

Membrane Systems for Waste Water Re-Use in Downstream Applications

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Presentation Outline

- Membrane Terminology
- Membrane Basics
- Membrane Re-Use Applications
- Re-Use Issues / Solutions

Membrane Terminology

- **Membrane:** Semi-permeable filter with controlled pore structure
- **Filtrate (or permeate):** Effluent from membrane process
- **Immersed Membrane:** Membrane submerged directly in mixed liquor, outside to inside flow under vacuum
- **MBR:** Membrane BioReactor-biological + membrane filtration process
- **UF:** UltraFiltration-from about 0.006 to 0.8 μm
- **UF-S:** UltraFiltration-Submerged

Membrane Terminology (cont.)

- **Flux:** Normalized flow across membranes surface area (gfd = gpd/ft² or LMH = L/m²/h)
- **TMP:** Trans-Membrane Pressure, pressure across the membrane surface (in psi or kPa)
- **Permeability:** Flux divided by TMP (gfd/psi or LMH/bar)
- **CIP:** Clean In Place-membrane cleaning procedure

What Is A Membrane ?

A membrane is a solid-liquid separation device used to separate suspended solids from the water-similar to a gravity clarifier

It is a Physical Barrier:
suspended solids larger than the nominal pore size remain in the process tank

Mixed Liquor

MLSS 5,000 –
16,000 mg/L

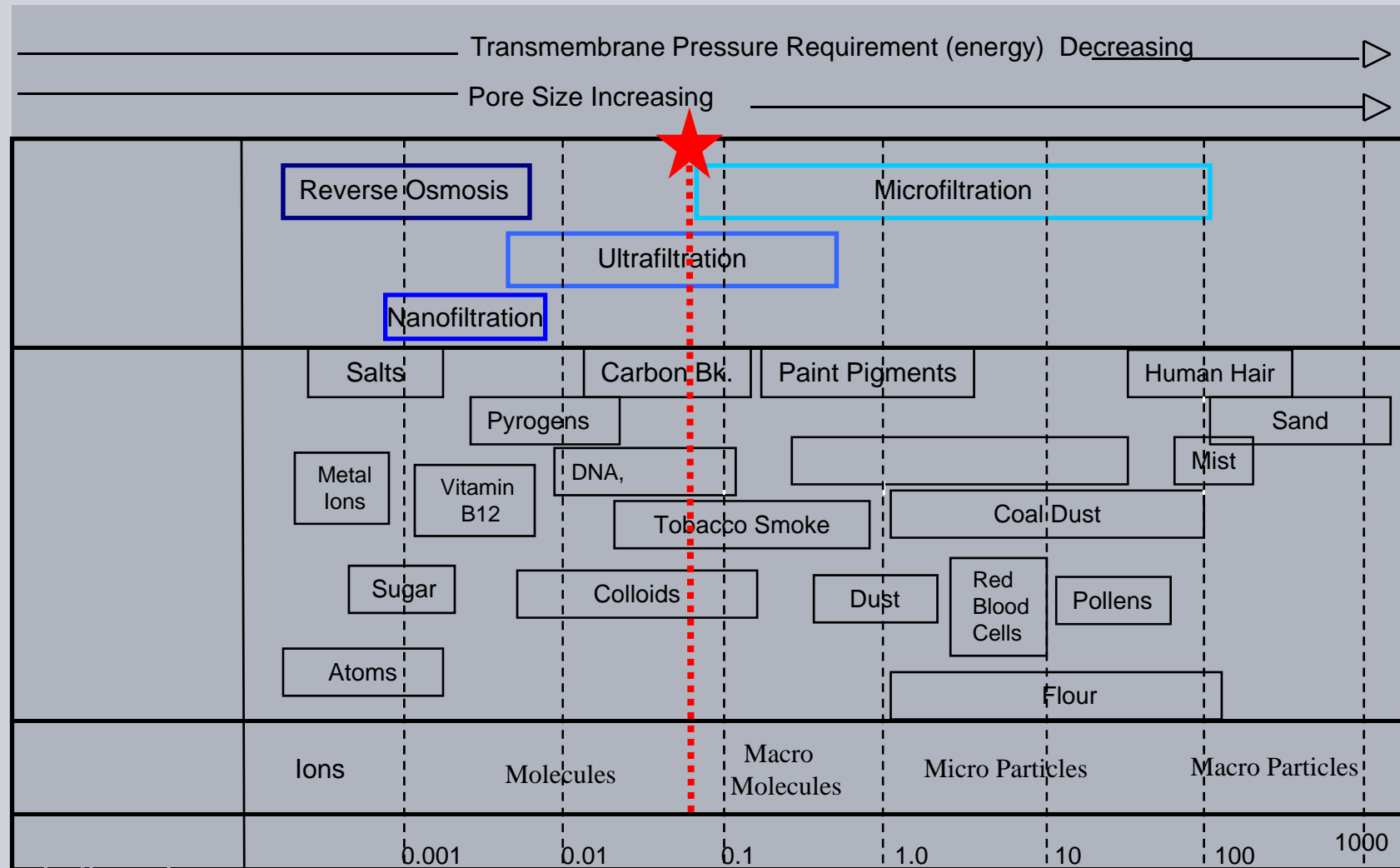
Permeate

TSS < 1 mg/l
Turbidity < 0.2
NTU

Flow



Membrane Filtration Spectrum

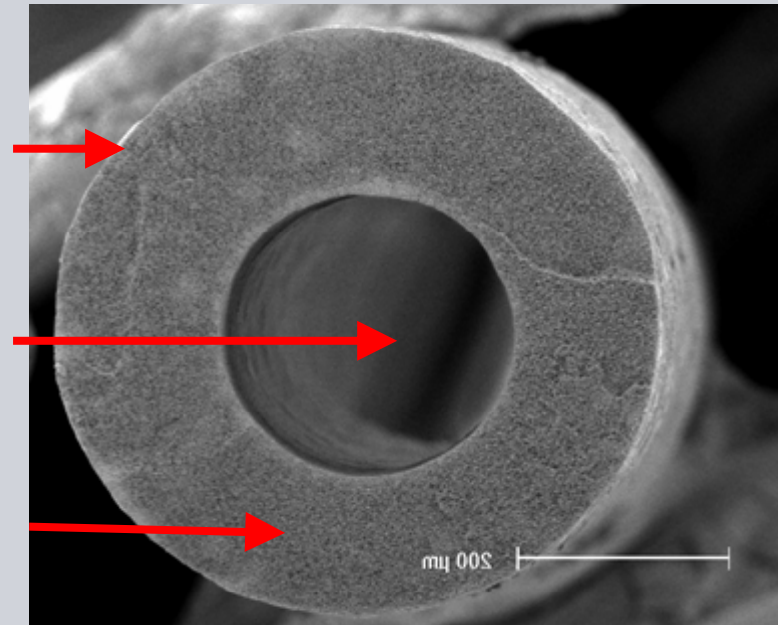


What Does It Look Like (fiber scale)

