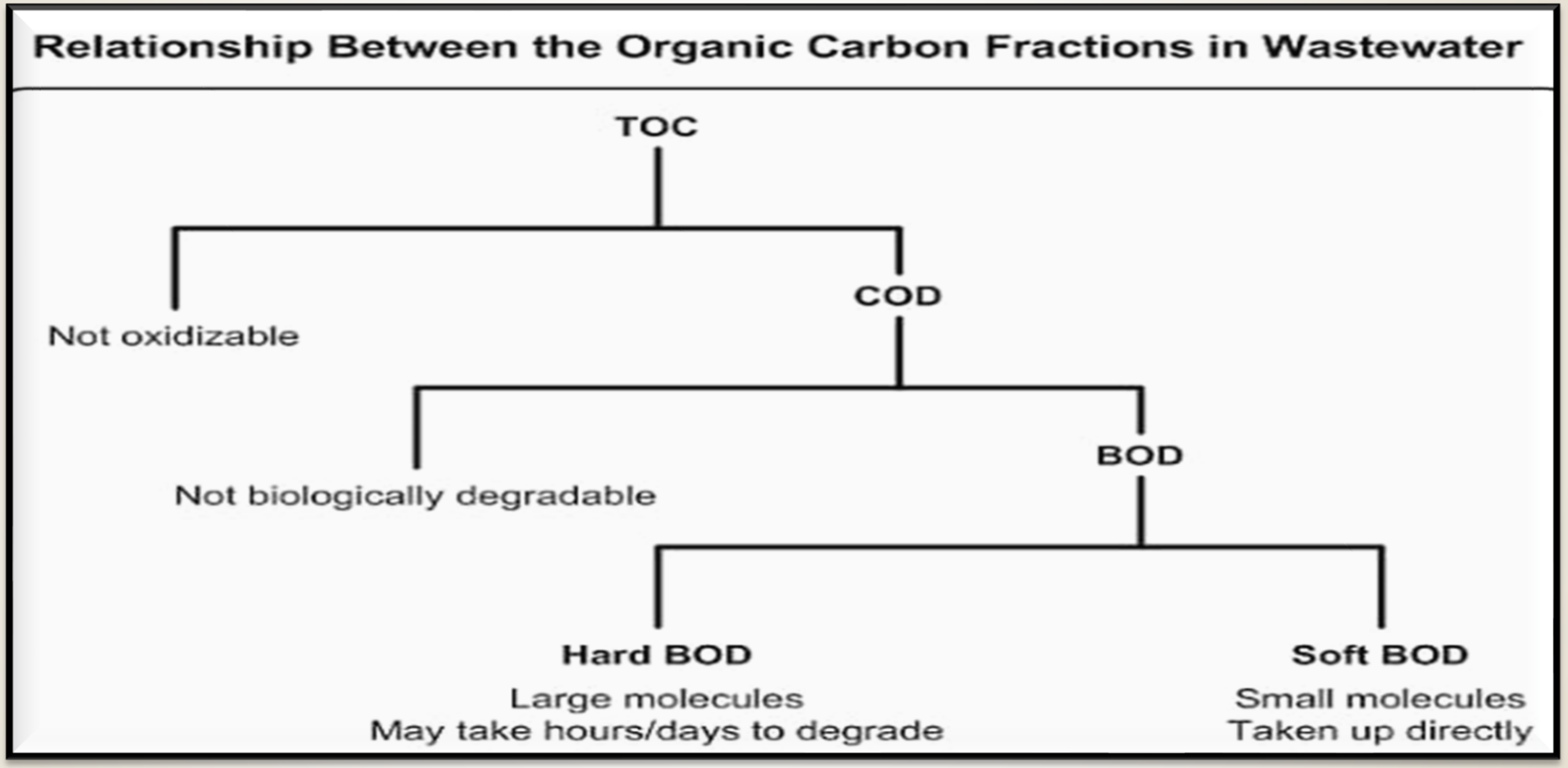
COD

is the amount of oxygen required to chemically oxidize organic matter in your wastewater into inorganic matter.

BOD

is the amount of oxygen required to biologically oxidize the organics in your sample.

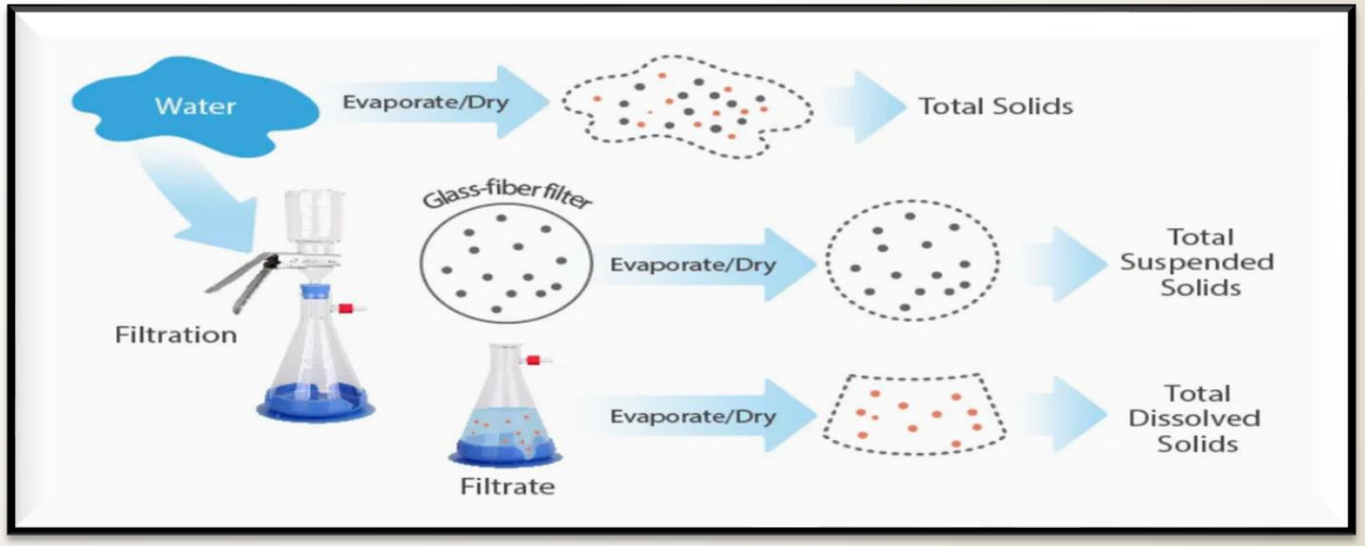
Characteristics Industrial Of Wastewater



Characteristics Industrial Of Wastewater

TSS & TDS

total suspended solids (TSS) and total dissolved solids (TDS) affect the water quality, high TSS may **decrease water's natural dissolved oxygen levels**



Characteristics Industrial Of Wastewater

Oils, grease and fats

- Organic substances are difficult to decompose by bacteria
- It must be removed before biological treatment, where oxygen exchange between air and water is hampered
- Increase BOD Value

FATS ***Solid at room temperature:*** butter, shortening, margarine, peanut butter, meat trimmings, uncooked poultry skin, cheese, milk, cream, sour cream, ice cream.

OILS ***Liquid at room temperature:*** vegetable oil, canola oil, olive oil, corn oil, salad dressings, cooking oils.

GREASE ***Liquid during cooking, solidified when cooled:*** gravy, mayonnaise, melted meat fat, bacon, sausage, boiled poultry skin, salad dressings.

Characteristics Industrial Of Wastewater

PH

- Hydrogen ion concentration is an important indicator of wastewater.
- The extent of proper concentration of the presence of most biological life is very small and critical.
- Over-the-range 6.5 : 8.5 wastewater is difficult to process biologically, so if pH is not proper , it will adversely affect pH in natural water.

