Biological Wastewater Treatment

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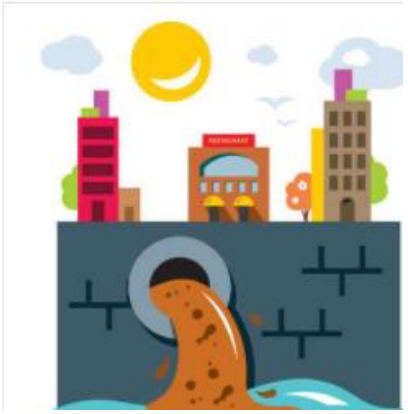
Wastewater (WW)

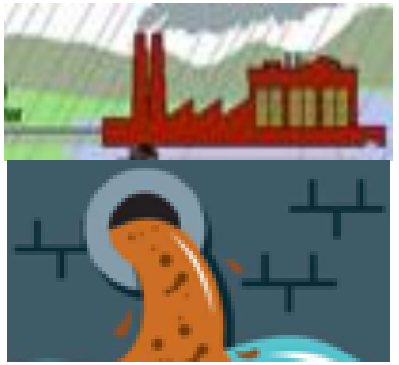
- Domestic WW

  From residential areas



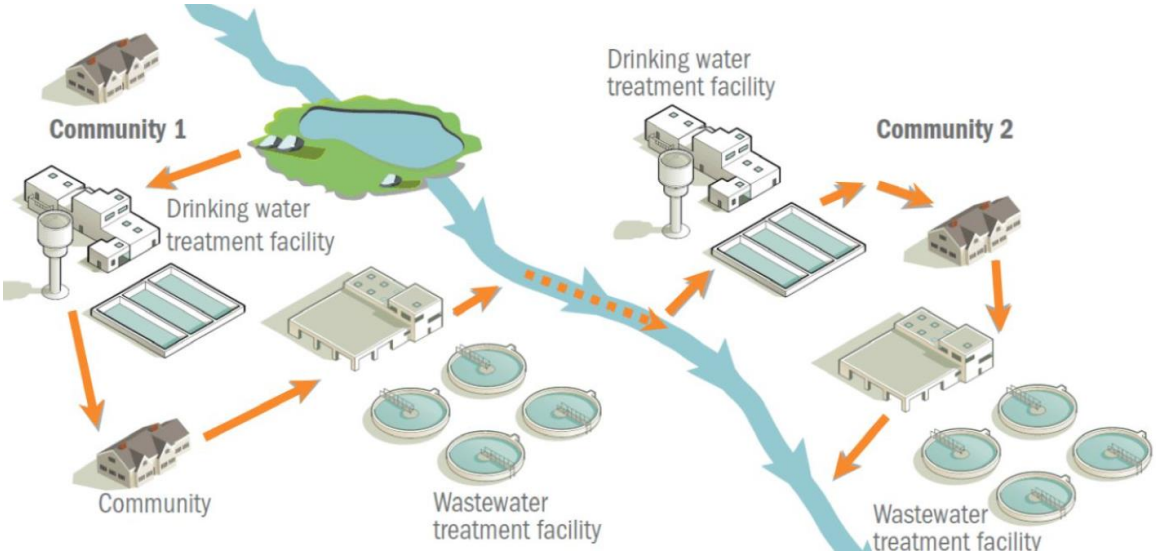
- Industrial WW

  From industries (textile, paper, chemical, food etc)



Wastewater Treatment

- To reduce the amount of pollutants in the water to such a level that the water can be returned to the environment without causing stress on aquatic life and be of sufficient quality for subsequent users.



Treatment plants reduce pollutants in wastewater to a level nature can handle.

Sustainable Development Goals (SDG)

SGD 6

'By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally'.

To track progress toward target

SGD indicator 6.3.1

monitors the proportion of total, industrial and domestic wastewater flows safely treated in compliance with national or local standards.

With the goal: «Halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally by 2030»

Global status of indicator 6.3.1 Proportion of wastewater flow (safely) treated > Domestic (2020)

More than 80 per cent of wastewater resulting from human activities is discharged into rivers or sea without any pollution removal