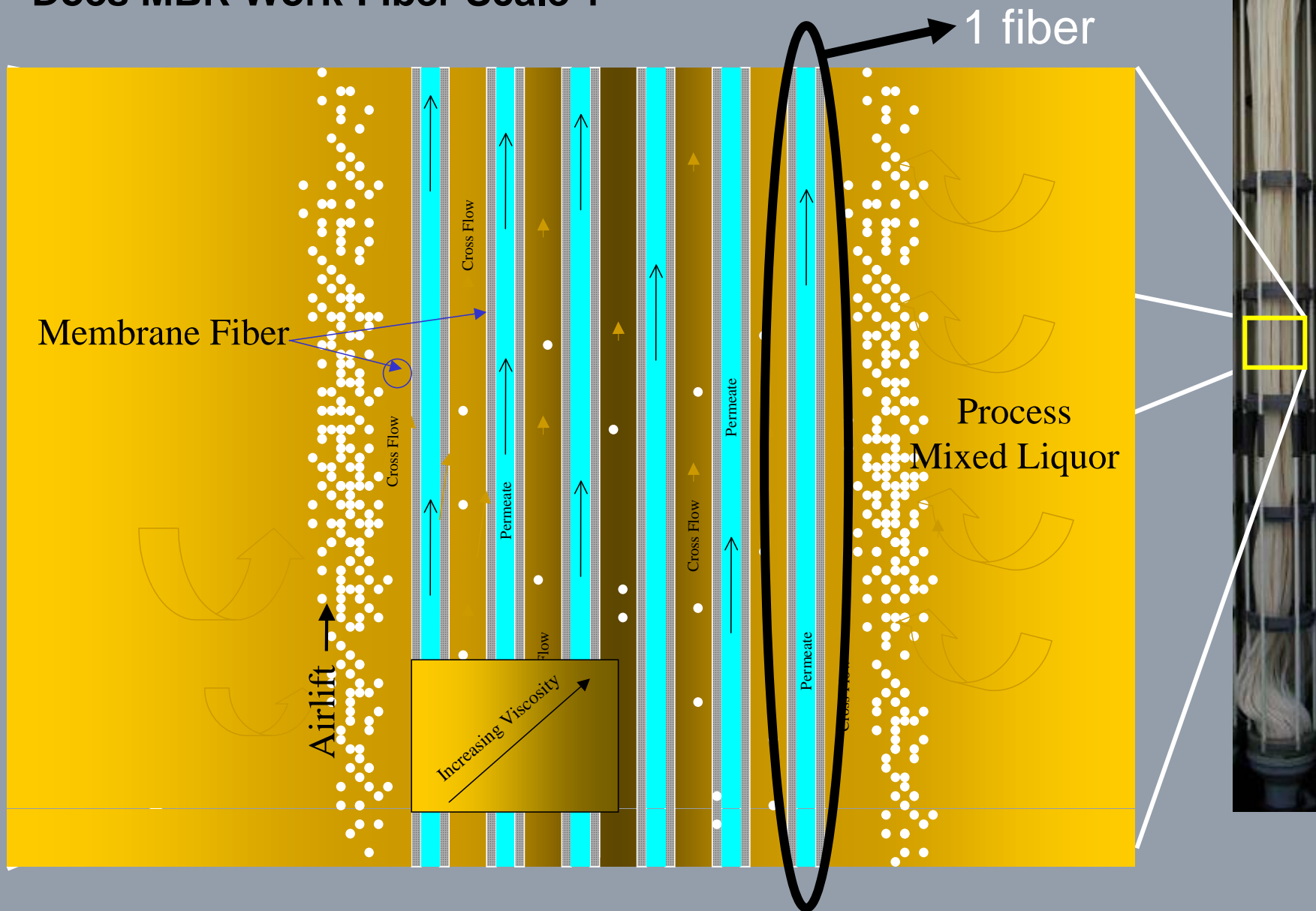
- Homogeneous-Monolithic structure
 - Single material that requires no bonding
 - Hollow fiber configuration only
 - Strong, self-supporting
 - Single manufacturing process
- Polypropylene
 - 0.1 micron **Membrane “skin”**
 - Acid & caustic resistant
- PVDF
 - 0.04 micron
 - Acid & chlorine resistant

