

REINHOLD ENVIRONMENTAL®



2026 Reinhold/PCUG Round Table Presentation

Hosted by TVA, Southern Company and Vistra
in the Sonesta Nashville Airport Hotel, Nashville, TN
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Wastewater 101 Things You Might Want to Know

Reinhold Roundtable
Nashville, Tn
22 June 2026

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Agenda

1. Pretreatment
2. Equalization
3. Physchem
4. Solids Removal
5. Biological
6. Membrane
7. Effluent
8. Analytical
9. Safety



What are we treating?

- What is in the water we are treating?
- How much of there is it?
- What are we treating for?
- How low do we need to go?



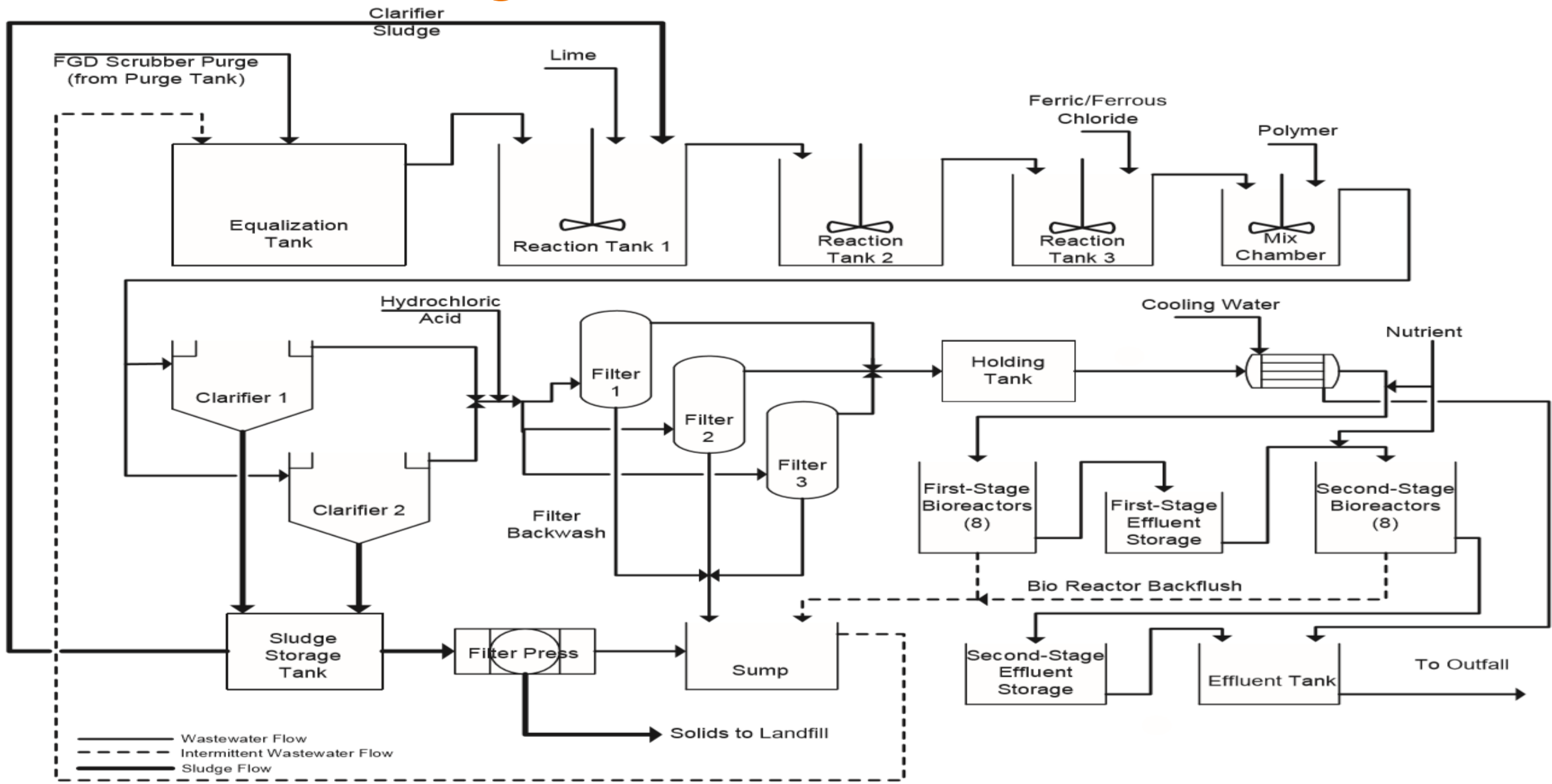
We are **NOT** trying to make pure water!

What is FGD Wastewater?

The bleed stream from a Wet Flue Gas Desulfurization System.

- Alkaline substance (lime/limestone) used to neutralize Sulfur Dioxide
- **Forced Oxidation:** Calcium Sulfate Hemihydrate (Gypsum)
 - Air added into the process
 - Selenium Speciation: Selenate/Selenite
- **Inhibited Oxidation:** Calcium Sulfite Hemihydrate
 - Elemental Sulfur to form thiosulfate (oxygen scavenger)
 - Calcium Sulfite harder to dewater = thickeners