https://www.sdg6data.org/indicator/6.3.1

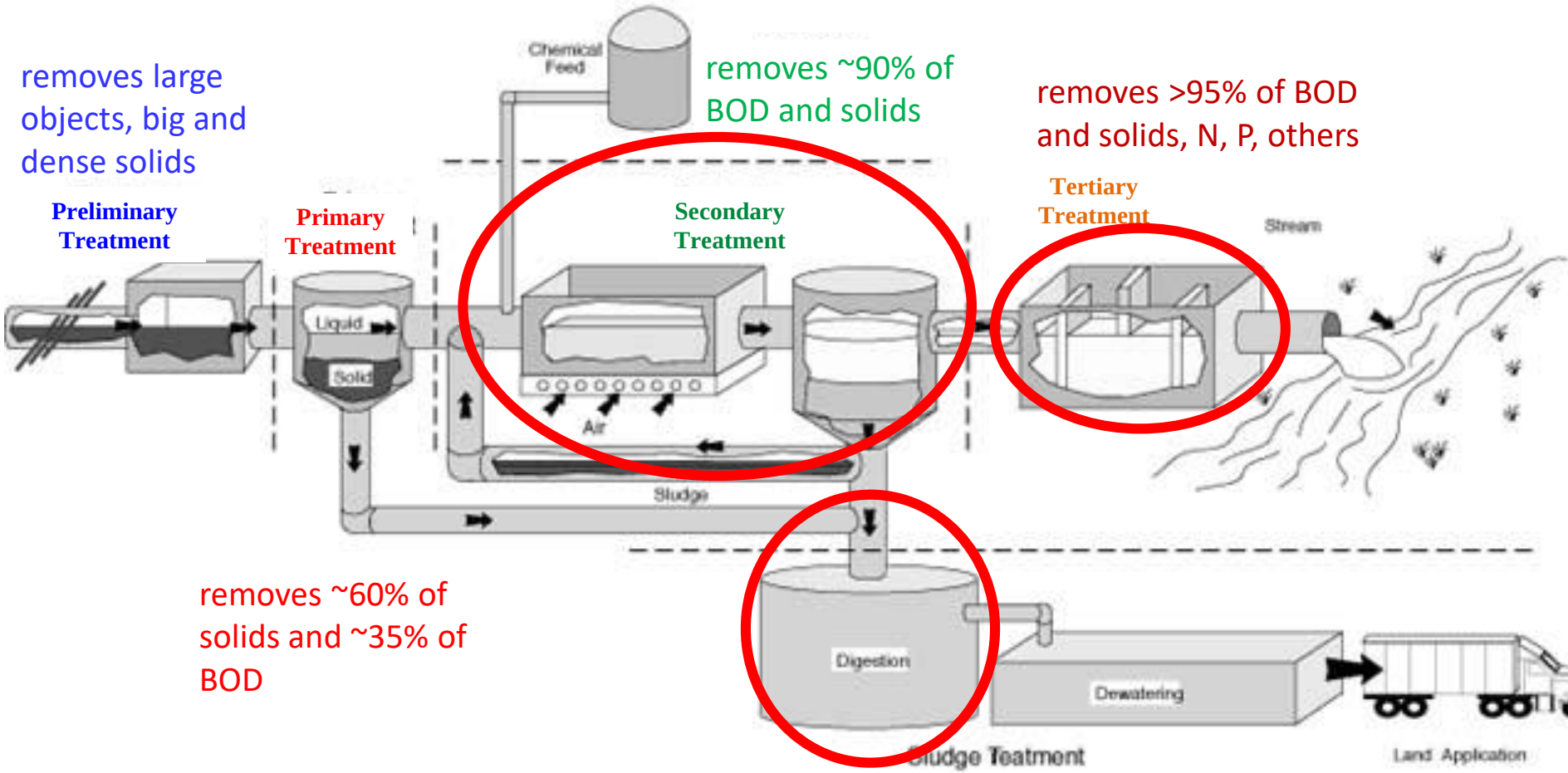
Wastewater Pollutants

- Suspended solids – cause turbidity, sludge deposits and anaerobic conditions in the environment
- Biodegradable organics – deplete oxygen and can cause anaerobic conditions in the environment
- Pathogens – transmit disease
- Nutrients – can cause eutrophication
- Heavy metals – toxicity to biota and humans
- Refractory organics – toxicity to biota and humans

Domestic Wastewater Composition

Contaminants	Unit	Weak	Medium	Strong
Solids, total	**mg/L**	350	720	1200
Dissolved Solids	**mg/L**	250	500	850
Suspended Solids	**mg/L**	100	220	350
Settleable Solids	**mL/L**	5	10	20
BOD_5	**mg/L**	110	220	400
TOC	**mg/L**	80	160	290
COD	**mg/L**	250	500	1000
Total N	**mg/L**	20	40	85
Total P	**mg/L**	4	8	15
Chlorides	**mg/L**	30	50	100
Sulfate	**mg/L**	20	30	50
Alkalinity as $CaCO_3$	**mg/L**	50	100	200
Grease	**mg/L**	50	100	150
Total Coliform	**#/100mL**	10^6-10^7	10^7-10^8	10^7-10^9
VOCs	**µg/L**	<100	100-400	>400

Typical Municipal WWTP



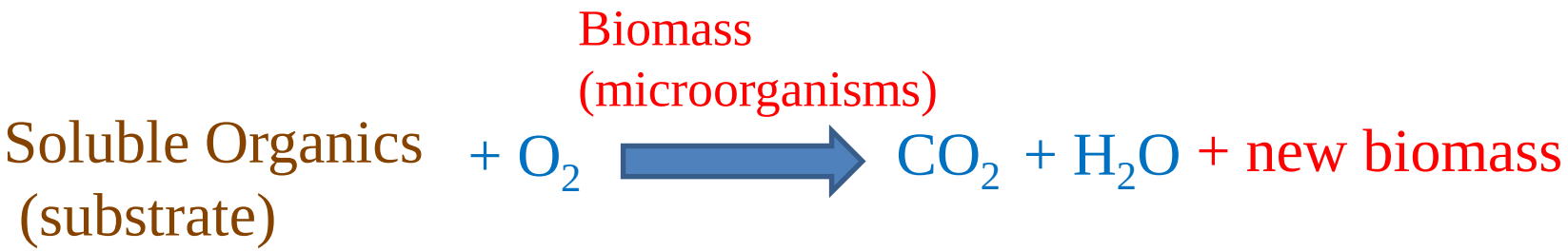
WWTP

Secondary treatment

Secondary Treatment

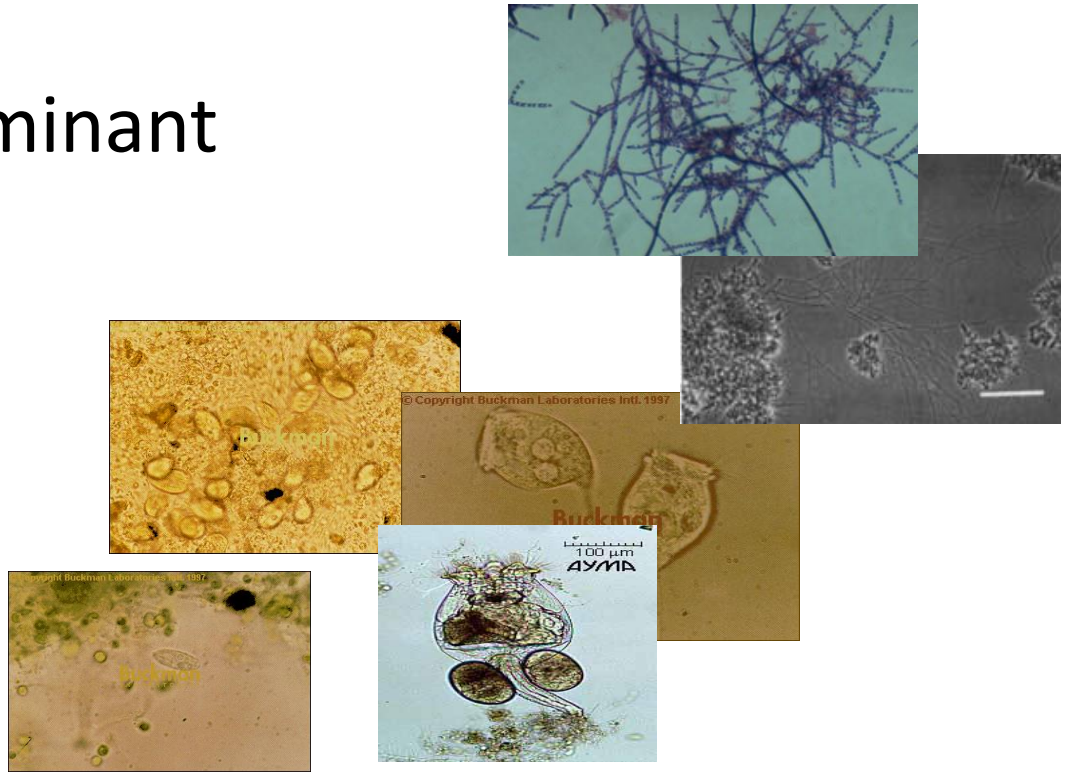
Basic approach:

is to use *aerobic* biological degradation



Microorganisms present

- Bacteria- Dominant
- Protozoa
- Rotifers
- Algae
- Fungi
- Virus
- Yeast

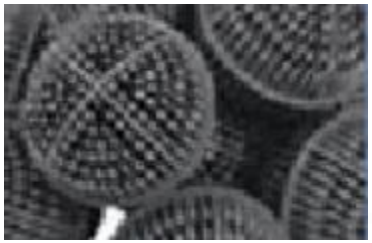


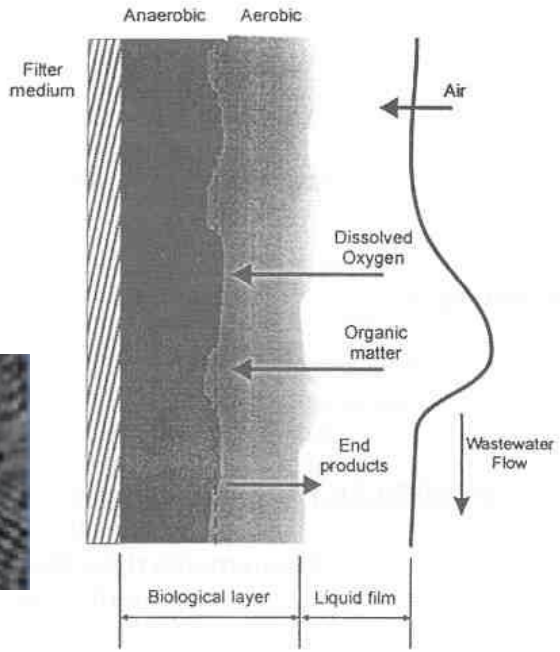
Biological WW Treatment Systems

Two Types

1. Attached growth or Fixed Film

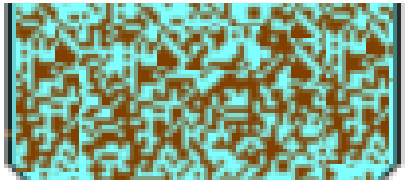
Organisms attached to some inert media like rocks or plastic.





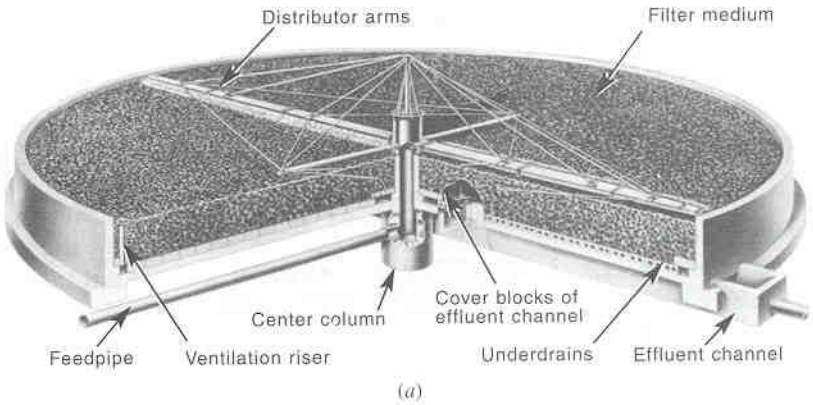
2. Suspended Growth

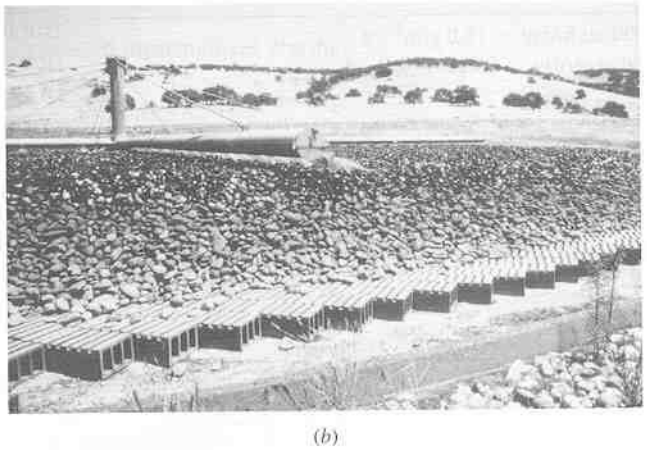
Organisms are suspended in the treatment basin fluid.



