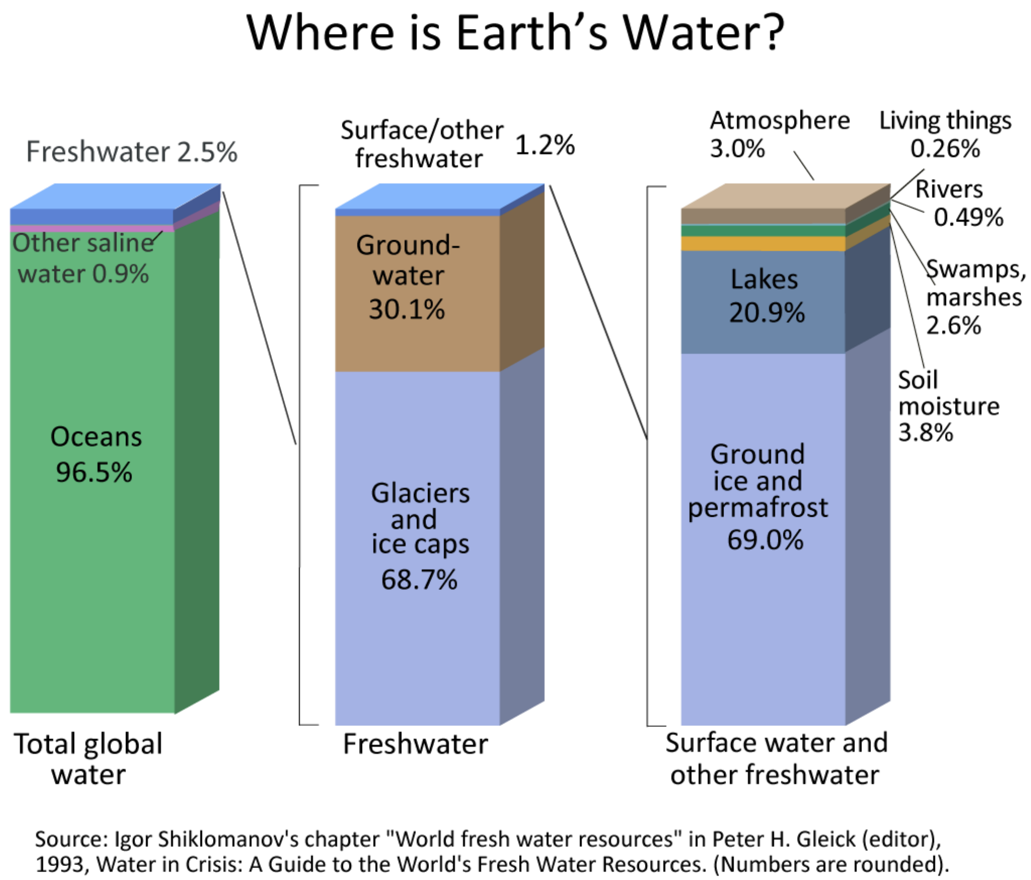
Water Resourse

total water supply of about 332.5 million cubic miles of water, over 96 percent is saline. And, of the total freshwater, over 68 percent is locked up in ice and glaciers. Another 30 percent of freshwater is in the ground. Fresh surface-water sources, such as rivers and lakes, only constitute about 22,300 cubic miles (93,100 cubic kilometers), which is about 1/150th of one percent of total water. Yet, rivers and lakes are the sources of most of the water people use everyday



Water Pollution

Organic water pollutants include:

- Detergents
- Disinfection by-products found in chemically disinfected drinking water, such as chloroform

- Food processing waste, which can include oxygen-demanding substances, fats and grease
- Petroleum hydrocarbons, including fuels (gasoline, diesel fuel, jet fuels, and fuel oil) and lubricants (motor oil), and fuel combustionbyproducts, from storm water runoff[26]
- Various chemical compounds found in personal hygiene and cosmetic products
- Drug pollution involving pharmaceutical drugs

inorganic water pollutants include:

- Acidity caused by industrial discharges (especially sulfur dioxide from power plants)
- Ammonia from food processing waste
- Chemical waste as industrial by-products
- Fertilizers containing nutrients--nitrates and phosphates—which are found in storm water runoff from agriculture, as well as commercial and residential use (see nutrient pollution)
- Heavy metals from motor vehicles (via urban storm water runoff) and acid mine drainage

.

In addition to the organic and inorganic contaminants also pathogens

Wastewater is a complex matrix containing significant concentrations of solids (total solids 350–1200mg/l), dissolved and particulate matter (chemical oxygen demand 250–1000mg/l), microorganisms (up to 109 number/ml), nutrients, heavy metals and micro-pollutants

Waste Water treatment stages

1-preliminary treatment

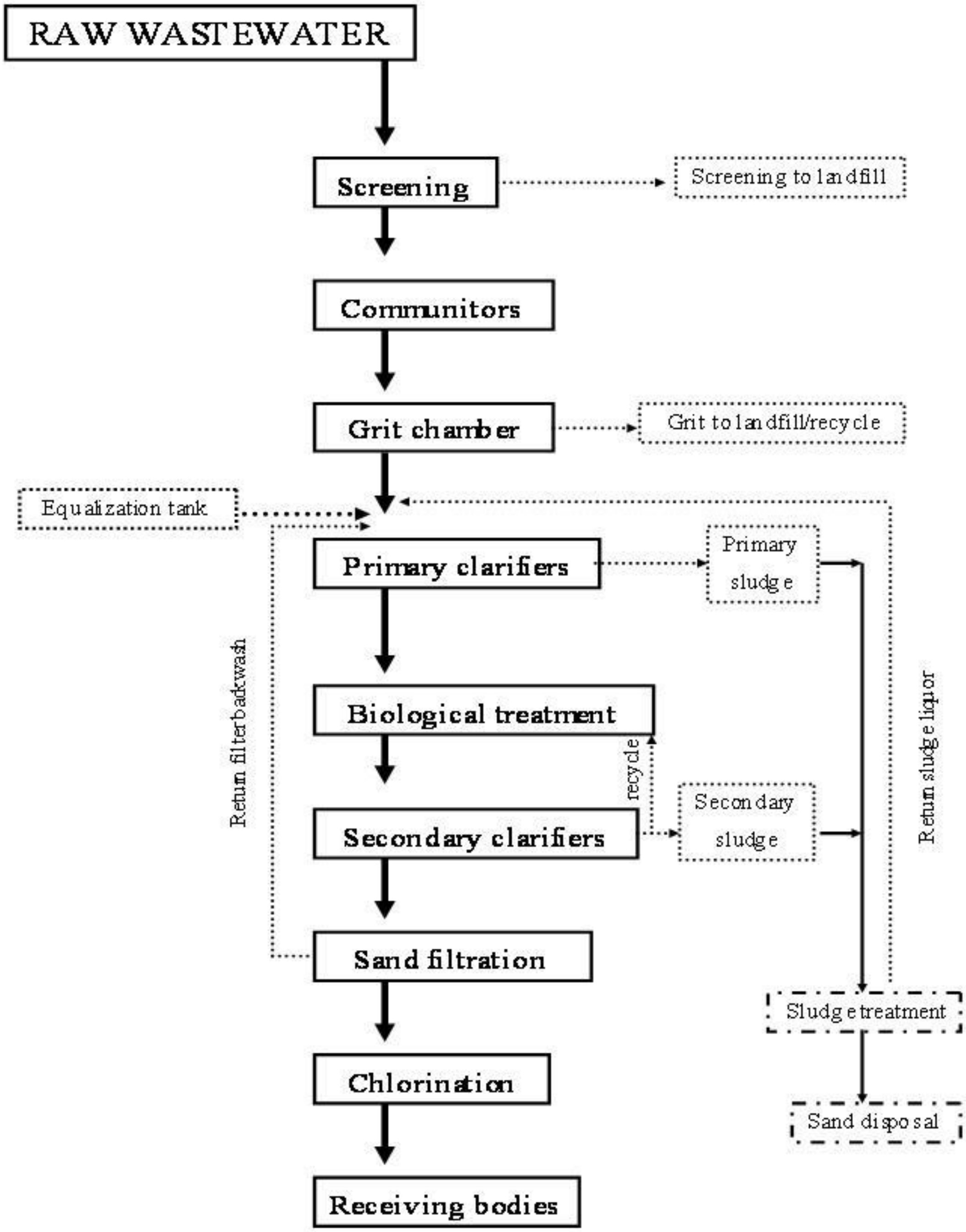
2-primary treatment

3-secondary treatment

4-advanced treatment

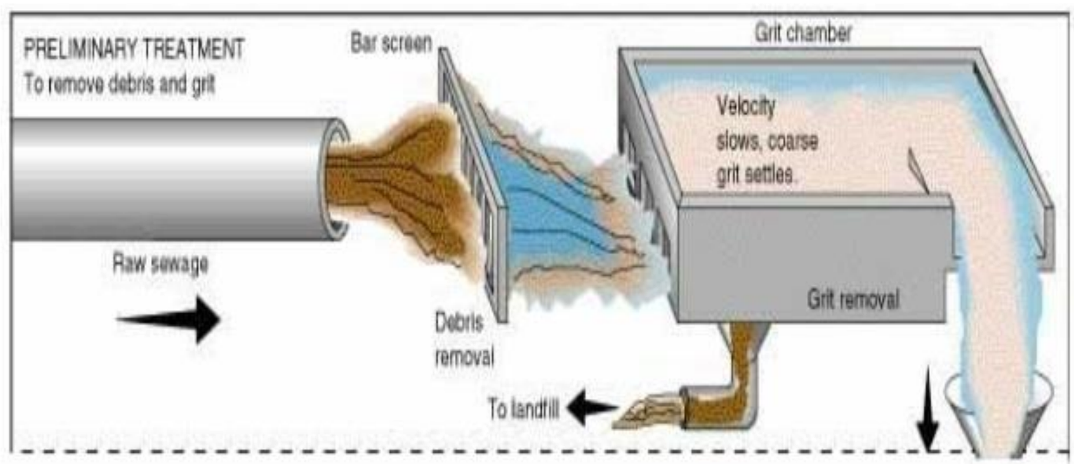
5-distinfaction

6-storage of treated water


RAW WASTEWATER
Screening
Screening to landfill
Communitors
Grit chamber
Grit to landfill/recycle
Equalization tank
Primary clarifiers
Primary sludge
Return filter backwash
Return sludge liquor
Biological treatment
recycle
Secondary clarifiers
Secondary sludge
Sand filtration
Sludge treatment
Chlorination
Sand disposal
Receiving bodies

Stage one preliminary treatment

Preliminary Treatment



The purpose of preliminary treatment is to ensure a satisfactory quality of final effluent and final sludge product and to protect the treatment process from malfunction associated with accumulation of screenings, debris, inorganic grit, excessive scum formation or loss of efficiency associated with grease or oil films or fat accumulation

Preliminary treatment of wastewater consists of the following steps:

Screening

Comminution

Grit Removal

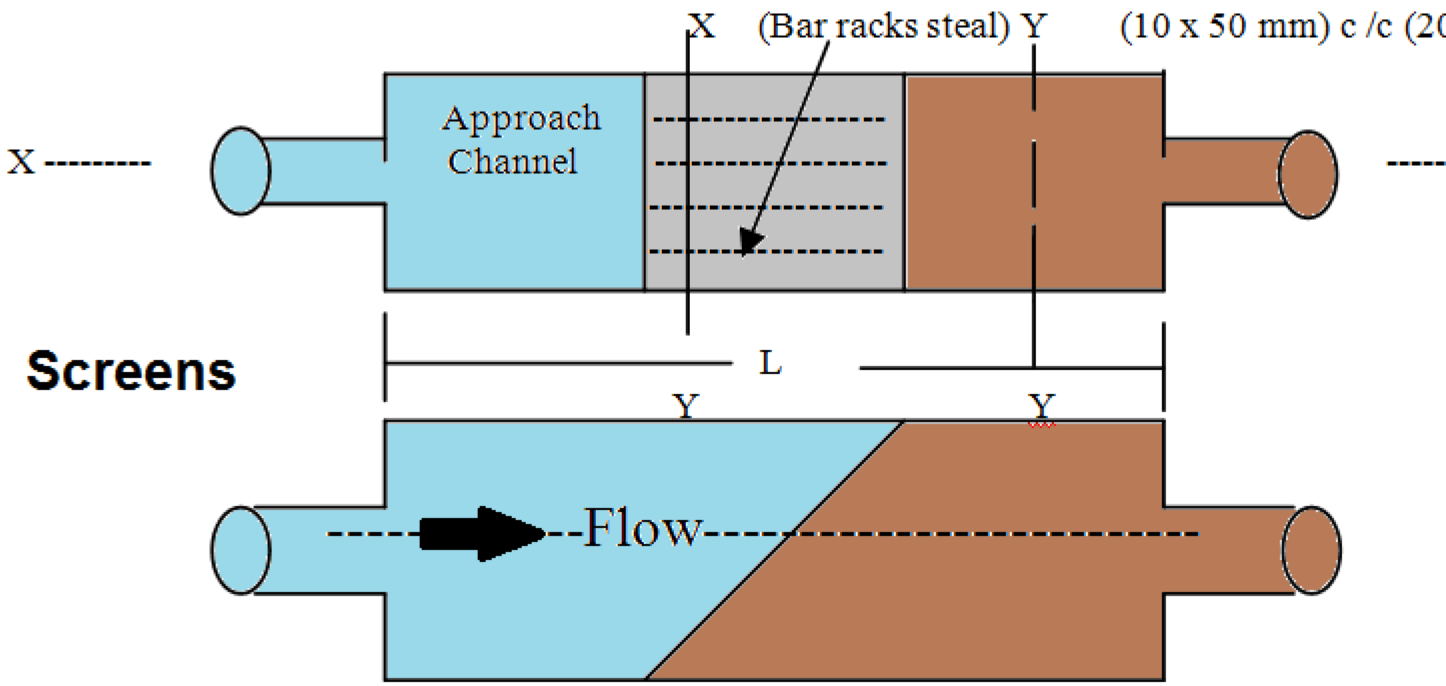
Flow Equalization

Oil and Grease Removal

Pre-Aeration

1. Screening

The first *unit operation* generally encountered in wastewater treatment plants is screening. A screen is a device with openings, generally of uniform size, that is used to retain solids found in the influent wastewater to the treatment plant. The principal role of screening is to remove coarse materials (pieces of wood, plastics, rags, papers, leaves, roots etc.) from the flow stream that could:



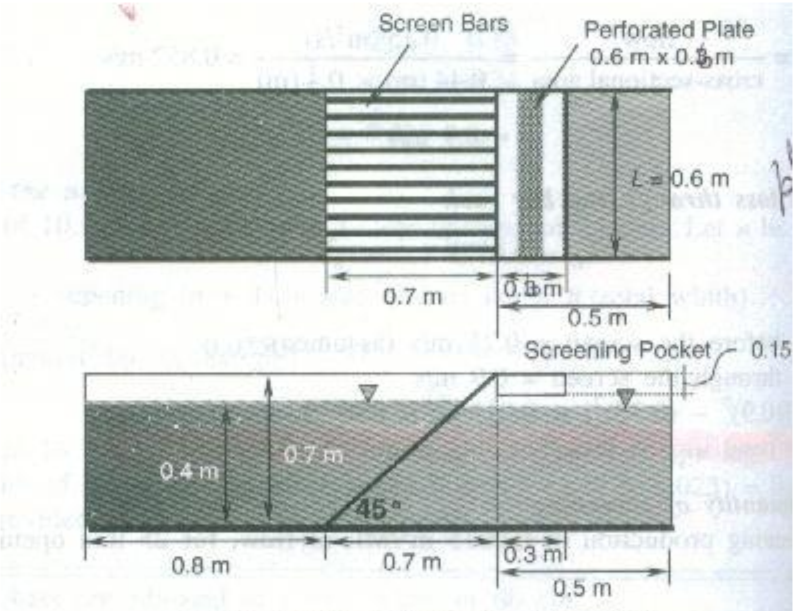
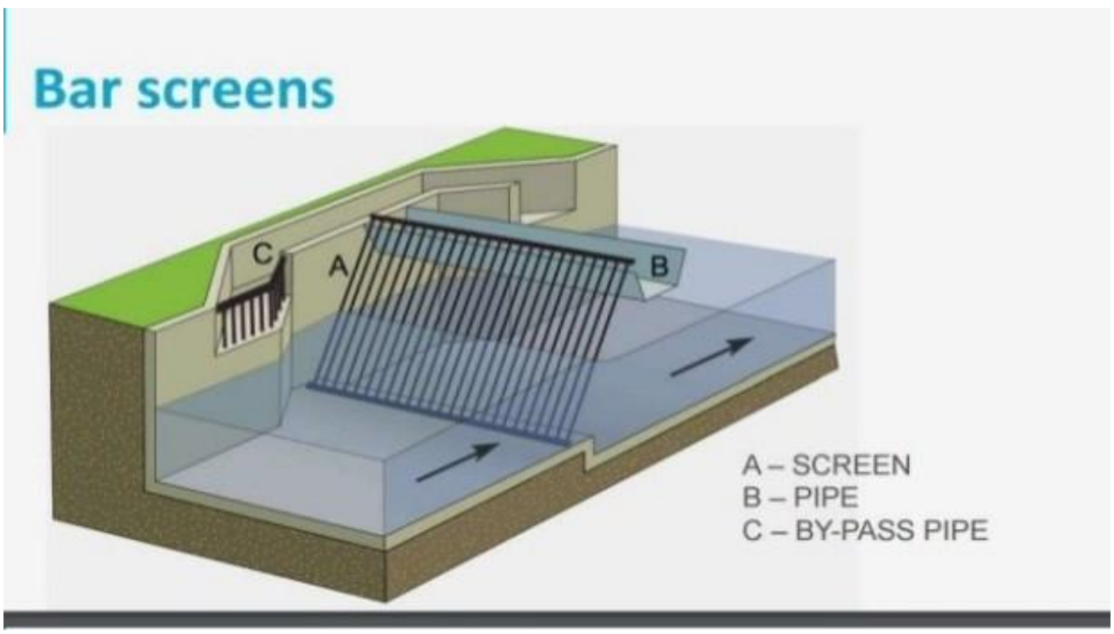


Figure 5.8 Details of a bar screen.



2. Wastewater treatment through Coarse Solids Reduction:

2. Wastewater treatment through Coarse Solids Reduction:

mechanically cleaned screens to shred screenings that are cut up into a smaller, more uniform size for return to the flow stream for subsequent removal by downstream treatment operations and processes, communitors, macerators and grinders can theoretically eliminate the messy and task of screening handling and disposal.

Comminutors – small WWT (0.2 m^3/s or 5 MGD) 6 - 20 mm (0.25 N 0.77in)

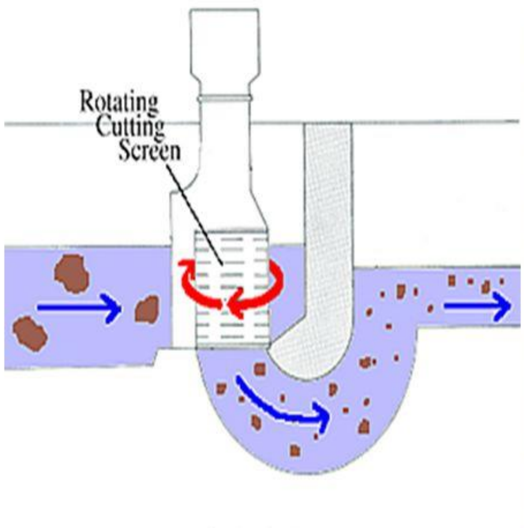
a. Comminutors:

Comminutors are used commonly in small wastewater treatment plants having discharge less than (0.2m^3/s or 5MGD). They are installed in a wastewater flow channel to screen and shred material to sizes from 6 to 20 mm (0.25 to 0.77 in) without removing the shredded solids from the flow stream. It cuts them to a relatively uniform size and prevents the solids from freezing/clogging in the flow.

Comminutors are always placed before the grit chamber

PRETREATMENT PROCESS
-COMMINUTORS & MACERATORS-

Comminutor



Macerators

b. Macerators:

Macerators are slow speed grinders that typically consist of two sets of counter rotating assemblies with blades. The assemblies are mounted vertically in the flow channel. The blades or teeth on the rotation assembles have a close tolerance that effectively chop material as it passes through the unit

.

c. Grinders:

High speed grinders, receive screened materials from base screen. The materials are pulverized by a high speed rotation assembly that wets the materials passing through the unit.

