ZENON Industrial Wastewater Treatment Overview for General Electric

Presentation Outline

- Product Line up
- Membrane Fundamentals
- Strike Zone/Key Applications
- How do We Win?
- Competitive Landscape
- Case Studies
- Contact Information

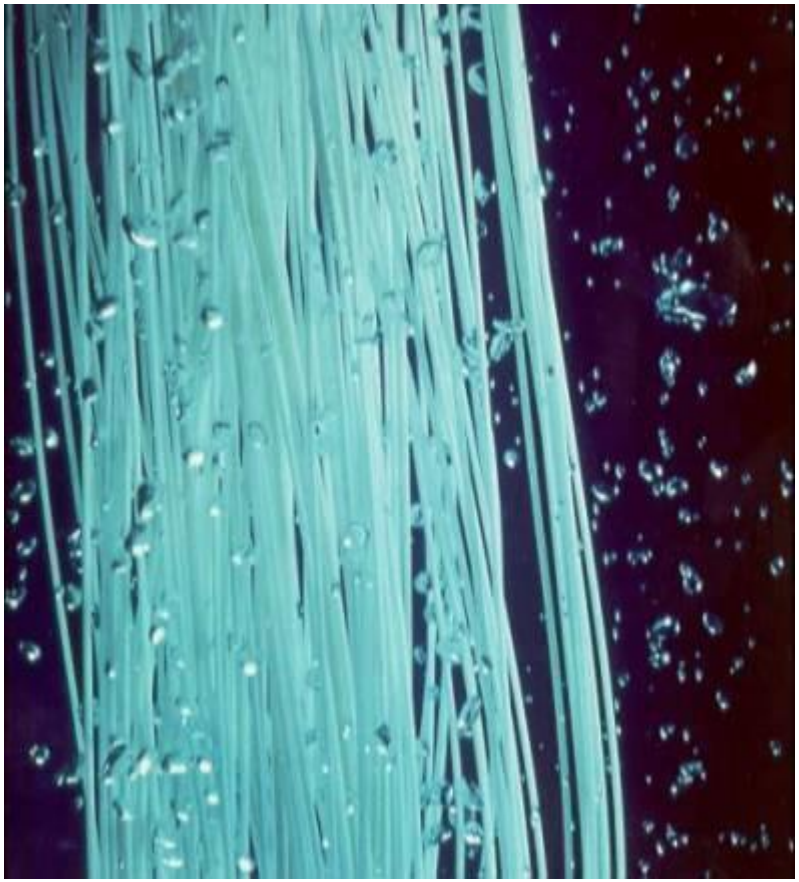
Product Line-up – IND WW

- ZeeWeed® Immersed Ultrafiltration
- MBR
- Tertiary Treatment
- Reverse Osmosis
- Ancillary Equipment, (Sludge Dewatering, Process Tanks etc.)
- Mobile Water Treatment Systems