Attached Growth or Fixed Film Processes

Trickling Filters

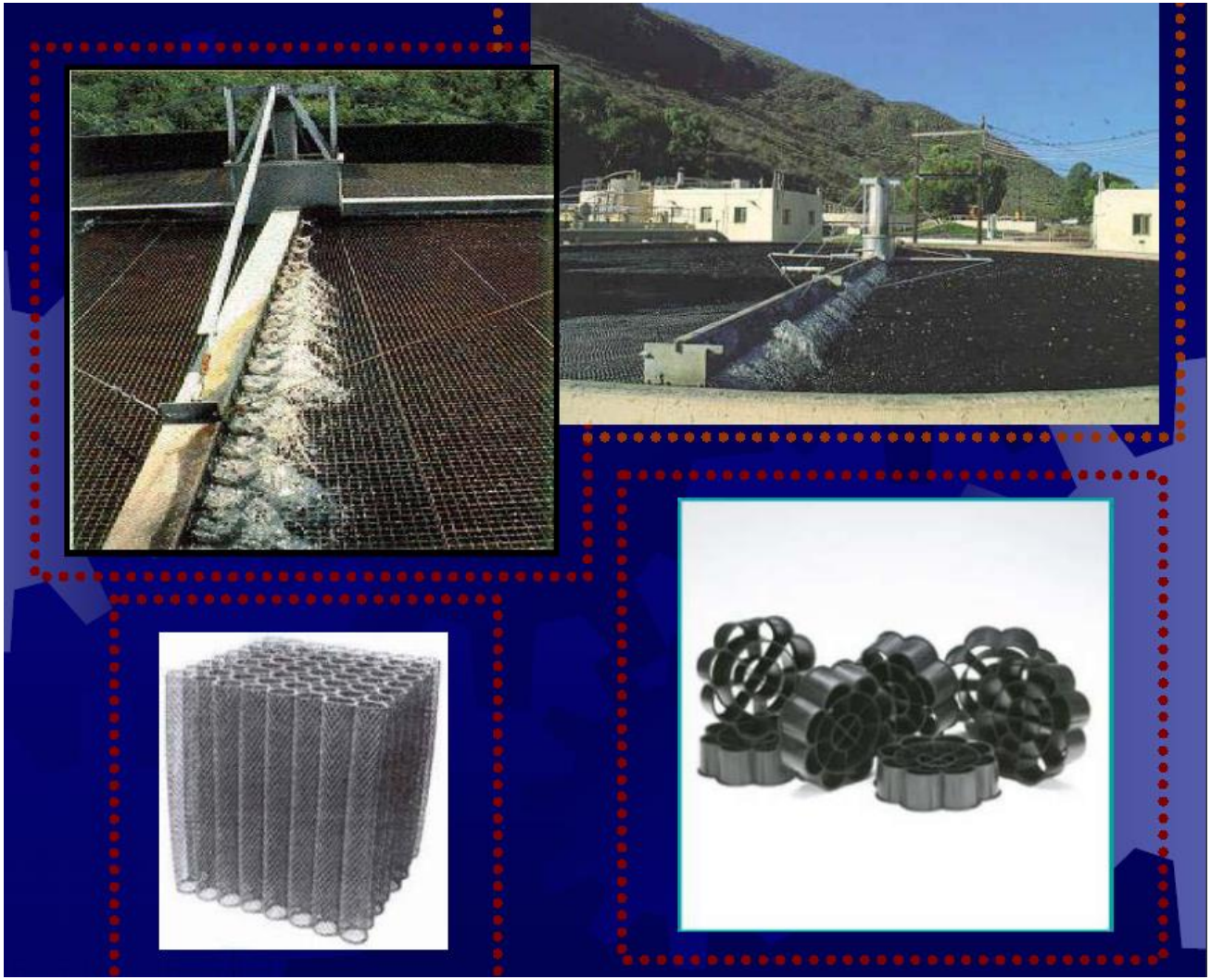




Rock Media

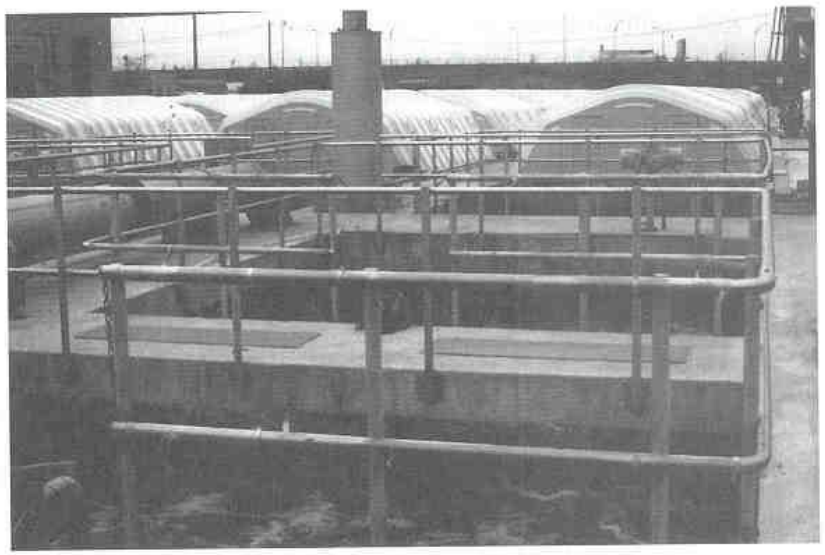
Typically 4 – 8 feet deep.

Trickling Filter (TF)



Plastic Media

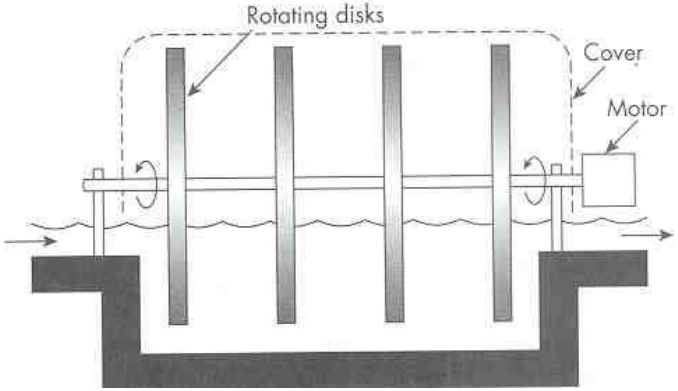
Rotating Biological Contactor (RBC)

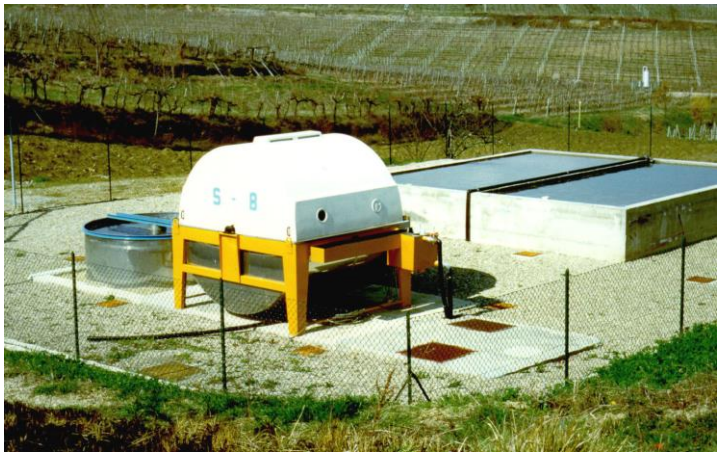


Discs mounted on a shaft and rotated while ~40% of discs is submerged in wastewater

