Op Cert: Modified Treatment Processes

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SOUTHWEST ENVIRONMENTAL FINANCE CENTER

This program is made possible under a cooperative agreement with US EPA.

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Weekly Wastewater Technical Assistance Office Hours

- Troubleshooting, operator certification, training, financials, FOG and other Pretreatment topics, etc.
- Tuesdays 11am-12pm (MST)
- Zoom
- Contact: A.J. Barney ajbarney1@unm.edu
  James Markham jmarkham@unm.edu

Or leave your email in the chat and we will send you a link

Operator Certification

Certification programs are regulated by the states

- Texas- TCEQ, New Mexico- NMED, Oklahoma- ODEQ

Certification levels (1-4, D-A, etc.)

- Complexity of the system
- Population
- Experience

Available resources

- California State University, Sacramento- Wastewater operation manuals
- State distributed resources and need to know lists

Certification exam- Study!!

Modified Treatment Processes

Membrane Bioreactors (MBR)

Sequencing Batch Reactors (SBR)

Advanced Oxidation Processes (AOP)

Anaerobic Digestion

Membrane Bioreactors (MBRs)

- Combines traditional biological wastewater treatment and membrane filtration
- Biological process uses microorganisms to breakdown organics
- Membrane filtration system separates treated wastewater from microorganisms and suspended solids

MBR Advantages

- High-quality effluent
- Smaller footprint than traditional treatment systems
- Highly effective in removing suspended solids, pathogens, and nutrients
- Higher SRTs with MLSS of 8,000-12,000 mg/L and as high as 15,000-25,000 mg/L

MBR Issues

Membrane Fouling

Maintenance Intensive

Constant Monitoring

Cost

How does an MBR work?

MBR Treatment Steps

1. Collected wastewater is transferred to the MBR plant
2. Pretreatment prior to MBR process unit
    1. Fine screening (1 to 3 mm) before membranes
3. Mixing and aeration of microorganisms and wastewater

How does an MBR work?

4. Membrane filtration to separates treated wastewater
5. Collection of treated wastewater or permeate
6. Solids handling to maintain solids levels
7. Nutrient removal and disinfection
8. Control and monitoring of system characteristics