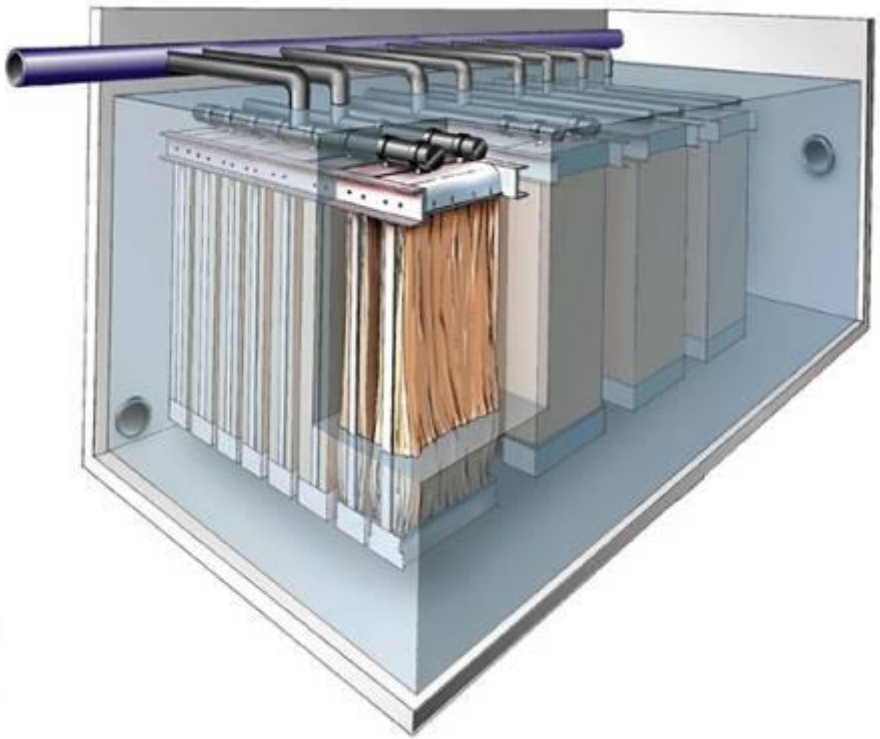
Membrane Fundamentals

ZeeWeed® – The Membrane

- Immersed
- Hollow fiber
- Outside-in
- Ultrafiltration (UF)
- PVDF chemistry (chlorine and oxidant-resistant)