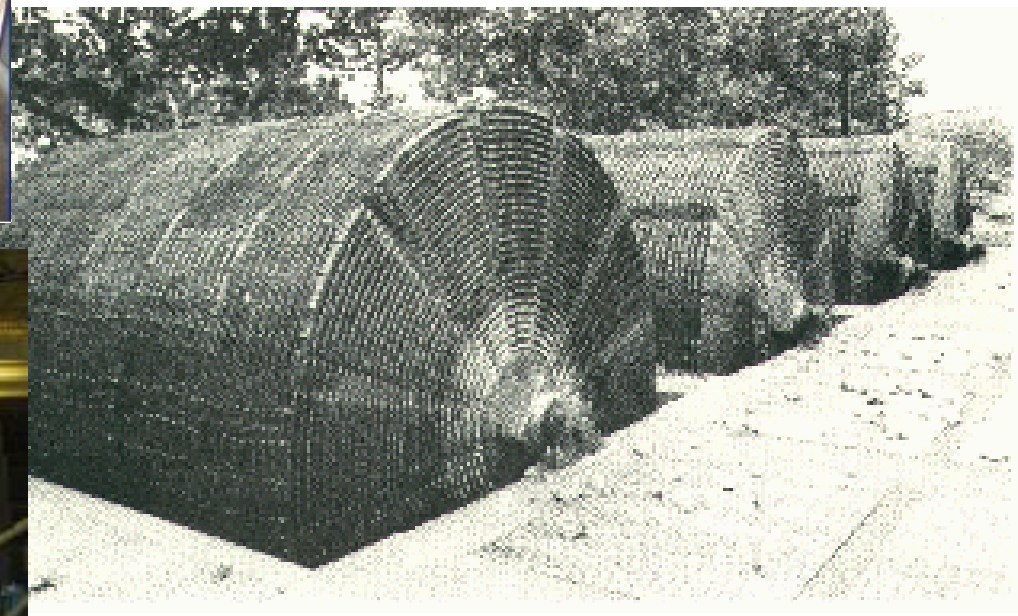
Discs: light-weight plastic or wire

Slime is 1-3 mm in thickness on disc



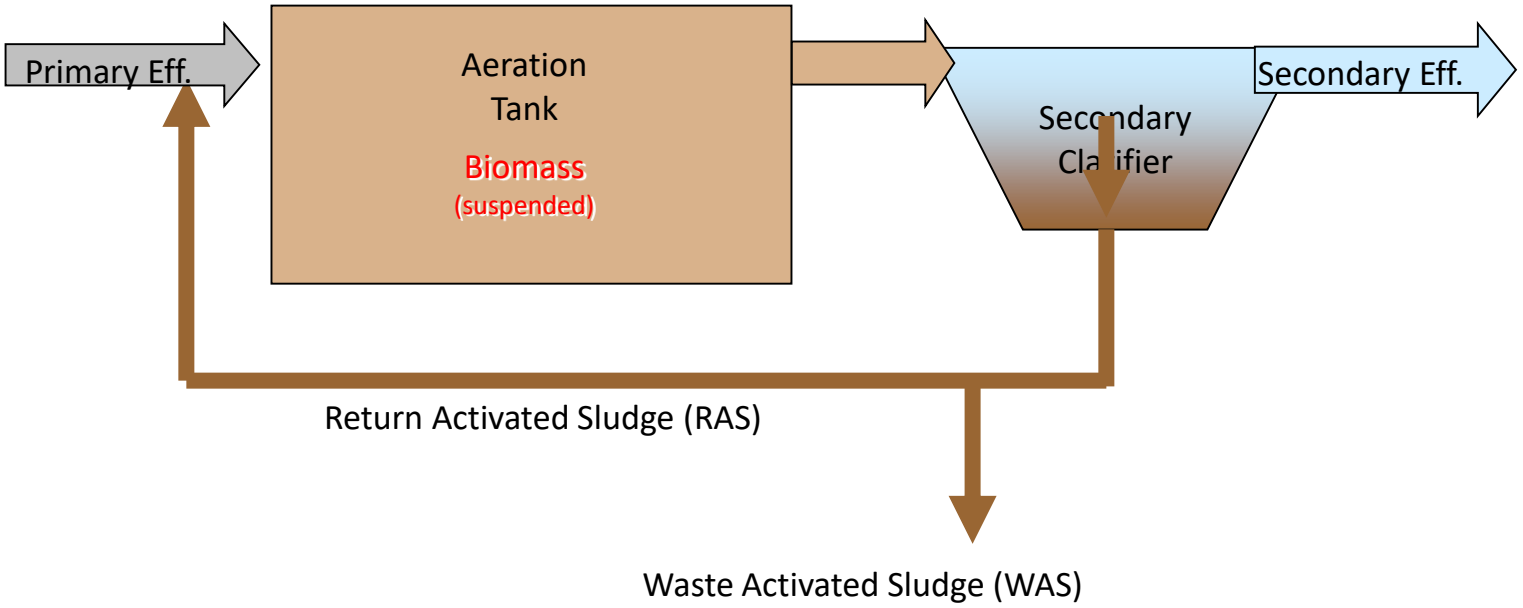


RBC



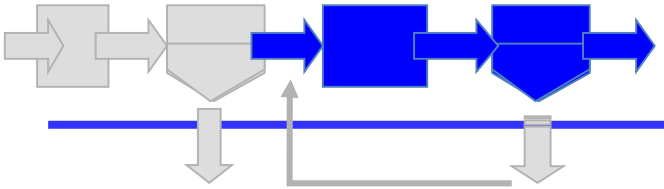
Suspended Growth Processes

Activated Sludge Process (ASP)



Performance of the process depends highly on the recycle of sufficient biomass.

Also, on the sludge age (SRT), influent strength and composition.



ASP- aeration tank & sedimentation tank

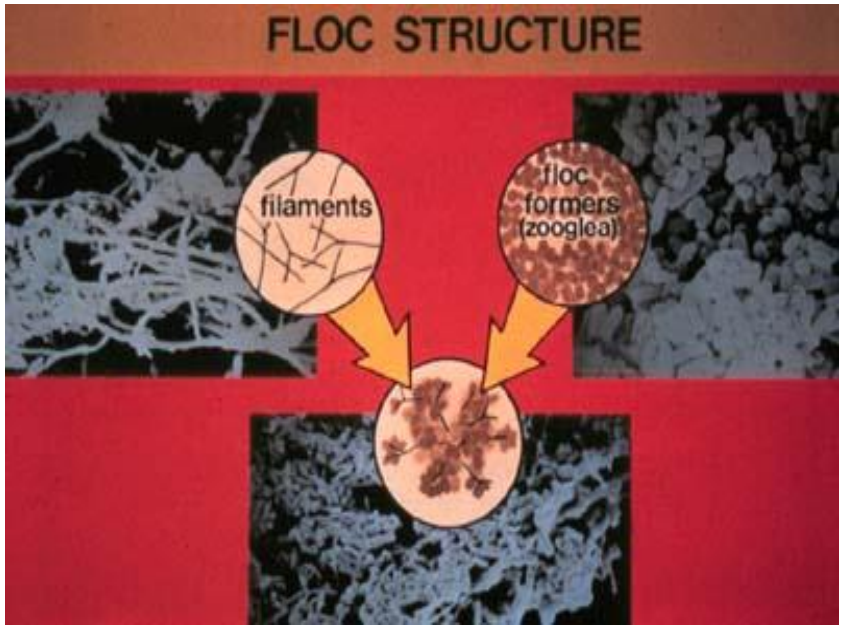
(Aeration Tank) Biological Process

Secondary Sedimentation

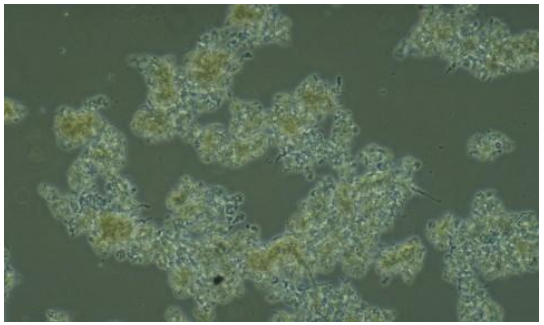
= Activated Sludge Process

Biomass - flocs

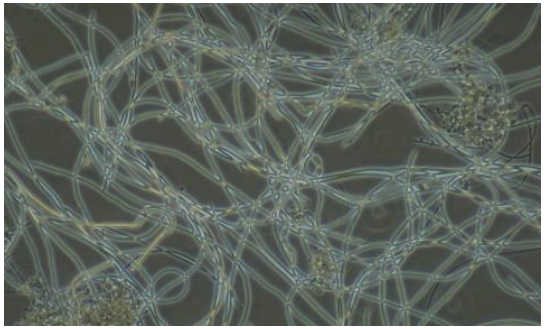
Floc structure → Sludge settleability → Recycle of sufficient biomass