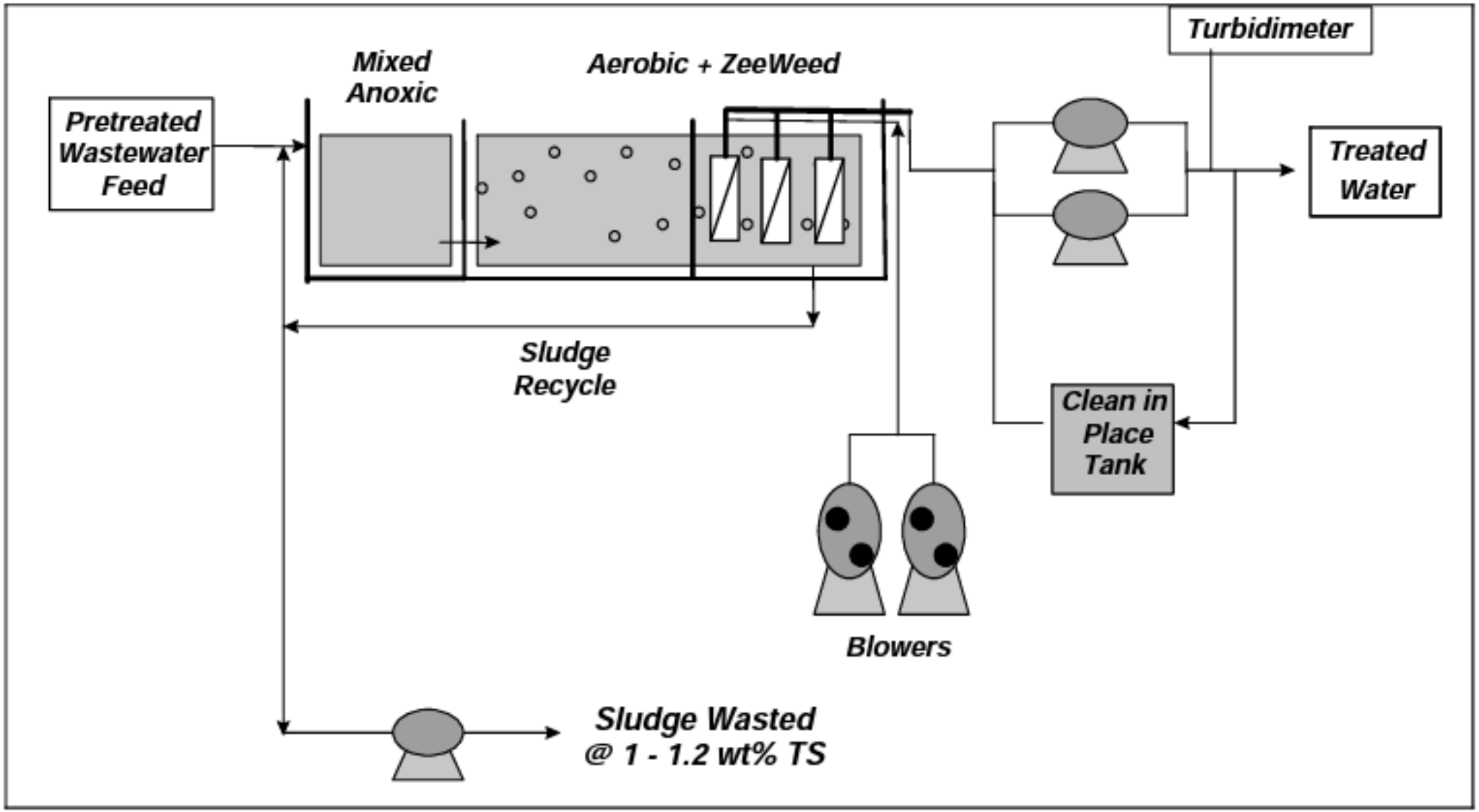


Figure 3. Immersed membrane system configuration (Image from GE/Zenon)

Membranes

Filtering of desired particle size

Treated water passes through the membrane as permeate

Filtration is driven by the pressure differential across the membrane

The rate that permeate passes through the membrane is referred to as flux

Membranes are prone to fouling and must be

Membranes configurations include hollow fibers, flat sheets, or tubular membranes