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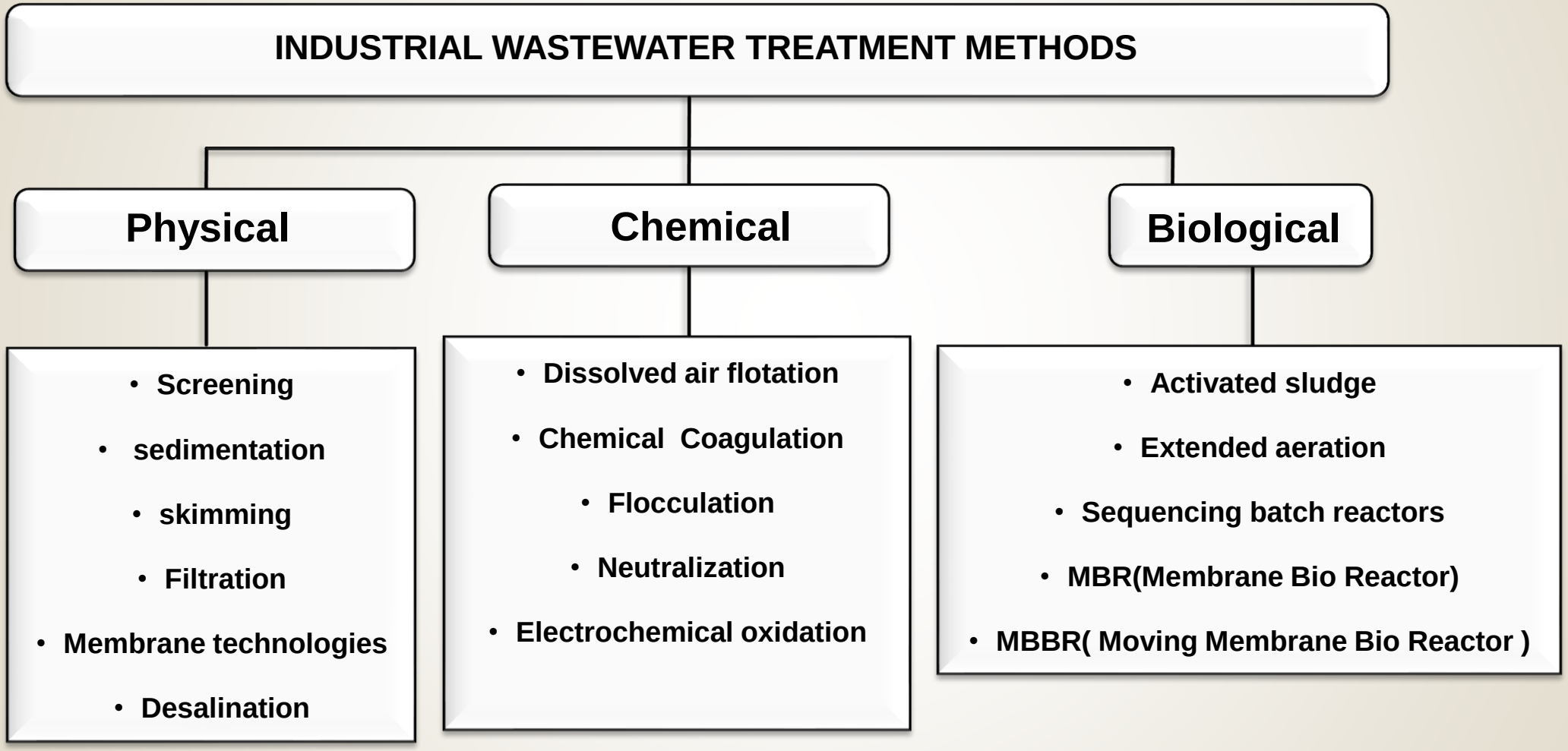
Wastewater Treatment Methods

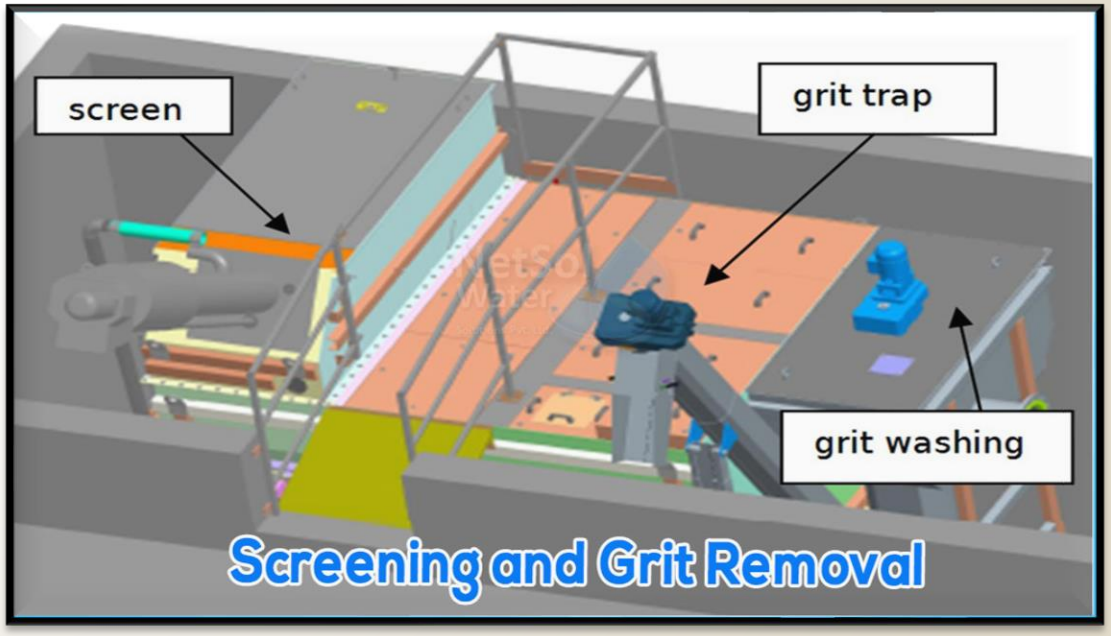


Wastewater Treatment Methods

1- Physical Treatment

Screening

We remove large solids and grit from wastewater because these solids and grit can interfere with the wastewater treatment processes.

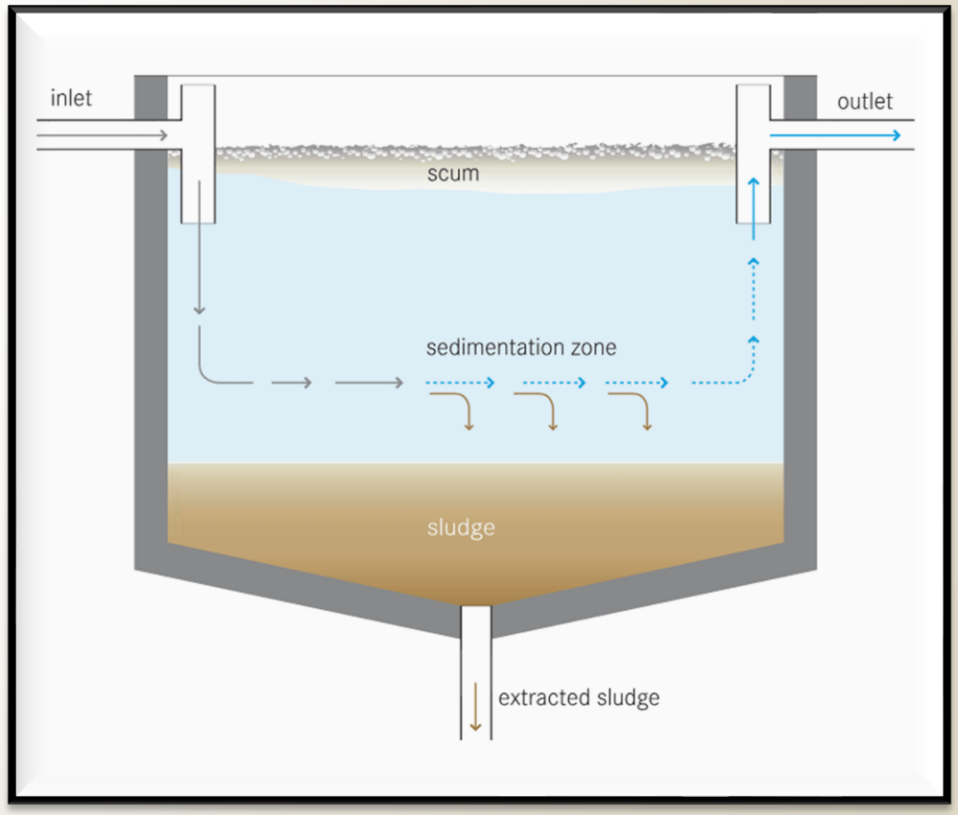


Wastewater Treatment Methods

1- Physical Treatment

Sedimentation

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.

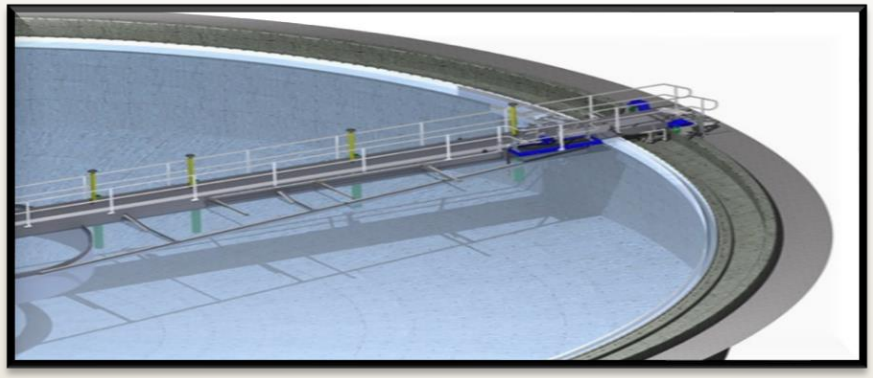


Wastewater Treatment Methods

1- Physical Treatment

skimming

The skimmer removes the floatable solids and liquids like oil and grease so that the wastewater can be further processed. Q. In the aeration tank of a wastewater treatment plant, aerobic bacteria help in getting rid of some contaminants.