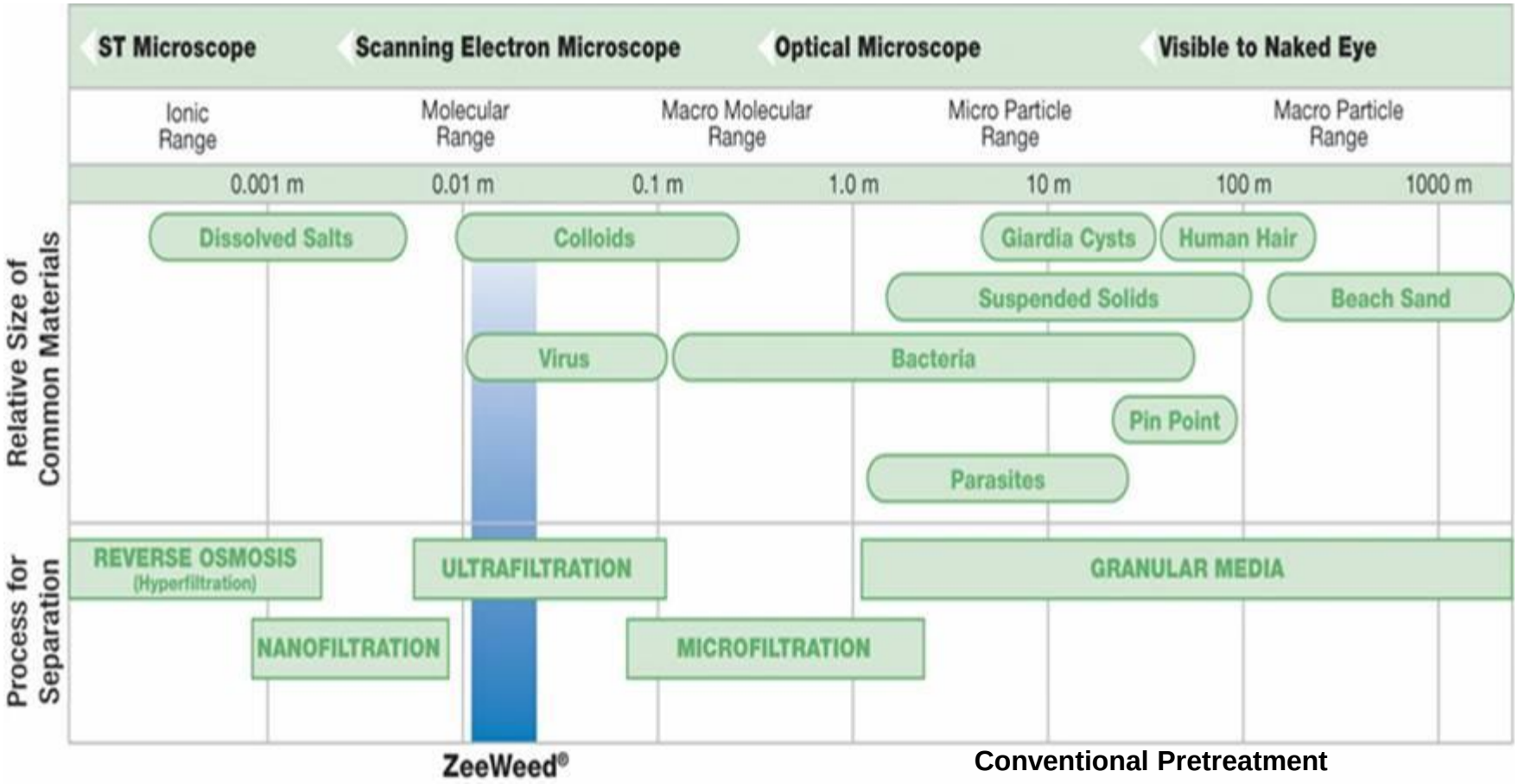


ZeeWeed® Immersed Hollow Fibre UF



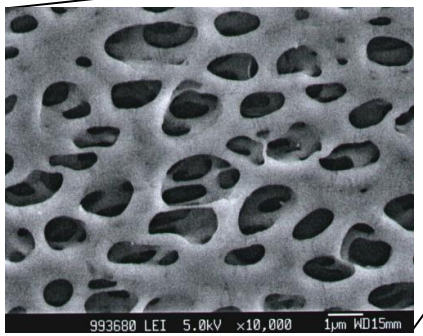
Membranes can be immersed in any tank,
and clean water is produced.

Membranes for Water Treatment

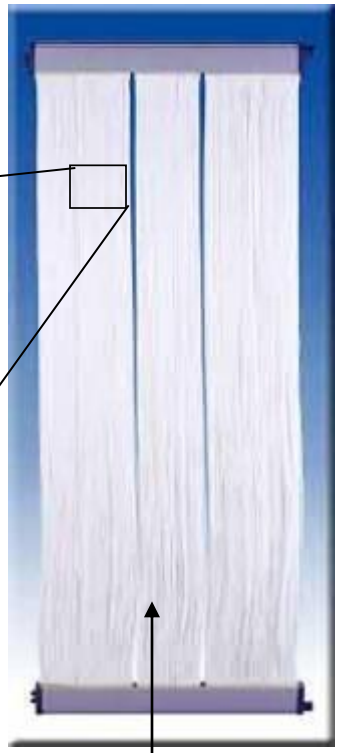


How Membranes Work

- Membrane fibers have billions of microscopic pores on the surface
- The pores form a barrier to impurities, while allowing pure water molecules to pass
- Water is drawn through the pores using a gentle suction