Block Flow Diagram



Pretreatment

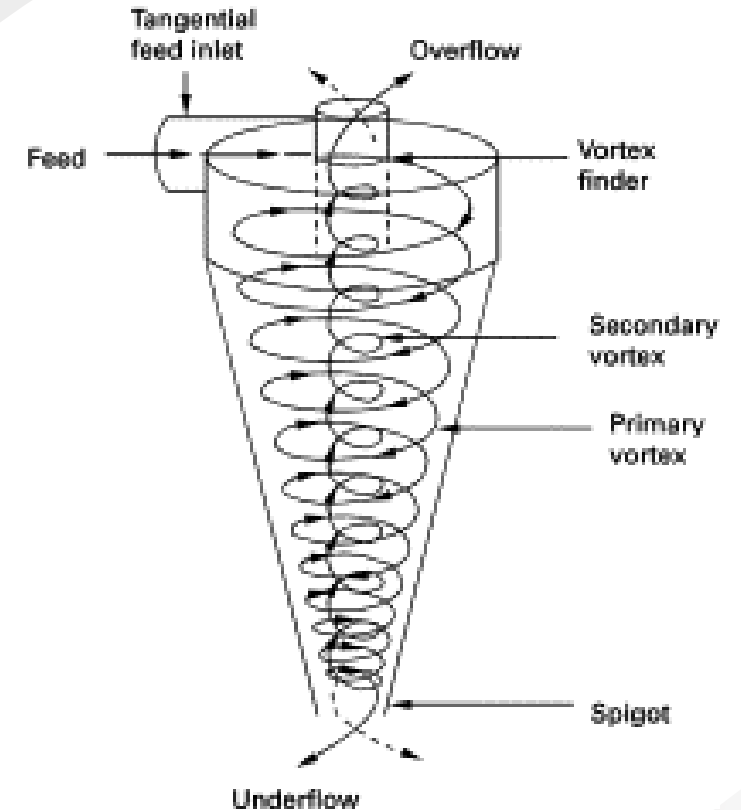
Pretreatment

Objective: To provide relative consistency for influent water characteristics. (% Solids)

Examples:

- Hydrocyclones
- Secondary Hydrocyclones
- Solids Removal System
- Belt Filters

Don't Over Do It



Equalization

Equalization

A Hydraulic and Chemical Buffering Operation

- Maintain Stable Flow Through WWT
- Knock the Peaks/Valleys off of Upstream Upsets
- Provides Breathing Room for Treatment Upsets

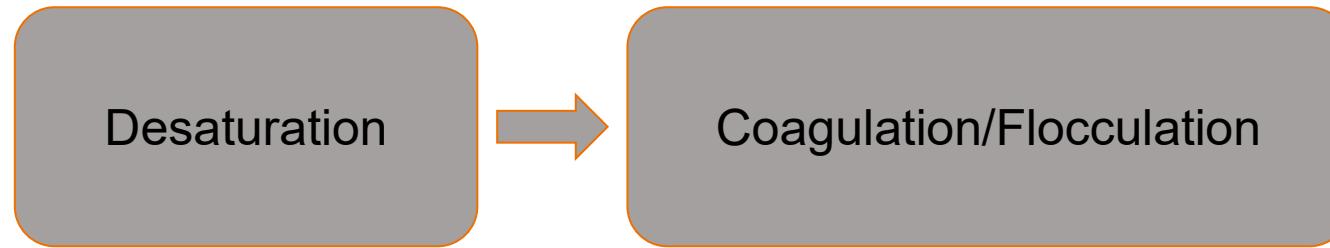


Equalization Tank

- **Purpose:** provide storage for FGD blowdown and a means to equilibrate WWT process streams
- **Design:** *Site Specific/Acceptance* on Risk Tolerance
 - Recommend: 24 Hour Design Influent Purge Flow
 - Sized for upsets & outages
- **Do NOT use as a RXN Tank**
 - Solids settling out
 - Changes in chemistry
 - Loose visibility on net feed chemistry into the system.

Physchem

FGD WWT - Physical/Chemical Reactions



Desaturation: prevent scaling, dissolved sulfate is roughly equivalent to the calcium concentration.

Hydraulic detention time: 40-60 mins

Coagulation: a coagulant is used to destabilize the suspension (precipitate metals) (10-20 mins)

Flocculation: agglomerate the destabilized particles

Reaction Tank 1: Desaturation

Purpose: when dissolved sulfate is roughly equivalent to the calcium concentration, lime can be added to precipitate sulfate, resulting in desaturation of calcium sulfate.

- prevent scaling
- **Hydraulic Detention Time:** 40-60 mins
 - provide dissolution of lime
- **pH:** 8.6-9.2
 - Review FGD WWT characterization for best application
- **Caustic vs. Lime**
 - Safety
 - Effectiveness

.....let's talk about scaling

Lime Silo/Slurry

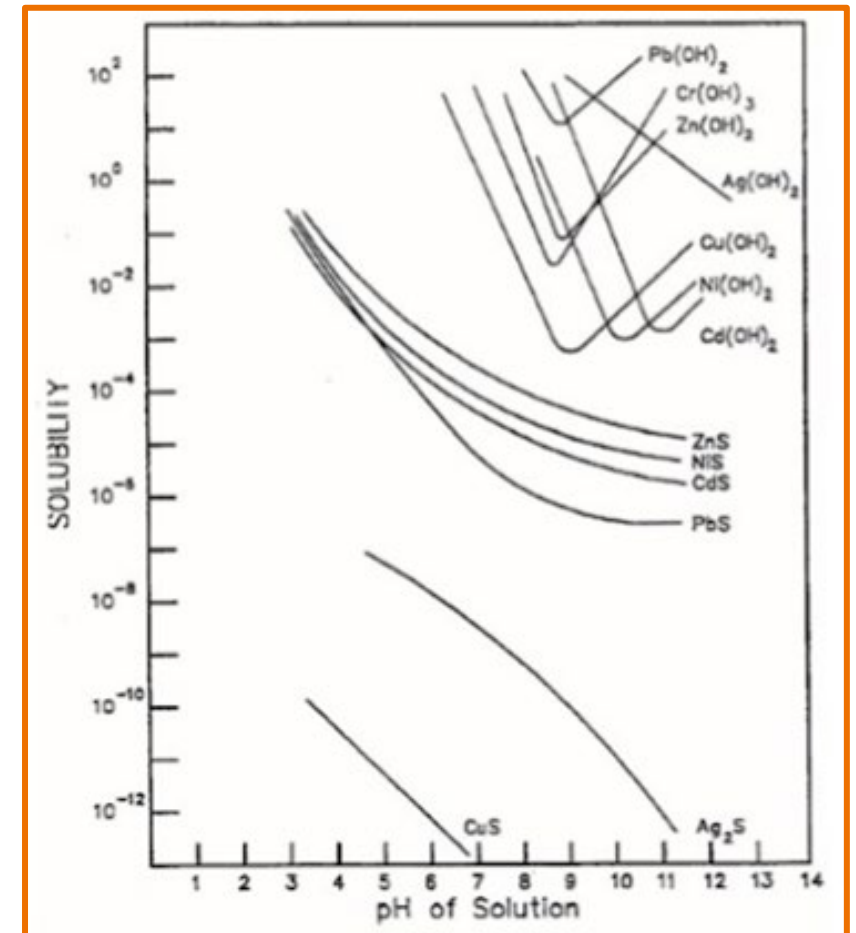
- Piping Design/No dead legs
- Control Slurry Concentration
 - 10% is the sweet spot
- Pump type
- Acid Cleaning: Citric Acid
- Don't Waste O&M \$\$ Buying ~~Water~~ Slurry
- Don't Buy Cheap Lime