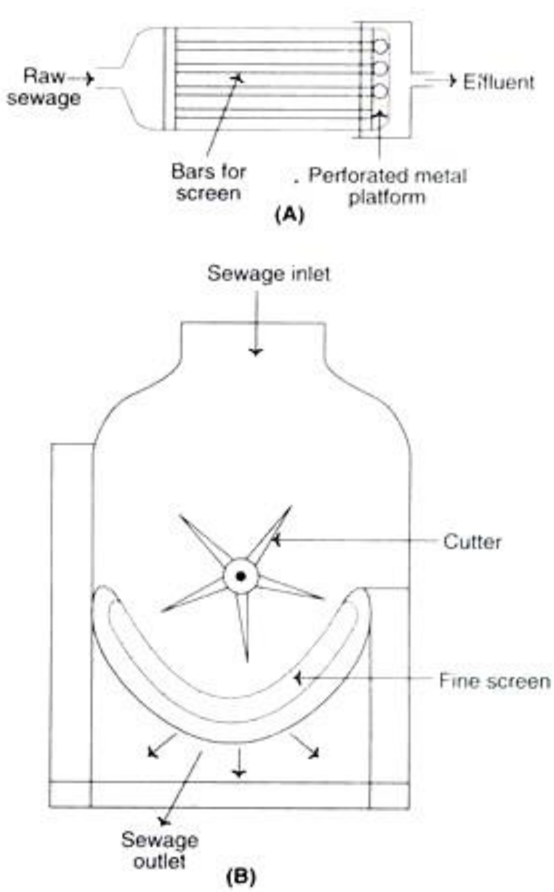
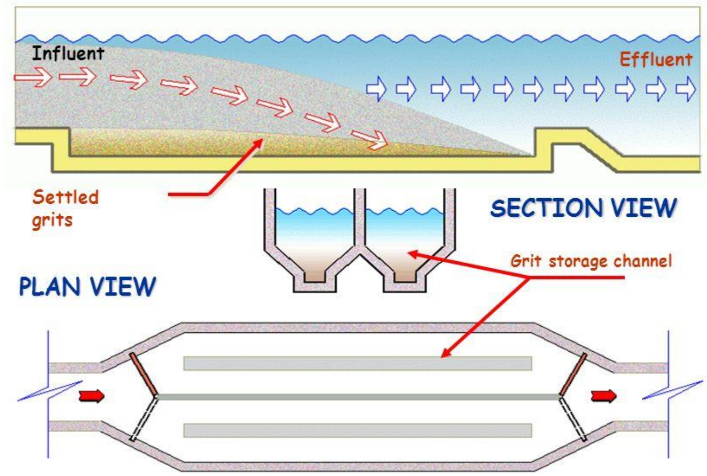
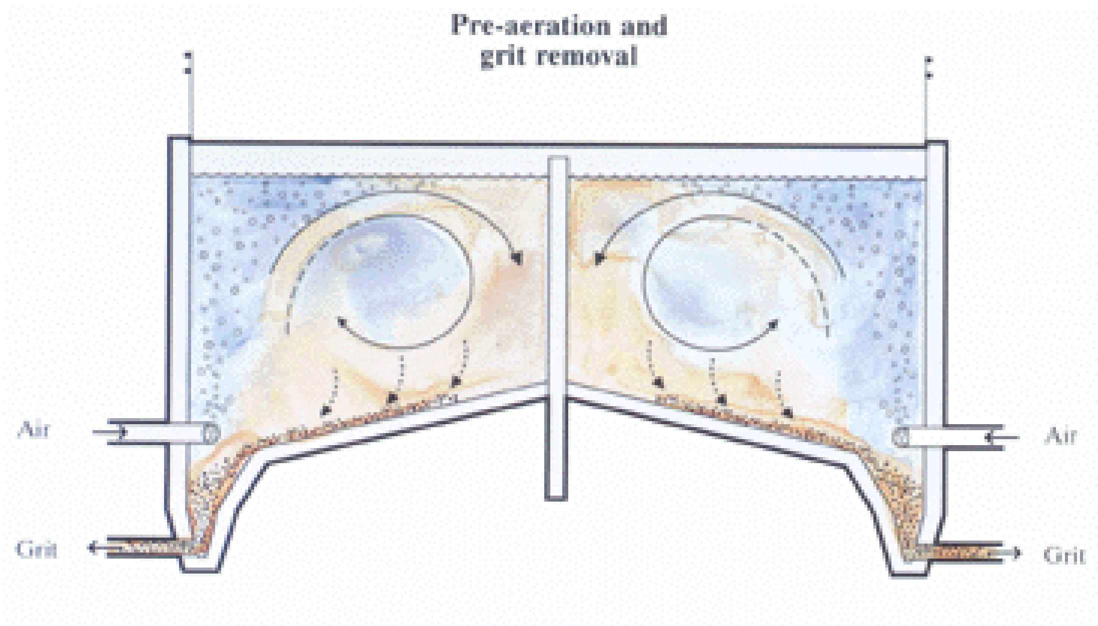


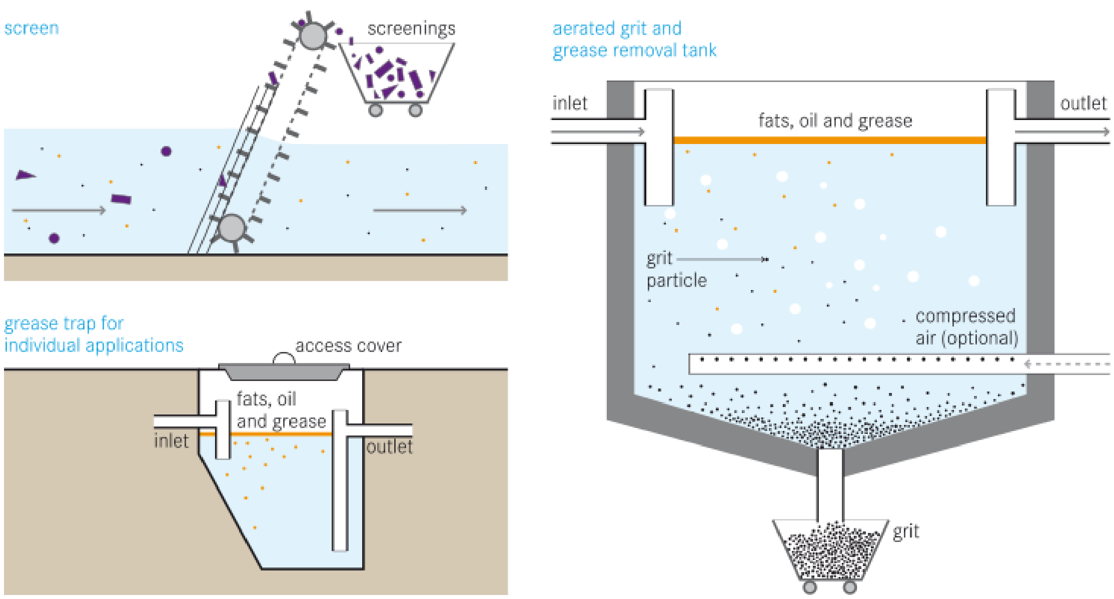
Fig. 57.1 : Diagrammatic representation of screeners
(A) Fixed bar screen (coarse or medium)
(B) Shredder.

3. Grit Removal system from Wastewater:

Grit Chamber







It is a Unit operation (physical). Removal of grit form waste water may be accomplished in grit chambers or by centrifugal separation of solids. Grit chambers are designed to remove grit, consisting of sand, gravel, , or other heavy solid materials that have specific gravities or setting velocities substantially greater than those of organic particles in wastewater. Grit chambers are most commonly located after the bar screens and before the primary sedimentation.

These are just like sedimentation tanks, design mainly to remove heavier particles or coarse inert and relatively dry suspended solids from the wastewater. There are two main types of grit chambers like rectangular horizontal flow types and aerated grit chambers. In the aerated grit chamber the organic solids are kept in suspension by rising aerted system provided at the bottom of the tank.

Purpose of Grit Chamber

Grit chambers are provided to:

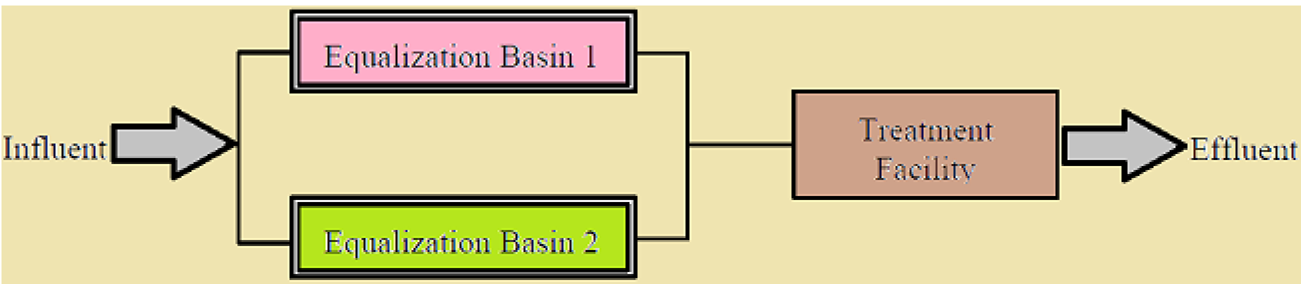
Protect moving mechanical equipment from abrasion and accompanying abnormal wear.

Reduce formation of heavy deposits in pipelines, channels and conduits.

Reduce the frequency of digester.

Flow Equalization tank

Flow equalization is method used to overcome the operational problems and flow rate variations to improve the performance of downstream processes and to reduce the size & cost of downstream treatment facilities. To prevent flow rate, temperature, and contaminant achieves its objective by providing storage to hold water when it is arriving too rapidly, and to supply additional water when it is arriving less rapidly than desired. A smaller the screen opening, greater will be the amount of material screened.

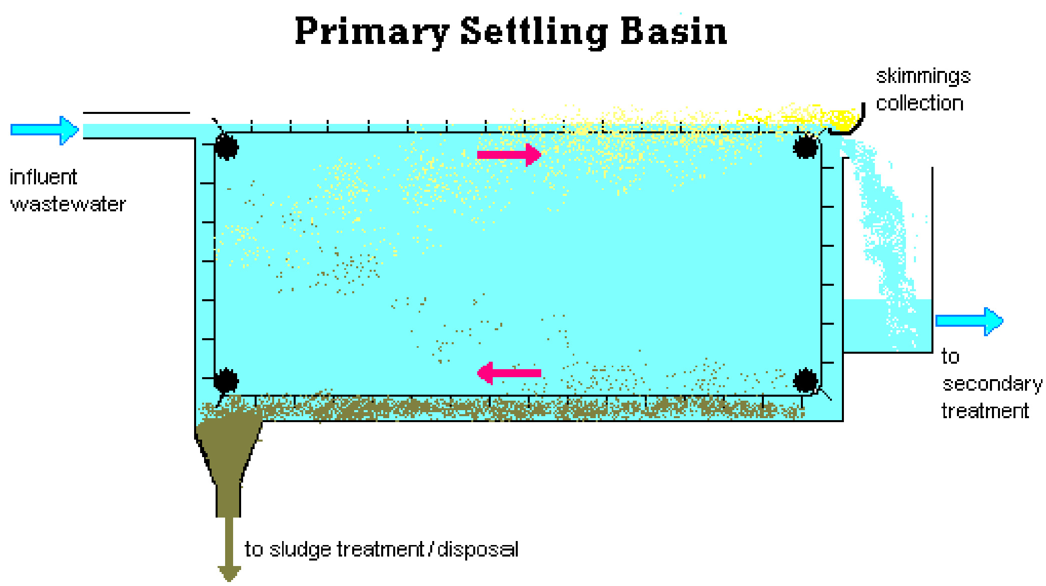


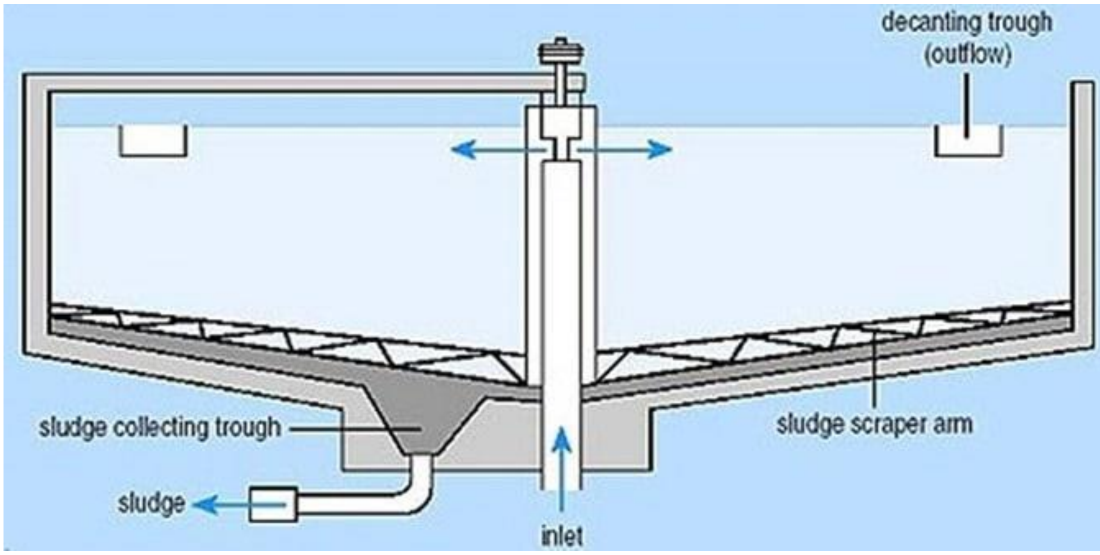
In order to improve the performance of a reactor, particularly the biological processes, it is required to equalize the strength of wastewater and to provide uniform flow, an equalization tank is design after screen and grit chamber. This may be in the line-off or off-line, as shown in the

primary treatment

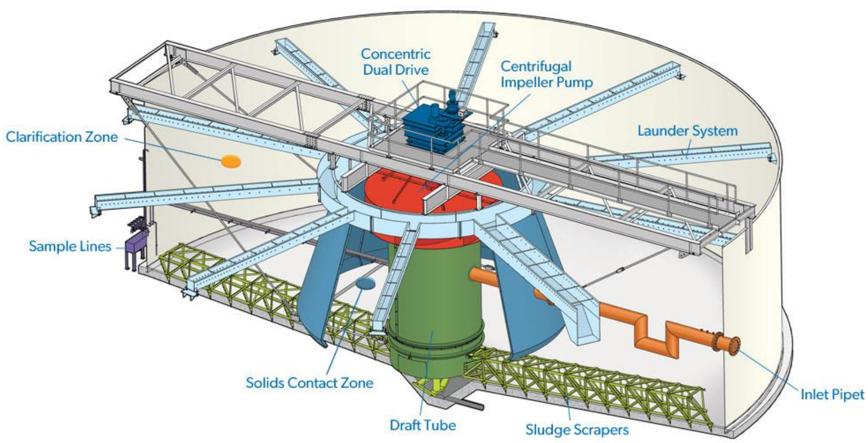
sedimentation tank ,settling tank,clarifier

After grit removal in grit chamber, the wastewater containing mainly lightweight organic matter is settled in the primary sedimentation tank (PST). Due to involvement of many unknown parameters under settling of light weight, sticky, and non regular shaped particles, the classical laws of sedimentation as applicable in grit removal are not valid and this settling is called as flocculant settling. The primary sedimentation tank generally removes 30 to 40% of the total BOD and 50 to 70% of suspended solids from the raw sewage. The flow through velocity of 1 cm/sec at average flow is used for design with detention period in the range of 90 to 150 minutesPrimary sedimentation is the process by which the velocity of the sewage is reduced below the point at which it can transport the suspended matter, so that much of this settles and can be removed as sludge. Basically, the purpose of sedimentation is to remove the maximum amount of polluting matter, in the form of readily settleable solids, from the sewage as quickly and as economically as possible.

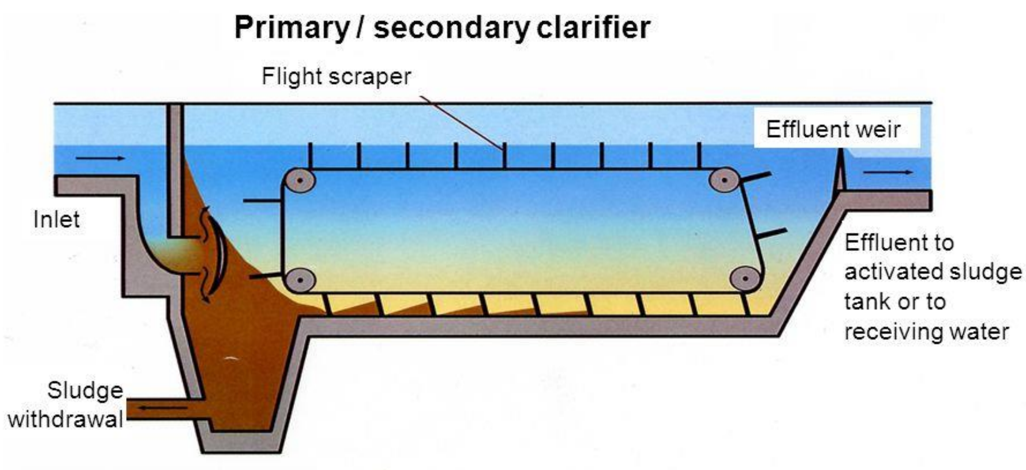




Elements of a True CONTACT CLARIFIER™

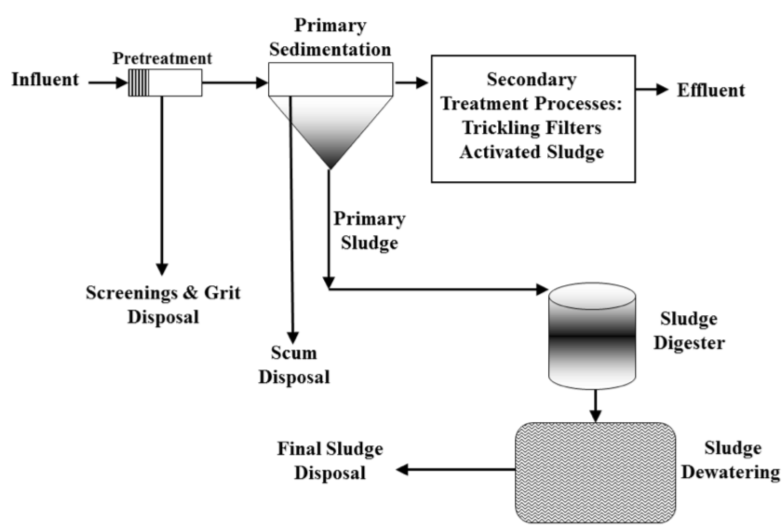


Rectangular sedimentation tank



Surface:

Primary clarifier	q_A = 2 to 6 m/h
Secondary clarifier	q_A = 0.5 to 1.5 m/h



Secondary treatment

Secondary treatment depends on biological processes to further reduce the suspended and dissolved solids, which are remaining in the liquid effluent after primary treatment. **Secondary treatment** consists of biological degradation, in which the remaining suspended solids are decomposed by microorganisms and the number of pathogens is reduced. In this stage, the effluent from primary treatment usually undergoes biological treatment

secondary treatment (biological treatment) include :

1-activated sludge

2-areated lagoon

3-aerobic granulation

4-membrane bio reactor

5-constructed wet land

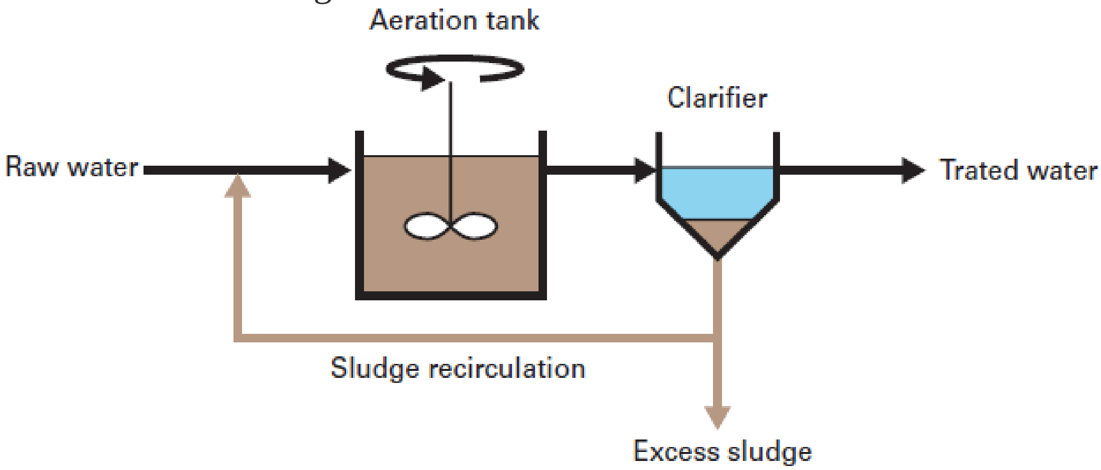
6-rotating biological contactor

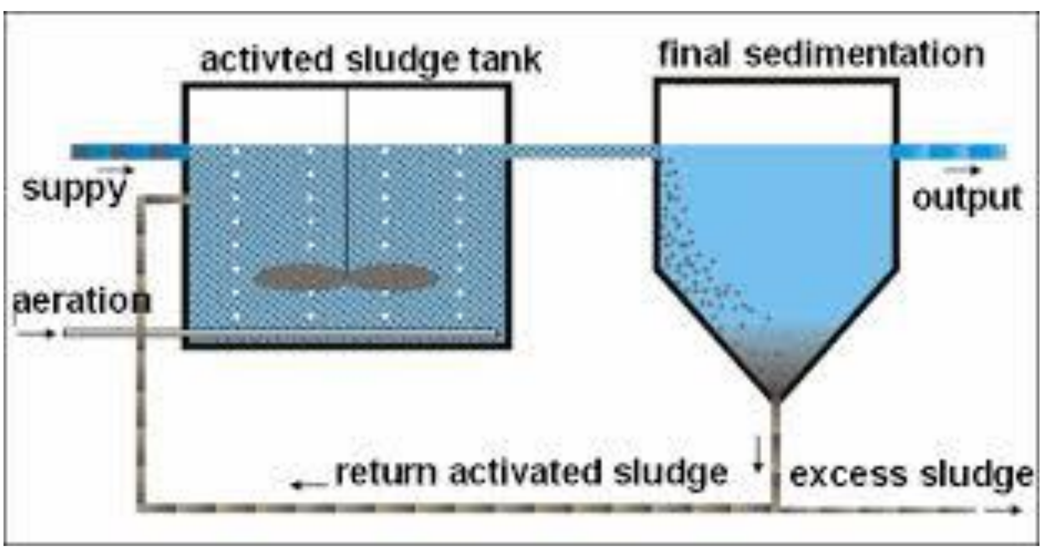
7-trickling filter

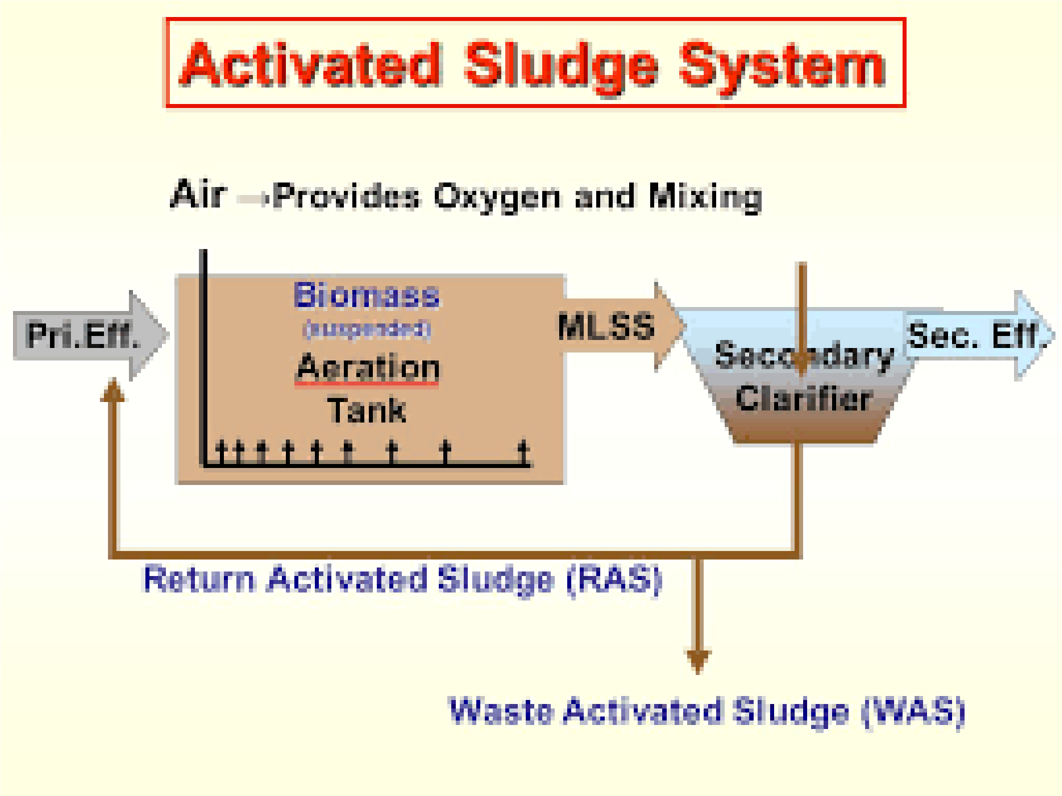
1-Activated Sludge

The activated sludge system (aeration and sedimentation tanks) is the main representative of the suspended-growth aerobic system. The activated sludge is the most widely used method to bring about stabilization in wastewater having organic matter constituents. The method depends on establishing and maintaining a population of degrading microorganisms and providing close contact of the degrading microorganisms and a supply of dissolved oxygen. The microorganisms feed and grow upon the oxidizable material in the wastewater and form a suspended floc of "activated sludge" in the water. Air bubbled through the water or absorbed by constantly renewing the air–water interface (by agitation) replenishes the oxygen needed for the biological oxidation. The mixture of wastewater and activated sludge, known as "mixed liquor", is then settled to separate the activated sludge solids from the treated (i.e. reduced BOD_5) water. Part of the

settled activated sludge is usually mechanically returned (by pump) to the aeration site (usually a tank or vessel).
The solids in an activated sludge system tend to build up due to accumulation of inert material and the growth of microorganisms. To control the amount of solids during aeration, the excess solids, i.e. “excess sludge” are wasted from the system regularly. Typically, the influent wastewater is mixed with about 20–30% by volume of activated sludge and approximately the same weight of suspended solids, which enter the treatment system each day, must be wasted as excess activated sludge.