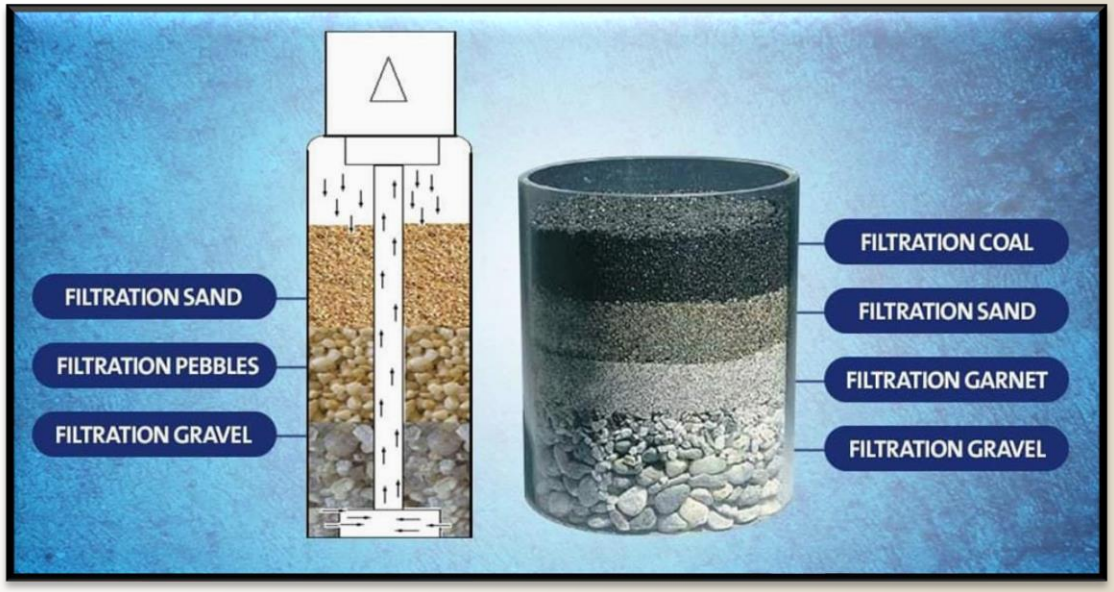


Wastewater Treatment Methods

1- Physical Treatment

Filtration

During filtration, the clear water passes through filters that have different pore sizes and are made of different materials (such as sand, gravel, and charcoal). These filters remove dissolved particles and germs, such as dust, chemicals, parasites, bacteria, and viruses.



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Wastewater Treatment Methods

2- Chemical Treatment

1. Reaction to produce an insoluble solid.
2. Reaction to produce an insoluble gas.
3. Reduction of surface charge to produce coagulation of a colloidal suspension
4. Reaction to produce a biologically degradable substance from a non biodegradable substance.
5. Reaction to destroy or otherwise deactivate a chelating agent.
6. Oxidation or reduction to produce a non-objectionable substance or a substance that can be removed more easily by one of the previous methods.

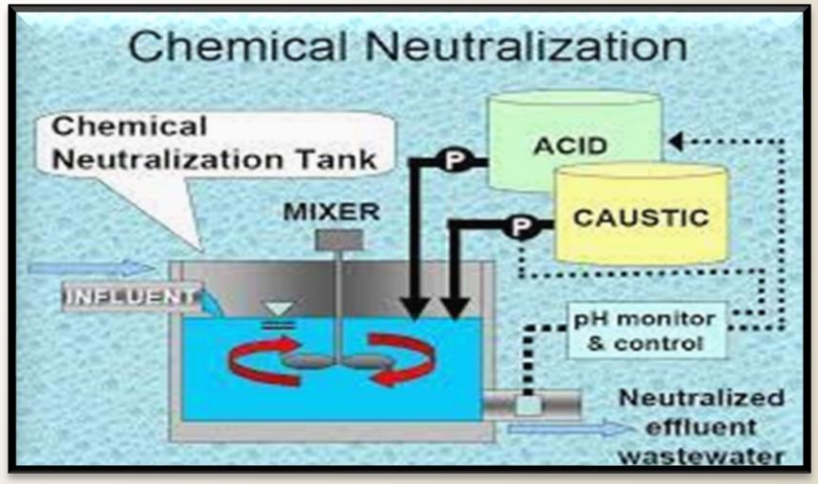
Wastewater Treatment Methods

2- Chemical Treatment

Neutralization

Chemical neutralization is important components of water and wastewater treatment.
Chemical neutralization is employed to balance the excess acidity or alkalinity in water.

- Caustic soda (NaOH)
- Sodium carbonate Soda Ash (Na_2CO_3)
- Calcium hydroxide ($Ca(OH)_2$)
- Hydrochloric acid (HCl)
- Sulfuric acid (H_2SO_4)

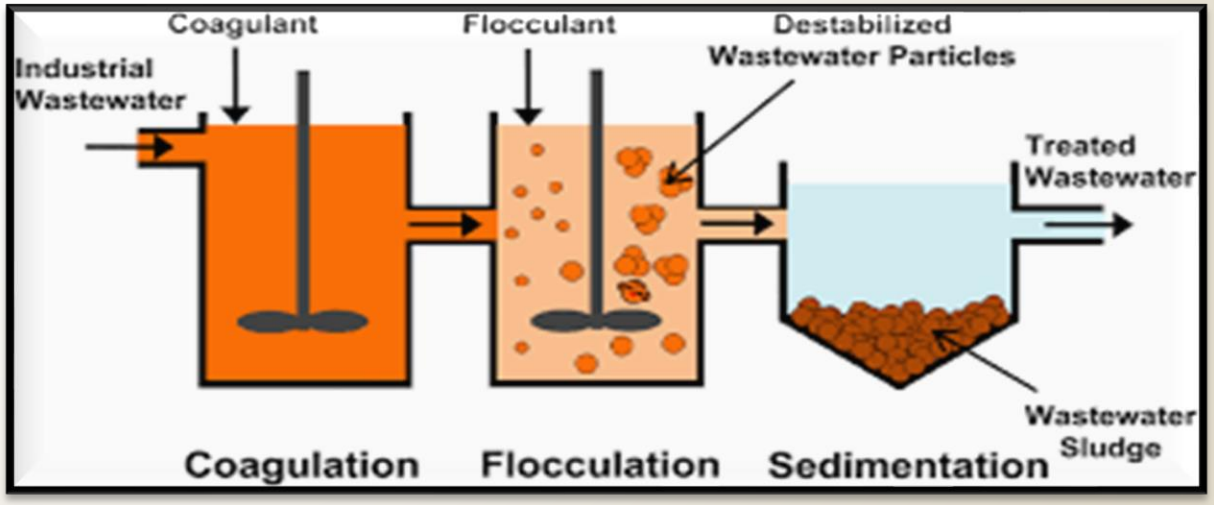


Wastewater Treatment Methods

2- Chemical Treatment

Chemical Coagulation

chemical water treatment process used to remove solids from water, by manipulating electrostatic charges of particles suspended in water. This process introduces small, highly charged molecules into water to destabilize the charges on particles, colloids, or oily materials in suspension.



Wastewater Treatment Methods

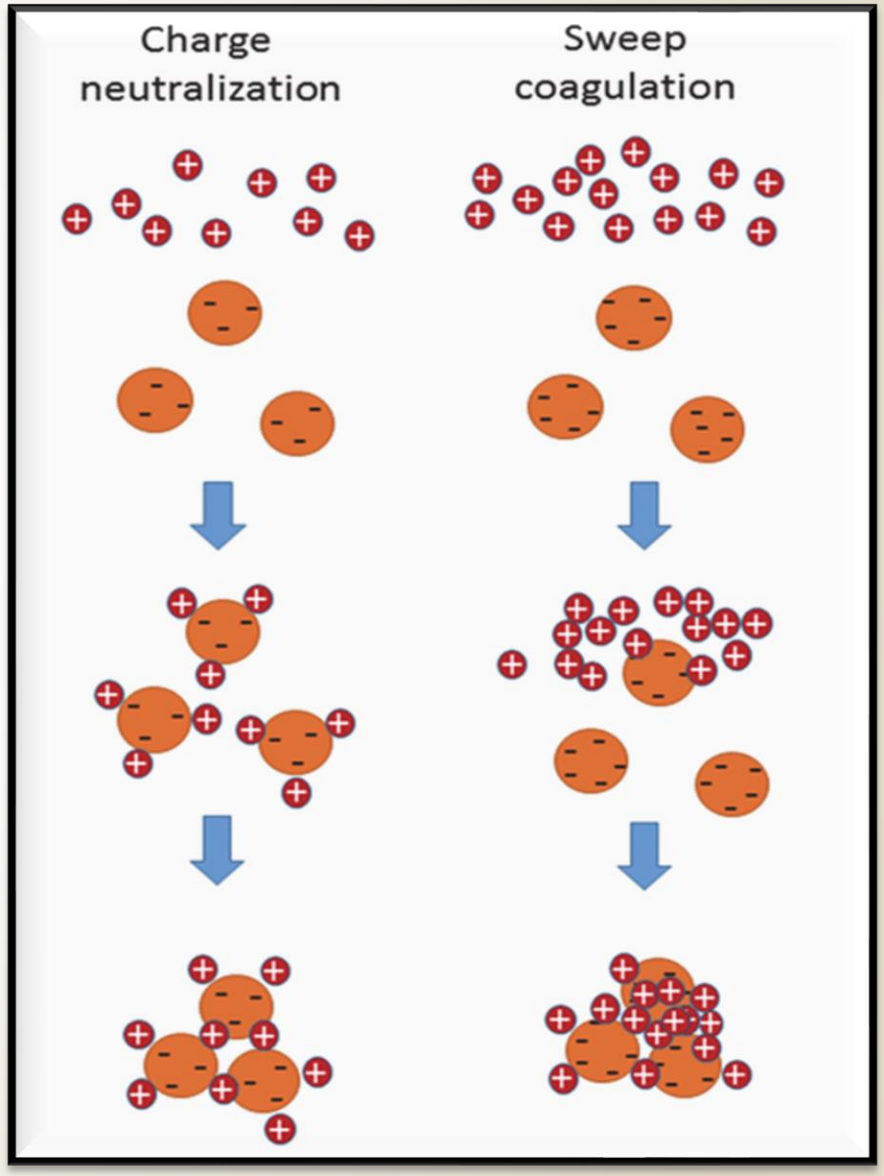
2- Chemical Treatment

Chemical Coagulation

Coagulation is a chemical process in which a chemical compound, a “coagulant”, is added to the water, in order to destabilize the suspended particles and promote creation of flocs.