Porous substrate

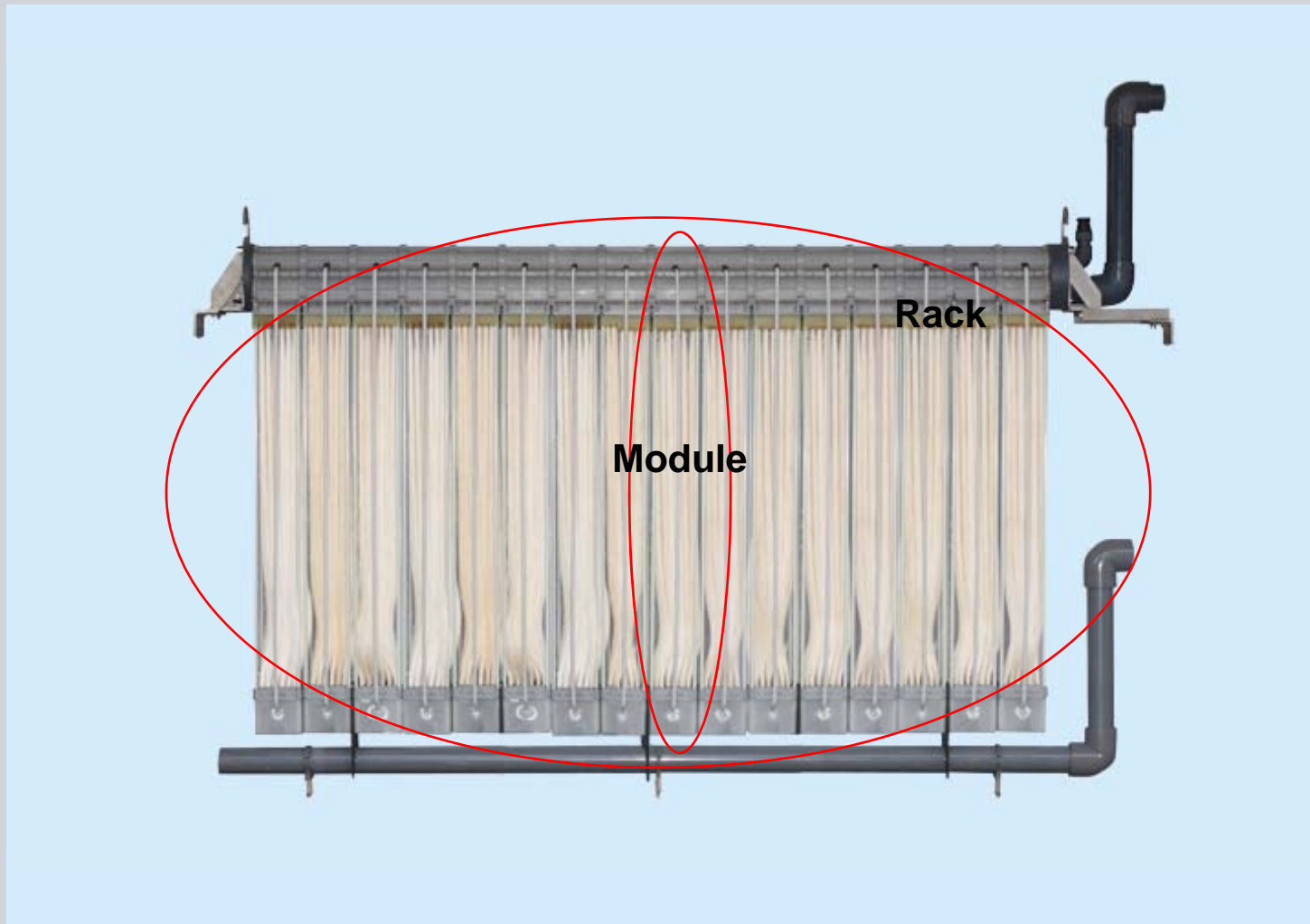
Lumen



How Does MBR Work-Fiber Scale ?