2-Aerated Lagoons

Types of Aerated Lagoons:

Aerated lagoons are deep waste stabilization ponds in which sewage is aerated by mechanical aerators to stabilize the organic matter present in the sewage, rather than relying only on photosynthetic oxygen produced by algae. Thus aerated lagoons represent a system of sewage treatment that is intermediate between oxidation ponds and activated sludge systems.

Depending on how the microbial mass of solids is handled in the aerated lagoons the same are classified as:

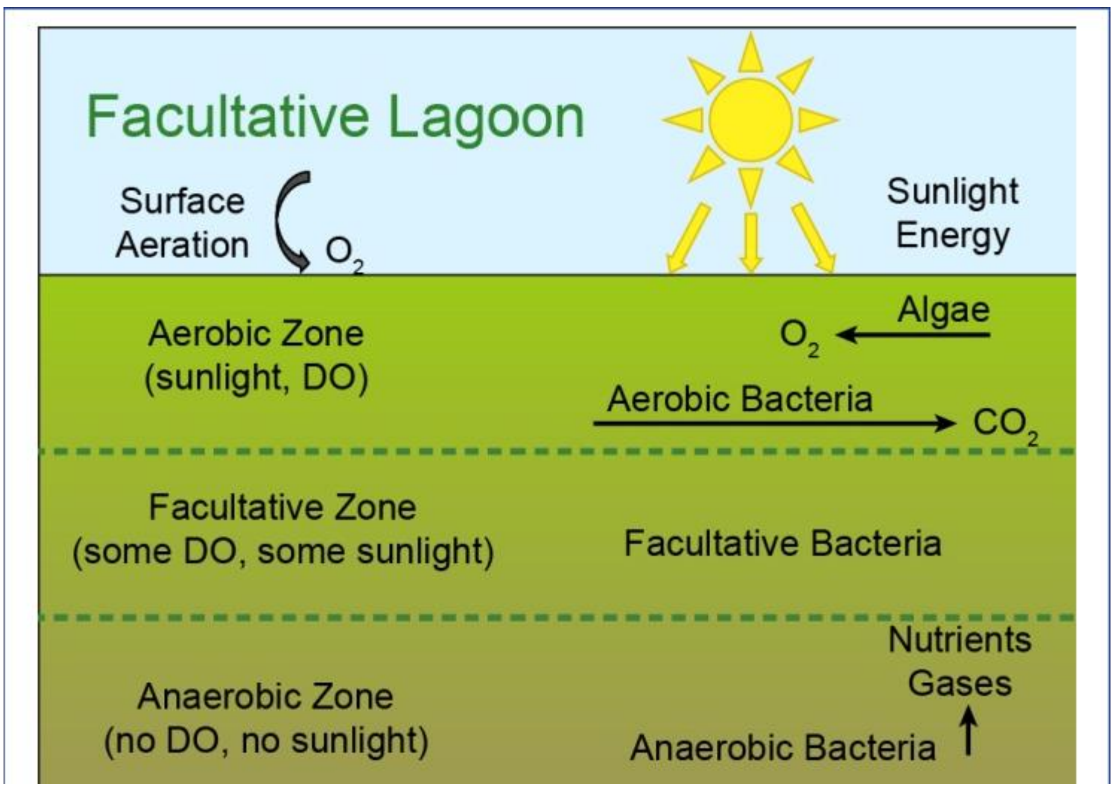
(i) Facultative aerated lagoons and

(ii) Aerobic aerated lagoons.

(i) Facultative Aerated Lagoons:

Facultative aerated lagoons are those in which some solids may leave with the effluent stream and some settle down in the lagoon since aeration power input is just enough for oxygenation and not for keeping all solids in suspension. As the lower part of such lagoons may be anoxic or anaerobic while the upper layers are aerobic, these are termed as facultative aerated lagoons.

Further the facultative aerated lagoons are also known as partially mixed type aerated lagoons because these are operated at a low rate of aeration which is not adequate to keep all the solids in suspension.



(ii) Aerobic Aerated Lagoons:

Aerobic aerated lagoons are those which are fully aerobic from top to bottom as the aeration power input is sufficiently high to keep all the solids in suspension besides meeting the oxygenation needs of the system. No settlement of solids occurs in these lagoons and under equilibrium conditions the new (microbial) solids produced in the system equal the solids leaving the system.

Thus in this case the solids concentration in the effluent is relatively high and some further treatment is generally provided after such lagoons. If the effluent is settled and the sludge recycled, the aerobic aerated lagoon, in fact, becomes an activated sludge or extended aeration type lagoon.

A few typical characteristics of the above types of aerated lagoons are given in Table 15.2.

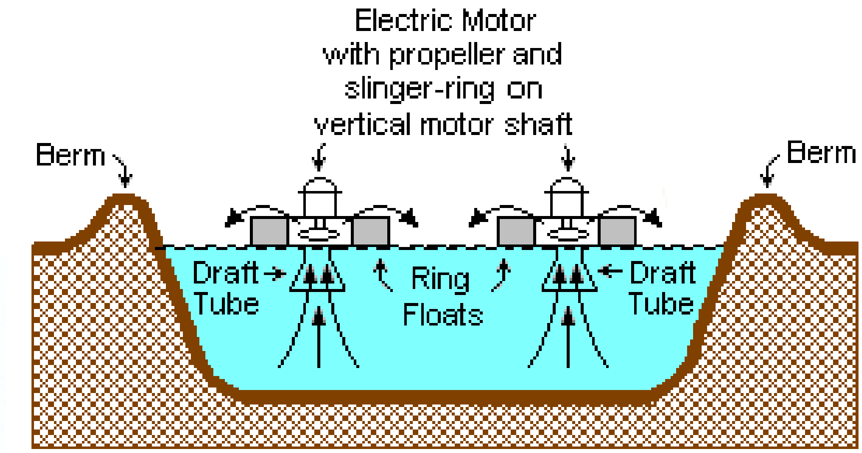
TABLE 15.2
Some Characteristics of Aerated Lagoons

S.No	*Characteristics*	*Facultative aerated lagoons*	*Aerobic aerated lagoons*	*Extended aeration system (for comparison)*
1.	Detention period, days	3–5	2–3	0.5–1.0
2.	Depth, m	2.5–5.0	2.5–4.0	2.5–4.0
3.	Land required, m^2/person	0.15–0.30	0.10–0.20	—
4.	BOD removal efficiency, %	80–90	50–60	95–98
5.	Overall BOD removal rate constant, K at 20°C (soluble only), per day	0.6–0.8	1–1.5	20–30
6.	Suspended solids (SS) in unit, mg/l	40–150	150–350	3000–5000
7.	VSS/SS	0.6	0.8	0.6
8.	Desirable power level watts/m^3 of lagoon volume	0.75	2.75–6.0	15–18
9.	Power requirement kWh/person/year	12–15	12–14	16–20

Facultative type aerated lagoons have been more commonly used the world over because of their simplicity in operation and minimum need of machinery. They are often referred to simply as ‘aerated lagoons’.

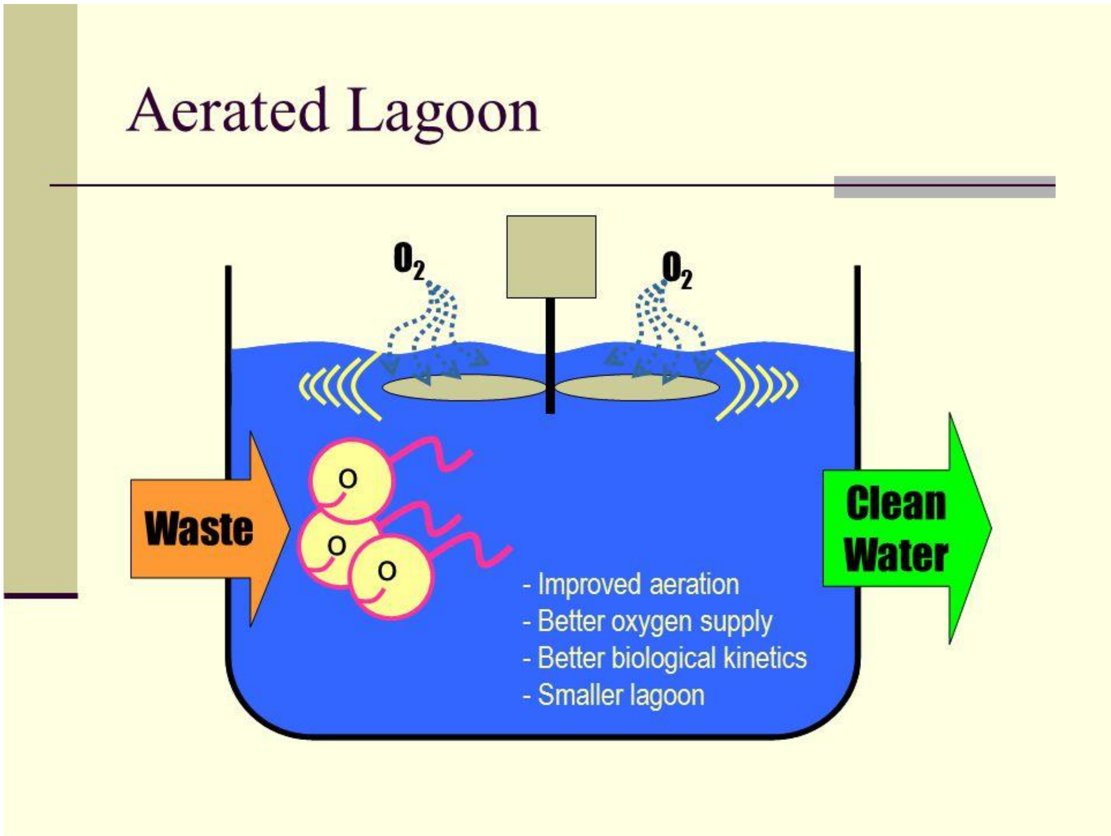
Their original use came as a means of upgrading oxidation ponds overloaded due to industrial wastes without adding to the land requirement. Further as the aerated lagoons are deeper than the oxidation ponds, and as they are artificially aerated, less land and less detention period are required for aerated lagoons as compared to oxidation ponds.

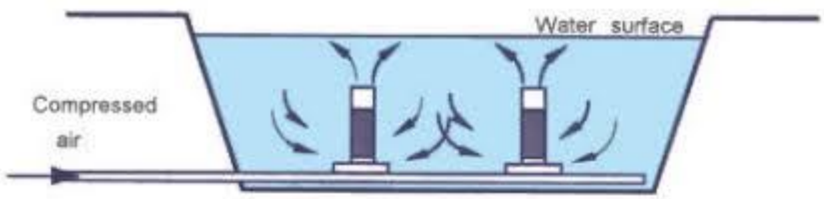
Flow conditions in aerated lagoons are neither ideal complete-mixing nor ideal plug-flow in nature.



A TYPICAL SURFACE – AERATED BASIN

Note: The ring floats are tethered to posts on the berms.





Arrows indicate flow of water

Advantages

1-Low operational and maintenance cost.

2- Lagoons provide effective treatment with minimal threat to the environment.

3-Work well in clay soils where conventional subsurface on-site absorption fields will not work.

Disadvantages

1- Lagoons must be constructed in clay soil or be lined to prevent leakage.
2- May overflow occasionally during extended periods of heavy rainfall.
3- If there are extended periods of overcast windless days, a rare occasion in Oklahoma, offensive odors may occur for a brief time. Lagoons usually recover rapidly if this occurs.
4- Can not be installed on a small lot. Takes up a relatively large space for only one use.
5- Lagoons are not aesthetically acceptable to some people. Some people consider lagoons unsightly and unsafe.
6- As with any other open body of water, there is some potential danger. Although lagoons are required to be fenced, this does not always prevent access by people or pets.

Oxidation ponds, also called lagoons or stabilization ponds, are large, shallow ponds designed to treat wastewater through the interaction of sunlight, bacteria, and algae. Algae grow using energy from the sun and carbon dioxide and inorganic compounds released by bacteria in water. During the process of photosynthesis, the algae release oxygen needed by aerobic bacteria.anbottom region, consisting of anaerobic bacteria, without the presence of dissolved oxygen. Under methanogenic conditions, the major products are carbon dioxide and methane

So, In **oxidation pond** we do all the process naturally and it requires longer time to regenerate the water. the area needed is also much more as compared with other process.

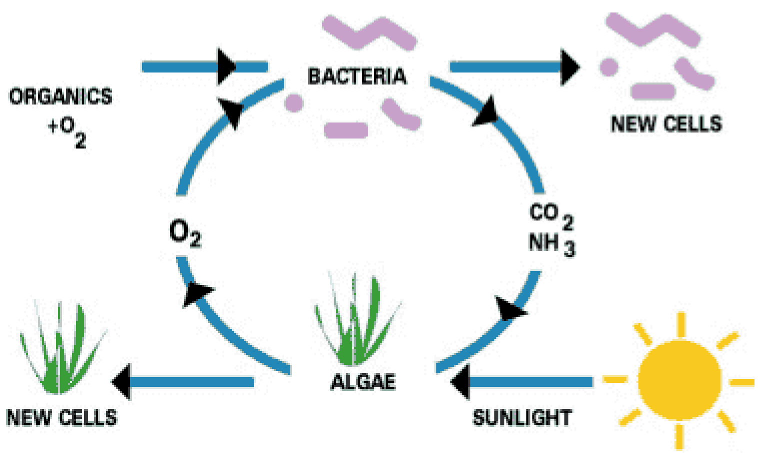
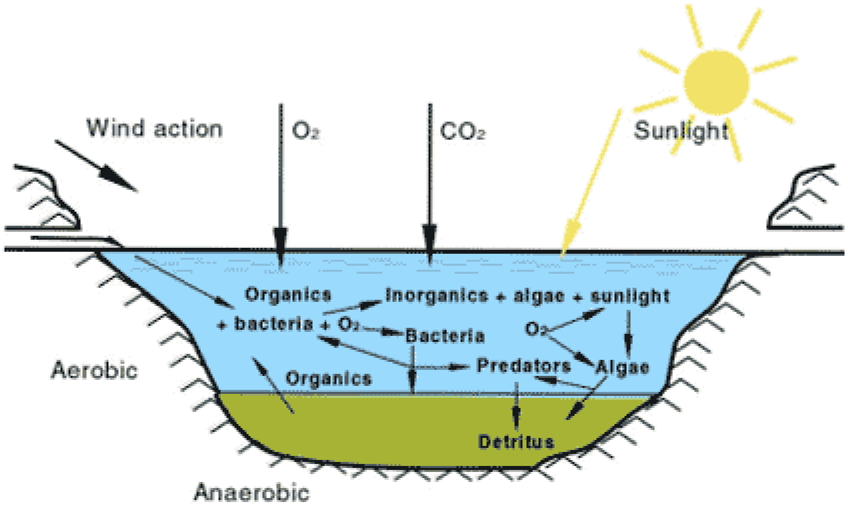
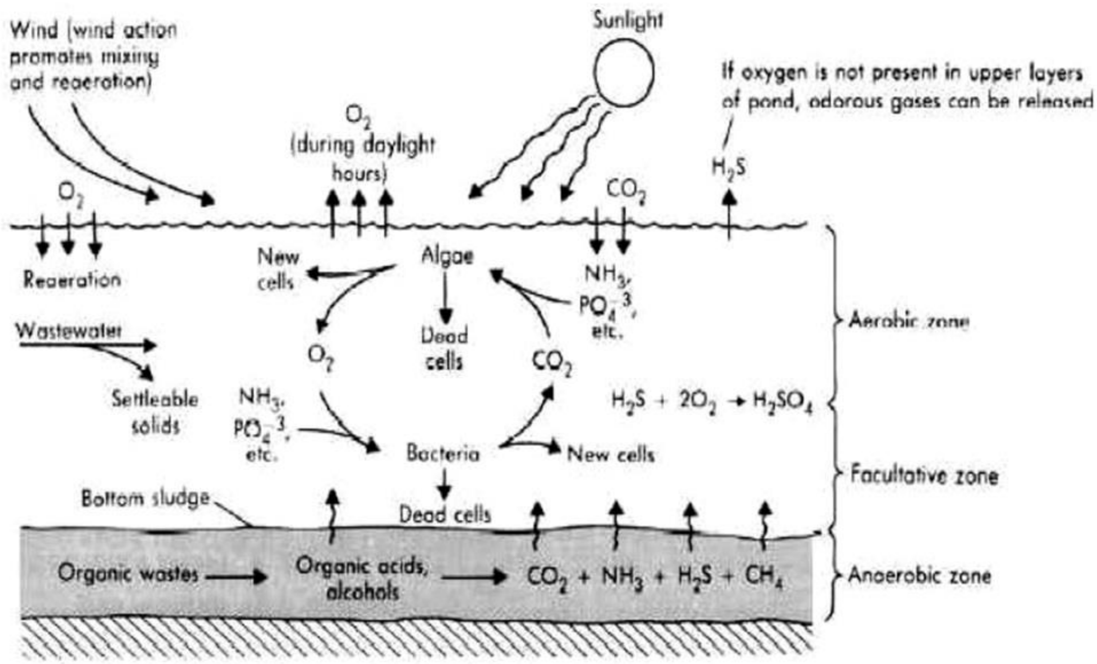


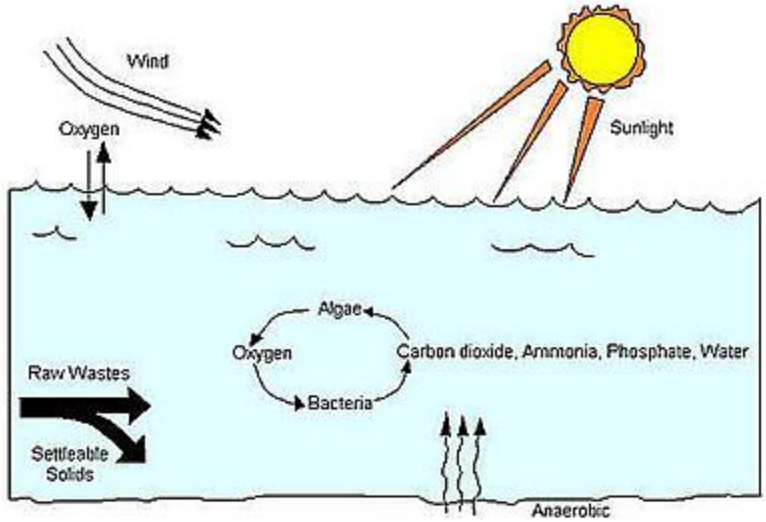
Figure 18: Symbiotic relationship between bacteria and algae in a wastewater

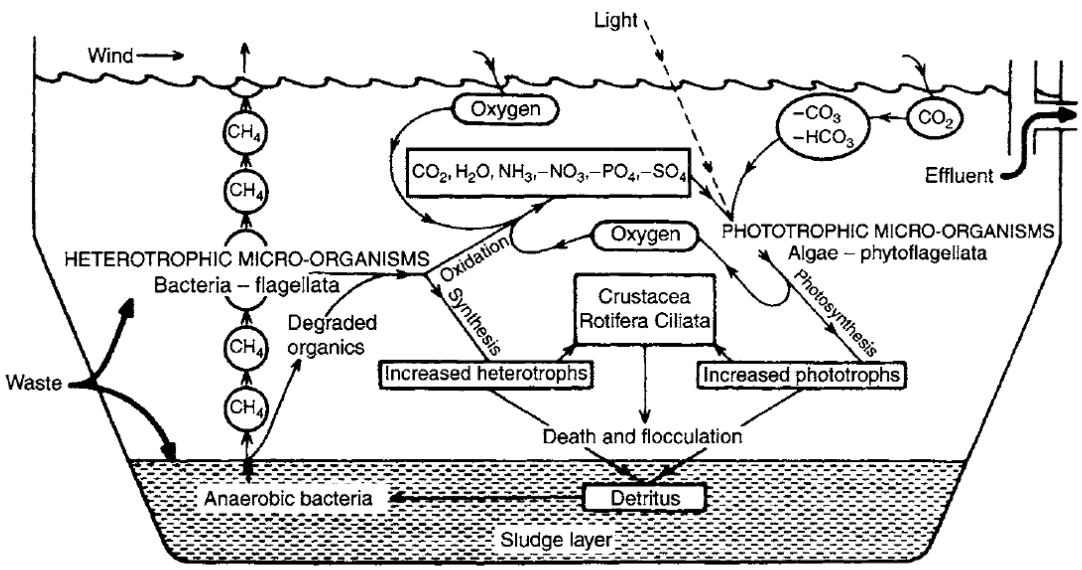


Wind action
O_2
CO_2
Sunlight
Organics
+ bacteria + O_2
Inorganics + algae + sunlight
Bacteria
O_2
Predators
Algae
Organics
Detritus
Aerobic
Anaerobic



Wind (wind action promotes mixing and reaeration)
Sunlight
If oxygen is not present in upper layers of pond, odorous gases can be released
O_2 (during daylight hours)
O_2
H_2S
CO_2
Reaeration
New cells
Algae
NH_3, PO_4^{-3}, etc.
Wastewater
Settleable solids
O_2
Dead cells
CO_2
$H_2S + 2O_2 \rightarrow H_2SO_4$
NH_3, PO_4^{-3}, etc.
Bacteria
New cells
Bottom sludge
Dead cells
Organic wastes
Organic acids, alcohols
$CO_2 + NH_3 + H_2S + CH_4$
Aerobic zone
Facultative zone
Anaerobic zone





3- Aerobic granulation

Aerobic granulation involves cell-to-cell adhesion that includes biological, physical and chemical phenomena and aerobic granules are formed through self-immobilization of microorganisms without any carrier material under aerobic or alternative aerobic–anaerobic conditions

. Bacterial aggregation is of two types:

(1) Auto aggregation: Cell-to-cell interaction of genetically iden-

tical strain; and

(2) Co-aggregation: Cell-to-cell adherence between genetically

distinct bacterial partners.