A ‘Stable colloidal particle’ is a colloidal particle that remains as a separate entity in the water, i.e. in a dispersed state.

The reason colloidal particles tend to remain in the dispersed state is because their surface is electrically charged, usually with a negative charge.



Wastewater Treatment Methods

2- Chemical Treatment

Chemical Coagulation

The factors that influence coagulation

- temperature
- pH
- effluent quality
- dosage and coagulant type
- Corrosivity

Wastewater Treatment Methods

S. No	Industries	Coagulant	Dosing	Optimum Alkalinity/pH	Temperature	Max. Mixing/rpm	Parameter	Remark	Author
1	Sugar Industries	$(Al_2(SO_4)_3+FeSO_4)$ and Aluminium salt $Al_2(SO_4)$	5mg/l	7 .1	nm	nm	COD	75% AND 77% COD REDUCTION	Khan et al., 2003
2	Pulp and paper	Calcium benoite+alum	100mg/l+ 200mg/l	7	nm	120	color	88% of color reduction found	Dilek et al., 2001
3	Pulp and paper	polyaluminium chloride (PAC) as the chemical coagulant and bagasse fly ash (BFA)	3kg/l PAC, 2kg FOR FLY	PAC=pH3 Fly ash =pH 4	nm	120	Color and COD	COD and colour to 87 % and 95 %, respectively	Srivastava et al., 2005
4	Pulp and paper	Poly-Aluminum-Silicate-Chloride	40mg/l	7	nm	200	Turbity and COD	93.13% and 91.12%	Kadhum et al., 2011
5	Pulp and paper	aluminium chloride, poly aluminium chloride and copper sulphate	PAC=8ml/l $AlCl_3$=5ml/l $CuSO_4$=5ml/l	PAC=pH5 $AlCl_3$=pH4 $CuSO_4$=pH6	18	flash-mixed	COD and color	PAC= COD to 84 % and 92 % AlCl3= 74 % COD and 86 % colour CuSO4= 76 % COD reduction and 78 %	Kumar et al., 2011
6	Textile Industry	PAC	25mg/l	7	nm	100	COD, TDS and turbidity	90.17, 74.09 and 93.47%	Sabur et al., 2012
7	Distillery (cane molasses based DWW, BDE, and the anaerobic lagoon effluent (LE).)	$FeCl_3$, $AlCl_3$ and polyferric-hydroxysulfate	40mg/l	6	nm	150	Color, TOC	Polyferric-hydroxysulphate 32, 87, 94 % color reductions and 21 %, 73 %, 73 % TOC (total organic carbon) reductions	Migo et al., 1993

Wastewater Treatment Methods

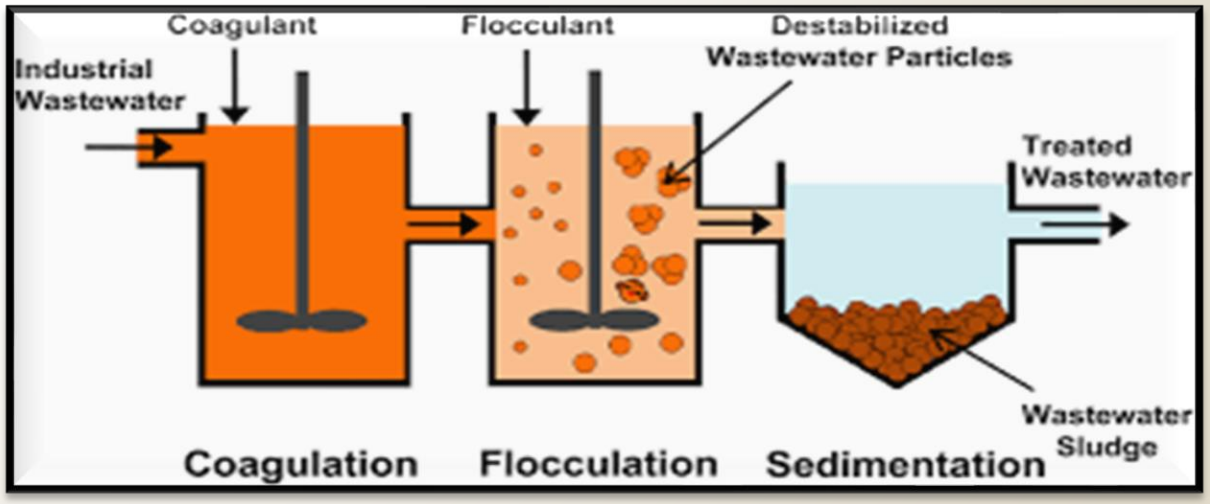
2- Chemical Treatment

Flocculation

Flocculation refers to the **process** by which fine particulates are caused to clump together into a floc. The floc may then **float** to the top of the liquid (creaming), **settle** to the bottom of the liquid (sedimentation),

Flocculants

- polyacrylamide (PAM
- sodium polyacrylate
- polyoxyethylene
- polyvinylamine
- polyvinyl sulfonate

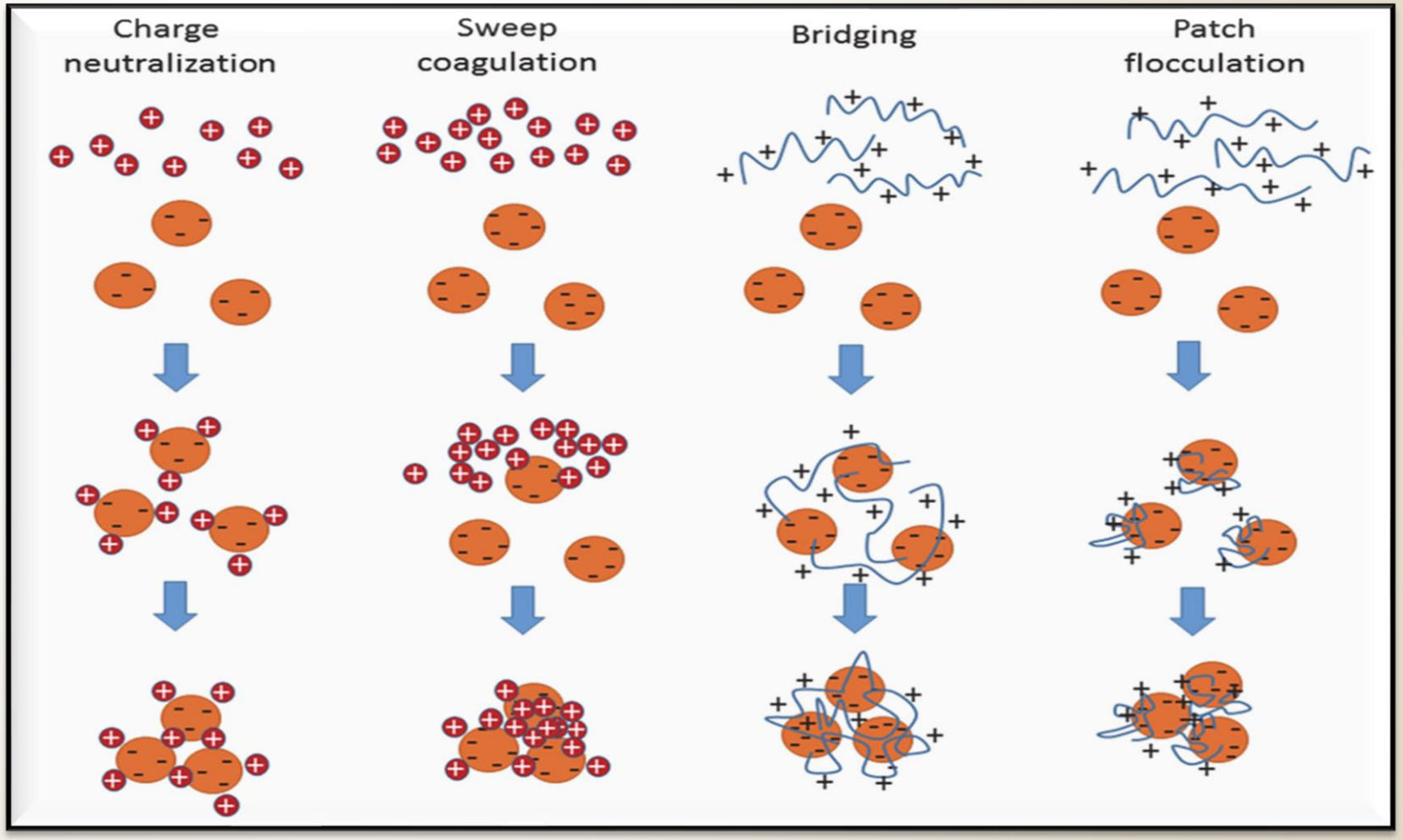


Wastewater Treatment Methods

2- Chemical Treatment

Flocculation

Flocculation is a process by which a chemical coagulant added to the water acts to facilitate bonding between particles, creating larger aggregates which are easier to separate.