Electron microscope view of membrane surface



ZeeWeed® Membrane Fibers

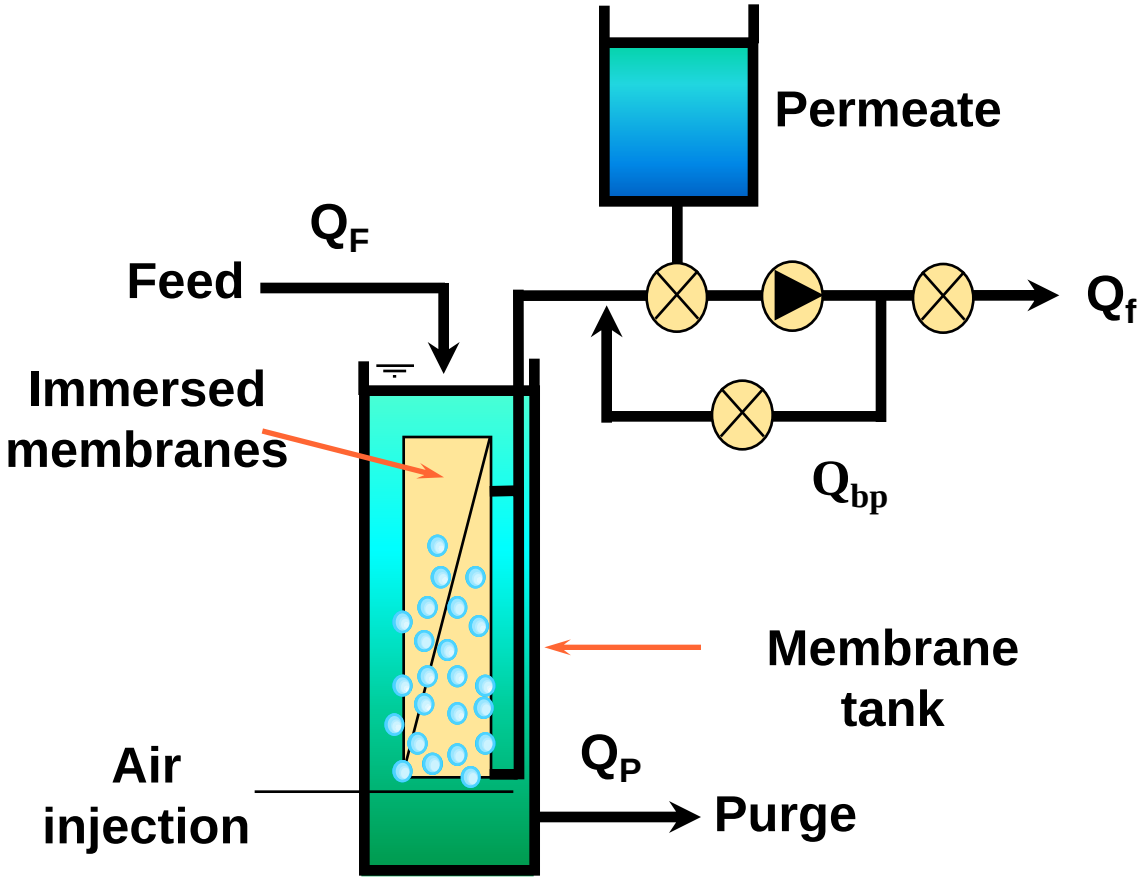
ZeeWeed® Immersed Outside-In Membrane

ZeeWeed® 500 – Reinforced Fibres

- Inner reinforcing structure covered with a composite polymer outer layer
- Pore Size:
  - 0.04 micron (average)
  - 0.1 micron (maximum)
- **Strong:** Single fiber can hold over 50 kg
- **Robust:** Can operate with < 1.0 mg/L TSS (DW) to 50,000+ mg/L MLSS (sludge thickening)
- **Durable:** Majority of modules installed are still in service (first ZeeWeed® membrane installed in 1993)