The formation of aerobic granules consists of five stages:

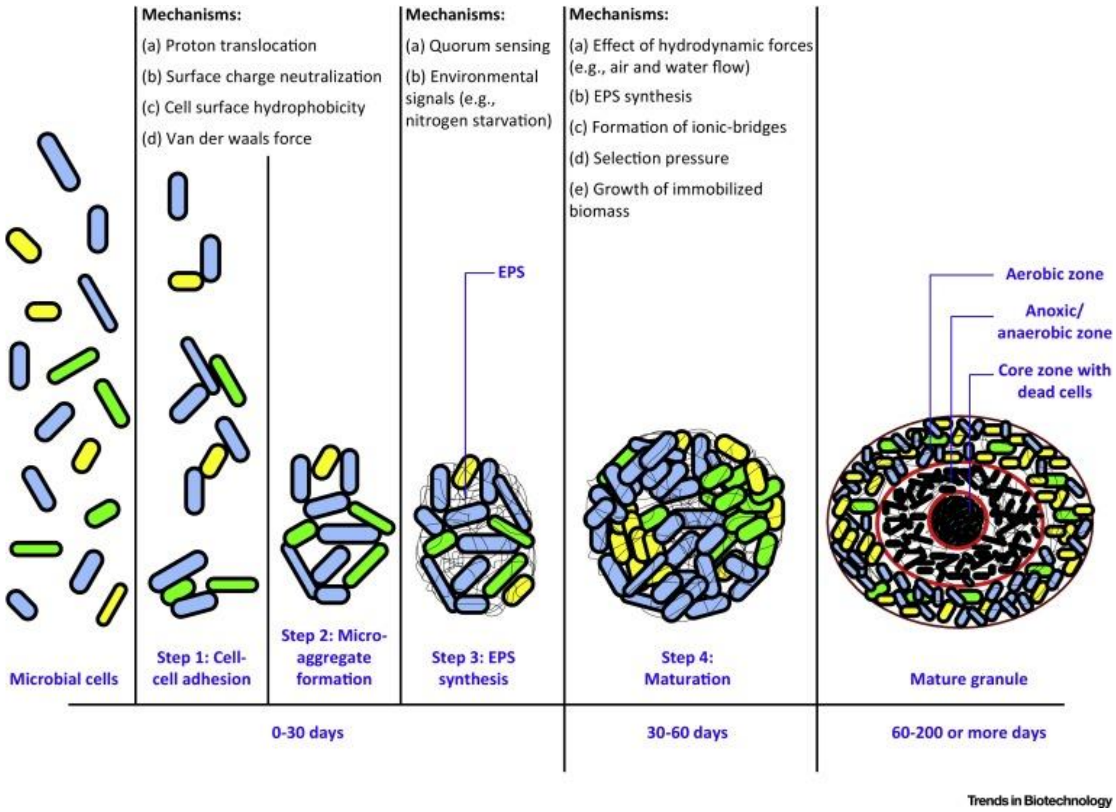
microbes' multiplication phase, floc appearance phase, floc cohe-

sion phase, mature floc phase and aerobic granule phase The granules thus formed are com-pact and strong with very high degradation efficiency Although aerobic granular technology would be a novel and

pronounced bio technique for wastewater treatment, the mechanisms behind the formation of aerobic granules was not yet understood, because bacteria would prefer a dispersed rather than aggregated state. Hence, there should be an initiating force that can bring bacteria together and, further, make them aggregate.

Aerobic granules are a type of sludge that can self-immobilize flocs and microorganisms into spherical and strong compact structures. The aerobic granular sludge usually is cultivated in SBR (sequencing batch reactor) and applied successfully as a wastewater treatment for high strength wastewater, toxic wastewater and domestic wastewater.


Aerobic granular sludge reactors for the treatment of wastewater containing particulate organic matter (X_S)
Reduced selection pressure for fast-settling biomass
Effluent
Influent with X_S
1 – Simultaneous fill-and-draw 90 min
2 – Aeration 146 min
3 – Settling 4 min
SBR cycle
Substrate conversion (%)
0
20
40
60
80
100
Mixture of granules and flocs → no filamentous outgrowths



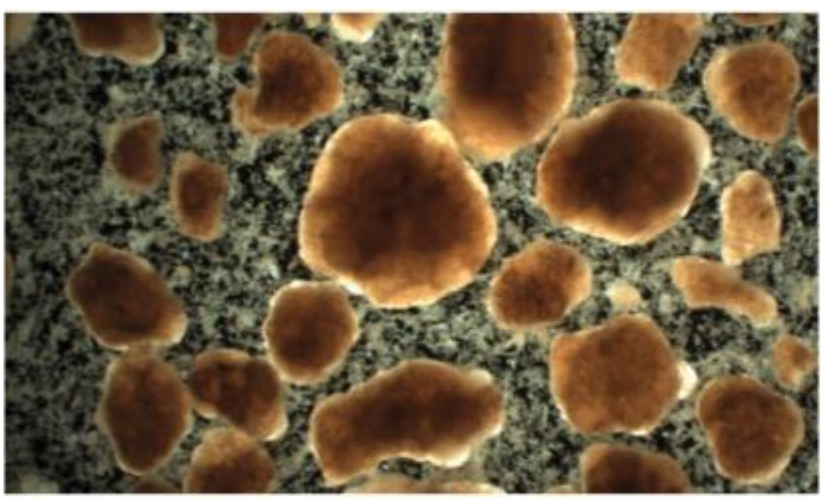
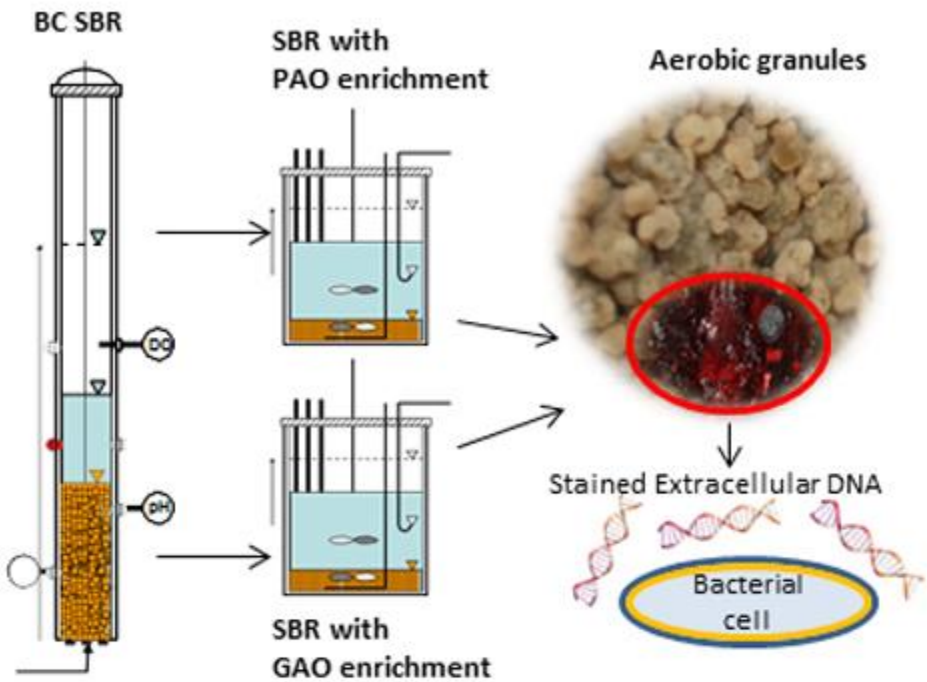


Figure 6

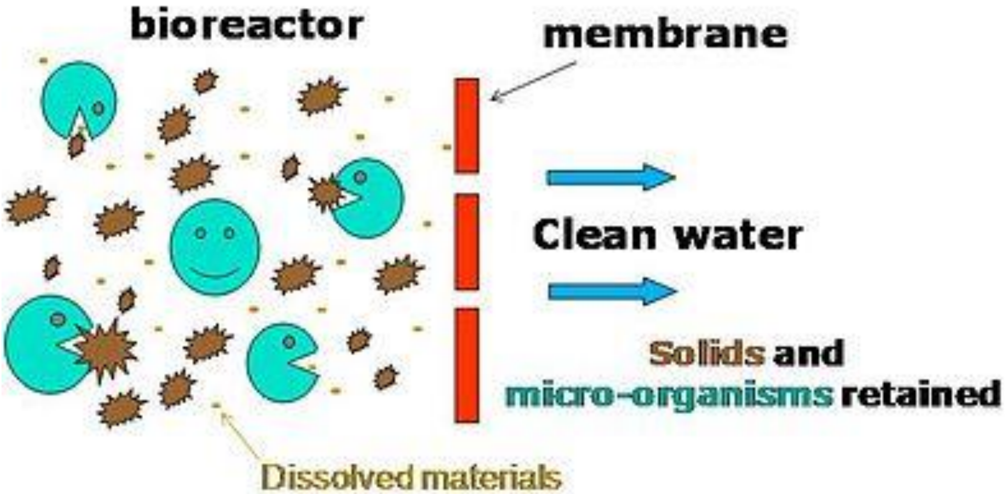
Aerobic granules – Ede WWTP

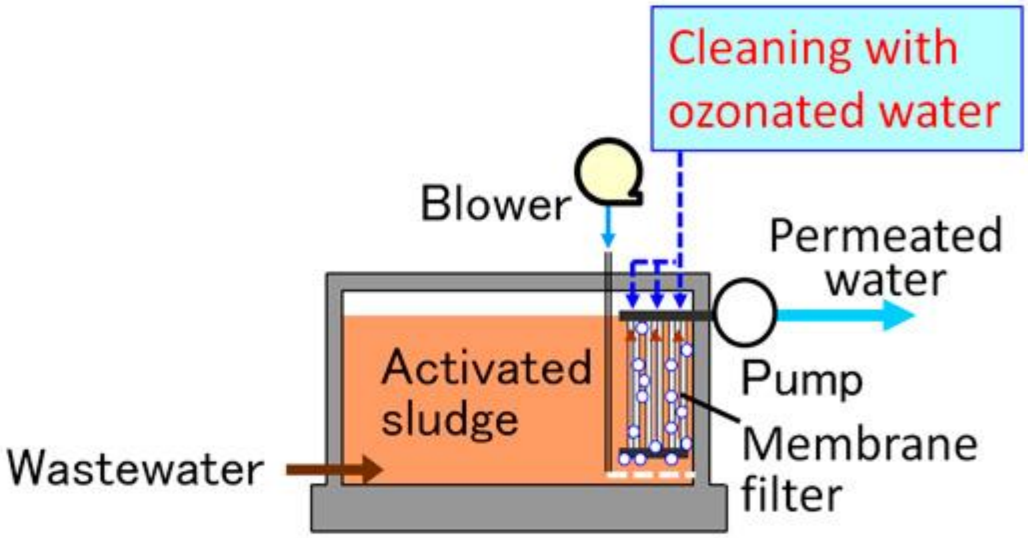

BC SBR
SBR with
PAO enrichment
Aerobic granules
DO
pH
Stained Extracellular DNA
Bacterial
cell
SBR with
GAO enrichment

Membrane Bioreactors

Membrane Bioreactors combine conventional biological treatment (e.g. activated sludge) processes with membrane filtration to provide an advanced level of organic and suspended solids removal. When designed accordingly, these systems can also provide an advanced level of nutrient removal. In an MBR system, the membranes are submerged in an aerated biological reactor. The membranes have porosities ranging from 0.035 microns to 0.4 microns (depending on the manufacturer), which is considered between micro and ultrafiltration. This level of filtration allows for high quality effluent to be drawn through the membranes and eliminates the sedimentation and filtration processes typically used for wastewater treatment. Because the need for sedimentation is eliminated, the biological process can operate at a much higher mixed liquor concentration. This dramatically reduces the process tankage required and allows many existing plants to be upgraded without adding new tanks. To provide optimal aeration and scour around the membranes, the mixed liquor is typically kept in the 1.0-1.2% solids range, which is 4 times that of a conventional plant.

During MBR wastewater treatment, solid–liquid separation is achieved by Microfiltration (MF) or Ultrafiltration (UF) membranes. A membrane is simply a two-dimensional material used to separate components of fluids usually on the basis of their relative size or electrical charge. The capability of a membrane to allow transport of only specific compounds is called semi-permeability This is a physical process, where separated components remain chemically unchanged. Components that pass through membrane pores are called permeate, while rejected ones form concentrate or retentate.


bioreactor
membrane
Clean water
Solids and
micro-organisms retained
Dissolved materials

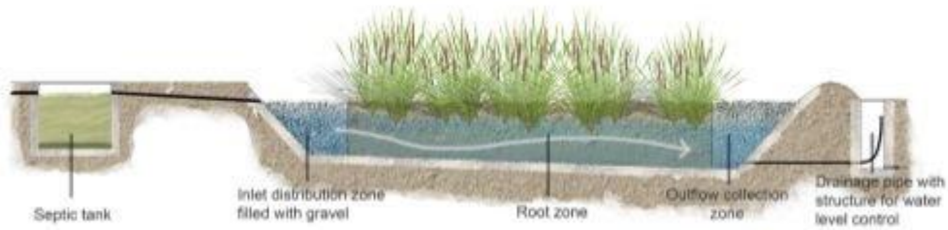


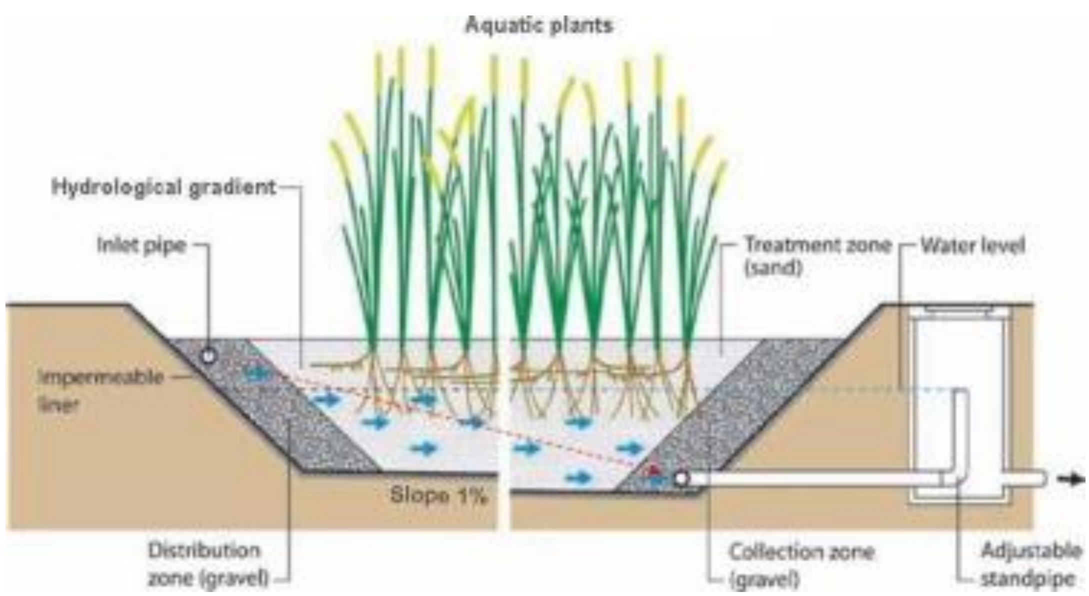
5-Constructed Wetland

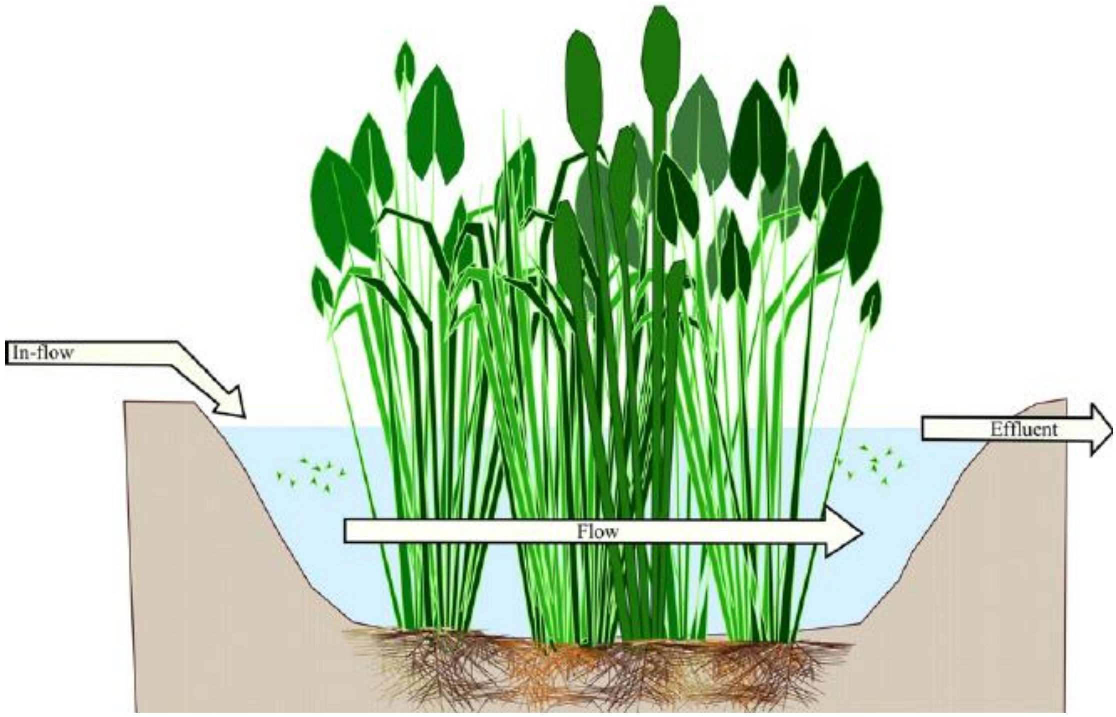
Constructed wetlands are engineered systems that use natural functions vegetation, soil, and organisms to treat wastewater. Depending on the type of wastewater the design of the constructed wetland has to be adjusted accordingly. Constructed wetlands have been used to treat both centralized and on-site wastewater. Primary treatment is recommended when there is a large amount of suspended solids or soluble organic matter (measured as BOD and COD).

Similarly to natural wetlands, constructed wetlands also act as a biofilter and/or can remove a range of pollutants (such as organic matter, nutrients, pathogens, heavy metals) from the water. Constructed wetlands are a sanitation technology that have not been designed specifically for pathogen removal, but instead, have been designed to remove other water quality constituents such as suspended solids, organic matter and nutrients (nitrogen and phosphorus).[1] All types of pathogens (i.e., bacteria, viruses, protozoan and helminths) are expected to be removed to some extent in a constructed wetland. Subsurface wetland provide greater pathogen removal than surface wetlands

CONSTRUCTED WETLANDS

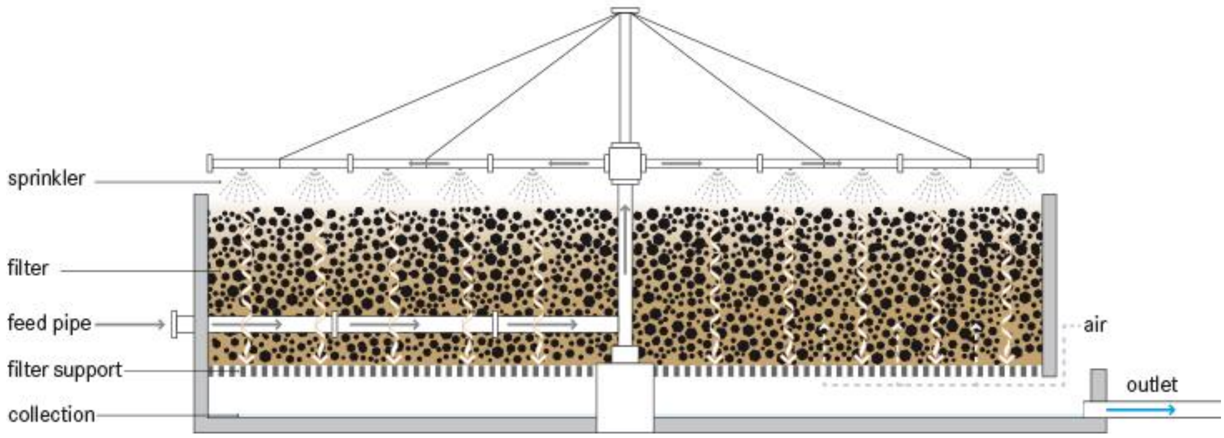


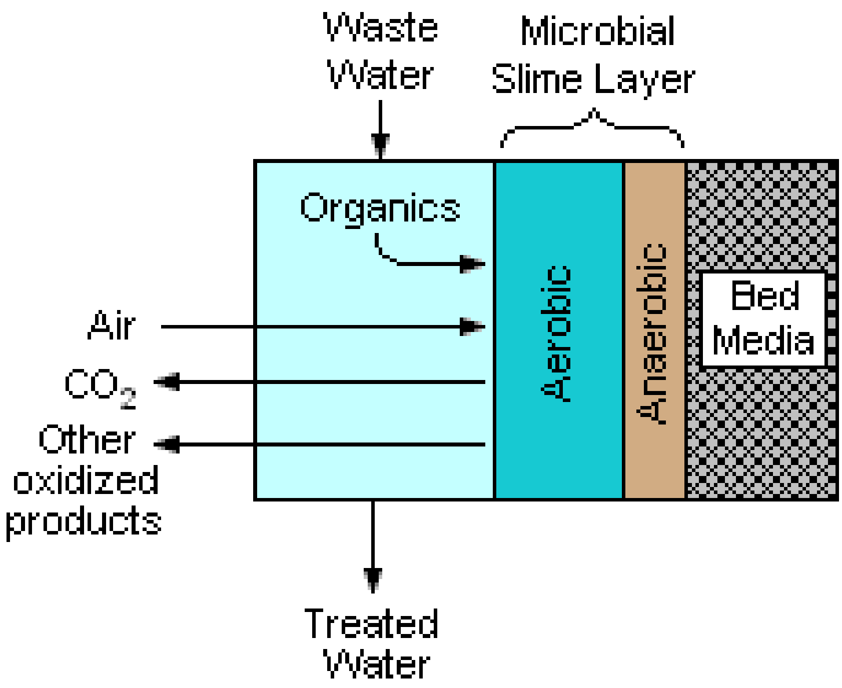


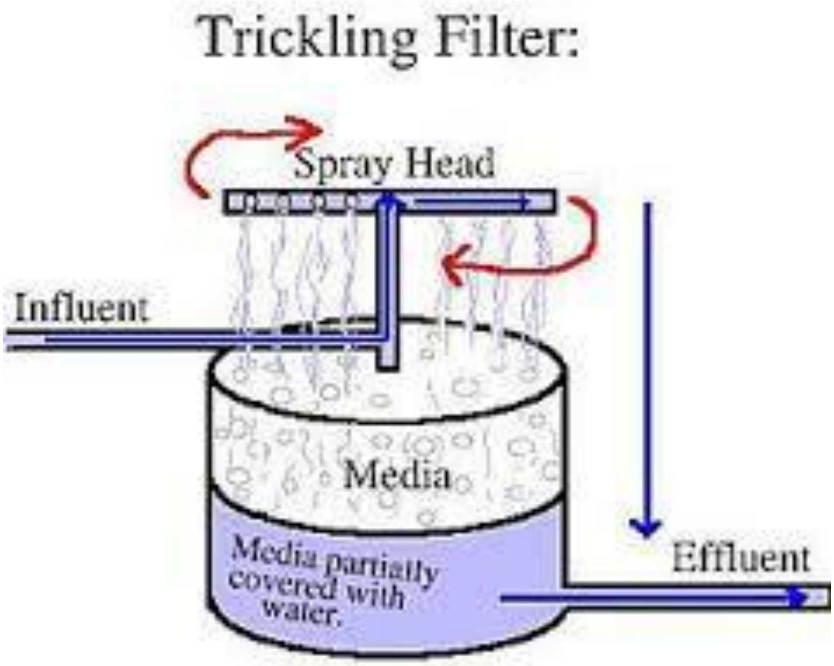

In-flow
Effluent
Flow

6-Trickling Filter

Trickling filter is a widely used aerobic biological treatment system. Also called a biofilter, it is a downflow packed bed type of reactor. It consists of a fixed bed made up of different inert materials. Biofilm grows on the surface of the inert bed. Different cheap and porous materials such as rocks, , gravel, stone, , ceramic, or plastic media can be used for making the porous bed. Wastewater enters from the top of the fixed bed making use of a rotating arm distributor or static nozzles fed with a variable head feed source. Microbial biofilm grown on the surface of the inert support helps to degrade the waste. Aerobic condition is achieved by active or passive aeration by using either a blower or fan (forced aeration) or natural convection of air due to the temperature difference between the water and ambient air


sprinkler
filter
feed pipe
filter support
collection
air
outlet


Waste Water
Microbial Slime Layer
Organics
Aerobic
Anaerobic
Bed Media
Air
CO_2
Other oxidized products
Treated Water


Trickling Filter:
Spray Head
Influent
Media
Media partially covered with water.
Effluent

7-Rotating Biological Contactor

A series of circular lightweight rotating discs are mounted on a shaft through which wastewater flows. The partially discs rotate through the wastewater slowly. The disks are most commonly made of high-density plastic sheets (e.g. Polyethylene, polystyrene or polyvinylchloride) and are usually ridged, corrugated, or lattice-like to increase the specific surface area The surface of the disks provides an attachment site for bacteria and as the discs rotate, a film of biomass grows on their surfaces This biofilm is alternately exposed to either the air or the wastewater as it rotates. The oxygen necessary for the growth of these microorganisms is obtained by adsorption from the air as the biofilm on the disk is rotated out of the liquid. As the biofilm passes through the liquid phase, nutrients and organic pollutants are taken up. All oxygen, nutrients and organic pollutants are necessary for the growth of the microorganism and the conversion of the organic matter to CO_2. Nitrogen is removed by nitrification and subsequent denitrification transforming it to gaseous N_2, which is released to the air. The process is optimized by adjusting the speed of rotation and the depth of submergence. In some designs, air is added to the bottom of the tank to provide additional oxygen in case of high-strength influents

The submerging level varies from 40 to 80 % and a usual rotating speed is 1 to 2 rpm The common disc diameter is between 0.6 and 3 m The degradation process is similar to the one in a trickling filter with a high rate of recirculation The higher contact time in RBCs due to rotation allows up to 8 to 10 times higher levels of treatment than in trickling filters Also because the rotation allows both optimum wetting and oxygen supply, RBCs are generally more reliable than other fixed-film processes. Additionally, the disc design is made in such a way that large amounts of biofilm can attach, which means that there is a large amount of biological mass present to degrade the pollutants The large amount of biomass and the stability of contact also results in an improved stability and a reduced ability to changes in hydraulic or organic loading compared to conventional activated sludge processes
As for all fixed-film processes, primary settling and/or screening is required for the removal of grit, debris, and excessive oil Such primary treatments are typically septic tanks, or anaerobic reactors. To remove sloughing sludge, a post-settling unit (i.e. a clarifier) is also required.