Reaction Tank 2: Heavy Metals Precipitation

Purpose - heavy metals precipitation with organosulfide

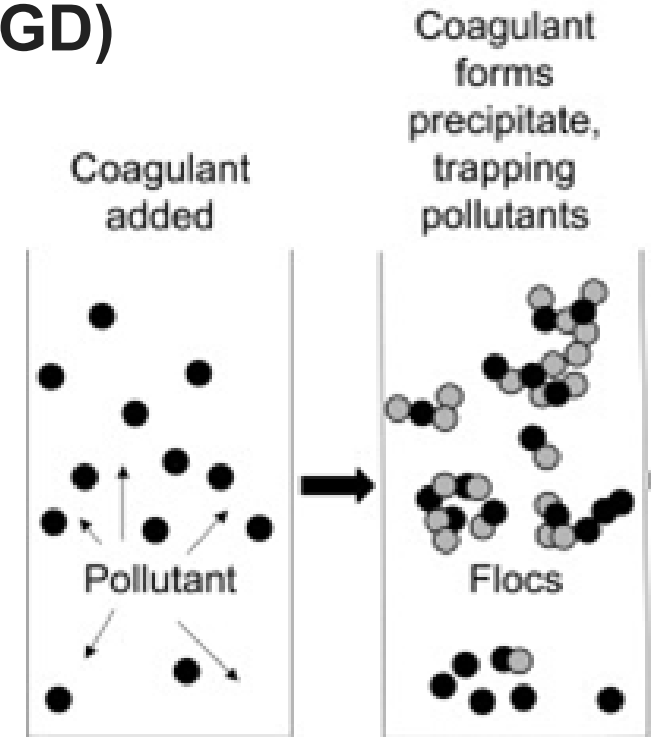
- **Organosulfide:** Sulfide Precipitation
 - Works better at lower pHs: <8
 - Concerns:
 - Aquatic Toxicity
 - Colloids Formation
 - Hydrogen Sulfide Formation
- Hydraulic Detention Time: 10-20 mins
 - pH Control mostly, reactions pretty fast



Reaction Tank 3: “Coagulation”

Purpose - iron salt for charge neutralization (Not in FGD)

- **Ferric (FeCl_3) or Ferrous Chloride (FeCl_2)**
 - Ferrous chloride:
 - Acts as a reducing agent
 - Maybe slightly less expensive
- **NO Iron Sulfate - Scaling**
- Hydraulic Detention Time: 10-20 mins



Splitter Box

Purpose - Flocculation w/ Polymer: enlarge the small particles to weight/remove in the clarifier.

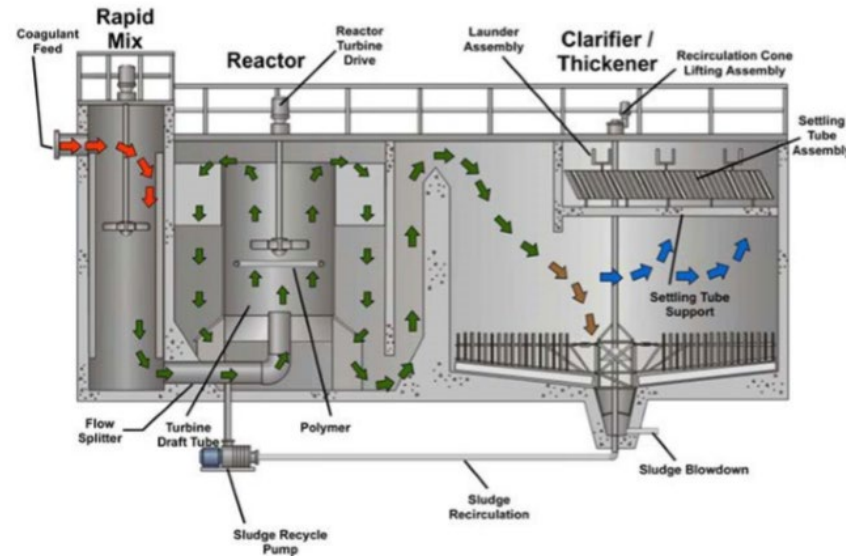
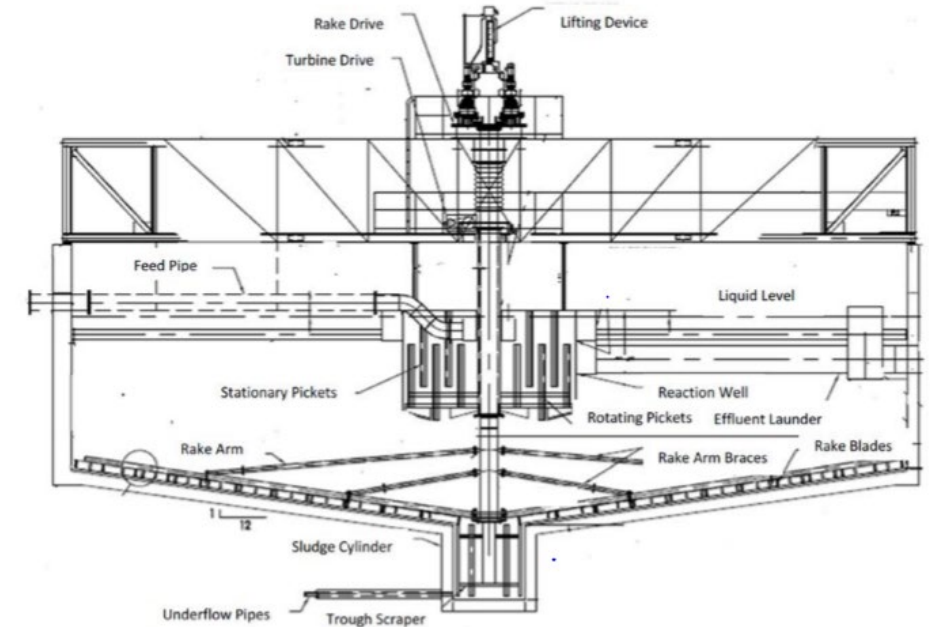
- Adequate mixing, but mitigate shearing (VFD)
- Splits flows between clarifiers
- Hydraulic Detention Time: N/A
- Accessible with a hose
- Do not need a Level Indicator Transmitter...