Well settling



Bad Settling



Effluent

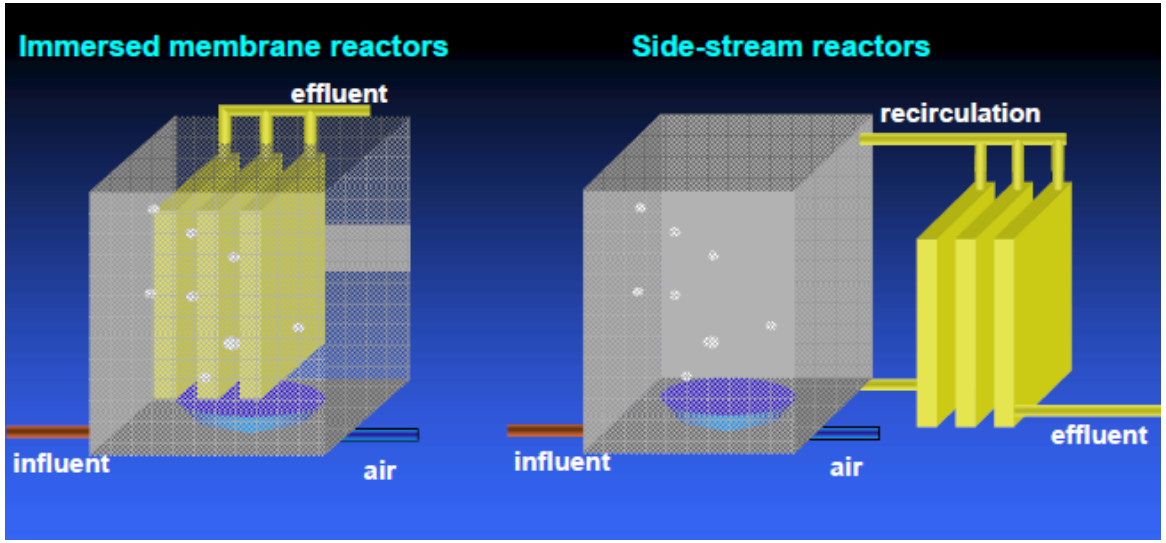
ASP Modifications

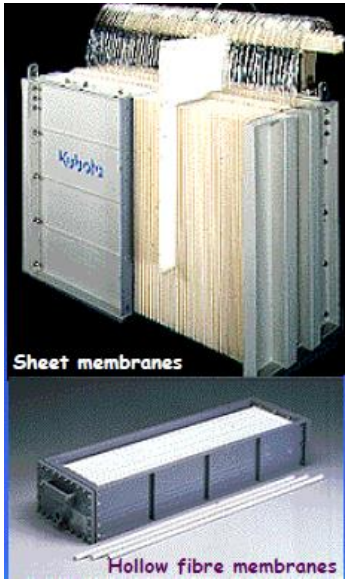
- ✓Conventional ASP (CAS)
- ✓Tapered/Step Aeration ASP
- ✓Completely-Mixed ASP
- ✓High Rate ASP
- ✓Extended Aeration ASP
- ✓Contact Stabilization ASP
- ✓Oxidation Ditch
- ✓Membrane Bioreactor (MBR)
- ✓Sequencing Batch Reactors (SBRs)

and others

Membrane Bioreactors (MBR)

- Uses membrane separation instead of settling
- Requires much lower footprint than clarifiers
- High-quality effluent (SS, COD, bacteria, turbidity, etc.)
- High biomass concentrations

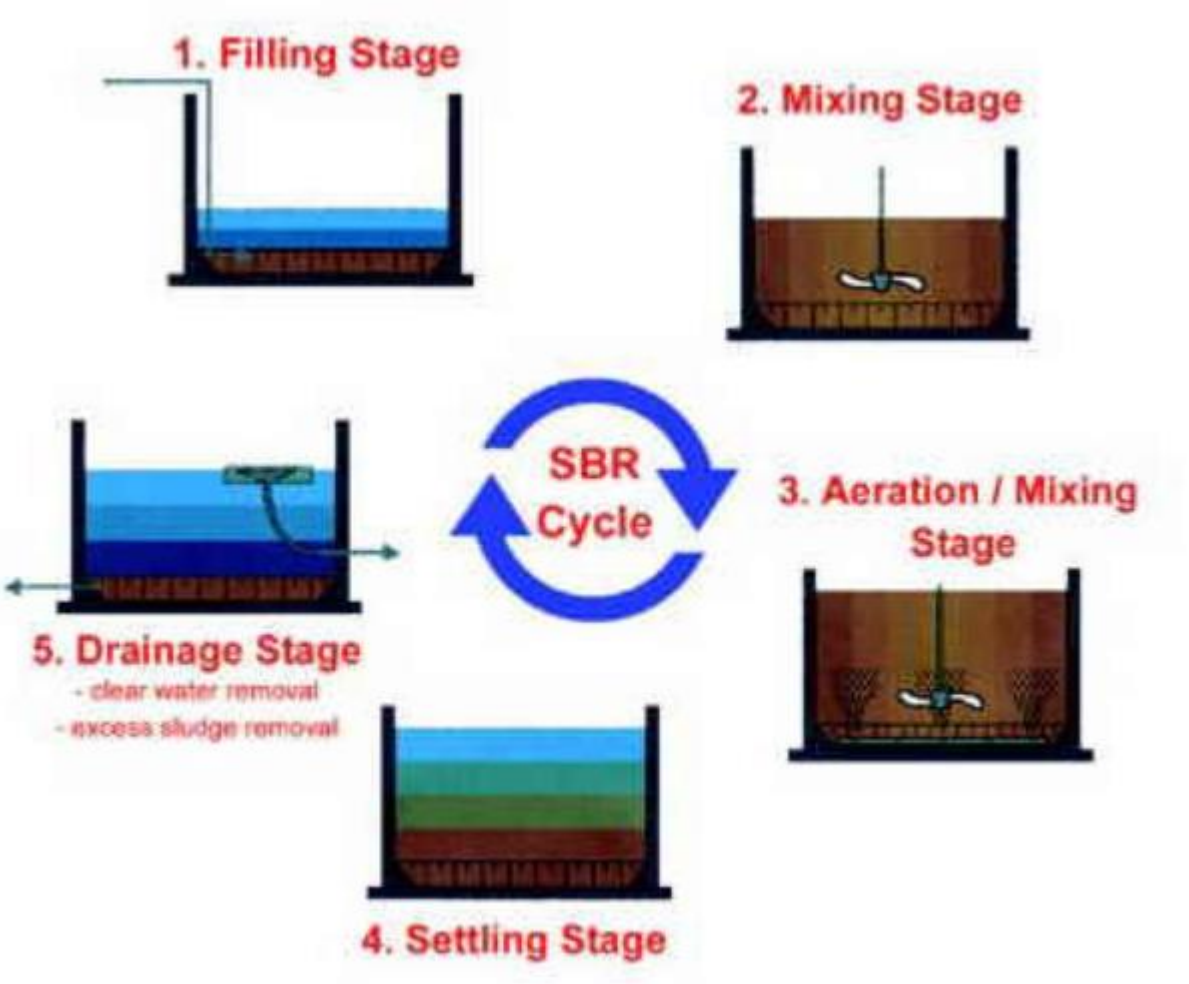




However:

- Cost & life expectancy of membrane modules
- Membrane fouling; • Aeration for membrane cleaning very intense

Sequencing Batch Reactors (SBRs)