Secondary Clarifier

Secondary clarifier are used to remove the settlable suspended solids created in biological treatment processes such as the activated sludge and trickling filter process

Advanced Waste Water Treatment Methods

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2-BOD

3-Plant nutrients

4-Dissolved solids

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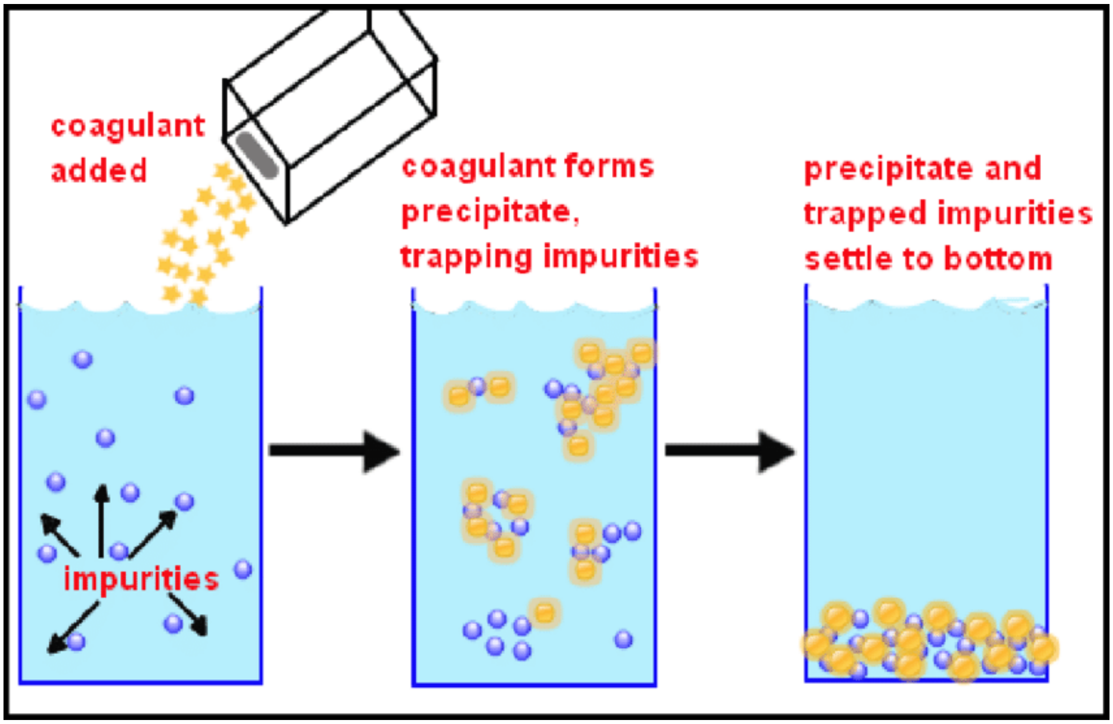
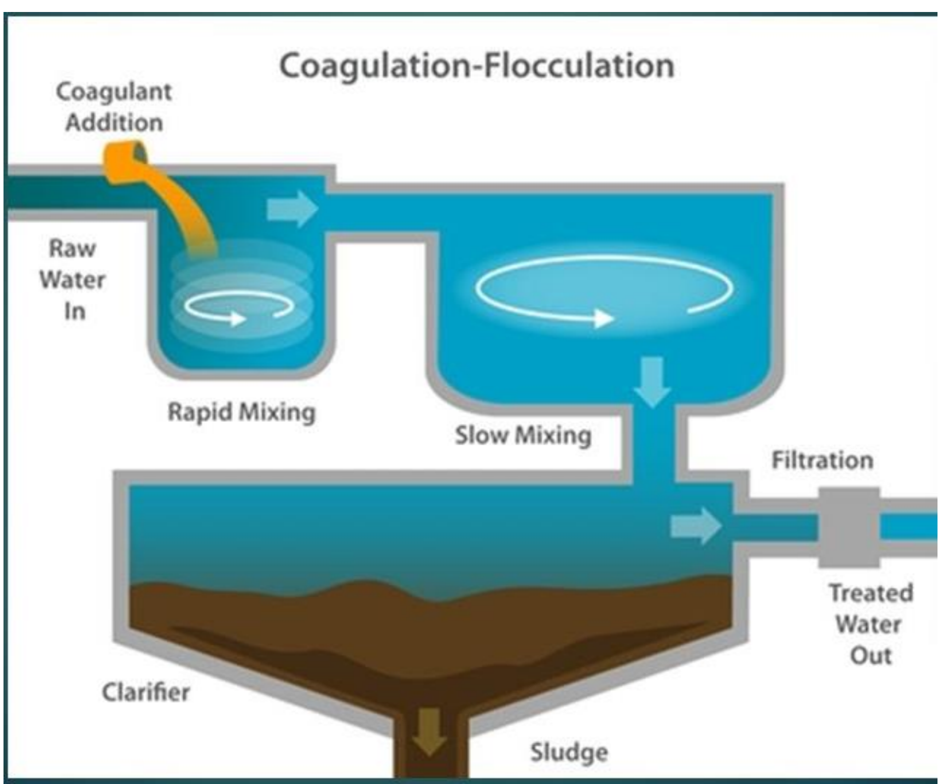
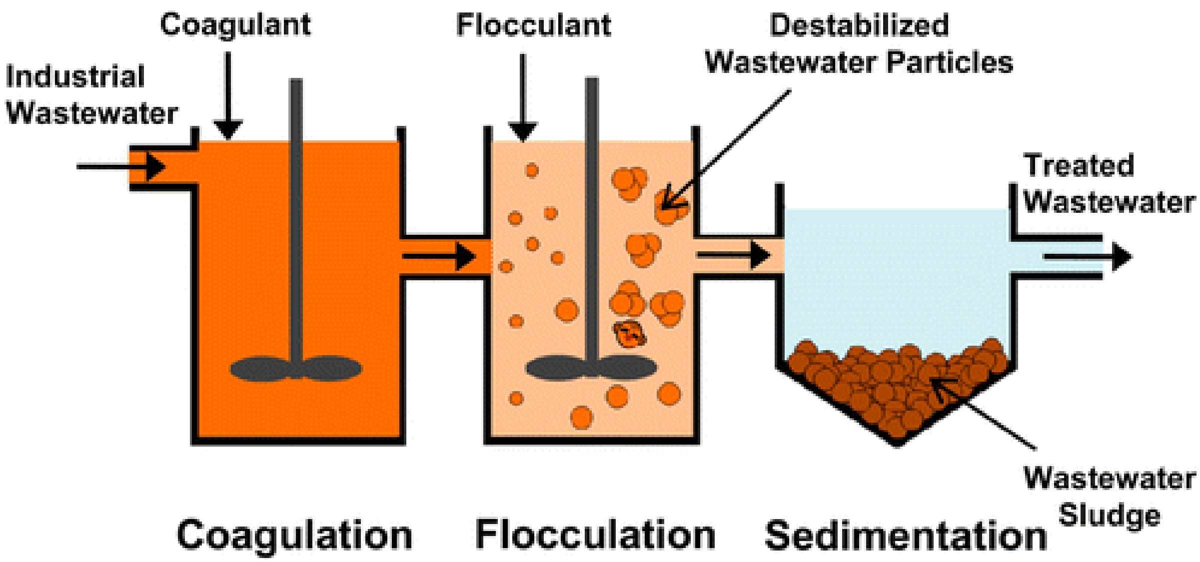
Most solids suspended in water possess a negative charge; they consequently repel each other. This repulsion prevents the particles from agglomerating, causing them to remain in suspension. Coagulation and flocculation occur in successive steps intended to overcome the forces stabilizing the suspended particles, allowing particle collision and growth of flocs, which then can be settled and removed (by sedimentation) or filtered out of the water. Coagulation-Flocculation is also a common process to treat industrial and domestic wastewater in order to remove suspended particles from the water.






Coagulant
Flocculant
Destabilized
Wastewater Particles
Industrial
Wastewater
Treated
Wastewater
Wastewater
Sludge
Coagulation
Flocculation
Sedimentation

Coagulation principles

Coagulation destabilizes the particles' charges. Coagulants with charges opposite to those of the suspended solids are added to the water to neutralize the negative charges on dispersed non-settable solids such as clay and organic substances.
Once the charge is neutralized, the small-suspended particles are capable of sticking together. The slightly larger particles formed through this process are called microflocs and are still too small to be visible to the naked eye. A high-energy, rapid-mix to properly disperse the coagulant and promote particle collisions is needed to achieve good coagulation and formation of the microflocs. Over-mixing does not affect coagulation, but insufficient mixing will leave this step incomplete. Proper contact time in the rapid-mix chamber is typically 1 to 3 minutes.

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The microflocs are brought into contact with each other through the process of slow mixing. Collisions of the microfloc particles cause them to bond to produce larger, visible flocs. The floc size continues to build through additional collisions and interaction with inorganic polymers formed by the coagulant or with organic polymers added. Macroflocs are formed. High molecular weight polymers, called coagulant aids, may be added during this step to help bridge, bind, and strengthen the floc, add weight, and increase settling rate. Once the floc has reached its optimum size and strength, the water is ready for the separation process (**sedimentation**, floatation or filtration). Design contact times for flocculation range from 15 or 20 minutes to an hour or more.

Coagulation flocculation separation

In water treatment, coagulation and flocculation are practically always applied subsequently before a physical separation. The **Coagulation-Flocculation** process consists of the following steps:

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Jar test

The jar test is used to identify the most adapted mix of chemical compounds and concentrations for coagulation-flocculation. It is a batch test consisting of using several identical jars containing the same volume and concentration of feed, which are charged simultaneously with six different doses of a potentially effective coagulant. The six jars can be stirred simultaneously at known speeds. The treated feed samples are mixed rapidly and then slowly and then allowed to settle. These three stages are an approximation of the sequences based on the large-scale plants of rapid mix, coagulation flocculation and settling basins. At the end of the settling period, test samples are drawn from the jars and turbidity of supernatant liquid is measured. A plot of turbidity against coagulant dose gives an indication of the optimum dosage (i.e. the minimum amount required to give acceptable clarification). The criteria thus obtained from a bench jar test are the quality of resultant floc and the clarity of the supernatant liquid after settling. The design of the full-scale plant process is then done based on the bench-scale selection of chemicals and their concentrations.

Unfortunately, the jar test suffers from a number of disadvantages, despite its widespread application. It is a batch test, which can be very time-consuming. And the results obtained from a series of jar tests might not correspond to the results obtained on a full-scale plant.

Filtration:

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While most of the flocculated material is removed in the settling tank, some floe do not settle. These floes are removed by the filtration process, which is usually carried out using beds of porous media such as sand or coal. The current trend is to use a mixed – media filter which consists of fine garnet in the bottom layer, silica sand in the middle layer and coarse coal in the top layer which reduces clogging.

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b. Removes e.g. various viruses.
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d. Membrane size 1 _ – 0.01 µm. is used
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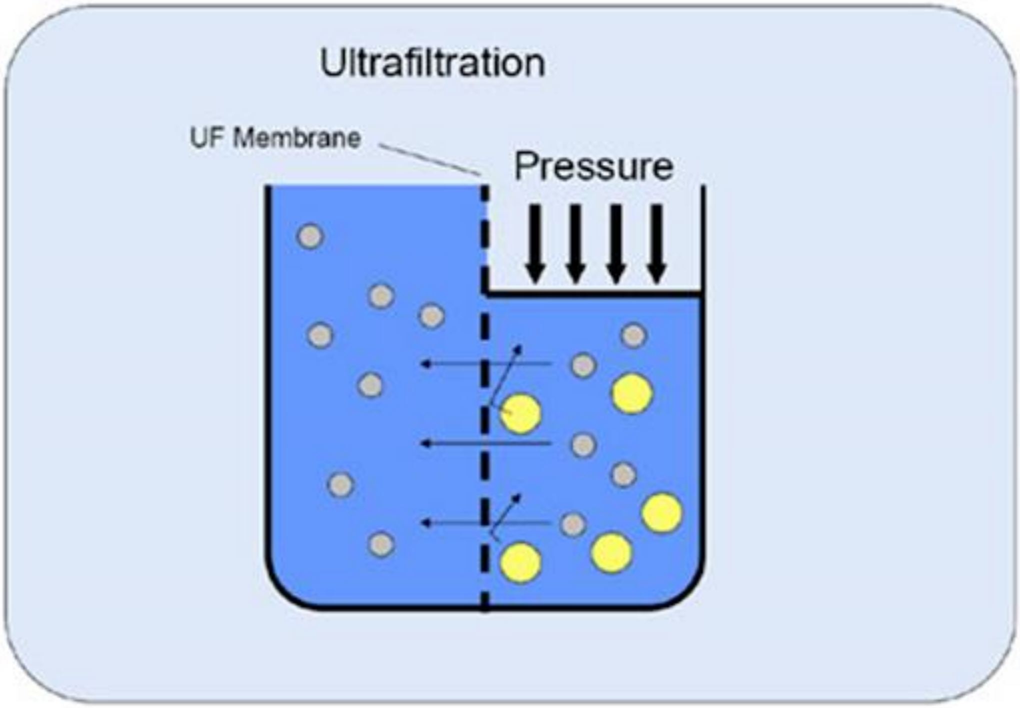
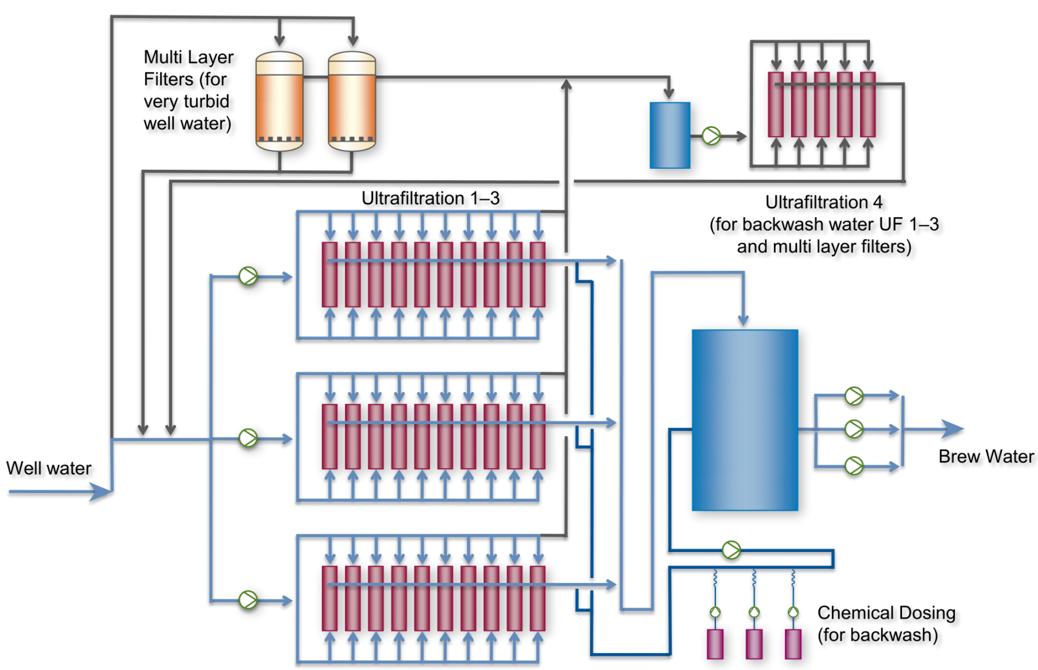


Ultrafiltration with Backwash Water Recycling




Ultrafiltration 1
Ultrafiltration 2
W.E.T.

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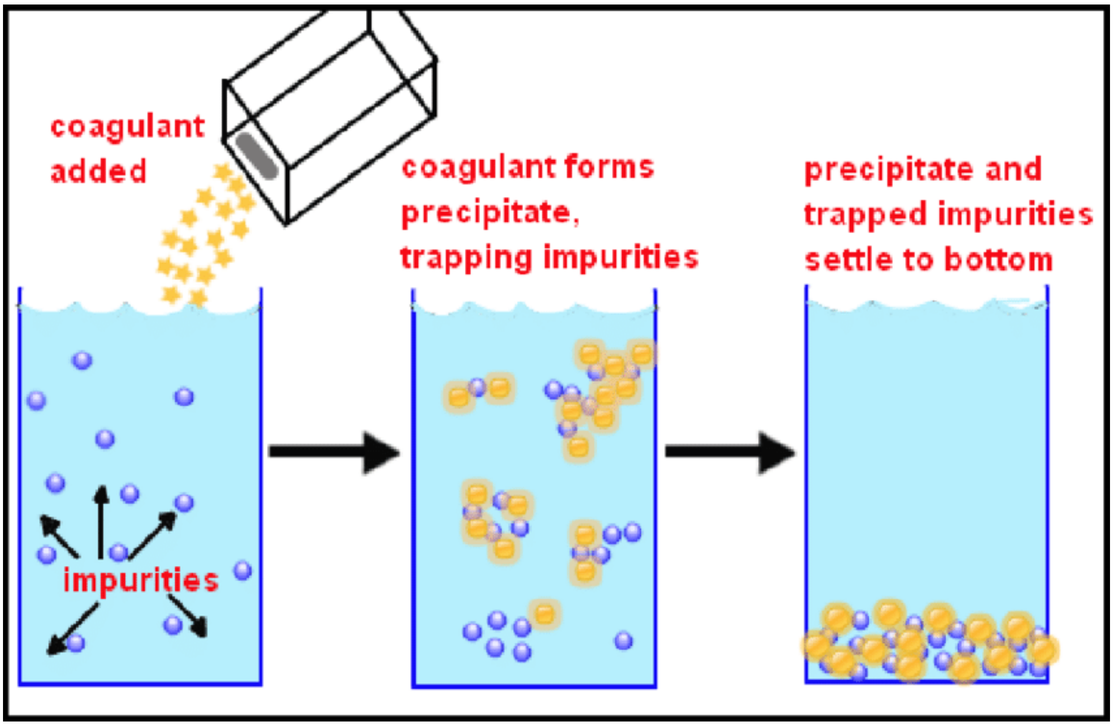