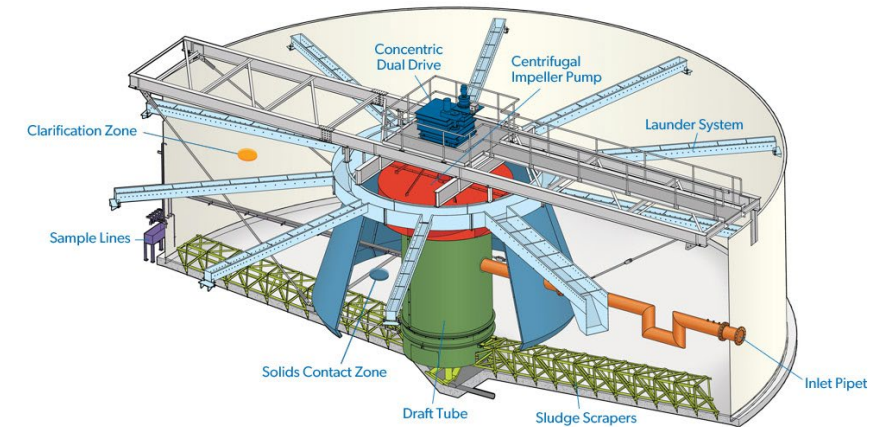
Clarifier

Many different types:

- Conventional
- **Flocculating - flocculation well**
- **Solids Contact - Sludge recirculated**
- Sludge Blanket
- Inclined Plate
- **High-Rate - condensed, but don't thicken**
- Ballasted



Elements of a True CONTACT CLARIFIER™



Clarifiers

- **Overflow Rate (gpm/ft²):** supernatant leaving the clarifier
 - **Good Design:** 0.28 - 0.33, no more than 0.5
- **Settling Rate (ft/s):** velocity a particle settles

Efficient Clarification: Overflow Rate should not exceed the Settling Rate.

Settling Rate (ft/s) x 7.5 gals/ft³ x 60 sec/min = Overflow Rate (gpm/ft²)

- **Polymer selection....dosing**

PARTICLE DIAMETER (mm)	TYPE	SETTLING VELOCITY
10	PEBBLE	0.73 m/s
1	COURSE SAND	0.23 m/s
0.1	FINE SAND	0.6 m/min.
0.01	SILT	8.6 m/d
0.0001 (10 micron) *	LARGE COLLOIDS *	0.3 m/y *
0.000001 (1 nano) *	SMALL COLLOIDS *	3 m/million y *

SETTLING GRAVITY

COAGULATION AND FLOCCULATION
(Examples of various sizes of particles in raw water)

* Colloids so small:
gravity settling
isn't possible

Stokes' Law

The force of viscosity on a small sphere moving through a viscous fluid is given by:

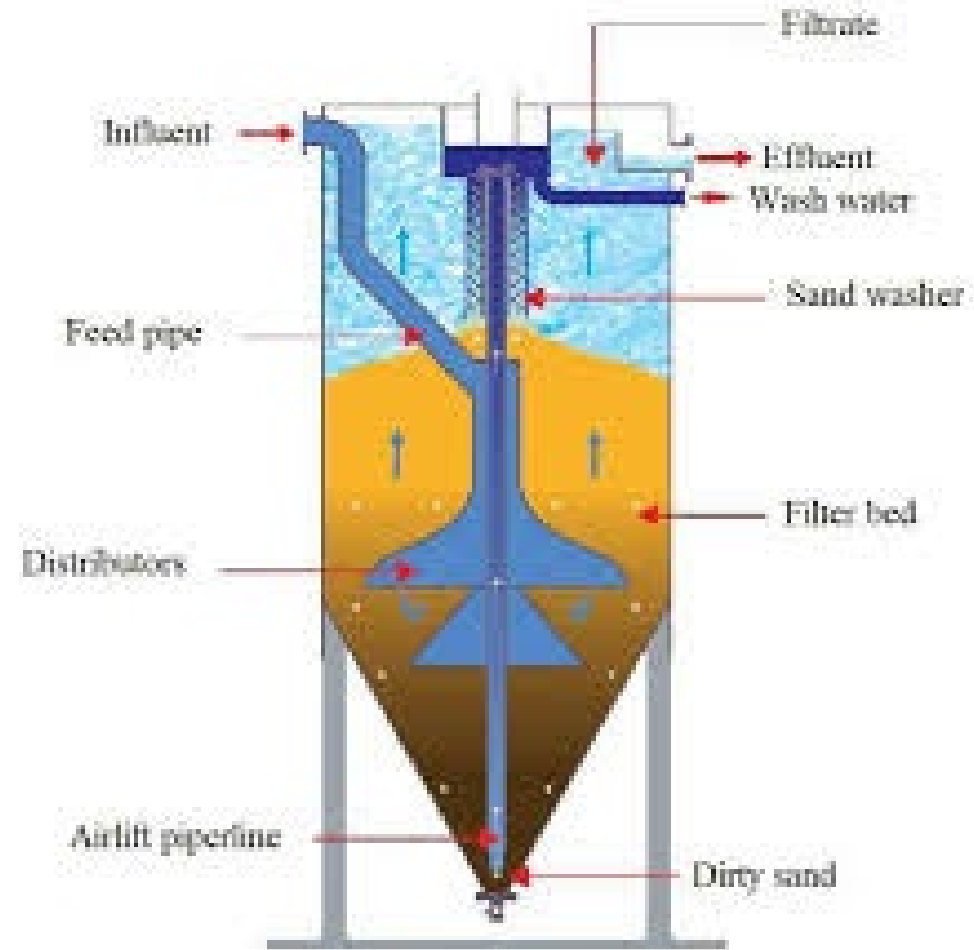
$$F_d = 6\pi\mu Rv$$

where:

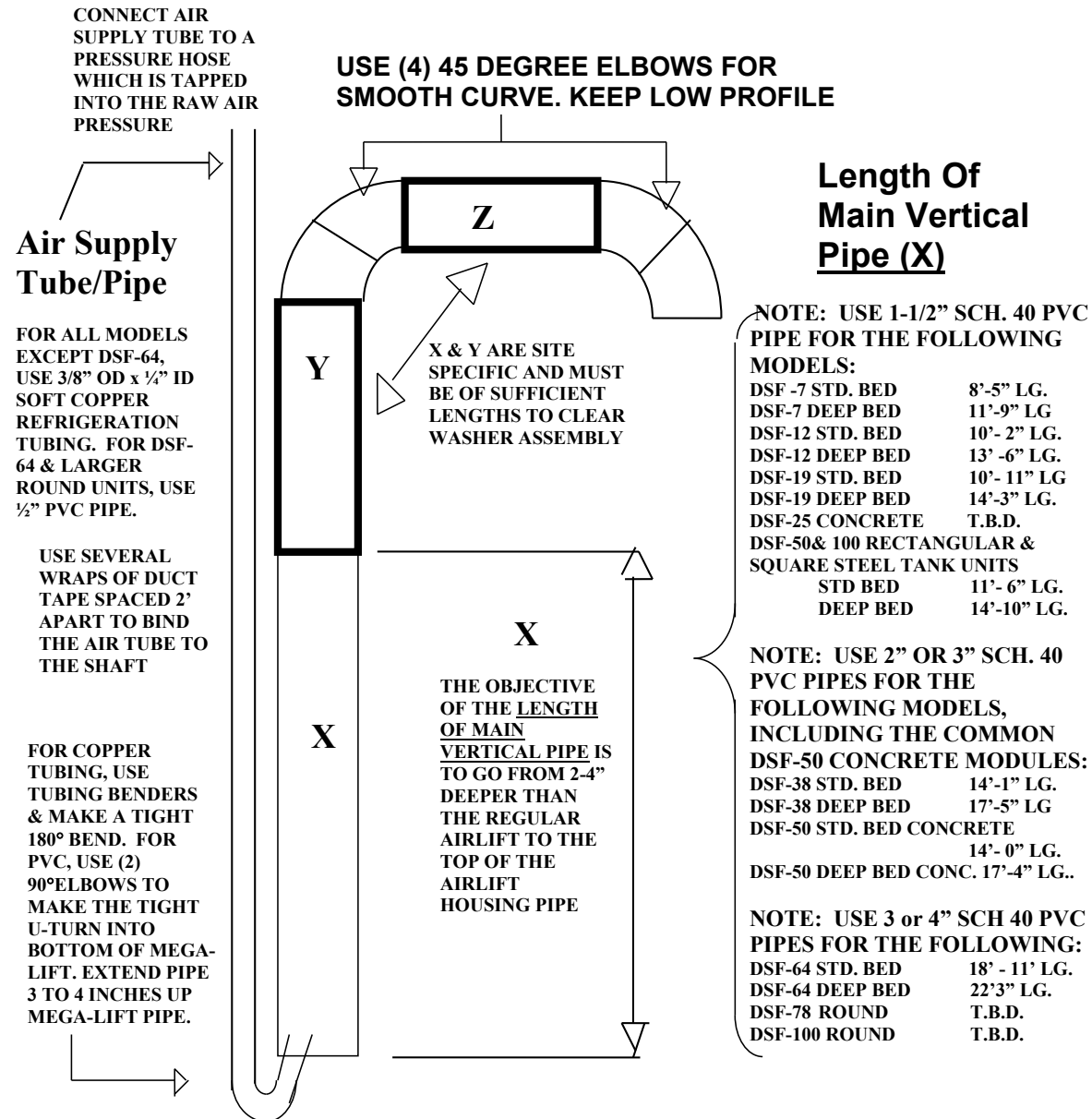
- F_d is the frictional force – known as **Stokes' drag** – acting on the interface between the fluid and the particle
- μ is the dynamic viscosity
- R is the radius of the spherical object
- v is the flow velocity relative to the object

Sand Filters

- pH adjustment
- Redundancy
- Mega-lift
- Operating flow range
- Matting



MegaLift Dimensions



Sludge Recycling

- Beneficial in the agglomeration of fine particles
- Reduces chemical flocculant
- 15-20 times the volume that is wasted gains optimum density
- Mitigate Shearing Particle



AOD Pumps



Rotary Lobe Pumps (\$\$)

Solids Removal

Sludge Wasting/Recycle/Holding Tank

- **% Solids:**
 - Moisture balance
- **Continuous vs. Batch Wasting**
- **Impact on Filter Press Operations**
- **Tank Sizing Basis: > 2 Batches of Sludge**
- **Knife Gate Valves - Leaking**



Filter Presses

- **Design basis**
 - % solids
 - Operations Schedule - Weekend/Nights?
- **Safety:** Elevation, pinch points
- **Cloth Wash: Must Have!**
- **Controller**
 - Umbilical vs. Wireless
- **Plate Scrapers**
- **Maintenance**
 - Clean/lube/tension chain



Cloth Wash



Filter Press Side

Biological

What is a bioreactor?

GOOGLE: bi·o·re·ac·tor, bīōrē'aktər/noun: **bioreactor**; plural noun: **bioreactors**
an apparatus in which a biological reaction or process is carried out, especially on an industrial scale.

Wikipedia:

A **bioreactor** may refer to any manufactured or engineered device or system that supports a biologically active environment. In one case, a bioreactor is a vessel in which a chemical process is carried out which involves organisms or biologically active substances derived from such organisms. This process can either be aerobic or anaerobic.

What is a bioreactor?

Around a coal fired station/retired station:

An active or passive treatment system designed to remove dissolved constituents from a wastewater stream. Specific applications include removal of:

- Nutrients (nitrates, ammonia, phosphates, COD)
- Selenium (Se)
- Metals (Hg, As, Ni, Cu, Zn, Cr, Cd, etc.)*

[*www.periodictable.com](http://www.periodictable.com)

www.nist.gov/sites/default/files/documents/2019/07/29/nist_periodictable_july2019.pdf

What Makes a Happy Bug (Microbe)?