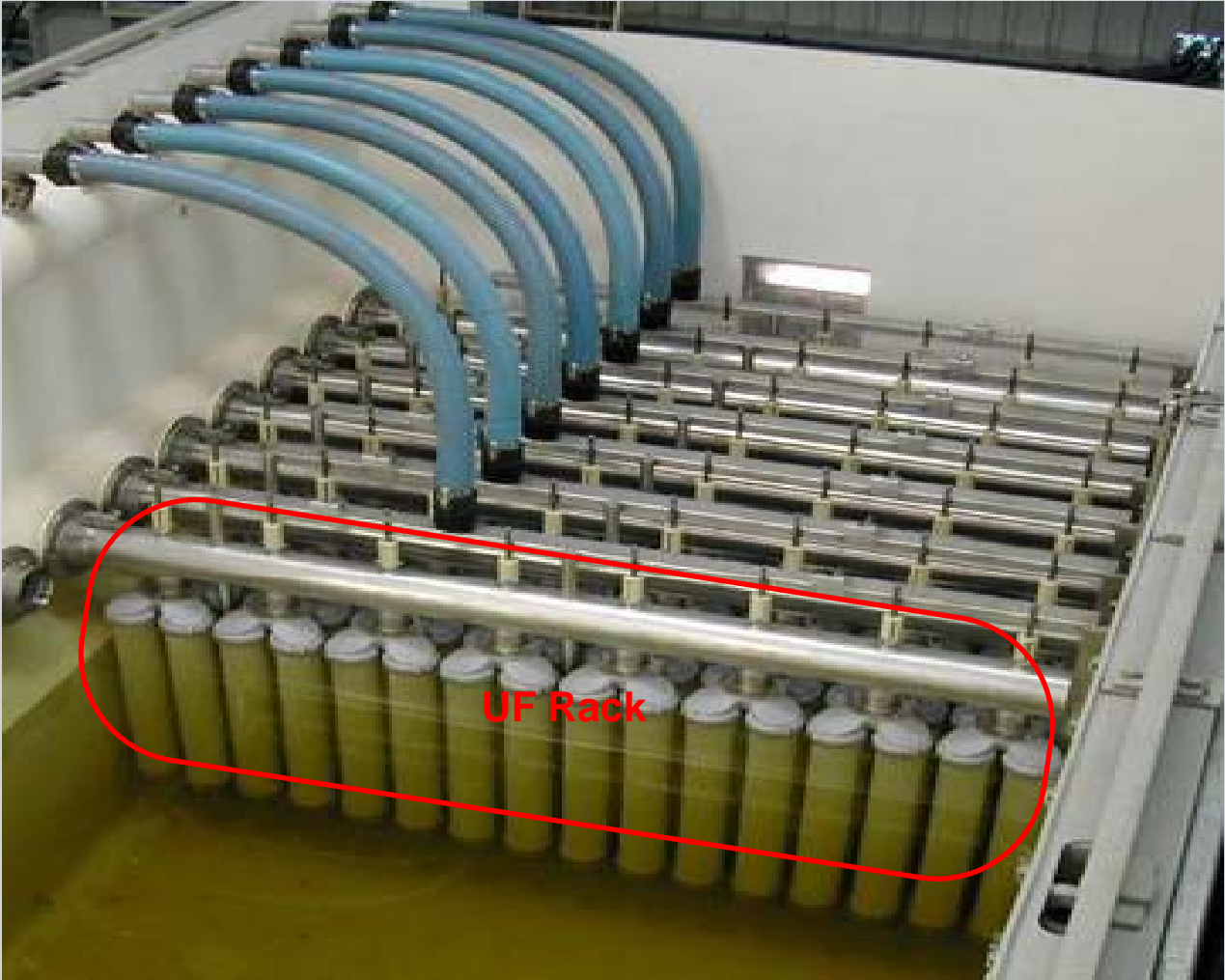
What Does It Look Like (MBR Rack scale) ?