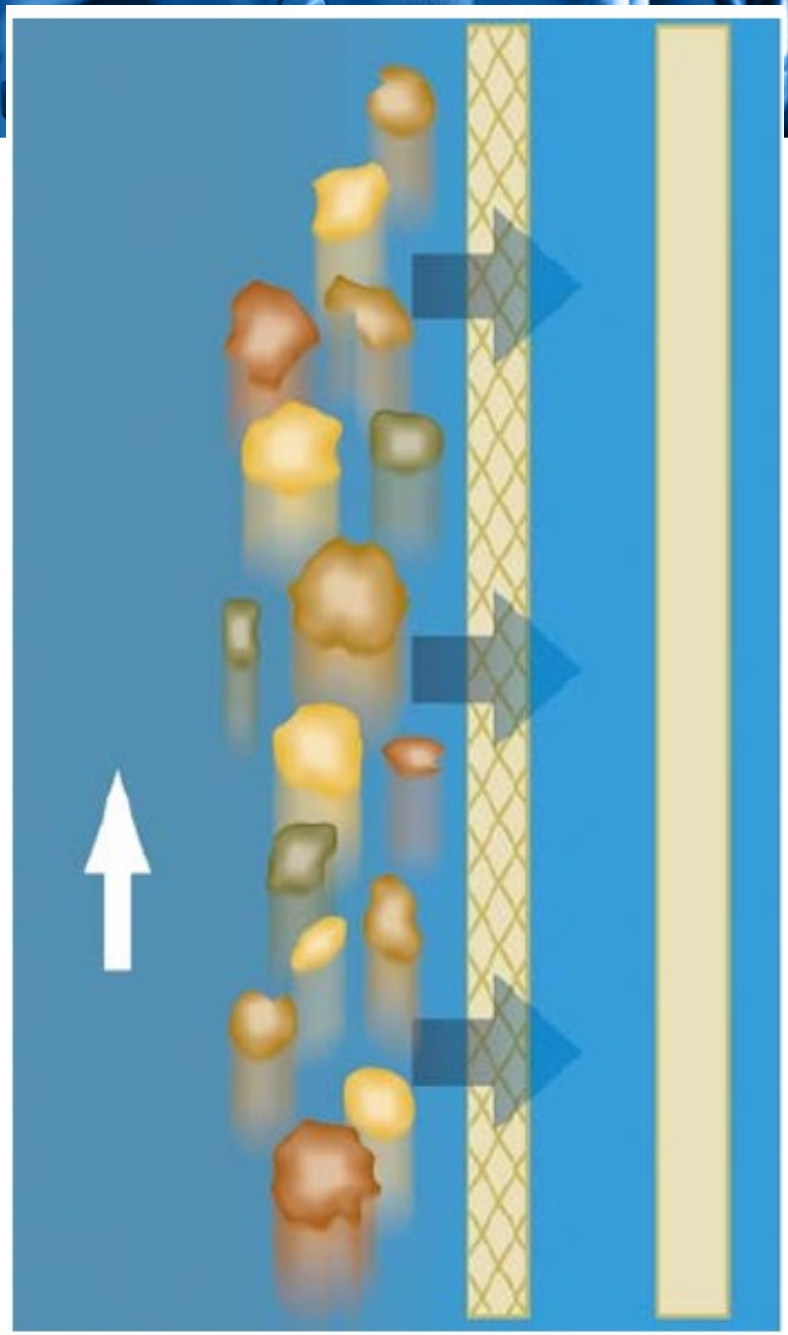


Figure 1. Membrane filtration process
(Image from Siemens/U.S. Filter)

Treated Wastewater

Permeate: Desired clean water product of membrane

Concentrate: Concentrated wastewater stream. Known as Reject stream or retentate. Recycled and mixed with influent to enhance treatment efficiency or reduce concentrate volume

Pressure

Transmembrane Pressure: Difference in pressure between feed side and the permeate side of the wastewater. Monitored by sensors on both sides of the membrane.

Hydraulic Pressure: Flow of the water forces water across the membrane.

Required pressure depends on the membrane and other system requirements.

Flux

$$Flux(LMH\ or\ GFD) = \frac{Litres}{(m^2)(hour)} = \frac{gallons}{(ft^2)(day)}$$

Typical value = 10-150 LMH

Influenced by transmembrane pressure, membrane characteristics, membrane fouling, and membrane integrity

MBR Fouling

Caused by:

- Suspended Solids
- Biological Growth
- Scaling
- Organic Fouling

Fouling Treatment

Membrane Cleaning

Membrane Surface Modification

Pre-Treatment

Operation Parameters Optimization

Membrane Configuration

Membranes can be immersed or external systems

Immersed systems integrate membranes directly into the bioreactor

Separated MBR membranes are separate from the bioreactor

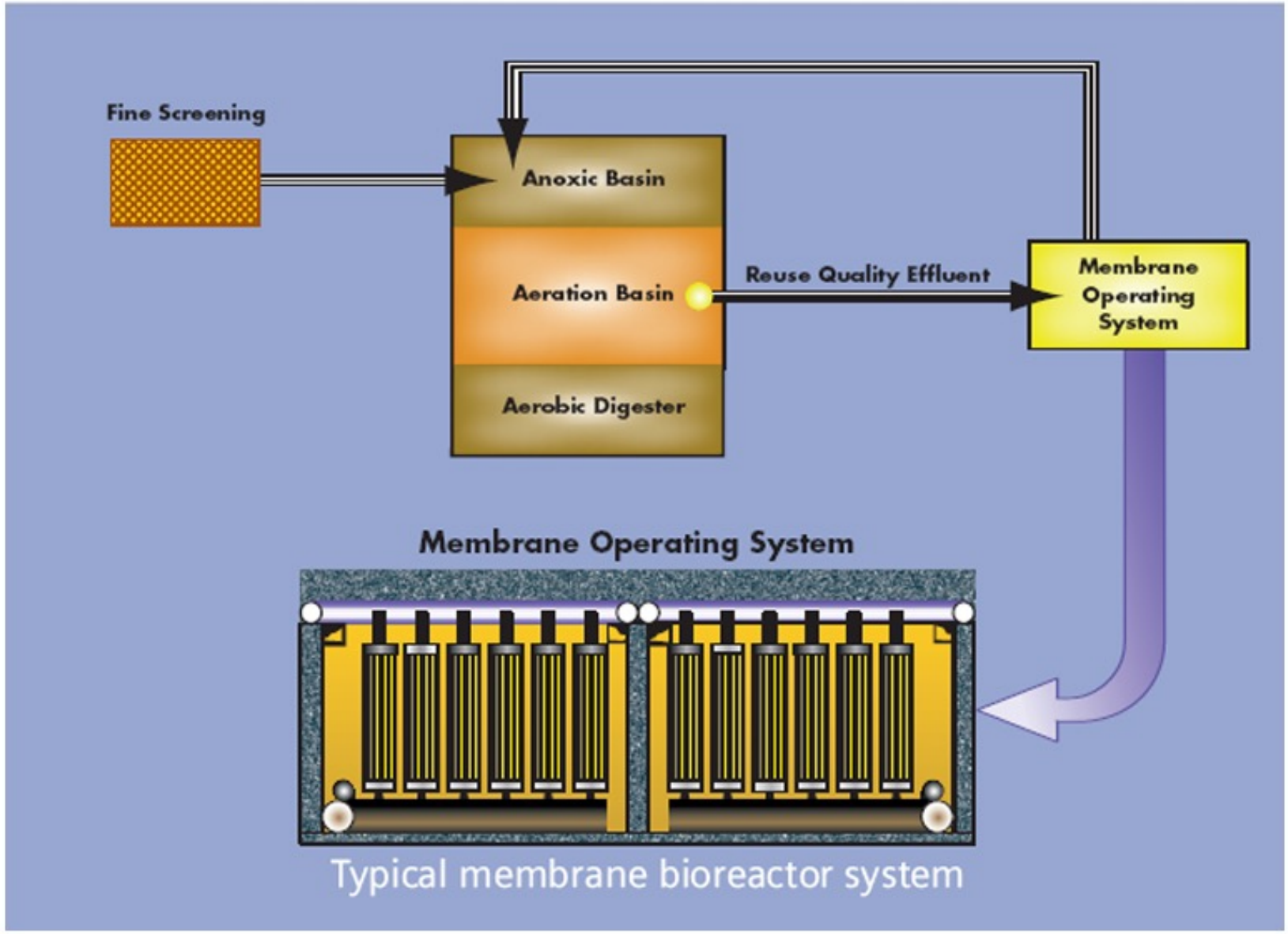


Figure 4. External membrane system configuration (Image from Siemens/U.S. Filter)