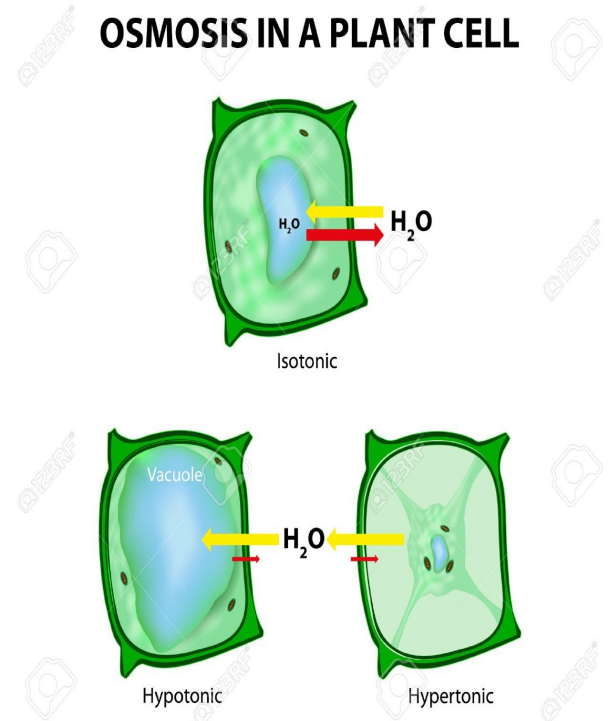
- An environment they have uniquely adapted to, i.e. temperature, pH and TDS;
- Electron acceptors and donors, i.e. oxygen and food;
- A balanced diet (C:N:P);
- Some elbow room;
- A clean home;
- Good neighbors (biomass).



Eat – Mate – Hibernate

Environment

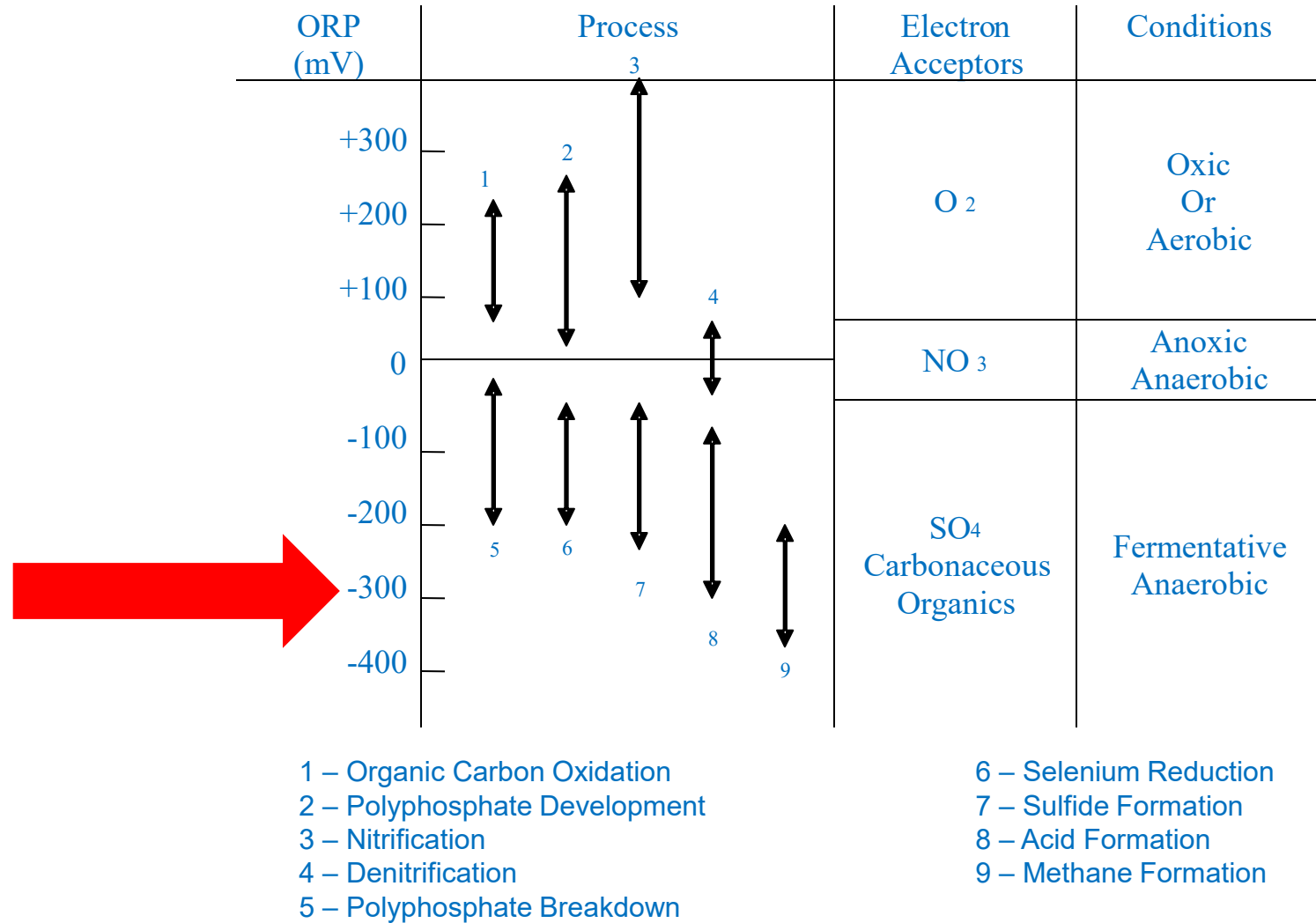
- **Temperature:** 32 – 100 °F, 80 – 95 °F seems to be the sweet spot
- **pH:** 6 – 9, bugs like ~8, scale prevention likes ~6.8
- **TDS:** 10,000 to 30,000 ppm have worked full scale
 - **Chlorides:** See TDS
 - **Ionic Strength:** The real issue
 - Hypotonic solutions explode red blood cells



A Balanced Diet

- C:N:P – Redfield Ratio
 - 106:16:1
- Carbon Sources
 - Lose on Ignition (LOI) – Soot
 - Absorber Additives – DBA, Formic Acid, etc
 - Commercial Carbon Sources
 - Molasses
 - Glycerin
 - Methanol
 - Acetic Acid
 - Biomass
- Nitrogen Sources
 - NO_x
 - Ammonia
 - Proteins
- Phosphorus Sources
 - Additives & Impurities
 - Proteins