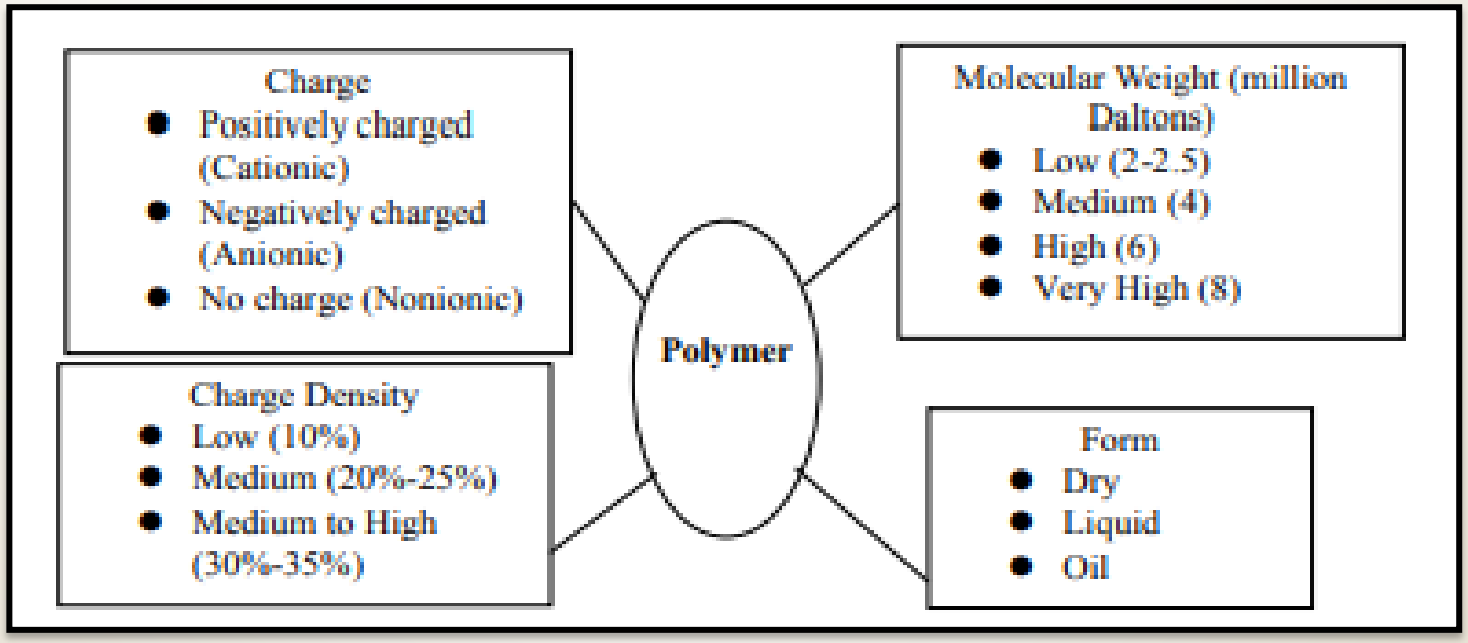


Wastewater Treatment Methods

2- Chemical Treatment

Chemical Flocculation

The factors that influence Flocculation



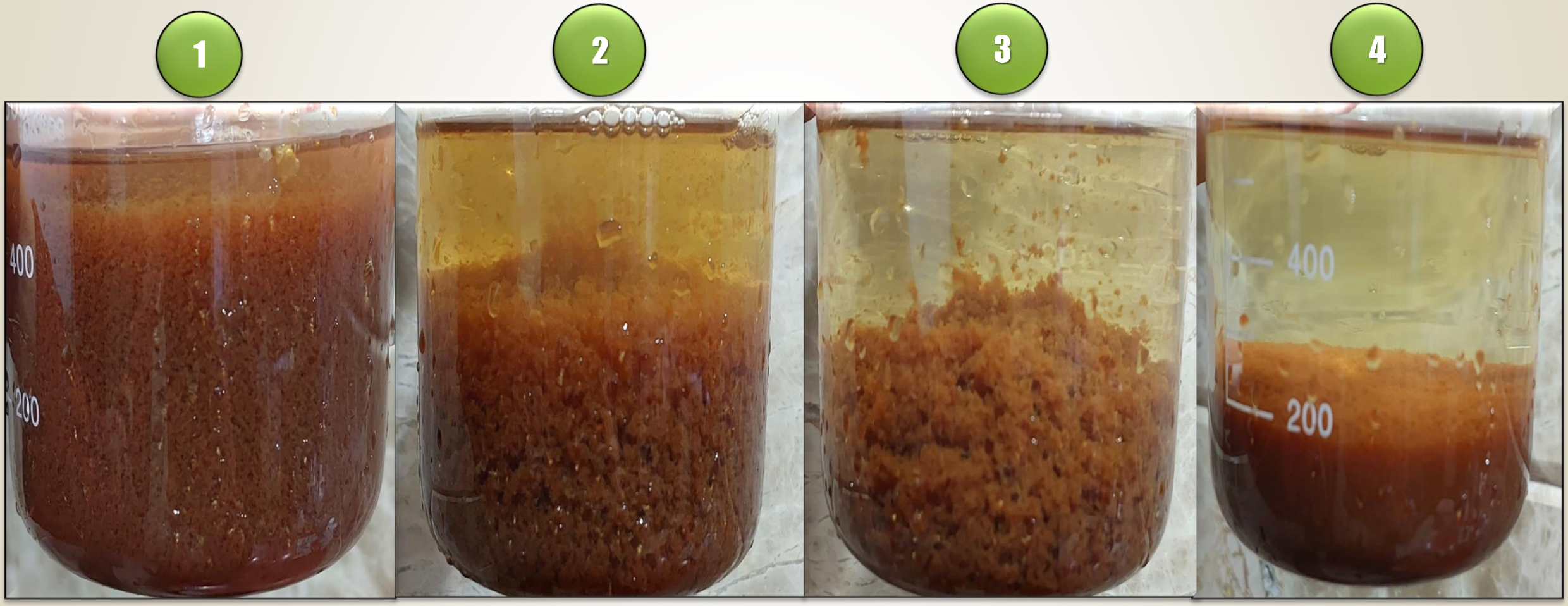
Wastewater Treatment Methods

2- Chemical Treatment

References	Coagulant		Polymer		TSS (mg/L)			References
	Name	Dosage (mg/L)	Name/type	Dosage (mg/L)	Influent	Effluent	Removal eff (%)	
Sarparastzadeh et al. (2007)	Aluminum sulfate	80	N/A	N/A	77.5	24	69	Sarparastzadeh et al. (2007)
	Ferric chloride	70	N/A	N/A	77.5	40.3	48	
Haydar & Aziz. (2009)	Aluminum sulfate	200-240	N/A	N/A	568-2130	N/A	94.3-97.1	Haydar & Aziz. (2009)
Amuda et al. (2006)	Ferric sulfate	500	Poly acrylamide polyelectrolyte	25	1620	97.2	94	Amuda et al. (2006)
	Ferric sulfate	500	N/A	N/A	1620	421.2	74	
Yu & Bourke (2000)	Ferric chloride	50	Anionic PAM	0.5	N/A	N/A	85	Yu & Bourke (2000)
Wang et al. (2009)	N/A	N/A	PAC	100	N/A	N/A	76	Wang et al. (2009)
He et al. (2016)	N/A	N/A	PAC	35	N/A	N/A	90	He et al. (2016)
Poon & Chu (1999)	Ferric chloride	30	Polyacrylamide	0.5	N/A	N/A	60-80	Poon & Chu (1999)
Johnson et al. (2008)	Ferric chloride	40	Anionic polymer	0.5	N/A	N/A	83	Johnson et al. (2008)
Aiyuk et al. (2004)	Ferrric chloride	50	Anionic polymer	10	N/A	N/A	85	Aiyuk et al. (2004)
Ghafari et al. (2009)	Aluminum	9500	N/A	N/A	80	7.92	90.1	Ghafari et al. (2009)
	N/A	N/A	PAC	2000	80	7.84	90.2	