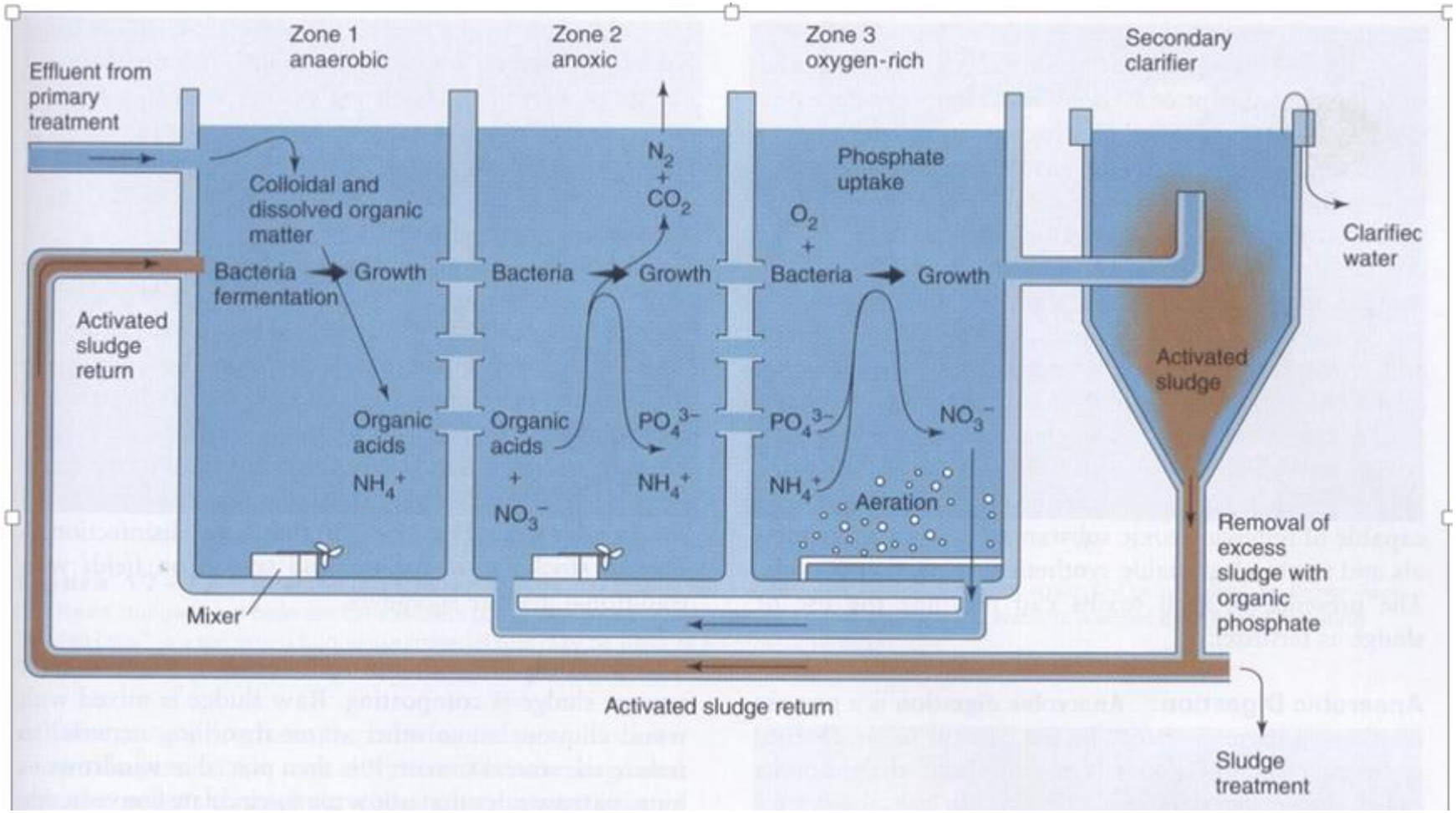


- Fill and draw type
- Sequentially in a single tank

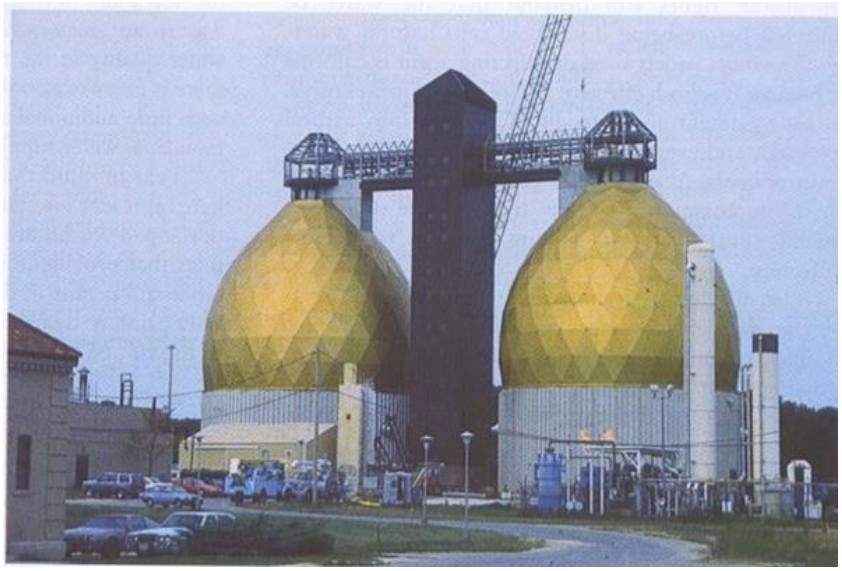
- Flexible

Advanced (Tertiary) Treatment)

Biological Nutrient (N, P) Removing (BNR) Systems



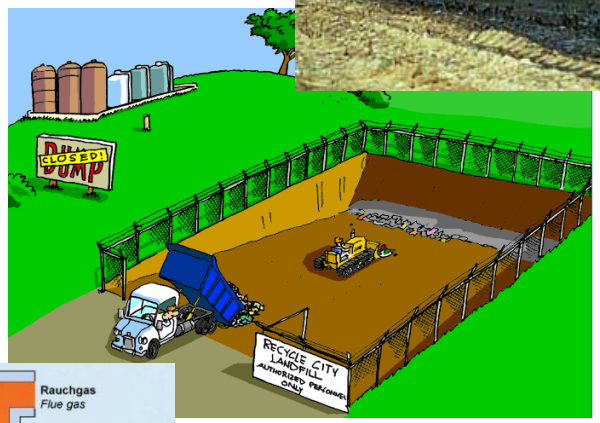
Sludge Processing



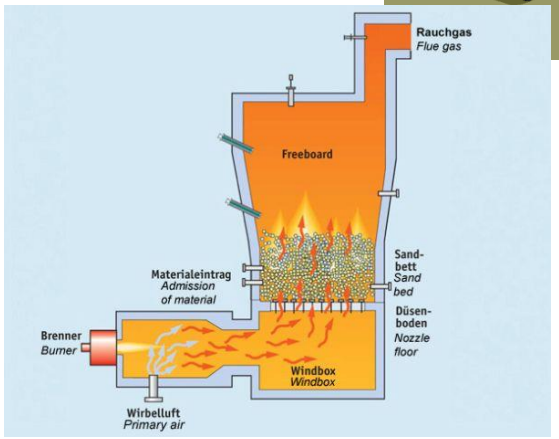
Sludge Disposal

- Land Spreading

Gardens, agricultural land, forest land, other public recreational areas



- Landfilling
- Incineration



Industrial WW pollutants

Industry	Major pollutants
Canning, Dairy	Organics, suspended solids (SS)
Tannery	Organics, metals, dyes, SS
Brewery	Color, organics, SS
Oil and refinery	Oil, petrochemicals
Textile	Color, dyes, SS, oil, organics
Mining	SS, metals, acids and salts
Electronic	Metals

High organic content; recalcitrant/toxic (hazardous) compounds

Hazardous organics

Emerging contaminants!