Redox Profile



How do Bioreactors Work

- Nitrates are converted to nitrogen gas



- Bacteria reduce oxidized forms of selenium (selenate & selenite) to elemental selenium



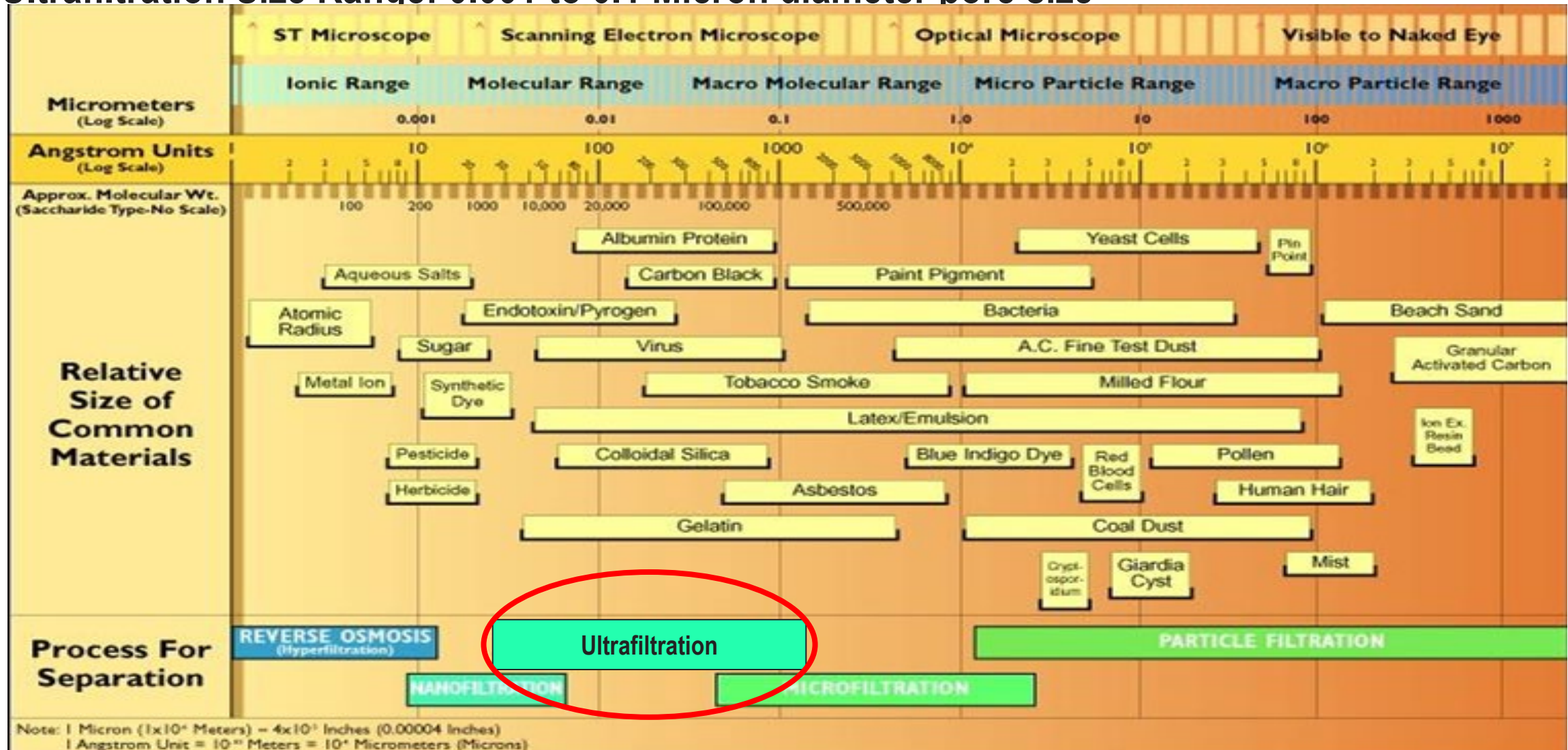
- Dissolved metals are converted to metal sulfides and are retained within the system