Wastewater Treatment Methods

Coagulation & Flocculation

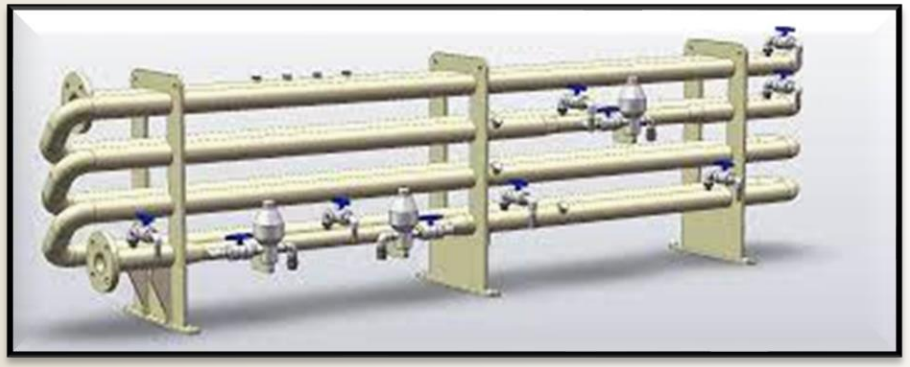


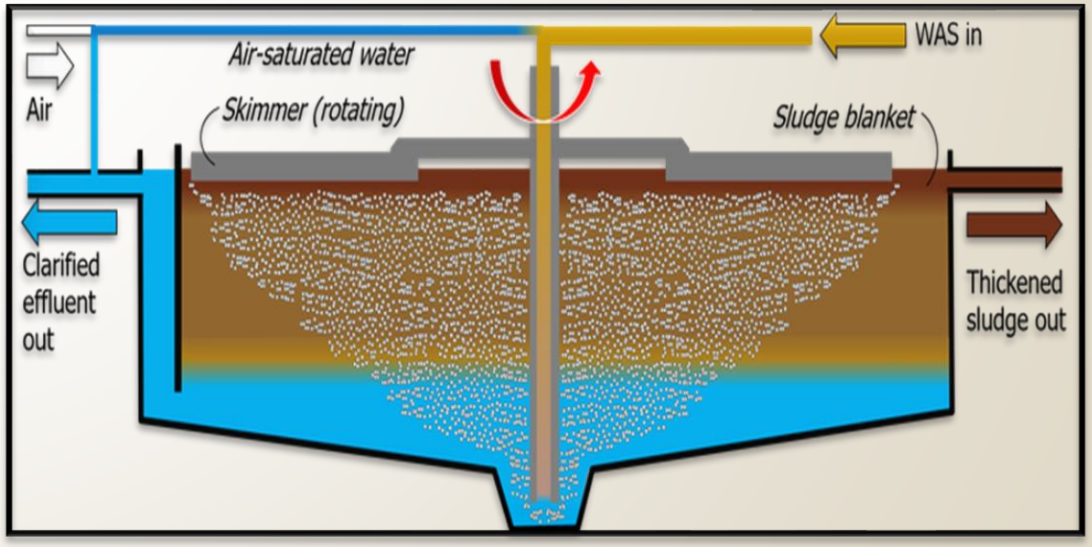
Wastewater Treatment Methods

2- Chemical Treatment

Dissolved Air Flotation (DAF)

Dissolved Air Flotation is a proven and effective physical/chemical technology for treating a variety of wastewater streams. DAF systems are designed to remove total suspended solids (TSS), biochemical oxygen demand (BOD), and oils and greases (O&G) from a wastewater stream.



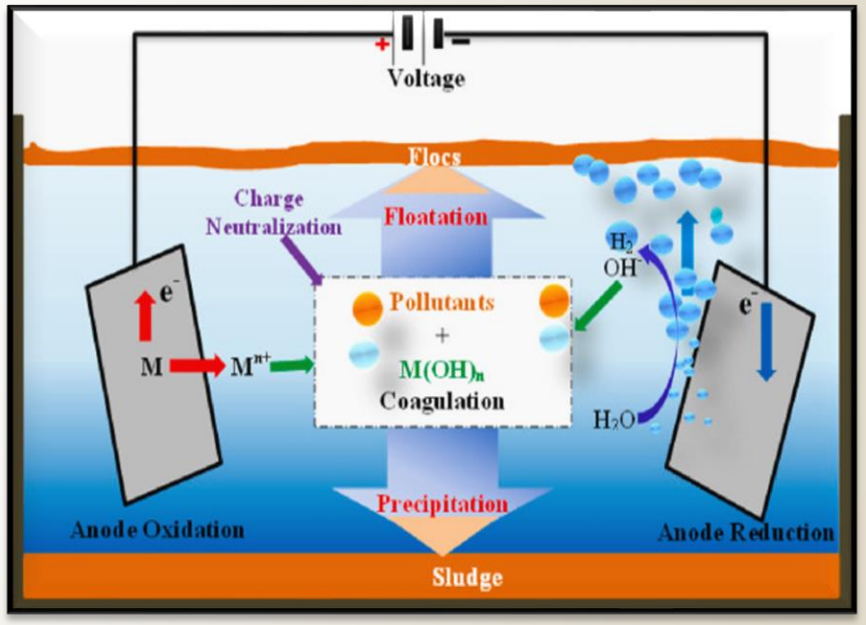


Wastewater Treatment Methods

2- Chemical Treatment

Electrocoagulation

In the EC process, different metal hydroxide species are formed. The metal hydroxides (coagulant) aggregate the dispersed particles in the solution, which forms bigger flocs and then is removed by sedimentation. In most cases, EC is not able to reduce the stable persistent organic compounds to below the allowable discharge limits. Also, the EO process is an emerging process where contaminants are removed by oxidizing directly at the surface of the electrode or indirectly by generating oxidants in the solution



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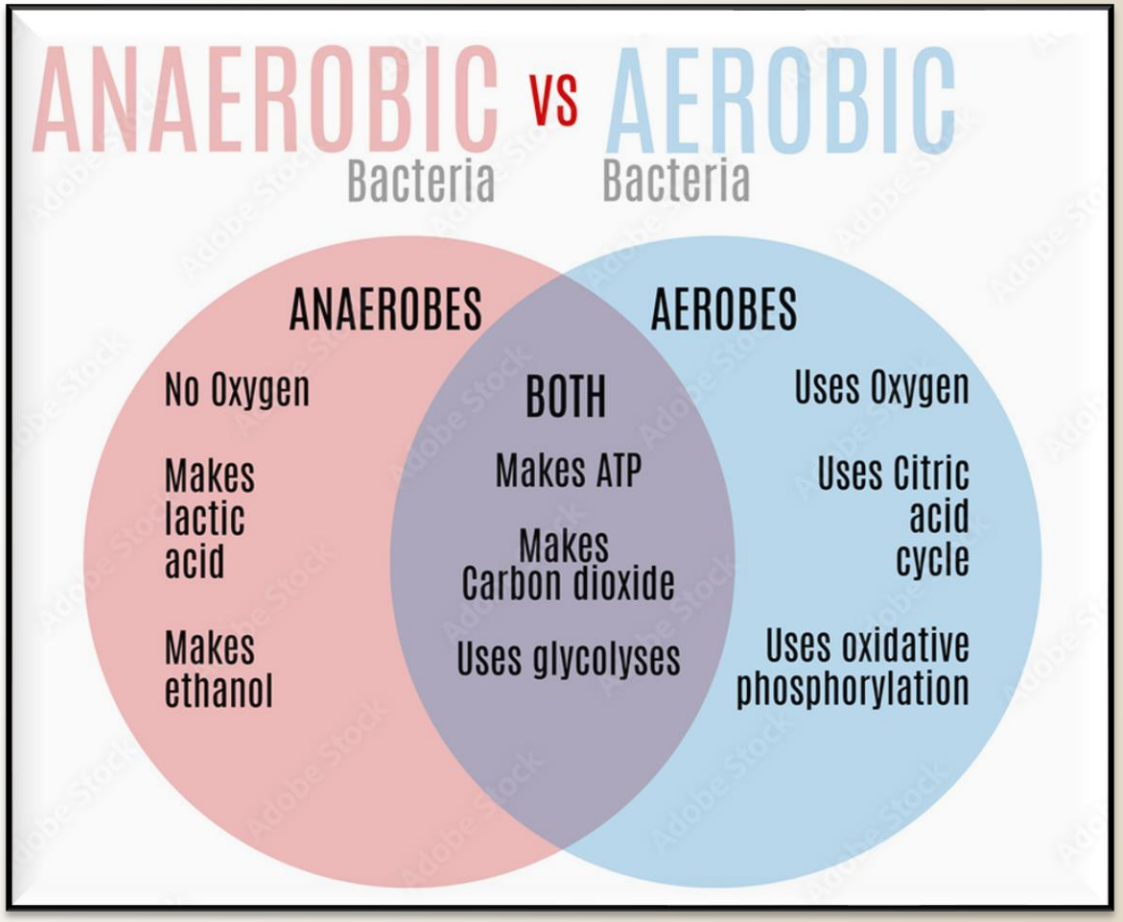
Wastewater Treatment Methods

3- Biological Treatment

Bacteria are exploited for the ability to:

Absorb the soluble and colloidal organic substances present in the wastewater, making them suspended and sedimentable (bio-flocculation).