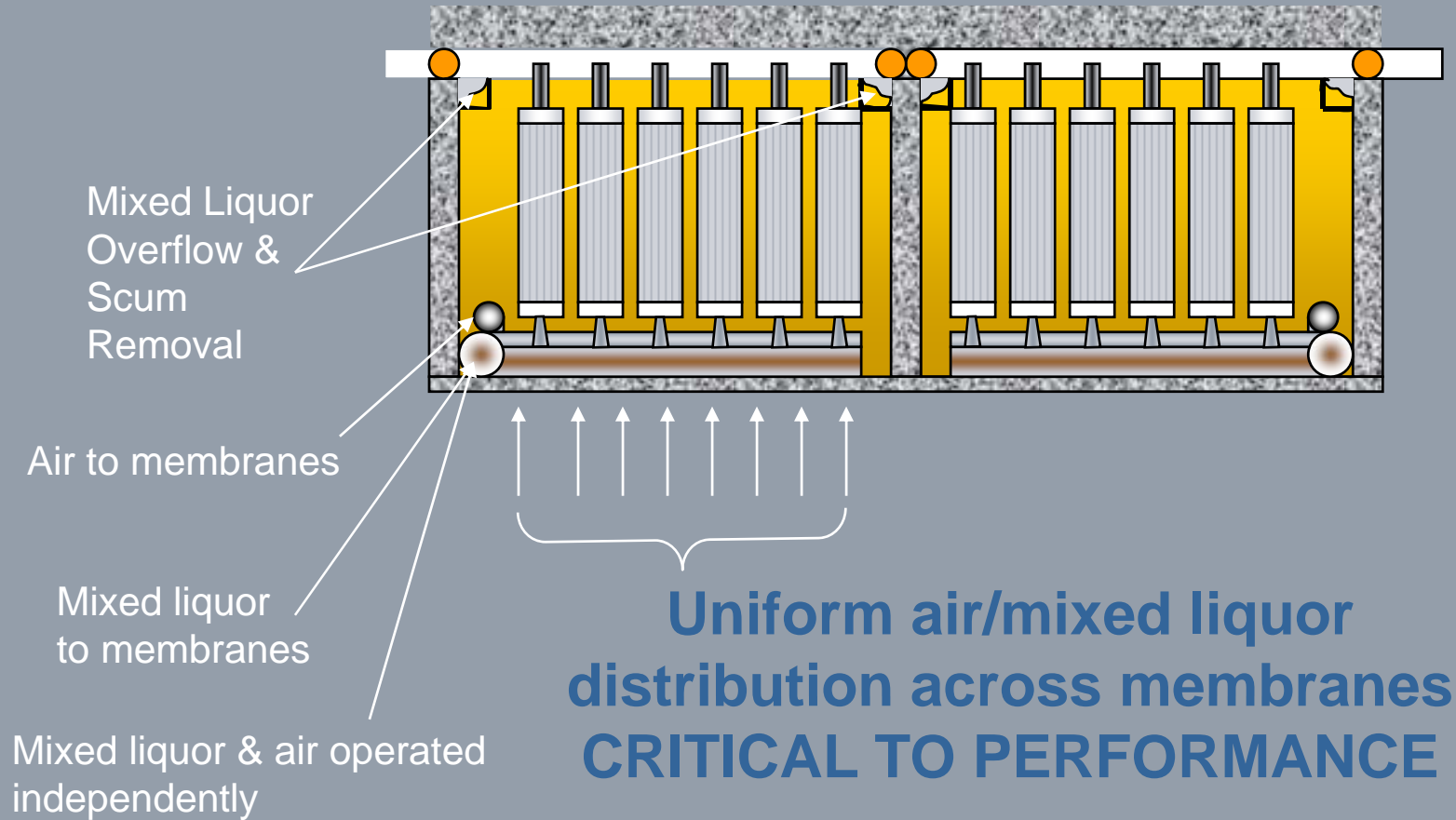
Membrane (MBR) Tank Scale



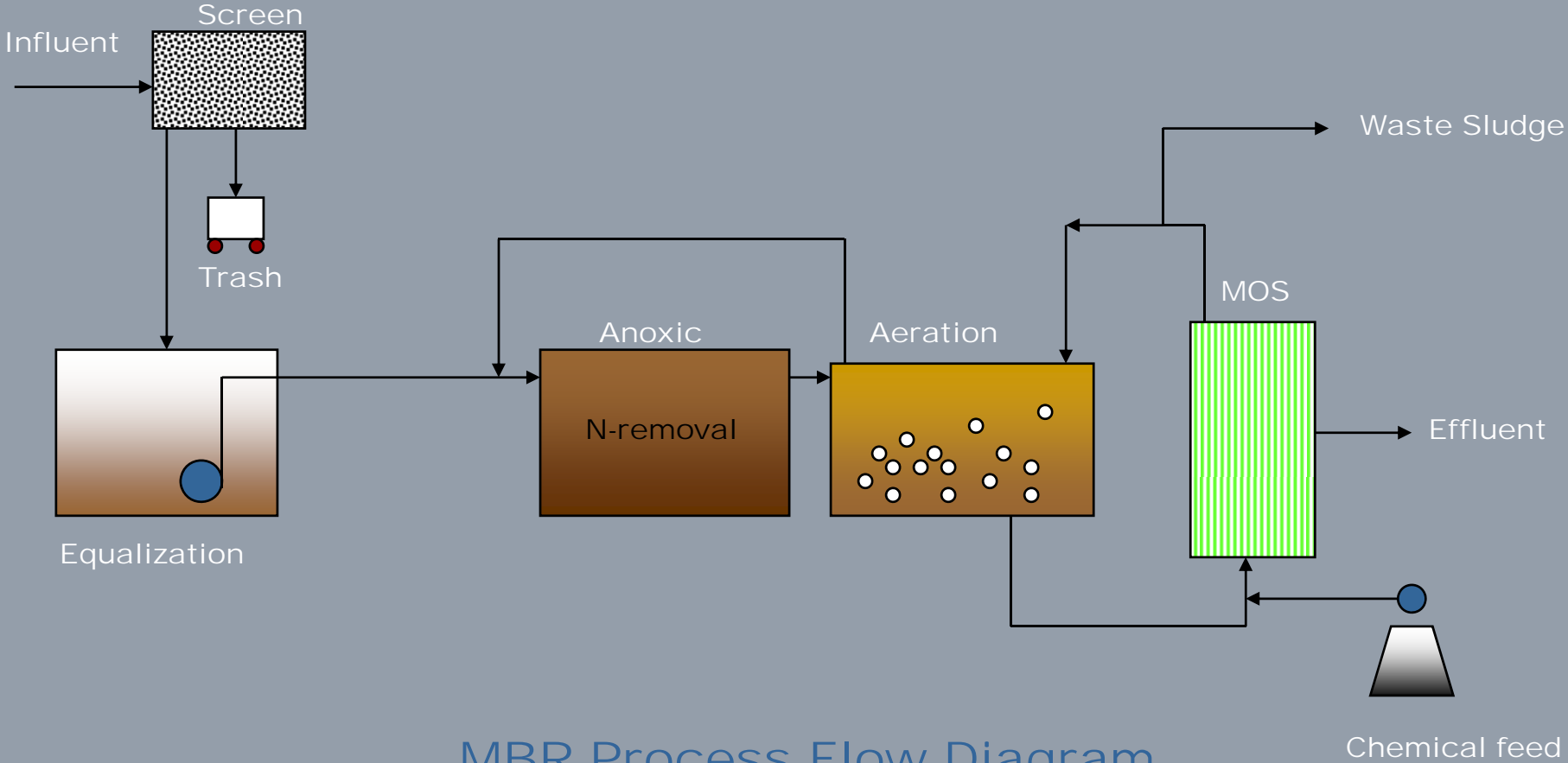
UF-S Systems Tank Scale



How Does Petro™ MBR work at the Membrane Tank Level?