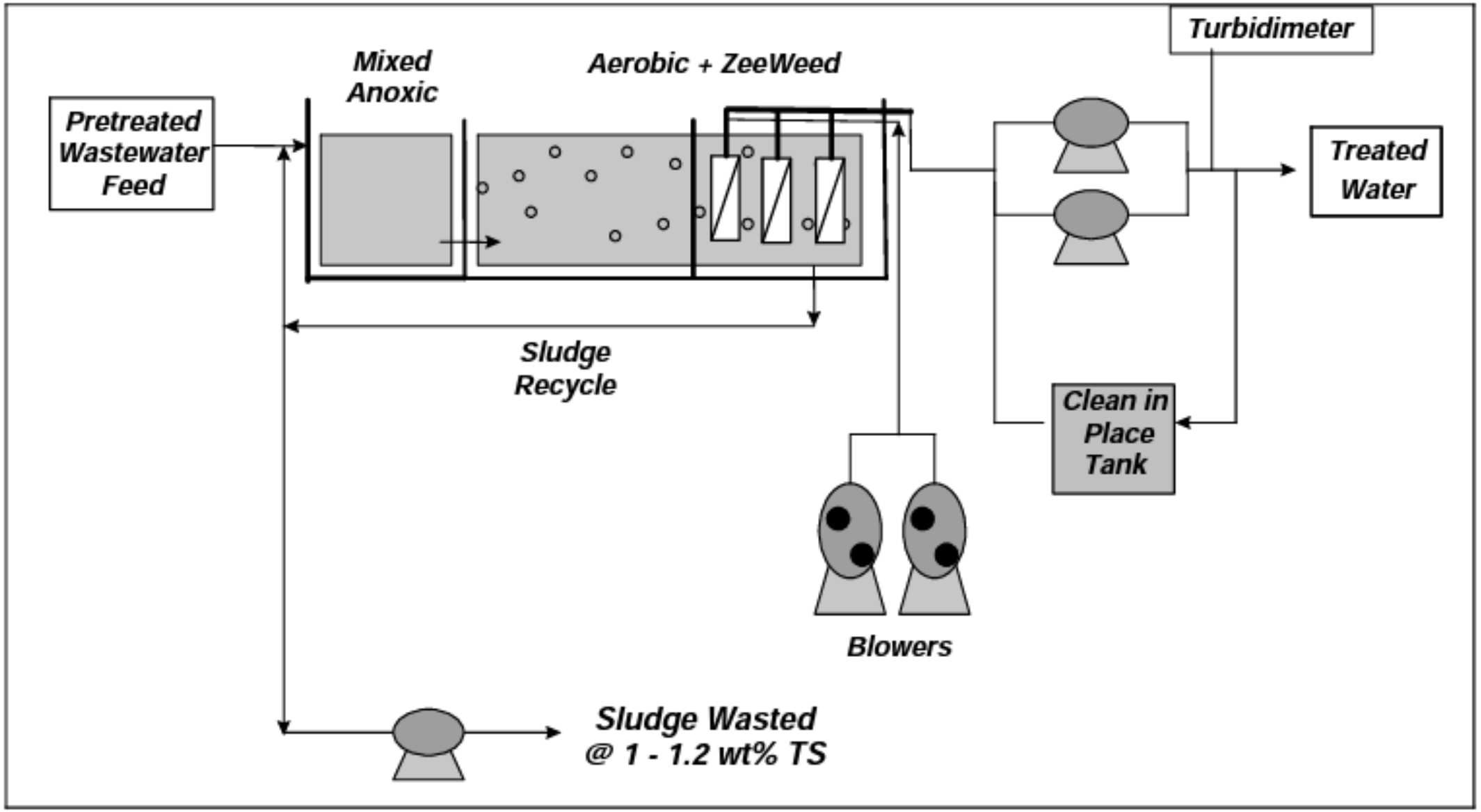


Figure 3. Immersed membrane system configuration (Image from GE/Zenon)

Types of MBRs

Microfiltration (MF): .01-.4µm

- Larger pores
- Lower filtration efficiency

Ultrafiltration (UF): .01-.1µm

- Smaller pores
- Higher filtration efficiency

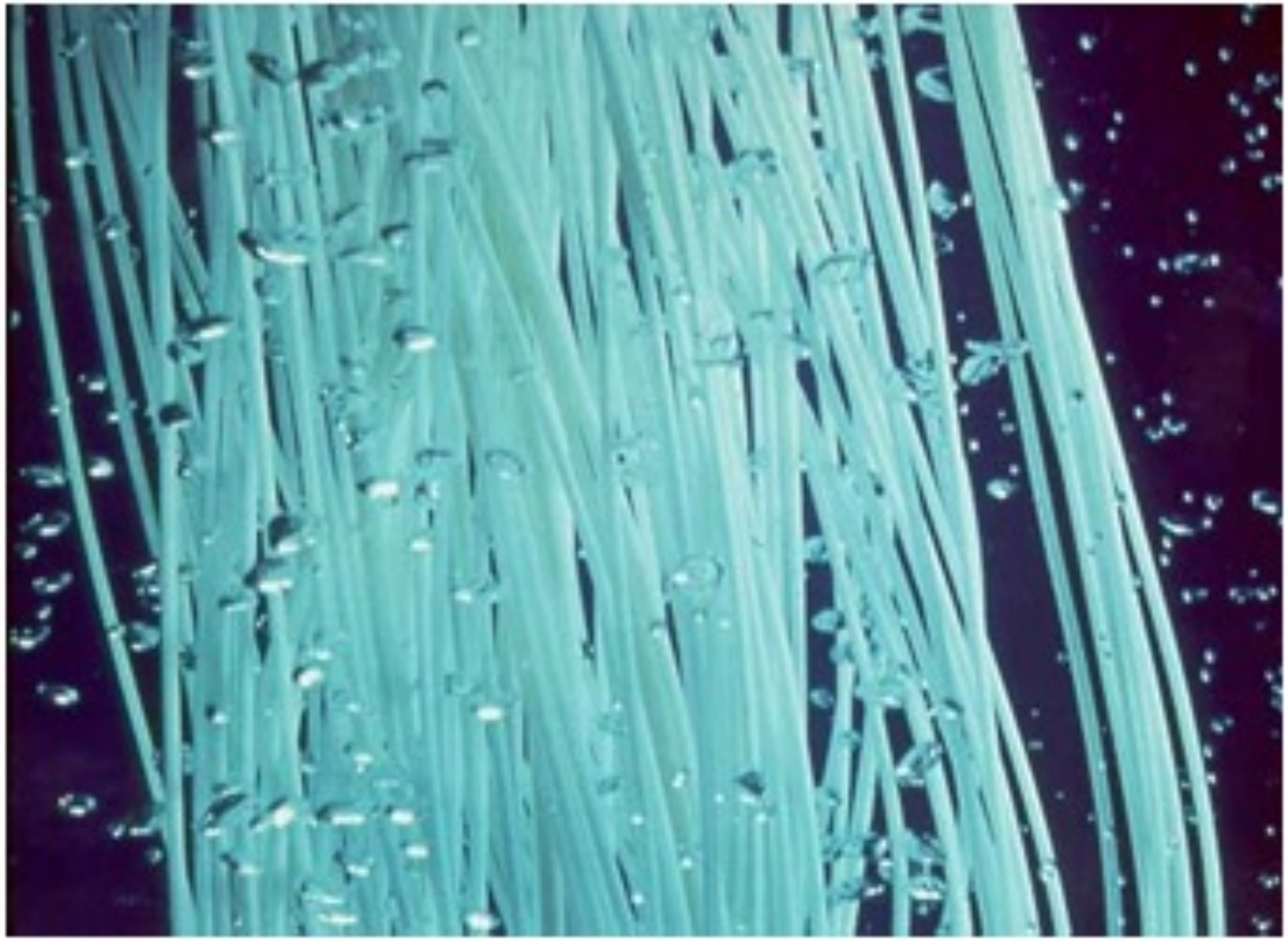


Figure 2. Hollow-fiber membranes (Image from GE/Zenon)