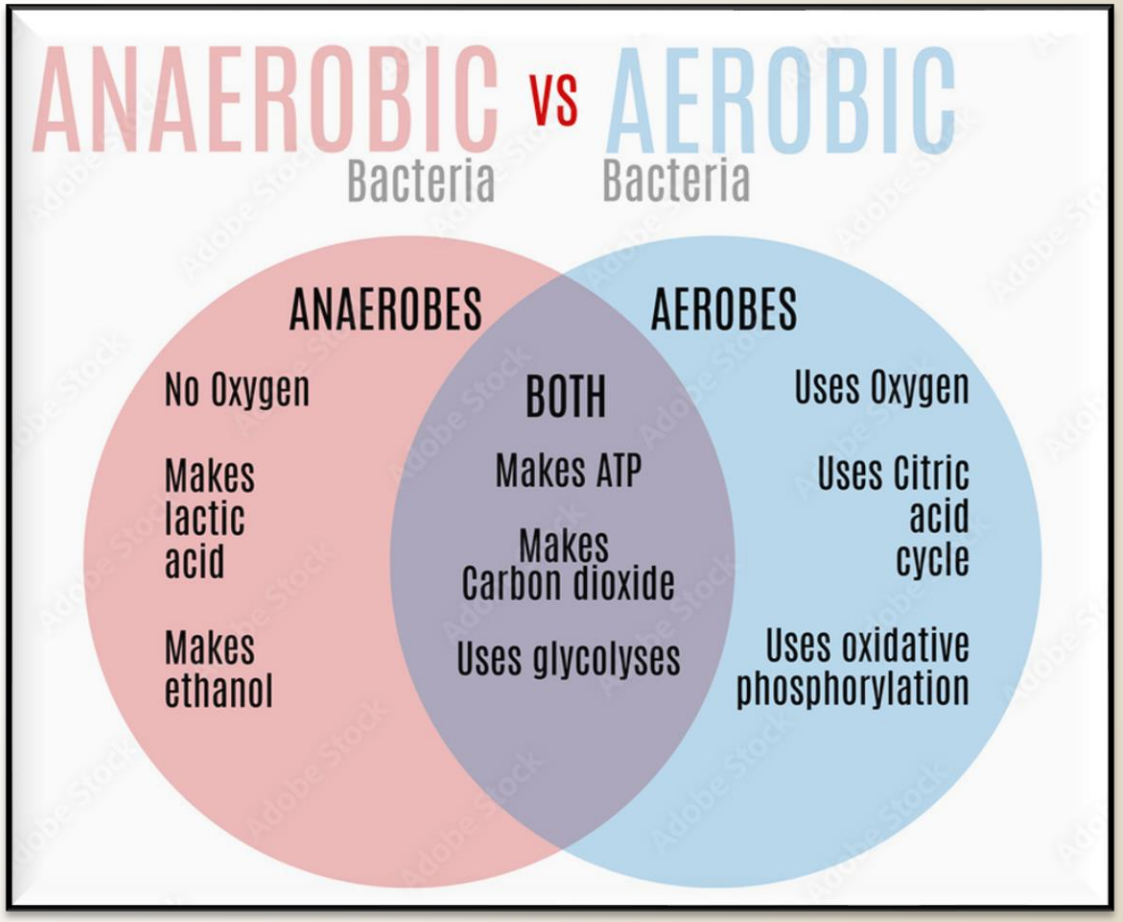
Directly degrade the organic substances used for their metabolism, turning them into aggregates (new cells synthesys).



Wastewater Treatment Methods

3- Biological Treatment

- Aerobic treatment is typically applied to efficiently treat low strength wastewater (COD <1000 mg/L) when the treatment requires the presence of oxygen.
- anaerobic treatment is typically applied to treat wastewater with higher organic loading (COD >4000 mg/L).



Wastewater Treatment Methods

3- Biological Treatment

Aerobic activated sludge	*Anaerobic degradation*
High energy intensive	Low energy intensive
Large volume of sludge	Small volume of sludge
Requires highly skilled operation and process control	Requires moderate skilled operation and process control
Additional nutrients is required	No additional nutrients required
Costly technical specifications	No costly technical specifications
Poor solid settleability	Good solid settleabiblity
Requires high hydraulic retention time (HRT)	Low HRT
Low elimination rate	High elimination rate

Wastewater Treatment Methods

3- Biological Treatment

For their growth, bacteria need:

- **Carbon source**:
  - Organic (heterotrophs).
  - Inorganic (autotrophs).

- **An electron acceptor**:
  - Free oxygen (aerobic processes).
  - Bound oxygen (anoxic processes).
  - An organic compound (fermentation).

- **An energy source**:
  - Light (photosynthetics).
  - Organic substances (heterotrophs).
  - Inorganic substances (chemolithotrophs).

Wastewater Treatment Methods

3- Biological Treatment

For their growth, bacteria need:

The presence of N and P is essential for proper **bacterial metabolism**. The following ratio in the influential slurry must be ensured:
BOD : N : P = 100: 5 : 1

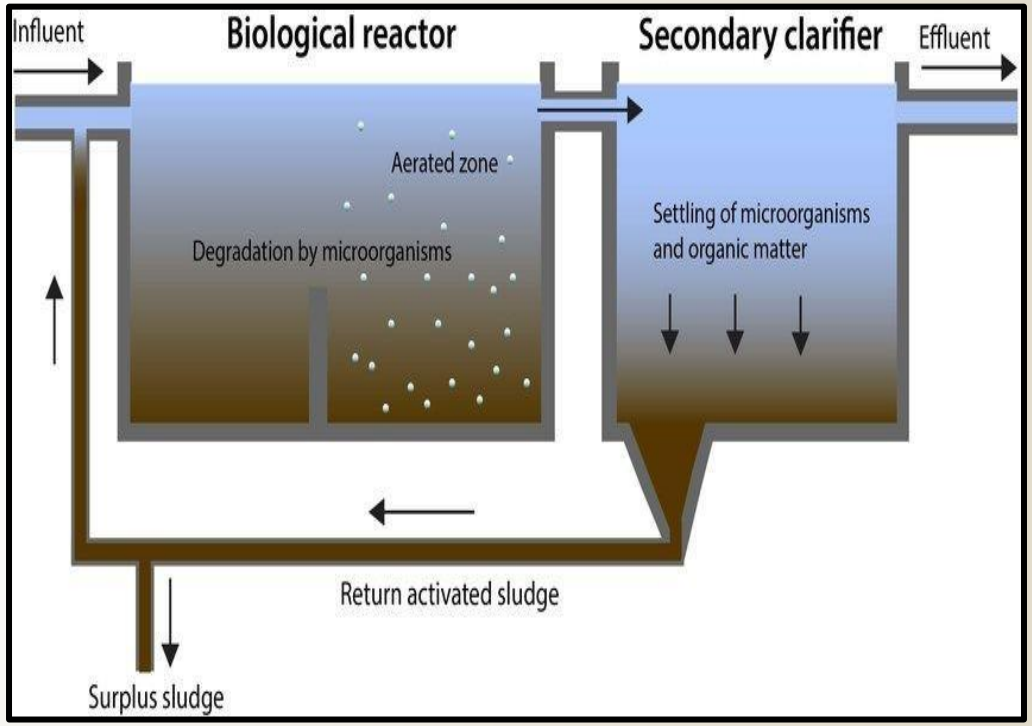
Deficiency of nutrients has to be integrated adding chemicals

Wastewater Treatment Methods

3- Biological Treatment

Activated sludge

The activated sludge process is the most widely used biological wastewater treatment. As is well known, by its means, suspended-growth microorganisms are applied The general arrangement of an activated sludge process for removing carbonaceous pollution

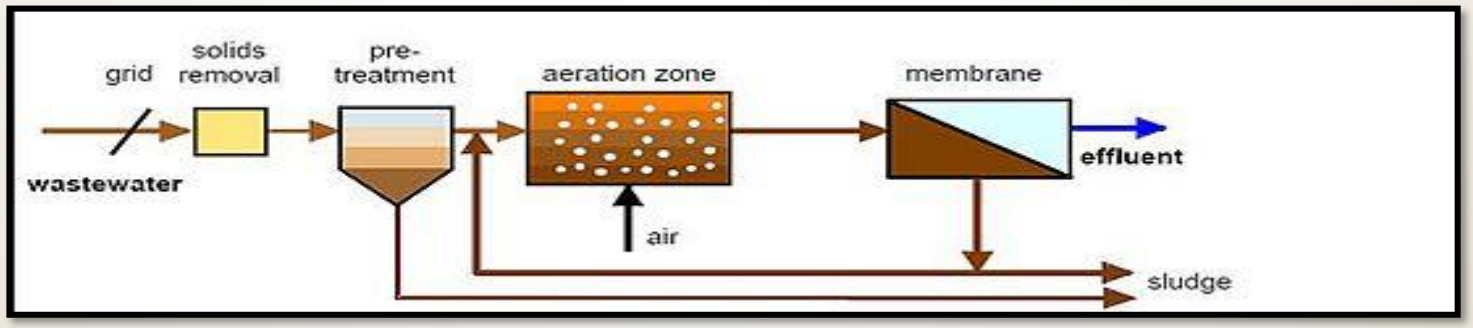


Wastewater Treatment Methods

3- Biological Treatment

MBR(Membrane Bio Reactor)