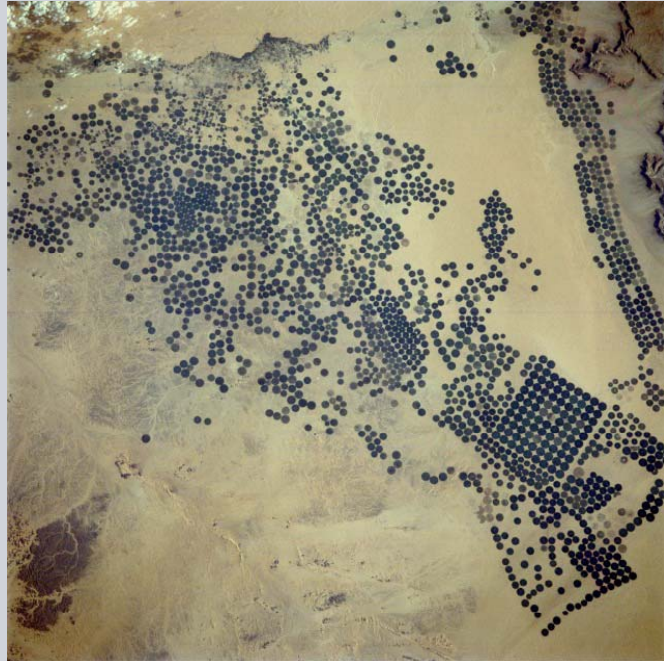


General Process Description-Petro™ MBR



MBR Process Flow Diagram

Membrane Re-Use Applications



Membrane Re-Use Applications

- Greenfield Petro™ MBR Systems
- UF Addition to Existing WWTP Facility
- Conversion of Existing WWTP to Petro™ MBR

Re-Use Applications

Greenfield Petro™ MBR Systems

- Direct use for Cooling Tower Make Up (dependent on cooling tower requirements and source water TDS, etc.)
- Pretreatment for RO → Boiler Feed Water (carbon-enhanced Petro™ MBR)
- Address difficult settling sludge from certain gas processing facilities
- Re-Use as Irrigation Water

- Added Benefits
 - More reliable COD/N Reduction
 - Reduced Sludge production
 - Decreased footprint-Hydraulic/BOD/COD per Land Area

Re-Use Applications (cont.)

UF (Tertiary Filtration) Addition to Existing WWTP Facility

- Direct use for Cooling Tower Make Up
 - Pretreatment for RO-Boiler Feed Water (Only if biological system has the capability to remove TOC to low levels)
 - Re-Use as irrigation water
 - Re-Use in contaminated aquifer re-injection systems (if biological system has the capability to remove TOC to low levels)
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- Note-UF following biological systems is generally more expensive and requires more area, so for green field systems, Petro™ MBR is typically more economical

Re-Use Issues / Solutions

UF Addition to Existing WWTP Facility-Issue

	Issue	Solution
Clarifier Performance	Solids loading	Verify bio-plant design equipment redundancy
Foulant	EPS from stressed culture in clarifier	Run minimum SRT in gravity chamber

Re-Use Applications

Conversion of Existing WWTP to Petro™ MBR

- Direct use for Cooling Tower Make Up
- Pretreatment for RO→ Boiler Feed Water (carbon-enhanced)
- Re-Use as irrigation water
- Re-Use in contaminated aquifer re-injection systems (more reliable nitrogen removal)

Re-Use Issues / Solutions

Conversion of Existing WWTP to Petro™ MBR

	Issue	Solution
Membrane Fouling	Potential for free oil	Upgrade with proper pre-treatment equipment
	Unknown fouling or scaling potential	Conduct testing to determine proper CIP
Performance	Rapid loss of permeability	Conduct testing to prove process design is adequate for service-provide redundancy
Aeration capacity	Insufficient capacity for MBR needs	Upgrade with higher capacity equipment
Membrane damage	Chemical additive usage	Run bench scale tests with membrane post-mortem inspection

Why Choose UF for Re-Use?

- Re-use of the treated water-as upgrade to existing system with gravity clarification for:
 - Irrigation water systems
 - Cooling tower make up
 - Pretreatment for Reverse Osmosis (RO) for boiler feed water

Summary - UF for Re-Use

Primarily well-suited for add-on to existing bio plant for TSS reduction

- Effluent suitability
 - cooling tower make up (Cooling Tower-dependent)
 - RO feed water (depending on TOC level after biological treatment)
 - irrigation water systems (if biological system is capable of reaching the limits)
- Higher effluent quality
 - Lower suspended solids
 - Lower turbidity

Summary – Petro™ MBR

- Effluent suitability
 - cooling tower make up
 - RO feed water (especially with carbon-assisted Petro™ MBR)
 - irrigation water systems
- Upgrade of facilities to increase capacity with existing tanks
- High effluent quality
 - More reliable nitrification
 - Lower suspended solids
 - Lower turbidity
 - Lower dissolved organic contaminants (vs. conventional or CMF addition to conventional WWTP)

Thank you for your attention!

Taking care
of the world's water

A large water splash with a globe in the center, set against a background of water with bubbles.