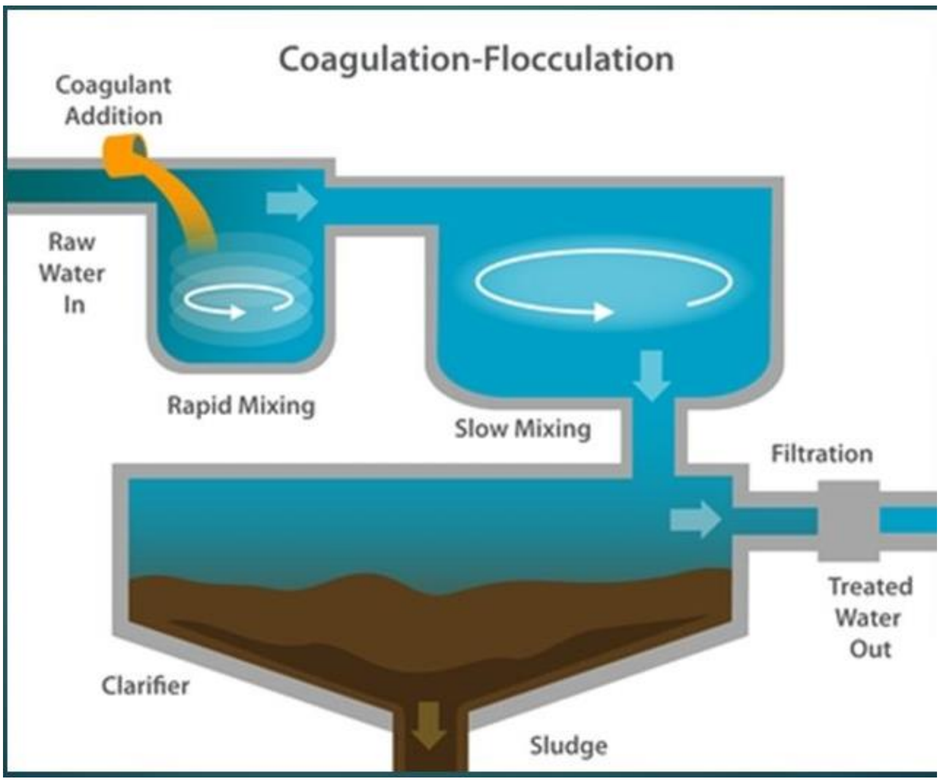

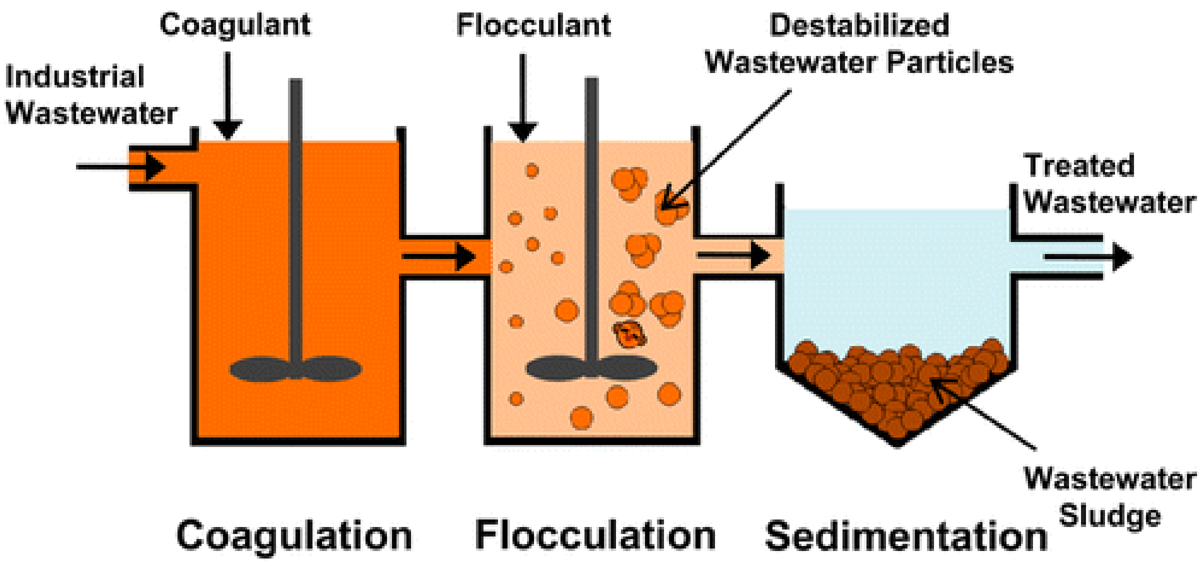

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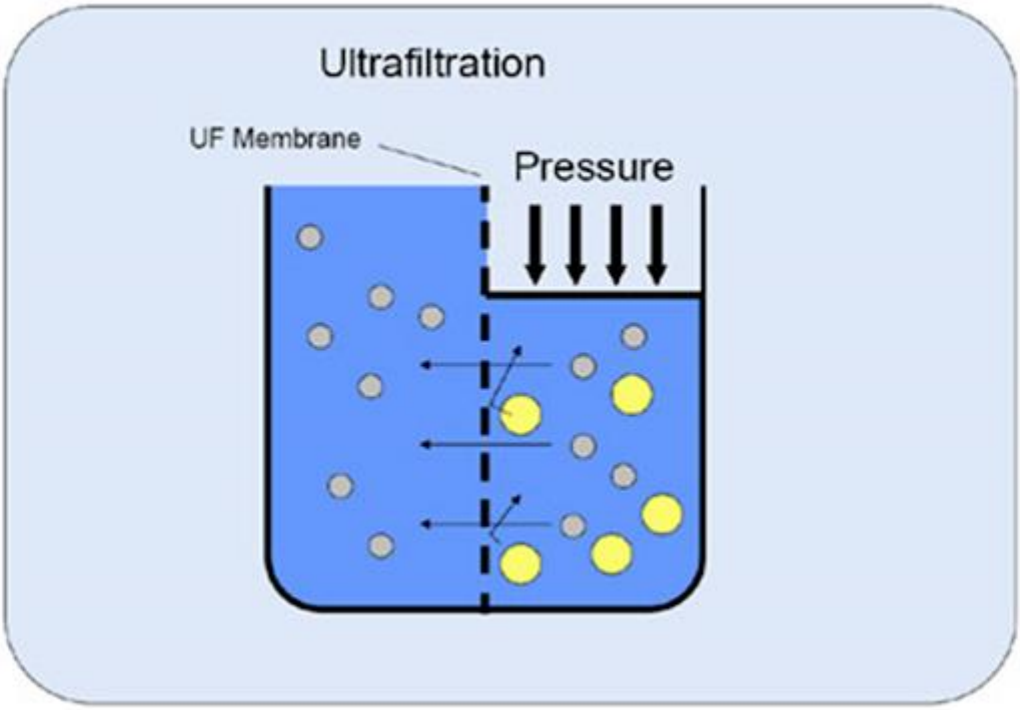
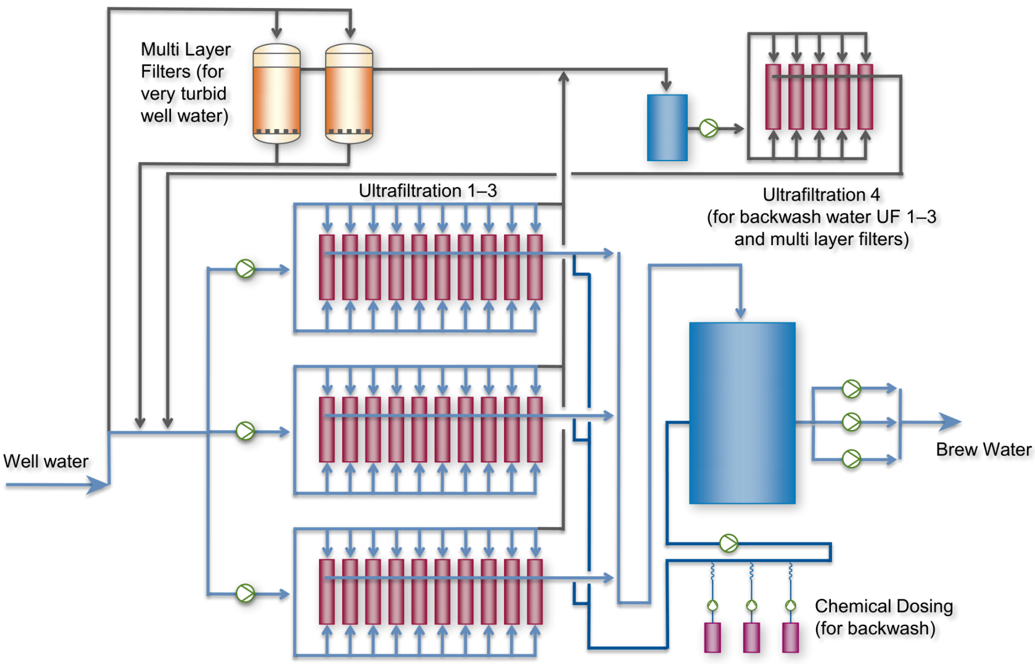


Ultrafiltration with Backwash Water Recycling



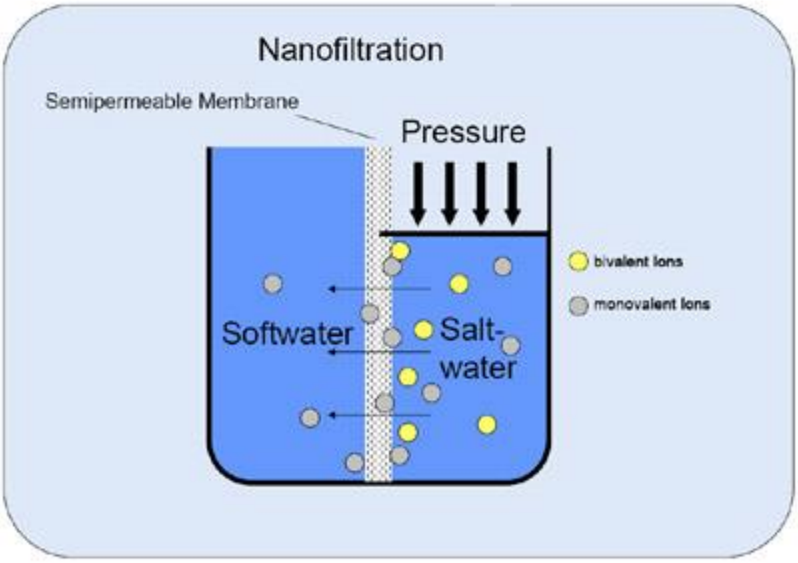
Nano Filtration:

The Nano filtration technique is mainly used for the removal of two valued ions and the larger mono valued ions such as heavy metals. This technique can be seen as a coarse RO (reversed osmosis) membrane. Because Nano filtration uses less fine membranes, the feed pressure of the NF system is generally lower compared to RO systems. Also the fouling rate is lower compared to Ro systems.

2. Removal of Dissolved Solids:

The dissolved solids are of both organic and inorganic types. A number of methods have been investigated for the removal of inorganic constituents from waste water.

Three methods which are finding wide application in advanced waste treatment are ion-exchange, electro dialysis and reverse osmosis. For the removal of soluble organics from waste water the most commonly used method is adsorption on activated carbon. Solvent extraction is also used to recover certain organic chemicals like phenol an d amines from industrial waste waters.



Ion exchange:

This technique has been used extensively to remove hardness, and iron and manganese salts in drinking water supplies. It has also been used selectively to remove specific impurities and to recover valuable trace metals like chromium, nickel, copper, lead and cadmium from industrial waste discharges. The process takes advantage of the ability of certain natural and synthetic materials to exchange one of their ions.

A number of naturally occurring minerals have ion exchange properties. Among them the notable ones are aluminium silicate minerals, which are called zeolites. Synthetic zeolites have been prepared using solutions of sodium silicate and sodium aluminate.

Alternatively synthetic ion-exchange resins composed of organic polymer with attached functional groups such as (strongly acidic cation exchange resins), or – COO – 3 -SO H+~ H+ (weakly acidic cation exchange resins or -N+(CH3)3OH~ (strongly basic anion exchange resins) can be used.

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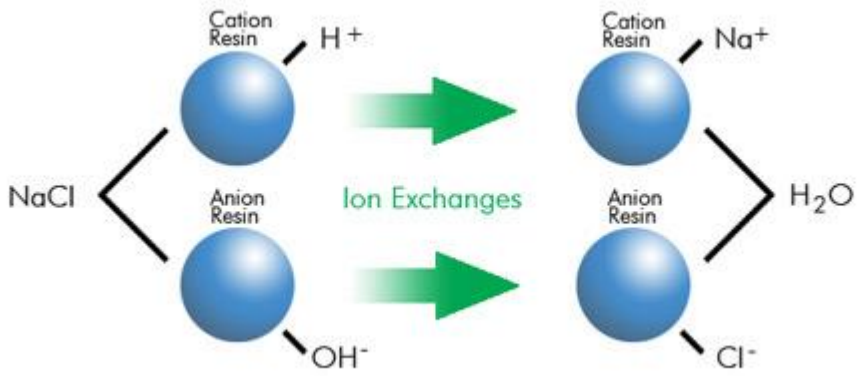
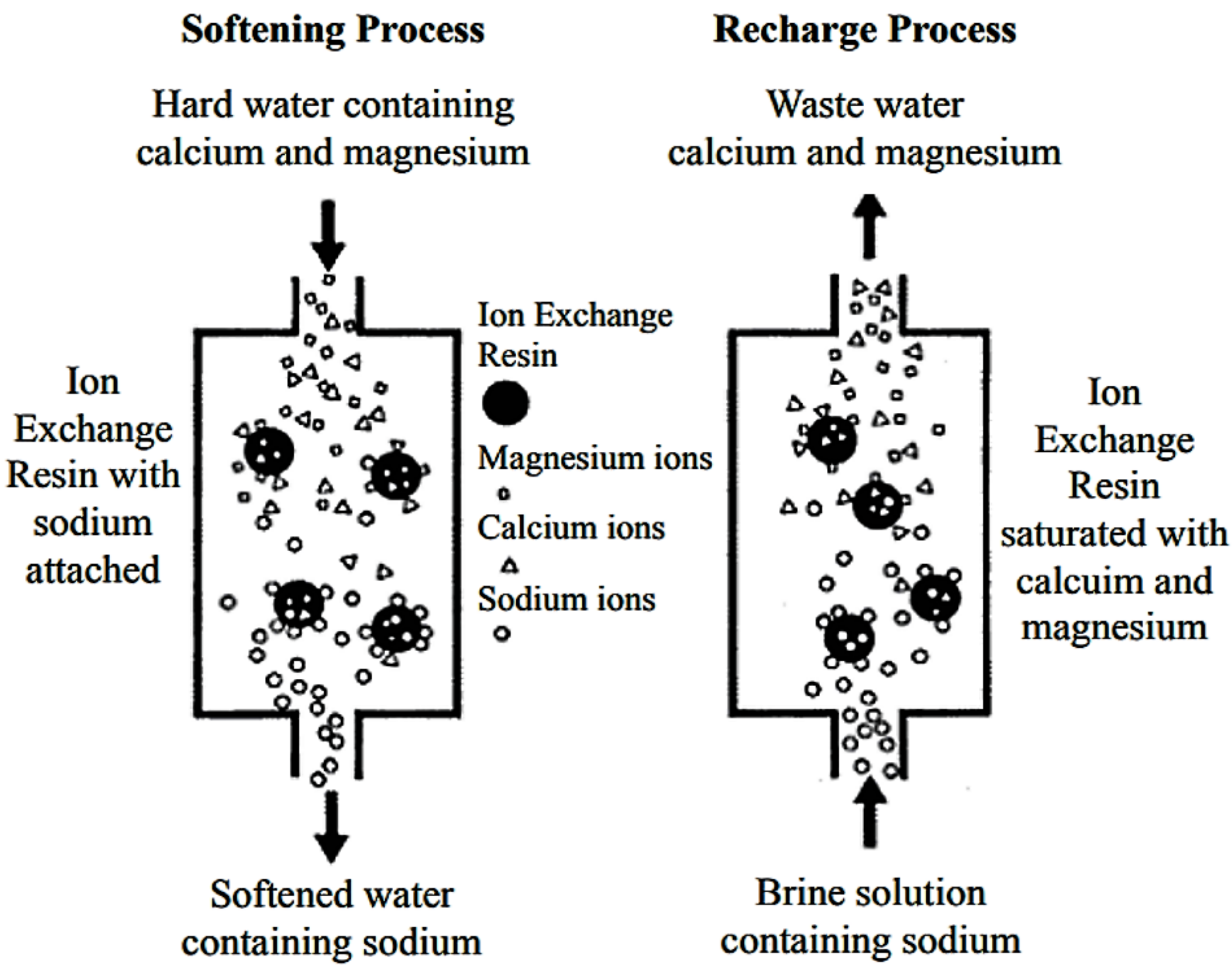
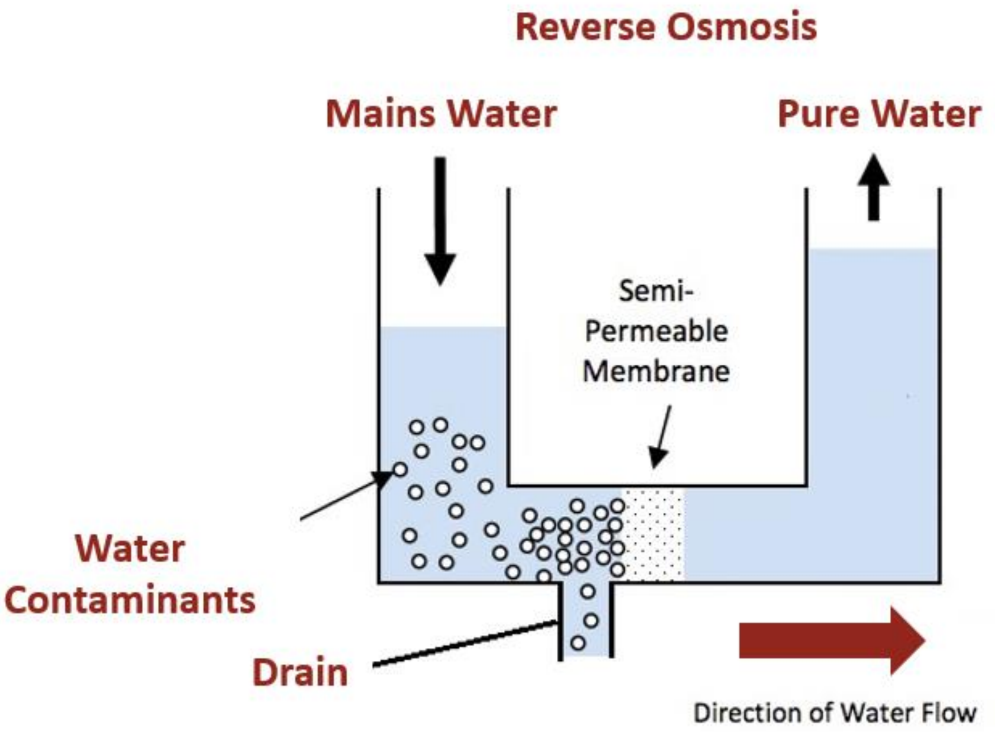
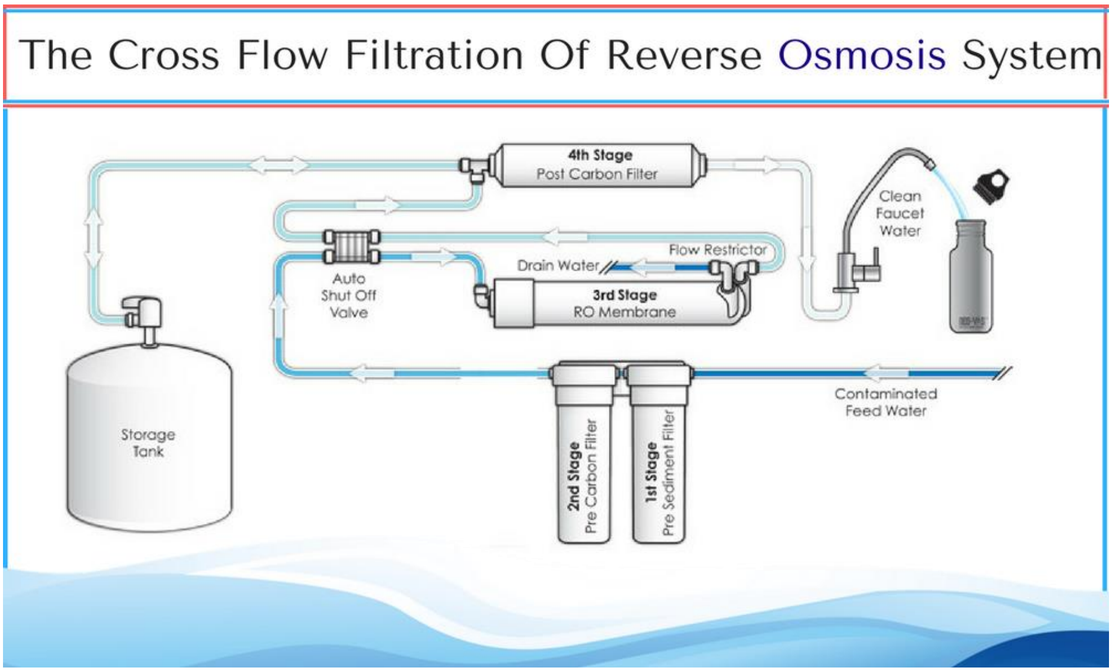




Reverse osmosis:

In the reverse osmosis process, de-mineralization water is produced by forcing water through semi permeable membranes at high pressure. In ordinary osmosis, if a vessel is divided by a semi permeable membrane (one that is permeable to water but not the dissolved material), and one compartment is filled with water and other with concentrated salt solution, water diffused through the membrane towards the compartment containing salt solution until the difference in water levels on the two sides of the membrane creates a sufficient pressure to counteract the original water flow. The difference in levels represents the osmotic pressure of the solution.