Pesticides, Pharmaceutical and personal care products (PPCPs), Endocrin disruptors (EDCs), Flame retardants, Drugs, Plasticizers, etc.

around 700 such different contaminants disposed into the environment; are not completely metabolized and enter into the sewage/drainage system making their way to wastewater treatment plants

Most of these contaminants are not eliminated by biological process because of their recalcitrant nature.

Factors

- Physico-chemical characteristics (such as solubility, biodegradability, toxicity)
- Operational parameters, especially sludge age (SRT)

Effect of operational parameters

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Contents lists available at ScienceDirect

Sustainable Chemistry and Pharmacy

journal homepage: www.elsevier.com/locate/scp

Investigating the effect of solids retention time on pesticides removal in an activated sludge process

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ARTICLE INFO

Keywords:
Biological treatment
Chemical oxygen demand removal
Pesticide removal
Solids retention time

ABSTRACT

The levels of pesticic
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30 d). When the pest
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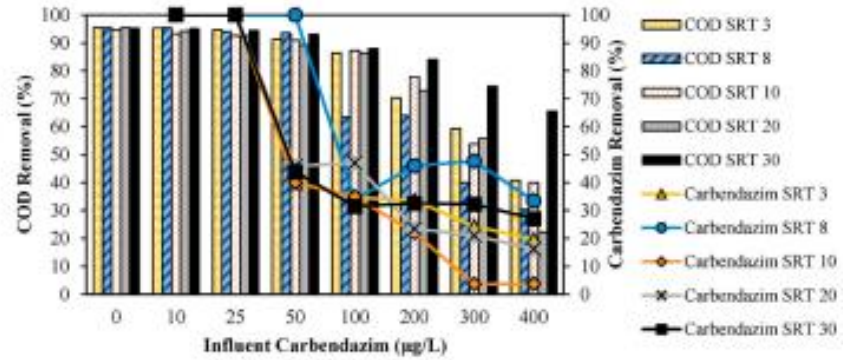
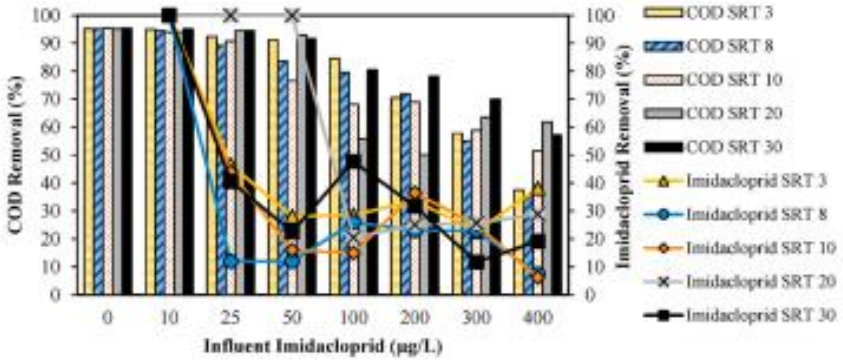
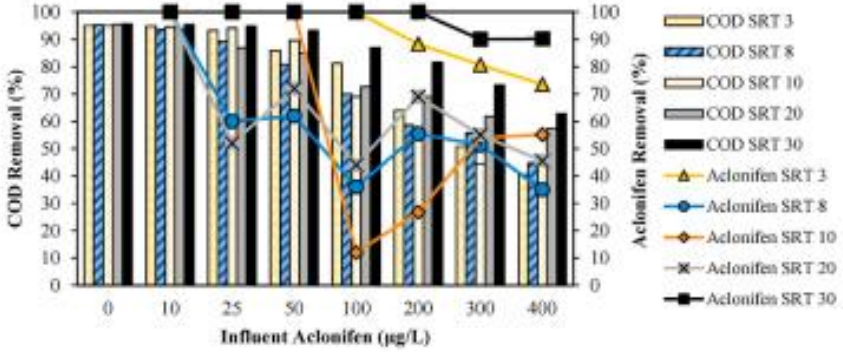
gardless of SRT. Wh
were generally attair
ciency. Aclonifen bei
in a mixture, when t
all until 50, 10, and
spectively, at all SR
were no adverse effe
COD removal was ev
receiving pesticides in combination could be operated with better pesticide and COD removal performances if SRT is closely controlled.

When the pesticides were present in combination, each 50 µg/L, there were no adverse effects on COD removal, provided that SRT is 30 d. The competitive inhibition of COD removal was evident. The activated sludge process receiving pesticides in combination could be operated with better pesticide and COD removal performances if SRT is closely controlled.







SRT is a very important.

But, still removal efficiency not high

Recently, Advanced Oxidation Processes (AOPs):

- UV
- H2O2
- O3
- Fenton's Oxidation
- Irradiation

either to remove them or to enhance their biodegradability!

But, the intermediate products generated may remain more toxic

Irradiation as pretreatment

Contents lists available at ScienceDirect

Radiation Physics and Chemistry

journal homepage: www.elsevier.com/locate/radphyschem

Treatment of opium alkaloid containing wastewater in sequencing batch reactor (SBR)—Effect of gamma irradiation

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SBR
Gamma irradiation

ABSTRACT

Aerobic biological treatment of opium alkaloid containing wastewater as well as the effect of gamma irradiation as pre-treatment was investigated. Biodegradability of raw wastewater was assessed in aerobic batch reactors and was found highly biodegradable (83–90% degradation). The effect of irradiation (40 and 140 kGy) on biodegradability was also evaluated in terms of BOD_5/COD values and results revealed that irradiation imparted no further enhancement in the biodegradability. Despite the highly biodegradable nature of wastewater, further experiments in sequencing batch reactors (SBR) revealed that the treatment operation was not possible due to sludge settleability problem observed beyond an influent COD value of 2000 mg dm^{-3}. Possible reasons for this problem were investigated, and the hi
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SBRs fed v
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of comple
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pre-irradiated wastewater provided complete thebaine removal and a better settling sludge, which was thought due to degradation of complex structure by radiation application.

Final remark

Tertiary treatment technologies are considered as the most suitable alternatives for emerging contaminats treatment, but their complete removal is yet to be achieved.

More research needed to quest newer, effective and economical treatment technologies for WW .

Thank you…