Membrane bioreactor (MBR) is the combination of a membrane process like microfiltration or ultrafiltration with a biological wastewater treatment process, the activated sludge process. It is now widely used for municipal and industrial wastewater treatment



Wastewater Treatment Methods

3- Biological Treatment

MBBR (Moving Membrane Bio Reactor)

Moving bed biofilm reactor (MBBR) is a type of wastewater treatment process

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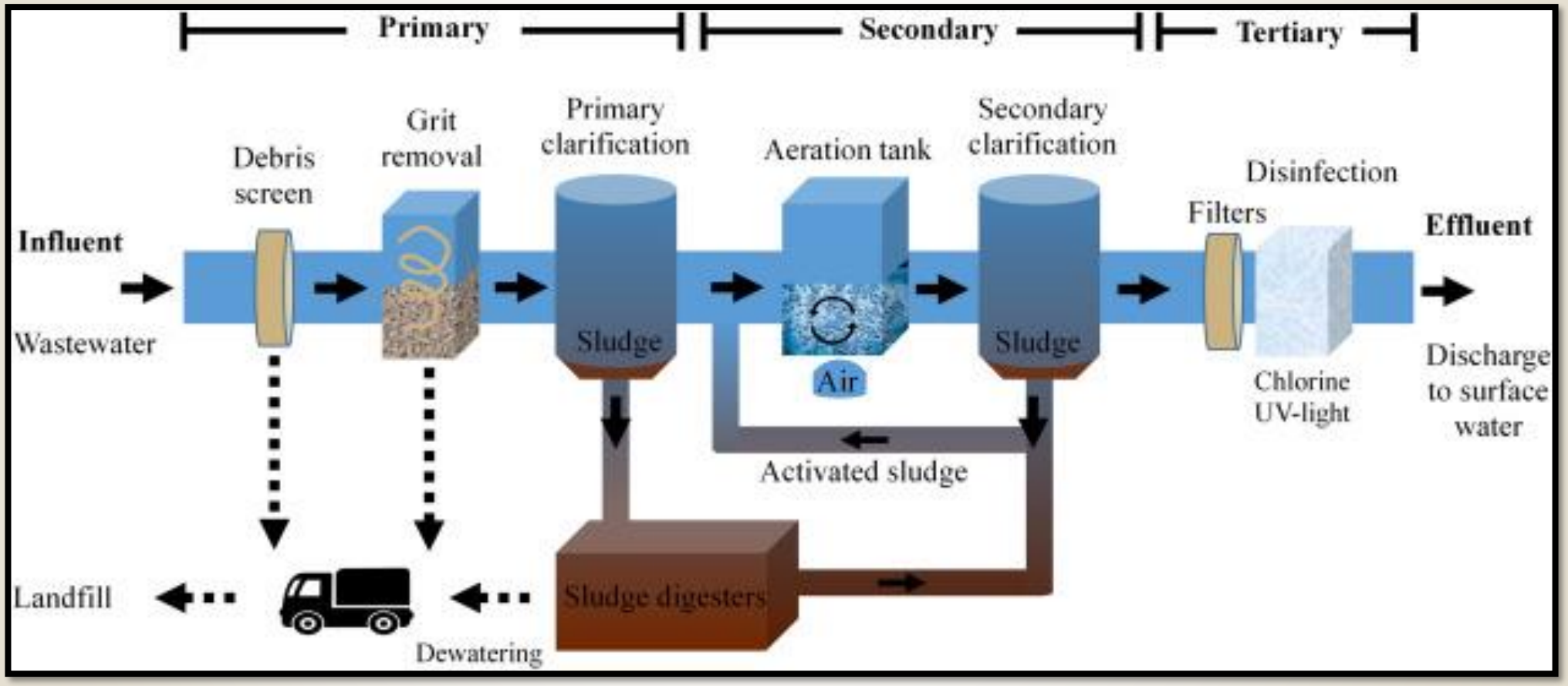
Wastewater Treatment Stages



Wastewater Treatment Stages

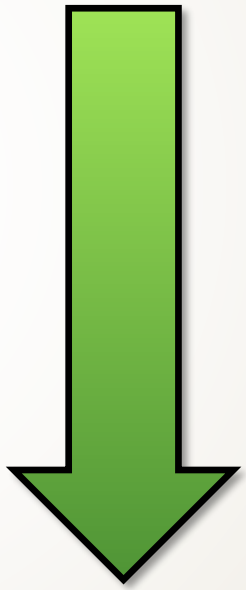
Wastewater Treatment Stages Based On The Following :

- Avoidance
- Re-use
- Re-cycling
- Recovery of energy
- Treatment
- Disposal
- The treating of wastewaters can take place at different points in the process.

Wastewater Treatment Stages

Characteristics Of Industrial Wastewater Removal

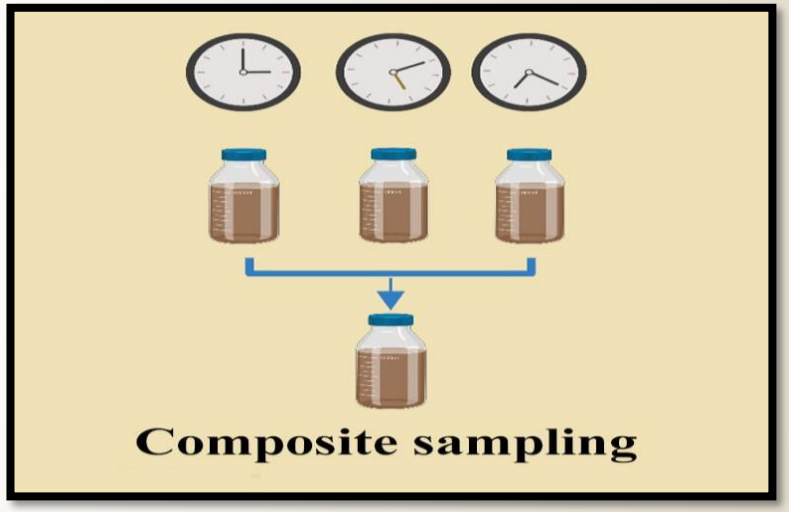
1. sedimentable Tss
2. Ph adjustment
3. Oil & Grease
4. Ph adjustment
5. non-sedimentable TSS
6. COD & BOD
7. TDS



Wastewater Treatment plants

Sample Collecting

Composite sampling consists of a collection of numerous individual discrete samples taken at regular intervals over a period of time, usually 24 hours



Wastewater Treatment plants

Jar test

Jar testing is a pilot-scale test of the treatment chemicals used in a particular water plant. It simulates the coagulation/flocculation process in a water treatment plant

Wastewater Treatment plants

Selection of Treatment System

- Daily flowrate
- Peak hour flowrate
- Available area
- Purpose of treatment
- Composite sampling analysis for

COD , BOD , TSS , TDS , PH , Oil & Grease

Wastewater Management

Case study

Before

parameters	Unit	Results
pH		11.9
Chemical oxygen demand ,COD	mgO_2/l	4100
Biological oxygen demand ,BOD	mgO_2/l	2200
Total suspended solids	mg/l	480
Settleable matter at 10 min	ml/l	suspension
Settleable matter at 30 min	ml/l	suspension
Total dissolved solids	mg/l	4900
Total nitrogen	mg/l	250
Total phosphorus	mg/l	43
Oil and grease	mg/l	47

After

Parameter	Untreated WW
pH	11.8
Chemical Oxygen Demand, COD, mgO_2/l	1980
Soluble Chemical Oxygen Demand, COD, mgO_2/l	1130
Biological Oxygen Demand, BOD, mgO_2/l	1050
Total Suspended Solids, TSS, mg/l	140
Total Dissolved Solids, TDS, mg/l	2630

Wastewater Management

Case study

TSS	COD	TDS	Temp	PH	اسم العينة
3788	7744	1969	36.7	7.31	مصنع كرتون
1500/mil	1100/mil	800/mil	Up to 43	6.0 - 9.5	النسب القياسية

Course content

- ✓ Wastewater type
- ✓ Characteristics Of Wastewater
- ✓ Wastewater Treatment Market
- ✓ Industrial Wastewater
- ✓ Industrial Wastewater Treatment
- ✓ Characteristics Industrial Of Wastewater
- ✓ New Borg El-Arab City factories
- ✓ Wastewater Treatment Methods
- ✓ 1- Physical Treatment
- ✓ 2-Chemical Treatment
- ✓ 3- Biological Treatment
- ✓ Wastewater Treatment Stages
- ✓ Wastewater Treatment plants
- ✓ Wastewater Management


Any questions?