The Cross Flow Filtration Of Reverse Osmosis System
4th Stage
Post Carbon Filter
Clean
Faucet
Water
Flow Restrictor
Drain Water
Auto
Shut Off
Valve
3rd Stage
RO Membrane
Contaminated
Feed Water
Storage
Tank
2nd Stage
Pre Carbon Filter
1st Stage
Pre Sediment Filter


RO Membrane
CTO Filter
PP Filter
PRO – 3.2
CAUTION
NOTICE
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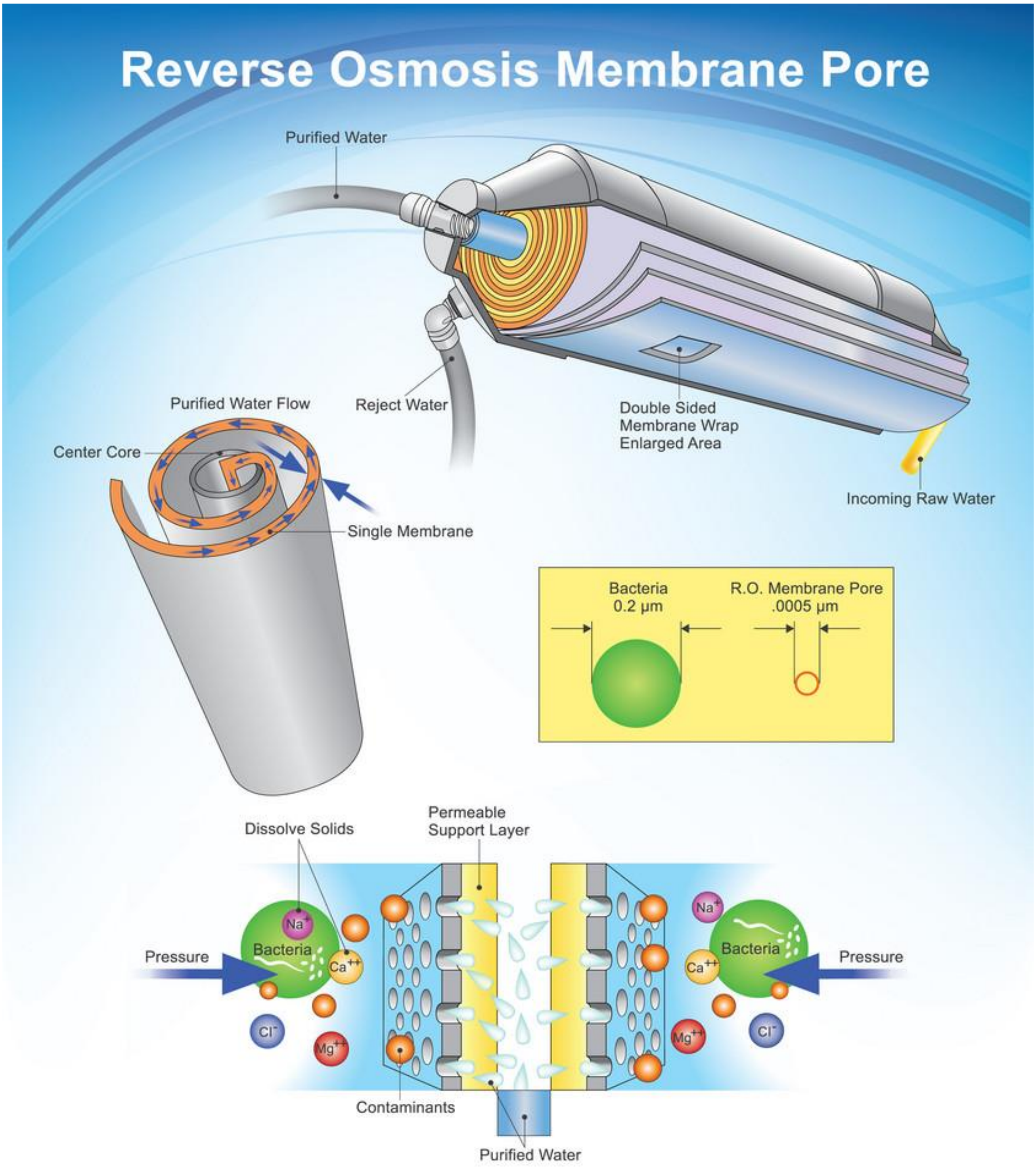


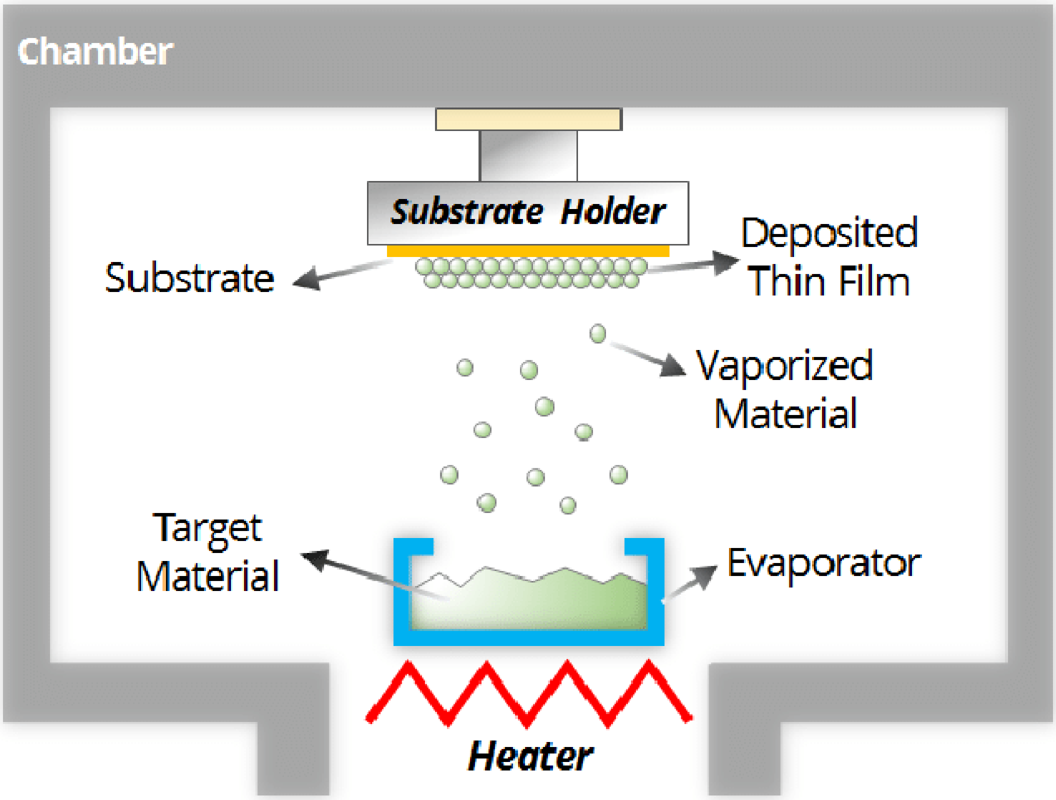
Reverse Osmosis Membrane Pore
Purified Water
Purified Water Flow
Reject Water
Center Core
Double Sided
Membrane Wrap
Enlarged Area
Incoming Raw Water
Single Membrane
Bacteria
0.2 µm
R.O. Membrane Pore
.0005 µm
Dissolve Solids
Permeable
Support Layer
Pressure
Bacteria
Na+
Ca++
Cl-
Mg++
Contaminants
Purified Water

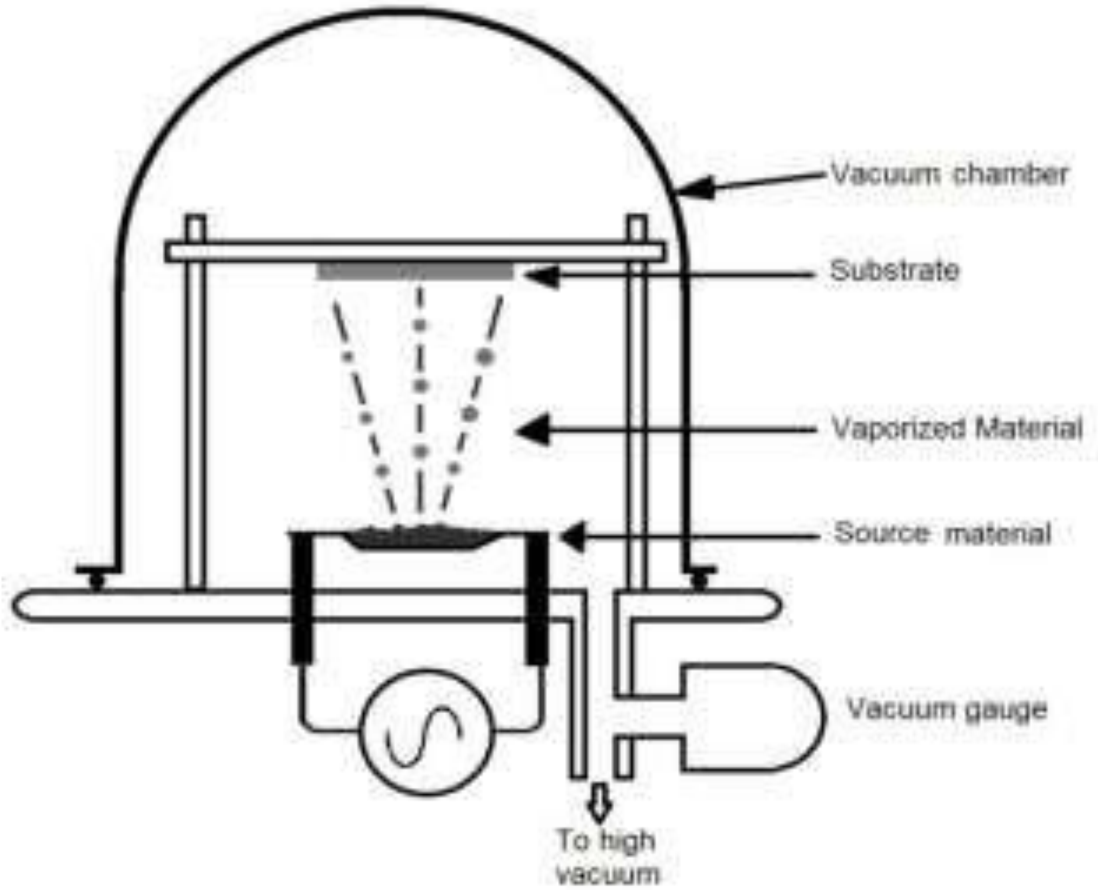
3. Thermal Evaporation:

Evaporation can take the form of vacuum distillation, atmospheric evaporation, and thermal evaporation. Vacuum distillation is accomplished by drawing a vacuum on a chamber and evaporating water at reduced temperatures, typically in the range of 90-150 degrees Fahrenheit. This technology is characterized by low energy cost, moderate to high manpower requirements, and very high capital cost.

Atmospheric evaporation involves spraying the wastewater across a high surface area medium and blowing large volumes of air across the medium. This type of evaporation is characterized by moderate energy cost, moderate capital cost, high manpower requirements due to the tendency for fouling and reduced throughputs caused by changes in atmospheric conditions.

Thermal evaporation/distillation is accomplished by heating the wastewater to a boiling temperature and evaporating the waste stream at various rates based on the amount of energy (BTU's) input into the system. This type of evaporation is characterized by moderate to high energy cost, low manpower requirements, moderate capital cost, high flexibility and high reliability. This system has the ability to exhaust water as clean water vapor or recover water as distilled water.


Chamber
Substrate Holder
Substrate
Deposited Thin Film
Vaporized Material
Target Material
Evaporator
Heater


Vacuum chamber
Substrate
Vaporized Material
Source material
Vacuum gauge
To high vacuum

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Total Solution:

Chemical treatment does not completely address parameters such as emulsified oils, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), or dissolved solids in the discharge wastewater. This becomes more important each year as Pollution control discharge limits become increasingly strict

Lower Disposal Cost:

Due to the addition of chemistry, the sludge volume being generated will be greater for chemical treatment compared to evaporation which typically does not require the addition of chemistry. This translates to lower disposal liability and cost for evaporation.

4. Removal of Dissolved Organic Compounds:

One of the most commonly used techniques for removing organics involves the process of adsorption, which is the physical adhesion of chemicals on to the surface of the solid. The effectiveness of the adsorbent is directly related to the amount of surface area available to attract the particles of contaminant.

The most commonly used adsorbent is a very porous matrix of granular activated carbon, which has an enormous surface area (~ 1000 m2/g).

Adsorption on activated carbon is perhaps the most economical and technically attractive method available for removing soluble organics such as phenols, chlorinated hydrocarbons, surfactants, and colour and odour producing substances from waste water.

Granular activated carbon treatment systems consist of a series of large vessels partially filled with adsorbent. Contaminated water enters the top of each vessel, trickles down through granulated activated carbon, and is released at the bottom.

After a period of time, the carbon filter becomes clogged with adsorbed contaminants and must be either replaced or regenerated. Regeneration of the carbon is accomplished by heating it to 950 °C in a steam air atmosphere. This process oxidizes surface, with an approximately 10% loss of carbon Activated carbon is commonly used to adsorb natural organic compounds, taste and odor compounds, and synthetic organic chemicals in drinking water treatment. Adsorption is both the physical and chemical process of accumulating a substance at the interface between liquid and solids phases. Activated carbon is an effective adsorbent because it is a highly porous material and provides a large surface area to which contaminants may adsorb. The two main types of activated carbon used in water treatment applications are granular activated carbon (GAC) and powdered activated carbon (PAC).

GAC is made from organic materials with high carbon contents such as wood, lignite and coal. The primary characteristic that differentiates GAC to PAC is its particle size. GAC typically has a diameter ranging between 1.2 to 1.6 mm and an apparent density ranging between 25 and 31 lb/ft^3), depending on the material used and manufacturing process..

Remove nutrients

1-Nitrogen control: ammonia in waste water effluent can be toxic to aquatic life in certain instances by providing additional biological treatment beyond the secondary stage nitrifying bacteria present in wastewater can biologically convert ammonia to the nontoxic nitrate through process known as nitrification the nitrification process is normally sufficient to remove the toxicity associated with ammonia in the effluent since nitrate is nutrient excess amounts can contribute to eutrophication in the receiving waters in situations where nitrogen must be completely removed from effluent an additional biological process can be added to the system to convert the nitrate to nitrogen gas the conversion of nitrate to nitrogen gas is accomplished by bacteria in a process known as denitrification effluent with nitrogen in the form of nitrate is placed into a tank devoid of oxygen where carbon containing chemicals such as methanol are added in this oxygen free environment bacteria use the oxygen attached to the nitrogen in the nitrate form releasing nitrogen gas because nitrogen comprises almost 80% of the air in the earth atmosphere the release of nitrogen into the atmosphere does not cause any environmental harm

2-phosphour control: like nitrogen phosphorus is a necessary nutrient for the growth of algae phosphorus reduction is often needed to prevent eutrophication before discharging effluent into likes reservoirs and estuaries phosphorus can be removed biologically in a process called enhanced biological phosphorus removal in this process specific bacteria called polyphosphate accumulating organism PAOS accumulating large quantities of phosphorus within their cells up to 20% of their mass when the biomass enriched in these bacteria is separated from the treated water these bio solids have a high fertilizer value phosphorus removal can also be achieved by chemical precipitation usually with salts or iron alum or lime this may lead to excessive sludge production as hydroxides precipitates and the added chemicals can be expensive despite this chemical phosphorus removal requires a significantly smaller equipment than biological removal is easier to operate and is often more reliable than biological phosphour removal

Fog removal

Fatty organic materials from animals, vegetables, and petroleum also are not quickly broken down by bacteria and can cause pollution in receiving environments. When large amounts of oils and greases are discharged to receiving waters from community systems, they increase BOD and they may float to the surface and harden, causing aesthetically unpleasing conditions. They also can trap trash, plants, and other materials, causing foul odors, attracting flies and mosquitoes and other disease vectors. In some cases, too much oil and grease causes septic conditions in ponds and lakes by preventing oxygen from the atmosphere from reaching the water. The removal of oil and grease depends on the condition of the oil water mixture the type of the equipment must be carefully selected the type of oil water mixture may be classified as oil and grease present as septic free oil dispersed oil, emulsified oil or dissolved oil the API separator is to separate free oil from waste water such gravity separators will not separate oil drop lets smaller than the size of free oil nor will it break down emulsion the dissolved air flotation DAF devices utilize the gravity separation concept for the removal of oil and grease from wastewater but tend to be more effective than API separators in removing the dispersed oil mixture because the bouncy differential is increased by induced small air bubbles

Coagulant aids such as polyelectrolytes are commonly used to promote agglomeration of the oil bearing matter into large flocs which are more easily removed the DAF device is reported effective in producing an effluent with 1 to 20 mg/l of oil and grease carbon adsorption or membrane filtration using reverse osmosis treatment is very effective to remove dissolved and emulsified oils biologically treatment is generally effective in degrading dissolved oils and other types of stabilized emulsions which cannot be destabilized by chemical coagulants however a biological system is only effective on highly dilute oil contaminated wastewater because mineral based oils are adsorbed by the microorganisms faster than they can be metabolized in activated sludge systems the adsorbed oil tends to damage sluge settling characteristics and cause system failure it has been reported that biological organism are efficient in oxidizing dispersed or emulsified oil but large amounts of free oil must be avoided

In these reservoirs wastewater is stored for long periods of time

The purpose of the storage is twofold

To obtain highly quality effluents wastewater treatment wastewater irrigation projects must match the almost homogenous sewage flow coming from the city to the discontinuous water demand for irrigation wastewater storage reservoirs add flexibility to the operation system optimize the reuse of the reclaimed water increase the area which can be irrigated and release effluents of a good and reliable quality these waste water storage and treatment reservoirs can be also applied to other situations

Coastal areas wastewater is stored during the summer in order to avoid the contamination of beaches during the summer in order to avoid the contamination of beaches during the tourism season by the end of summer when the last tourist has gone wastewater will be released from the reservoirs into the sea meanwhile these effluents will reach excellent quality due to long residence time within the reservoirs during the summer months

River stream recovery 1wastewater is stored during the dry season when the river runs at minimum flow wastewater of high quality will be released from the reservoirs to the river when river flow is at maximum thus obtaining maximum dilution and minimum negative ecological impact

River stream recovery 2 wastewater is stored when river flow is at maximum wastewater of very high quality is then released from the reservoirs to the river during the dry period as a substitute for freshwater in order to avoid total drying of the river and ecosystem destruction

High quality effluents are required wastewater contains not only organic matter but also significant concentrations of pathogens heavy metals hard detergents pesticides organic micro pollutants and other pollutants which are not removed by classic sewage treatment plants stabilization reservoirs are able to remove most of them

Cooling water wastewater is more and more used as cooling water in power stations and other installations wastewater storage reservoirs can supply cooling towers with wastewater of proper quality and temperature in due time

Besides, stabilization reservoirs are green

Processes occurring within the reservoirs are natural they utilize solar energy (mechanical plants use electricity) algae within the reservoirs produce most of the oxygen required by the processes mechanical plants take oxygen from the atmosphere with high energy consumption

Aquatic birds find the reservoirs a good refuge this is important in areas where the natural habitat of the birds have been invaded by urban tourism or agriculture development

Disinfection

Disinfection Methods Disinfection of wastewater is achieved using a variety of methods in Victoria, including: • chemical (for example, chlorination, ozonation); • physical (for example, ultraviolet radiation, microfiltration); and • biological (for example, detention lagoons). Chemical Chlorination Chlorine is used to disinfect wastewater in either gaseous form (Cl2), or as hypochlorite salts. Disinfection by ozonation is achieved using the formation of free radicals as oxidizing*- agents. Ozonation is more effective against viruses and bacteria than chlorination, yet problems with effective bactericidal action occur when conditions are not ideal. The low solubility of ozone in water is the main factor that greatly reduces its disinfection capacity, and any ozone residual produced rapidly dissipates as a consequence of its reactive nature. The absence of a lasting residual may also be seen as a disadvantage as this may allow possible microbial DISINFECTION OF TREATED WASTEWATER EPA Victoria 8 re-growth and make it difficult to measure the efficiency of the disinfection process. Physical Ultraviolet radiation The disinfection of treated wastewater via ultraviolet (UV) radiation is a physical process that principally involves passing a film of wastewater within close proximity of a UV source (lamp). The efficiency of UV disinfection depends on the physical and chemical water quality characteristics of the wastewater prior to disinfection. With a better quality of wastewater comes a more efficient UV disinfection process. The advantage of the UV disinfection process is that it is rapid and does not add to the toxicity of the wastewater. There have been no reports of byproducts produced from UV disinfection that adversely impact on the receiving environment. UV disinfection does not

result in a lasting residual in the wastewater. This is a disadvantage when wastewater must be piped or stored over significant distances and time (particularly relevant to reuse schemes) as re-growth of the microbial population is considered a risk. Membrane filtration Membrane technologies disinfect treated wastewater by physically filtering out microorganisms. This disinfection process does not require the addition of reactive chemicals and as such, no toxic disinfection by-products are produced. Key membrane technologies include: • reverse osmosis; • ultrafiltration; • nanofiltration; and • microfiltration. Microfiltration is the most commercially viable technology for the disinfection of treated wastewater. The wastewater passes through membrane fibres, hollow cylinders permeated with millions of microscopic pores. These pores allow wastewater to flow through the same fibres that act as a physical barrier to particles and microorganisms. Microfiltration efficiently reduces particulates, bacteria, and a range of viruses, algae and protozoans. Protozoa are generally larger than 0.2 micron and are removed effectively by microfiltration, giving this method an advantage over other technologies. Viruses larger than 0.2 micron (which includes most enteric viruses) are also reduced effectively. The main disadvantages associated with microfiltration include the potentially high capital costs, the resultant concentrated backwash with significant microbial contamination, and the handling and management of contaminated chemicals produced by periodic cleaning of the membranes. Biological Lagoons The storage of secondary treated wastewater in pondage systems (nominally 30 days) allows natural disinfection to take place before discharging or reusing the treated wastewater. Natural disinfection can occur via sunlight and/or natural microbial dieoff. Natural disinfection processes can be affected by a number of factors such as the: DISINFECTION OF TREATED WASTEWATER Guidelines for Environmental Management 9 • turbidity of the wastewater, as it affects sunlight penetration; • amount of suspended matter in the water, as viruses and bacteria may be shielded from the rays of the sun by being absorbed into surface pores; and • ineffectiveness of sunlight in seawater compared with freshwater. Temperature, pH, adsorption and sedimentation further influence the natural disinfection and inactivation processes occurring in wastewater stored in lagoons. The ability of ponds to remove or reduce the number of pathogens depends on such factors as the load of incoming solids and microorganisms, temperature, sunlight and pond design related to detention time. Re-infection of ponds by bird populations can also pose a problem for operators. Algal blooms in the ponds over summer will also reduce the efficiency of the natural disinfection process. Systems using only detention do not typically result in a Class A effluent and are unsuitable as the sole means of pathogen reduction for high contact uses.

Nano Filtration:

The Nano filtration technique is mainly used for the removal of two valued ions and the larger mono valued ions such as heavy metals. This technique can be seen as a coarse RO (reversed osmosis) membrane. Because Nano filtration uses less fine membranes, the feed pressure of the NF system is generally lower compared to RO systems. Also the fouling rate is lower compared to Ro systems.

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The dissolved solids are of both organic and inorganic types. A number of methods have been investigated for the removal of inorganic constituents from waste water.