Sequencing Batch Reactors (SBR)

Biological wastewater treatment system

Used in small to medium sized plants and decentralized and industrial applications

Utilize a fill-and-draw batch approach

Multi-step treatment process in one tank

Multiple tanks used to maximize efficiency

Activated sludge system that operates in time not space

SBR Overview

Pretreatment- Removes debris and grit

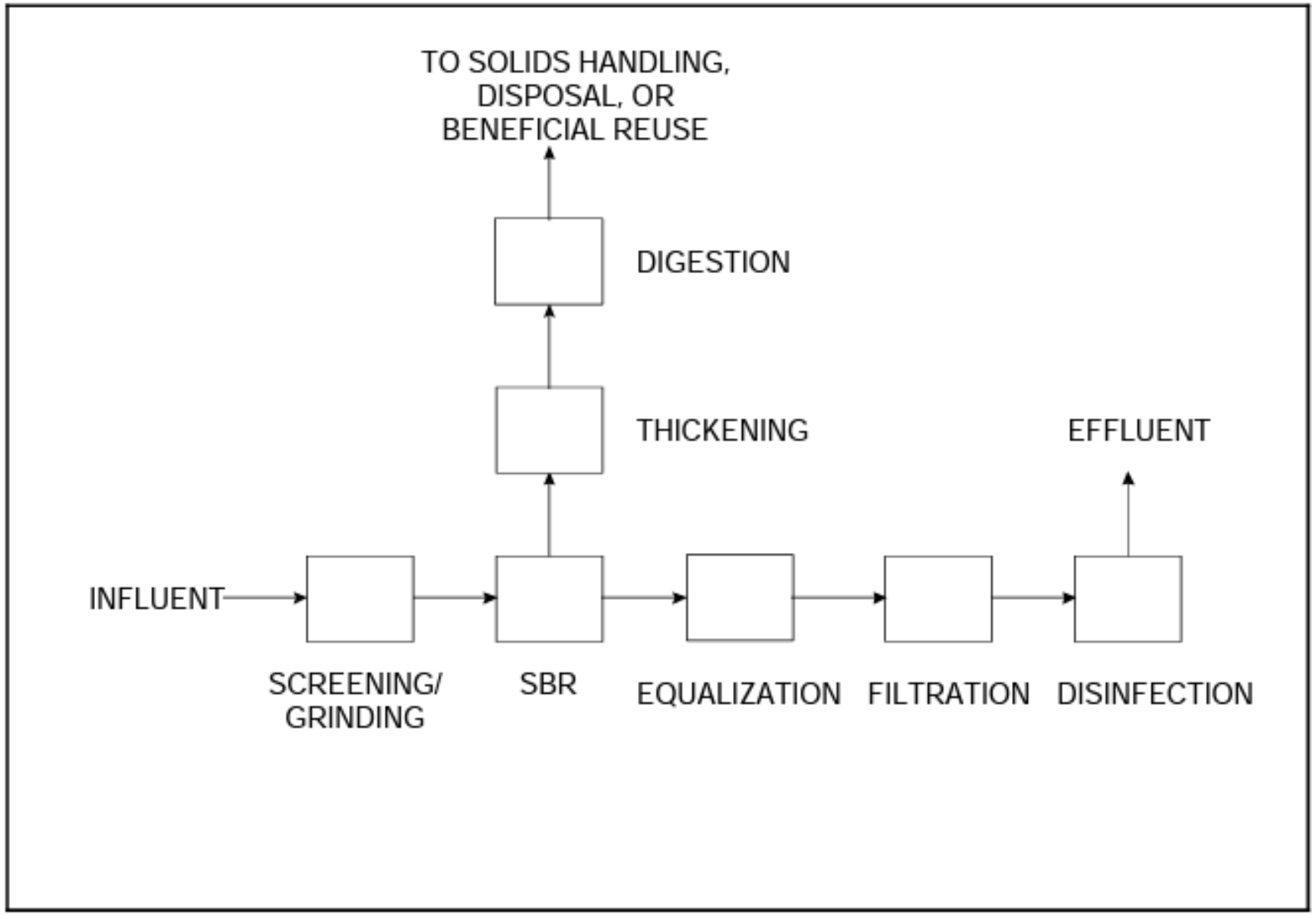
Fill Bioreactor- Controlled fill of partially filled reactor

Aeration- Creates aerobic environment for mixing and to promote growth

Settling- Suspended solids and biomass settle to the bottom of the tank

Decanting- Clarified water at the top of the tank is removed

Idle Time: Tank idled to prepare for next cycle



Source: Parsons Engineering Science, 1999.