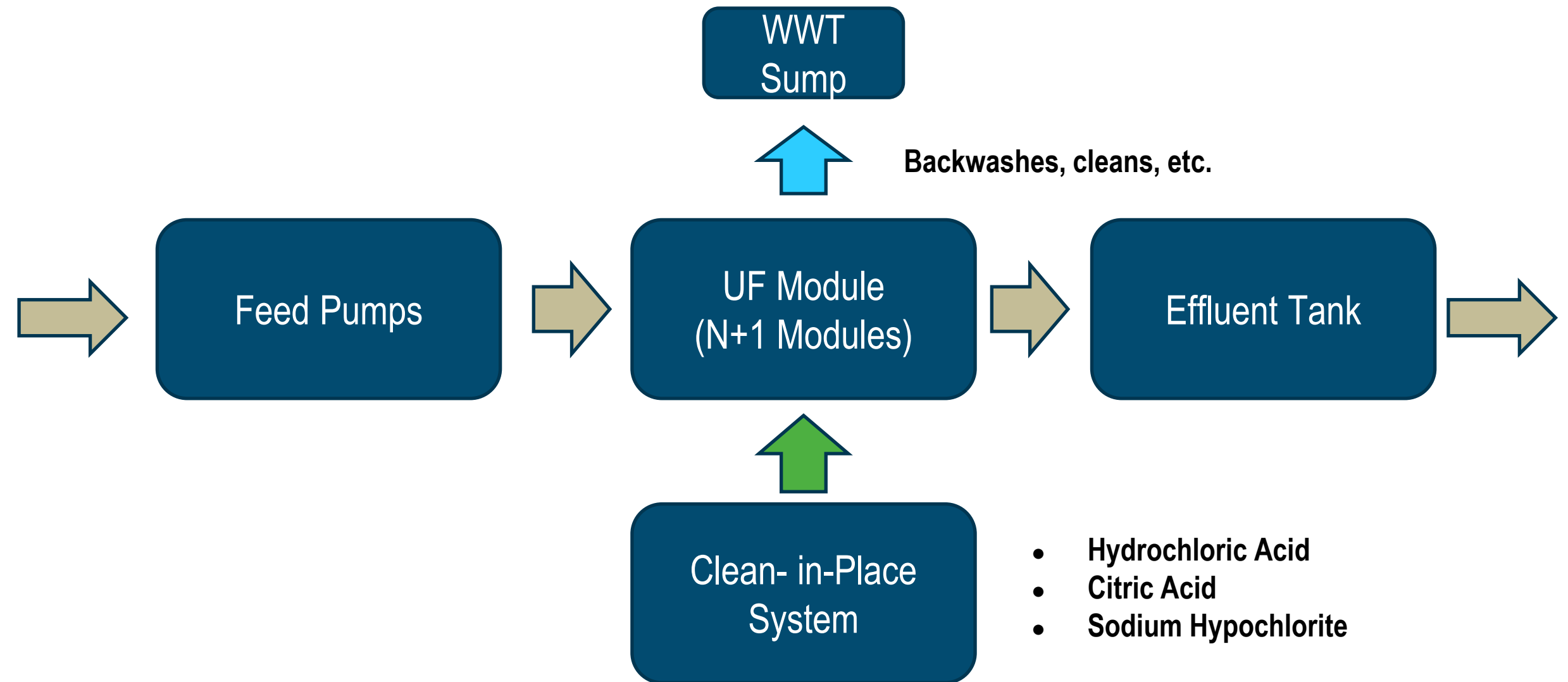
Membrane

Introduction

Ultrafiltration Size Range: 0.001 to 0.1 Micron diameter pore size



Ultrafiltration Components



- **Filtration Size:** 0.001 to 0.1 Micron diameter pore size
- **N+1 Redundancy:** Municipality vs. Utility
 - Utility - 100% Redundancy means no limit to operation when modules are down
- **Automatic Operation**
 - Maintenance & CIP Cleans: **Operator Initiated**
- **Hydrogen Sulfide** - a concern since after biological
 - Placed monitor inside building
 - Vent and drain modules to outside
- **Long term Layup: Free Available Chlorine need to Monitor**
 - 5-10 ppm Experience on Free Available Chlorine Target
 - Reach out to Vendor for guidance/input
 - Use Service Water for storage layup

Effluent

Effluent

- Keep it clean
- Closed top tanks



Analytical

Analytical Lab

Keep it clean

- Keep fire doors closed (safety and quality)
- Keep operators out
- Mop the floor and wipe down the counters
- NO FANS
- Keep food and drink out



Analytical Lab

- **Operational Samples**
 - Hach Kits: Nitrates, Ammonia, COD, Phosphate
 - pH/ORP Solutions
 - TSS/TDS - equipment and supplies
- **Check Storage & Shelf Life**

Major Forgotten Items:

- Refrigerator & Ice Machine
- DI Water System
- Workspace/Operator Interface
- Lab Drains
- Space
- HVAC Sizing



Performance Monitoring Sample Requirements - Normal Operation										
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Constituent	Test Location	Test Instrument / Method	Method Detection Limit (MDL)	Frequency ¹	Sampling Locations	EQ Tank Effluent	Phys-Chem Effluent	Denite Effluent	Stage 1 Bio Effluent	Stage 2 Bio Effluent	UF Effluent		
Alkalinity	Field	HACH	-	Daily		X ³	X	X	X	X	X		
Ammonia	Field	HACH	-	Daily		X	X	X	X	X	X		
Chloride	Field	QuanTab Test Strips	-	Daily		X	X				X		
COD	Field	HACH	-	Daily		X	X	X	X	X			
Nitrates	Field	HACH	-	Daily		X	X	X	X	X			
ORP	Field	Record from DCS	-	Daily		X	X	X	X	X			
Ortho-Phosphate	Field	HACH	-	Daily		X	X	X	X	X			
pH	Field	Hand Held	-	Daily		X	X	X	X	X	X		
Sulfide	Field	HACH	-	Daily				X	X	X	X		
TDS	Field	METTLER TOLEDO HC103	-	Daily		X	X			X	X		
TSS	Field	METTLER TOLEDO HC103	-	Daily		X	X				X		
Arsenic	Lab	EPA 200.8	1 ug/L	2x per Month		X	X			X	X		
Mercury ²	Lab	EPA 245.1	0.5 ng/L	2x per Month		X							
		EPA 1631		2x per Month			X			X	X		
Selenium	Lab	EPA 200.8	1 ug/L	2x per Month	X	X		X	X	X			
Selenium Speciation	Lab	SOP BAL-4201 ⁴		2x per Month	X	X		X	X	X			

- | | |
|--|--|
| 1. Collect weekly until Commercial, then collect 2x per month during the 1st and 3rd weeks of every month. | |
| 2. Sampling procedure should include a trip blank. | |
| 3. Sample should be filtered to reduce interference of unreacted limestone. | |
| 4. Brooks Applied Labs | |

Safety

Inert/Toxic Atmosphere

- Carbon Dioxide and Nitrogen generation
- Hydrogen Sulfide Generation
 - **Monitoring:** Self vs. Field
 - **Alarms:** Audible & Visible prior to backwash
 - **Training**
- Hydrogen Cyanide Generation
- Carbon Monoxide during start-up/commissioning
 - Damp Activated Carbon → CO↑

H₂S warning signs

Concentration in parts per million (ppm)*	Observations and health effects
Less than 1	Most people smell "rotten eggs."
3 to 5	Odour is strong.
20 to 150	Nose and throat feel dry and irritated. Eyes sting, itch, or water; and "gas eye" symptoms may occur. Prolonged exposure may cause coughing, hoarseness, shortness of breath, and runny nose.
150 to 200	Sense of smell is blocked (olfactory fatigue).
200 to 250	Major irritation of the nose, throat, and lungs occurs, along with headache, nausea, vomiting, and dizziness. Prolonged exposure can cause fluid buildup in the lungs (pulmonary edema), which can be fatal.
300 to 500	Symptoms are the same as above, but more severe. Death can occur within 1 to 4 hours of exposure.
Above 500	Immediate loss of consciousness. Death is rapid, sometimes immediate.



Bioreactor - H₂S Monitor



Questions?