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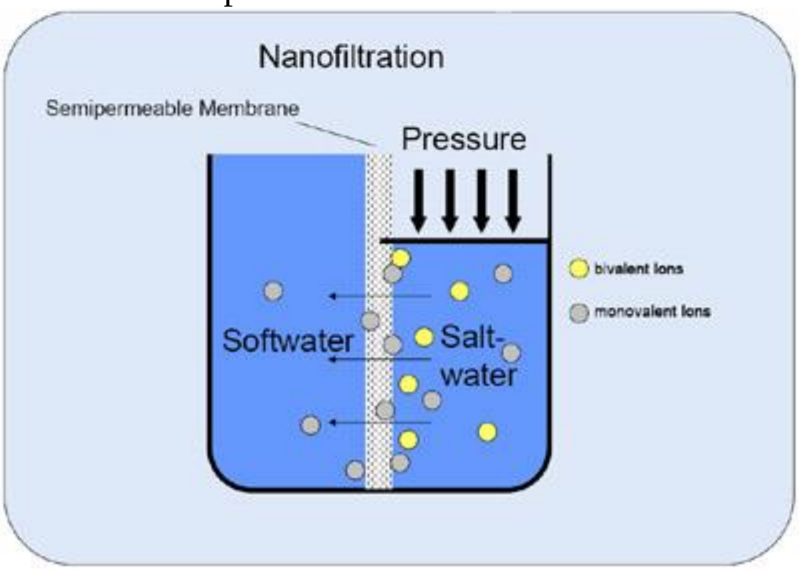

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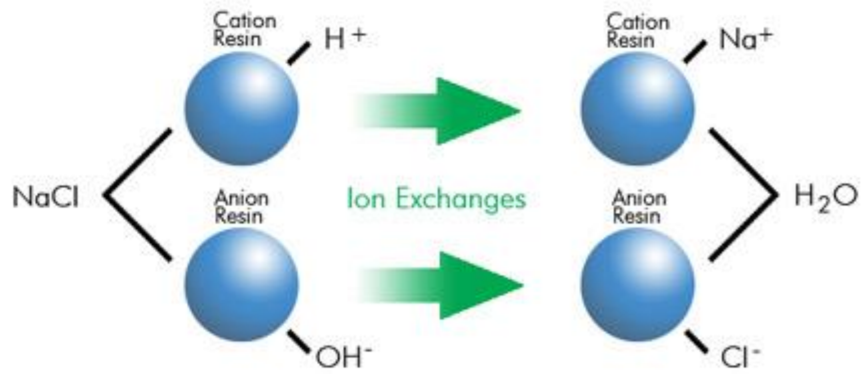

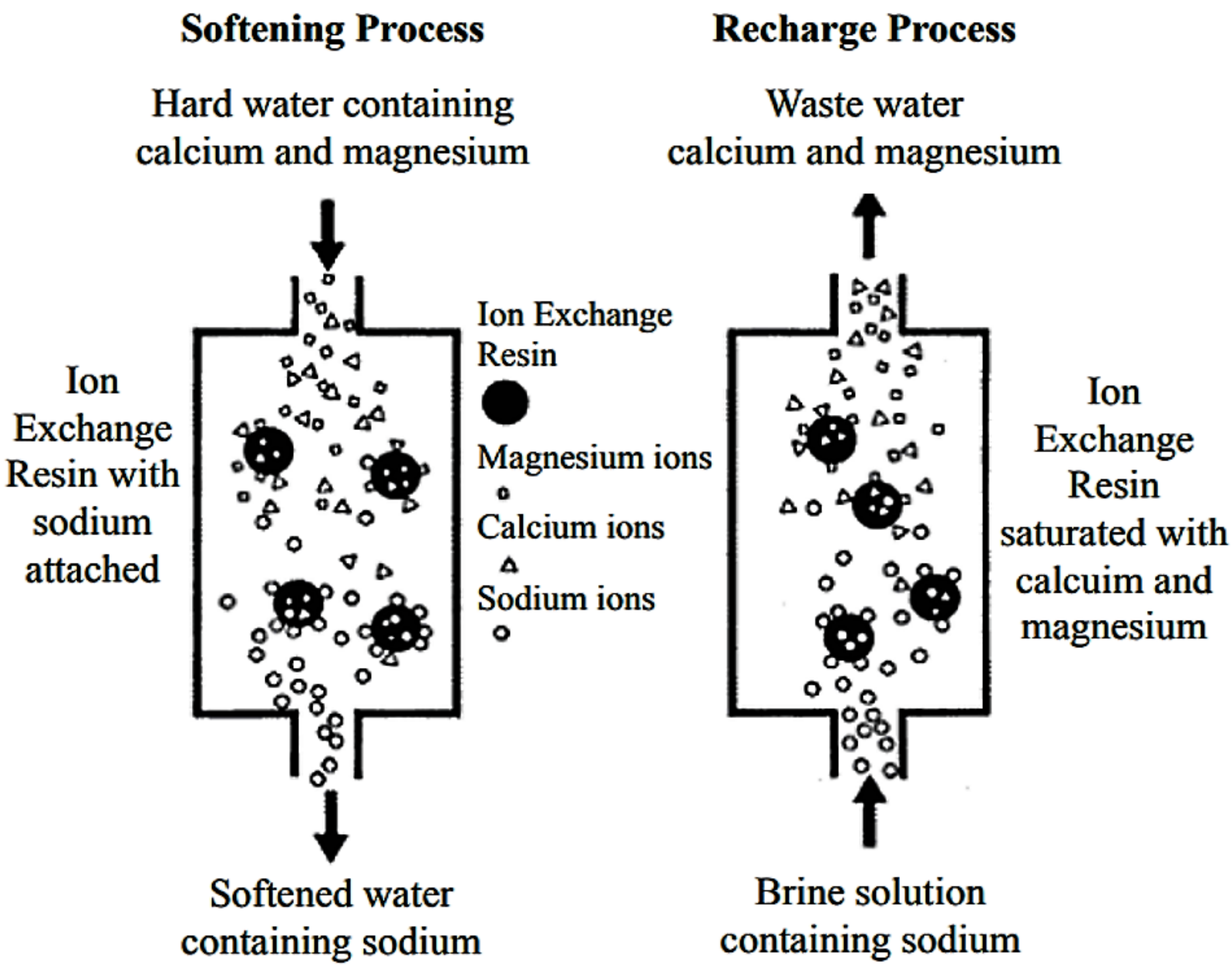

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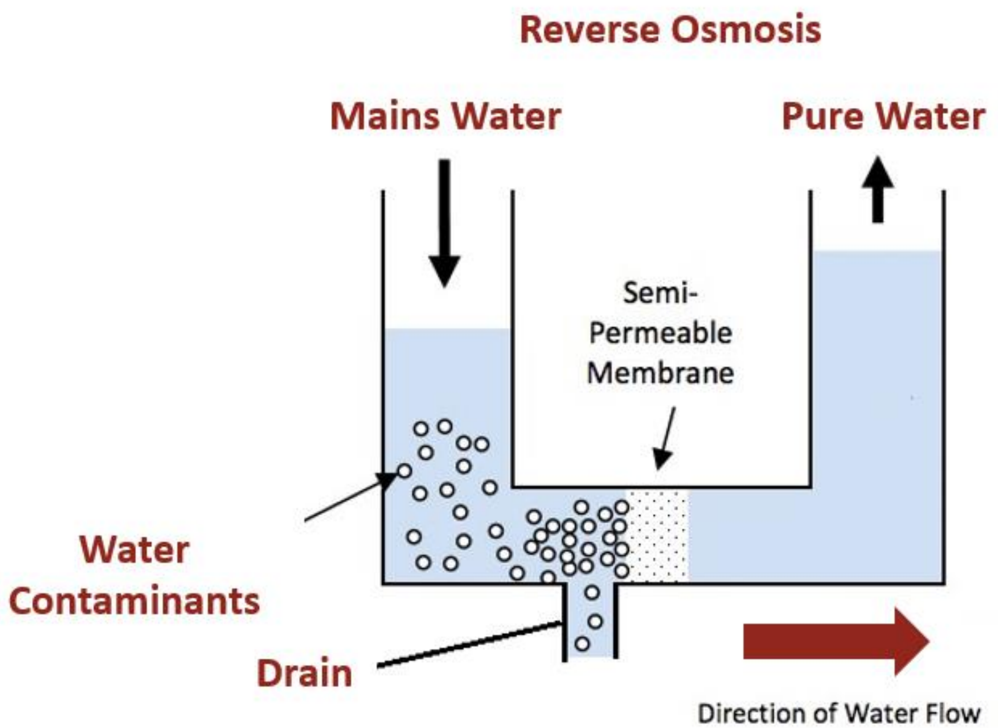
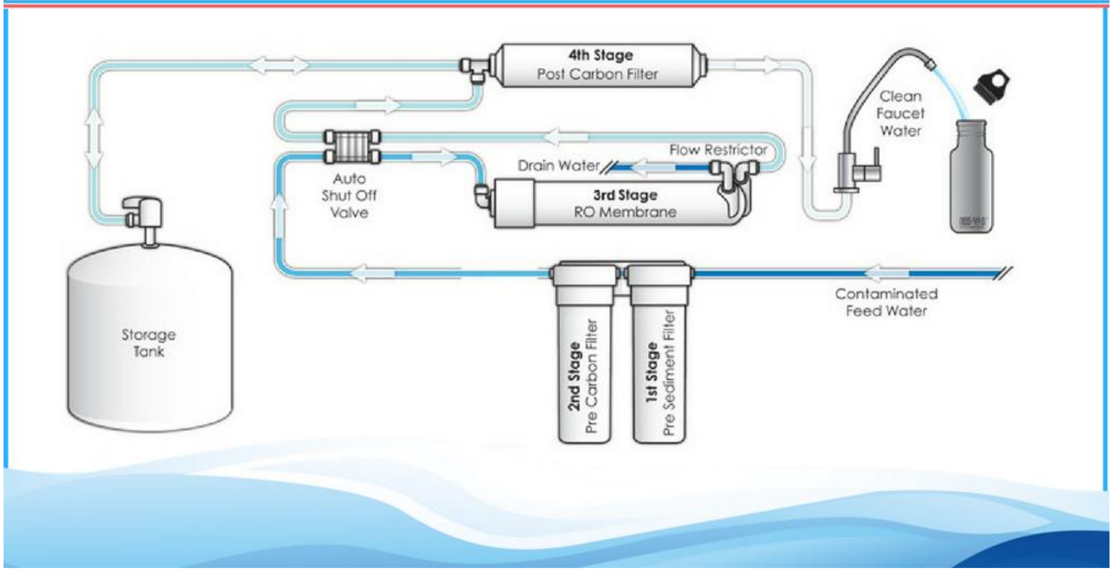
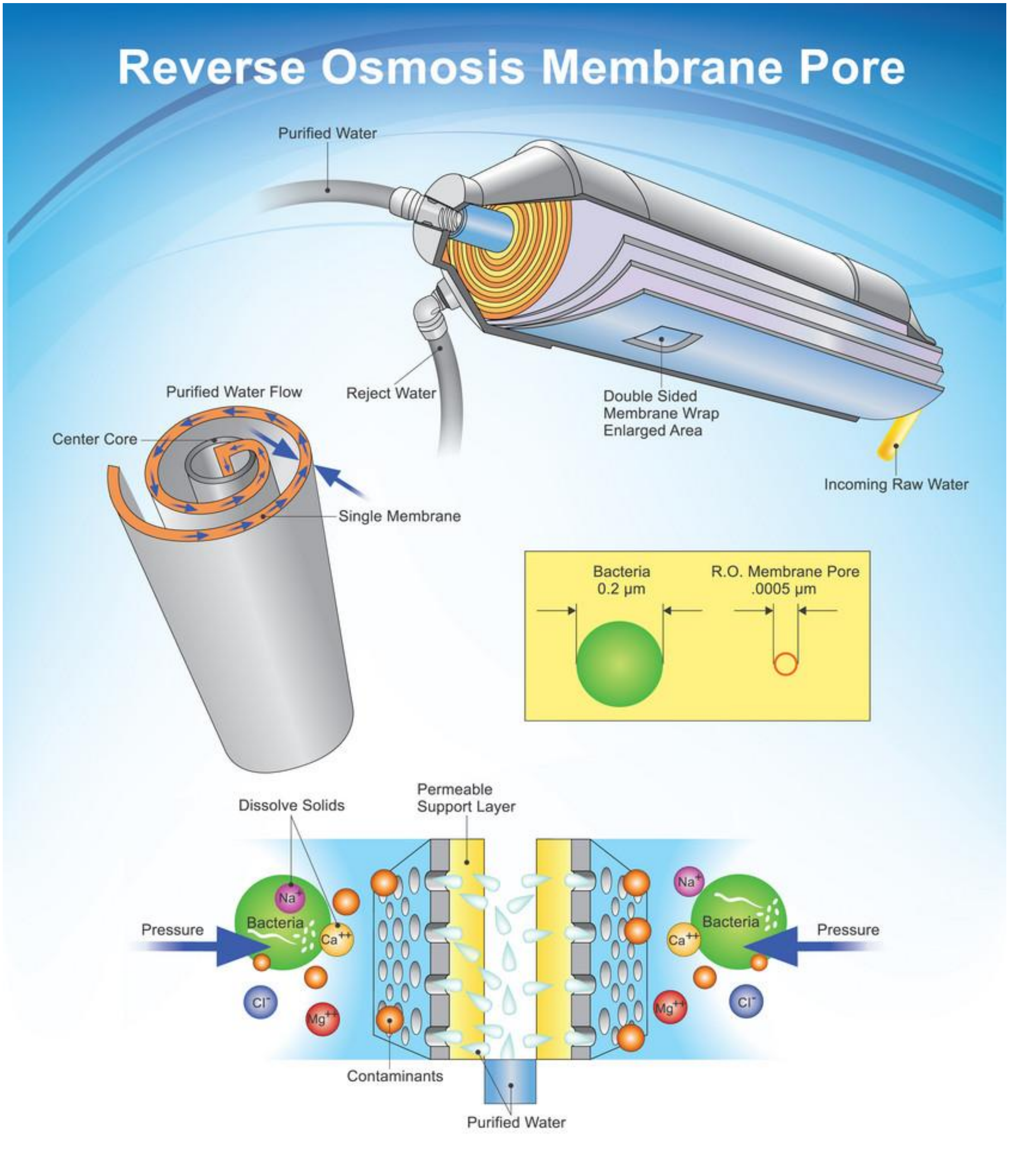

Reverse Osmosis
Mains Water
Pure Water
Semi-
Permeable
Membrane
Water
Contaminants
Drain
Direction of Water Flow

The Cross Flow Filtration Of Reverse Osmosis System




RO Membrane
CTO Filter
PP Filter
PRO – 3.2
CAUTION
NOTICE
190103A


Reverse Osmosis Membrane Pore
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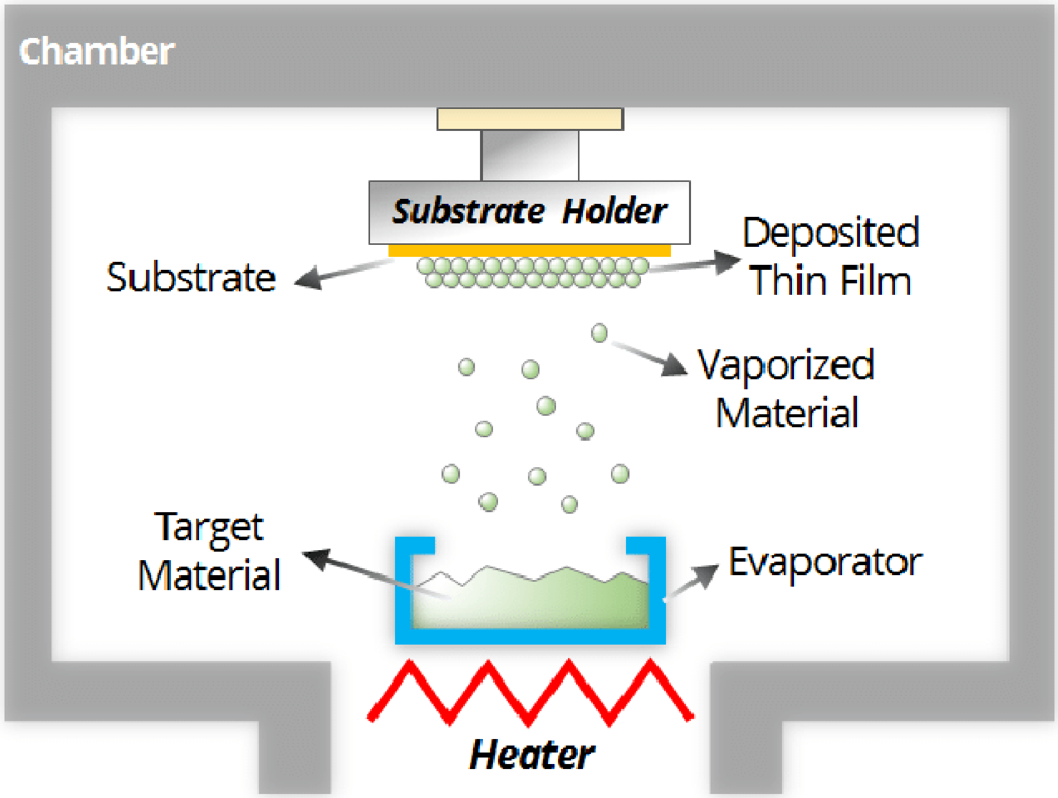
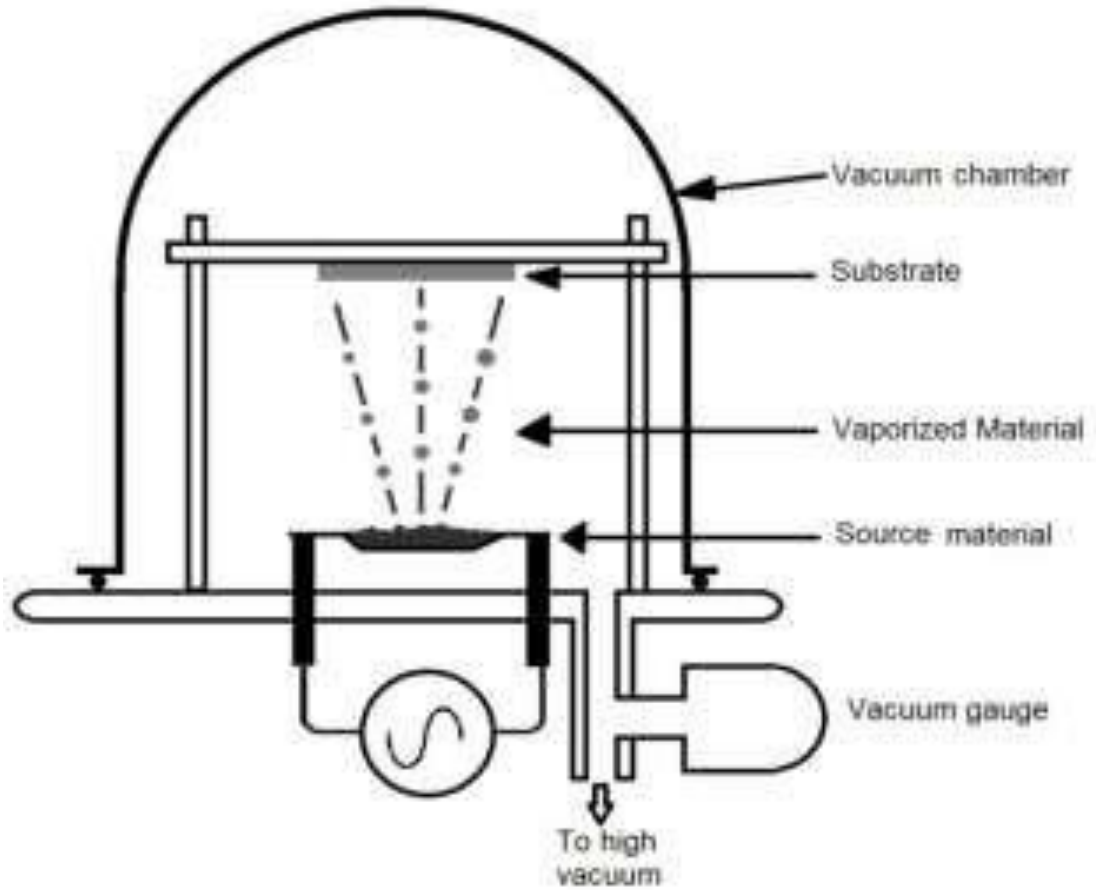

Chamber
Substrate Holder
Substrate
Deposited
Thin Film
Vaporized
Material
Target
Material
Evaporator
Heater



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The purpose of the storage is twofold

To obtain highly quality effluents wastewater treatment wastewater irrigation projects must match the almost homogenous sewage flow coming from the city to the discontinuous water demand for irrigation wastewater storage reservoirs add flexibility to the operation system optimize the reuse of the reclaimed water increase the area which can be irrigated and release effluents of a good and reliable quality these waste water storage and treatment reservoirs can be also applied to other situations

Coastal areas wastewater is stored during the summer in order to avoid the contamination of beaches during the summer in order to avoid the contamination of beaches during the tourism season by the end of summer when the last tourist has gone wastewater will be released from the reservoirs into the sea meanwhile these effluents will reach excellent quality due to long residence time within the reservoirs during the summer months

River stream recovery 1wastewater is stored during the dry season when the river runs at minimum flow wastewater of high quality will be released from the reservoirs to the river when river flow is at maximum thus obtaining maximum dilution and minimum negative ecological impact

River stream recovery 2 wastewater is stored when river flow is at maximum wastewater of very high quality is then released from the reservoirs to the river during the dry period as a substitute for freshwater in order to avoid total drying of the river and ecosystem destruction

High quality effluents are required wastewater contains not only organic matter but also significant concentrations of pathogens heavy metals hard detergents pesticides organic micro pollutants and other pollutants which are not removed by classic sewage treatment plants stabilization reservoirs are able to remove most of them

Cooling water wastewater is more and more used as cooling water in power stations and other installations wastewater storage reservoirs can supply cooling towers with wastewater of proper quality and temperature in due time

Besides, stabilization reservoirs are green

Processes occurring within the reservoirs are natural they utilize solar energy (mechanical plants use electricity) algae within the reservoirs produce most of the oxygen required by the processes mechanical plants take oxygen from the atmosphere with high energy consumption

Aquatic birds find the reservoirs a good refuge this is important in areas where the natural habitat of the birds have been invaded by urban tourism or agriculture development

Disinfection

Disinfection Methods Disinfection of wastewater is achieved using a variety of methods in Victoria, including: • chemical (for example, chlorination, ozonation); • physical (for example, ultraviolet radiation, microfiltration); and • biological (for example, detention lagoons). Chemical Chlorination Chlorine is used to disinfect wastewater in either gaseous form (Cl2), or as hypochlorite salts. Disinfection by ozonation is achieved using the formation of free radicals as oxidizing*- agents. Ozonation is more effective against viruses and bacteria than chlorination, yet problems with effective bactericidal action occur when conditions are not ideal. The low solubility of ozone in water is the main factor that greatly reduces its disinfection capacity, and any ozone residual produced rapidly dissipates as a consequence of its reactive nature. The absence of a lasting residual may also be seen as a disadvantage as this may allow possible microbial DISINFECTION OF TREATED WASTEWATER EPA Victoria 8 re-growth and make it difficult to measure the efficiency of the disinfection process. Physical Ultraviolet radiation The disinfection of treated wastewater via ultraviolet (UV) radiation is a physical process that principally involves passing a film of wastewater within close proximity of a UV source (lamp). The efficiency of UV disinfection depends on the physical and chemical water quality characteristics of the wastewater prior to disinfection. With a better quality of wastewater comes a more efficient UV disinfection process. The advantage of the UV disinfection process is that it is rapid and does not add to the toxicity of the wastewater. There have been no reports of byproducts produced from UV disinfection that adversely impact on the receiving environment. UV disinfection does not result in a lasting residual in the wastewater. This is a disadvantage when wastewater must be piped or stored over significant distances and time (particularly relevant to reuse schemes) as re-growth of the microbial population is considered a risk. Membrane filtration Membrane technologies disinfect treated wastewater by physically filtering out microorganisms. This disinfection process does not require the addition of reactive chemicals and as such, no toxic disinfection by-products are produced. Key membrane technologies include: • reverse osmosis; • ultrafiltration; • nanofiltration; and • microfiltration. Microfiltration is the most commercially viable technology for the disinfection of treated wastewater. The wastewater passes through membrane fibres, hollow cylinders permeated with millions of microscopic pores. These pores allow wastewater to flow through the same fibres that act as a physical barrier to particles and microorganisms. Microfiltration efficiently reduces particulates, bacteria, and a range of viruses, algae and protozoans. Protozoa are generally larger than 0.2 micron and are removed effectively by microfiltration, giving this method an advantage over other technologies. Viruses larger than 0.2 micron (which includes most enteric viruses) are also reduced effectively. The main disadvantages associated with microfiltration include the potentially high capital costs, the resultant concentrated backwash with significant microbial contamination, and the handling and management of contaminated chemicals produced by periodic cleaning of the membranes. Biological Lagoons The storage of secondary treated wastewater in pondage systems (nominally 30 days) allows natural disinfection to take place before discharging or reusing the treated wastewater. Natural disinfection can occur via sunlight and/or natural microbial dieoff. Natural disinfection processes can be affected by a number of factors such as the: DISINFECTION OF TREATED

WASTEWATER Guidelines for Environmental Management 9 • turbidity of the wastewater, as it affects sunlight penetration; • amount of suspended matter in the water, as viruses and bacteria may be shielded from the rays of the sun by being absorbed into surface pores; and • ineffectiveness of sunlight in seawater compared with freshwater. Temperature, pH, adsorption and sedimentation further influence the natural disinfection and inactivation processes occurring in wastewater stored in lagoons. The ability of ponds to remove or reduce the number of pathogens depends on such factors as the load of incoming solids and microorganisms, temperature, sunlight and pond design related to detention time. Re-infection of ponds by bird populations can also pose a problem for operators. Algal blooms in the ponds over summer will also reduce the efficiency of the natural disinfection process. Systems using only detention do not typically result in a Class A effluent and are unsuitable as the sole means of pathogen reduction for high contact uses.