TABLE 1 KEY DESIGN PARAMETERS FOR A CONVENTIONAL LOAD

	Municipal	Industrial
Food to Mass (F:M)	0.15 - 0.4/day	0.15 - 0.6/day
Treatment Cycle Duration	4.0 hours	4.0 - 24 hours
Typically Low Water Level Mixed Liquor Suspended Solids	2,000-2,500 mg/L	2,000 - 4,000 mg/L
Hydraulic Retention Time	6 - 14 hours	varies

Source: AquaSBR Design Manual, 1995.

Operation Parameters

Fill Time- Duration of filling phase

Aeration Time- Time in the aeration phase

Settling Time- Allotted time for settling

Duration Time- Duration of the decanting phase

Idle Time- Period between decanting and next cycle

MLSS, DO, pH, and other water quality parameters should be monitored

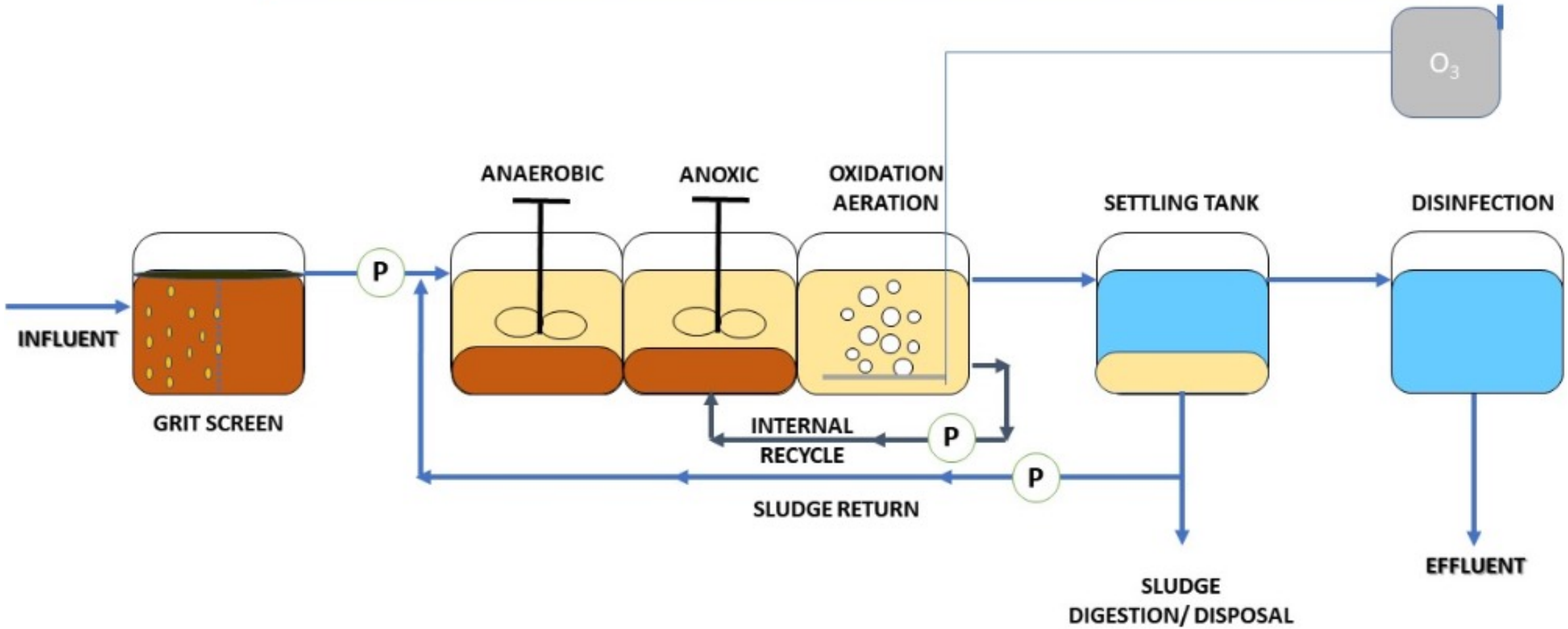
Advanced Oxidation Processes (AOPS)

Chemical treatment processes that generate strong oxidizing agents to remove pollutants from wastewater.

Organics converted to smaller, less harmful molecules.

AOPs- Ozone based, Fenton’s reagents, photochemical, and electrical processes

Advance Oxidation Process (AOP)



AOP Pros and Cons

Pros: Effective removal of pollutants, broad spectrum of treatment, environmental compatibility, treatment efficiency

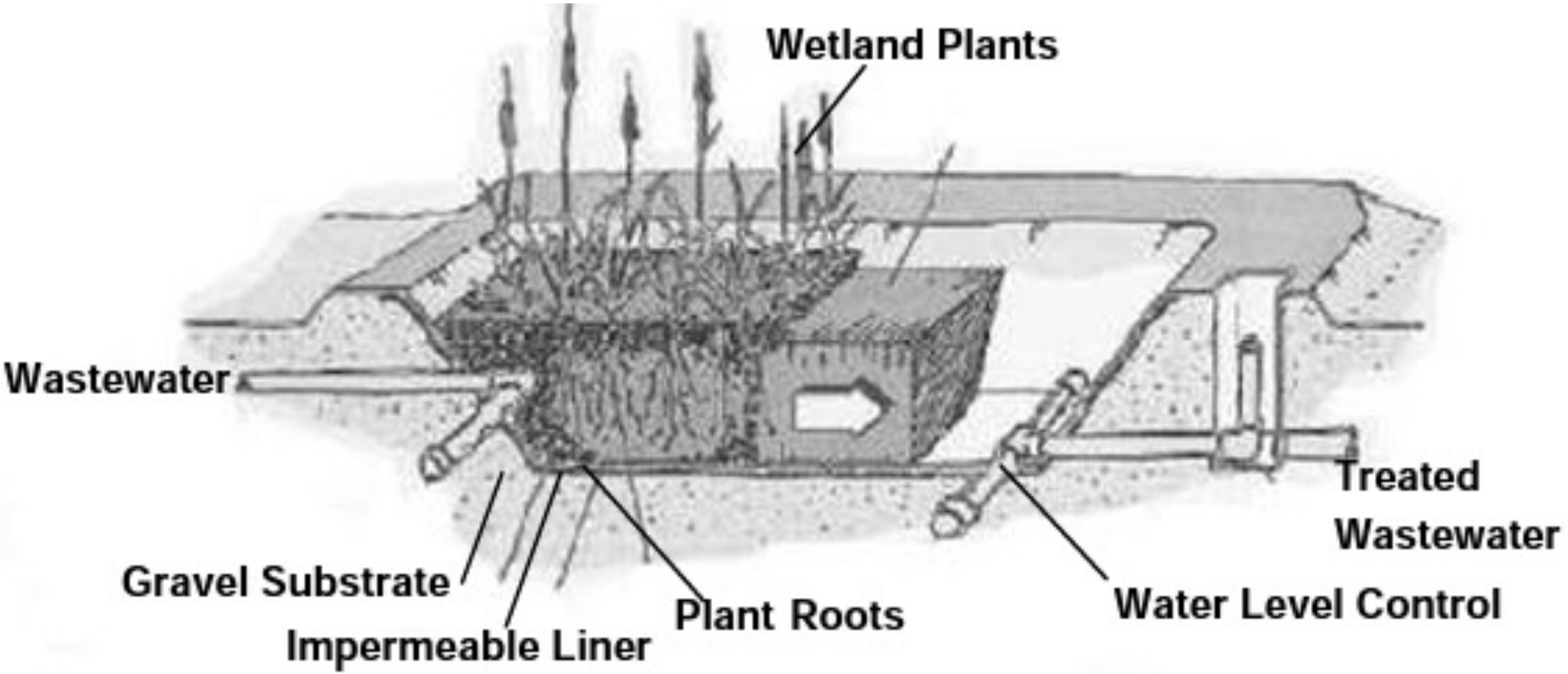
Cons: Energy intensive, high cost, possible harmful by-products, limited scalling

Constructed Wetlands

Artificially designed wetlands that naturally replicate wetlands.

Functions:

- Physical Filtration
- Biological Degradation
- Adsorption and Ion Exchange


Wetland Plants
Wastewater
Treated
Wastewater
Gravel Substrate
Impermeable Liner
Plant Roots
Water Level Control

Constructed Wetlands Pros and Cons

Pros: Effective water treatment, cost-effective, provides sustainability and ecological benefits, provide aesthetic value and recreational opportunities, versatility and adaptability

Cons: Land requirements, long start-up period, specific design and maintenance requirements, climate and seasonal variations, limited treatment of certain pollutants


Questions?

CONTACT INFORMATION

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