15 lb bowling ball

Principles of Operation of Immersed Membranes



Recovery

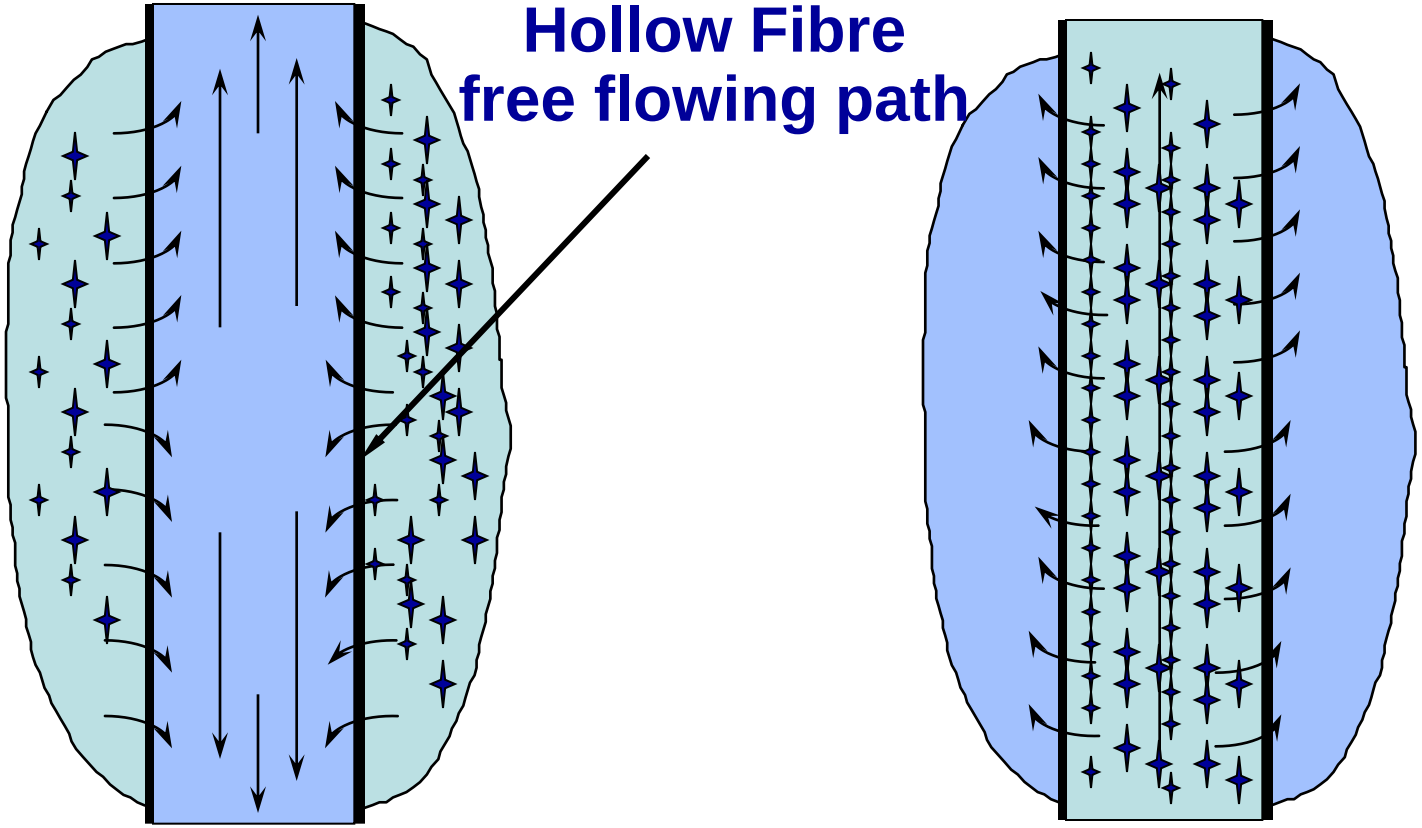
$$Y = \frac{Q_F - Q_P}{Q_F}$$

Hollow Fibre Permeate Flow Path

Outside In

Inside Out

ZeeWeed®
Hollow Fibre
free flowing path



ZeeWeed®

vs.

Other

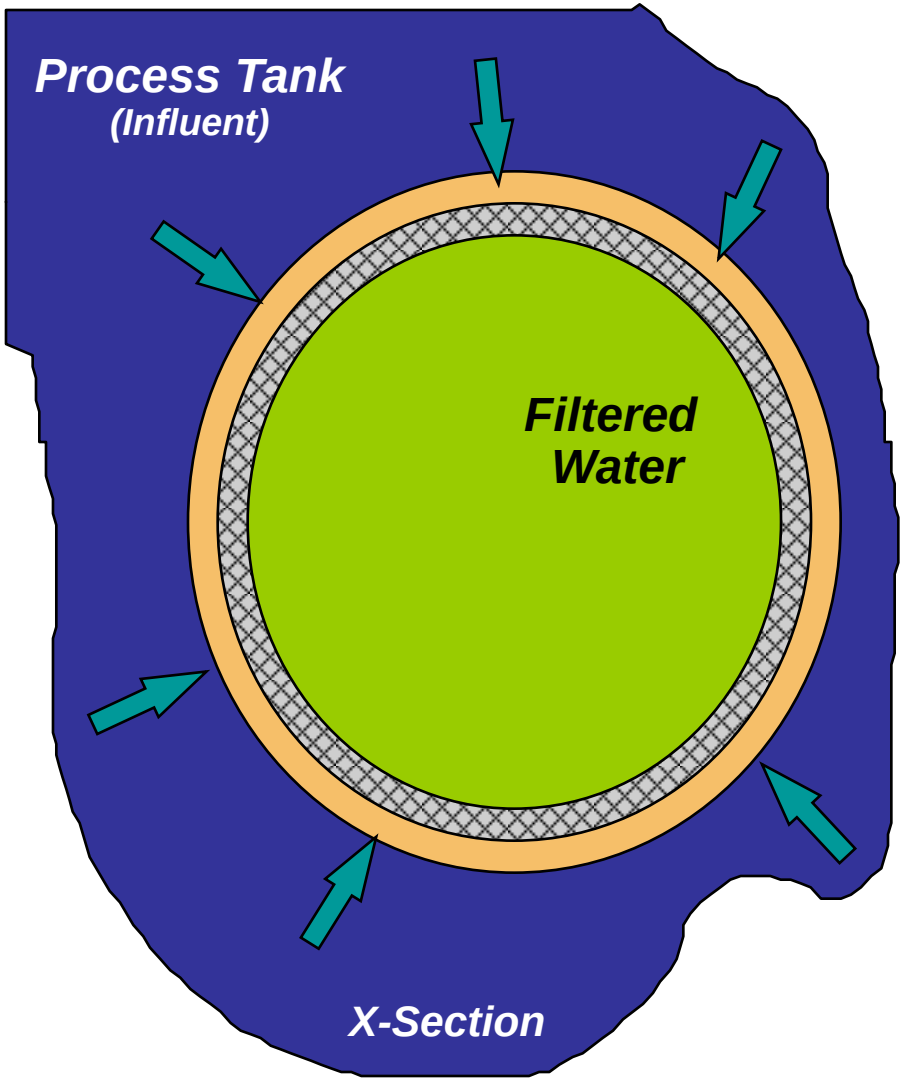
ZeeWeed® Membrane

Immersible, Ultra Low Pressure, Oxidant Resistant, High Strength

Inner reinforcing structure covered with a composite polymer outer layer

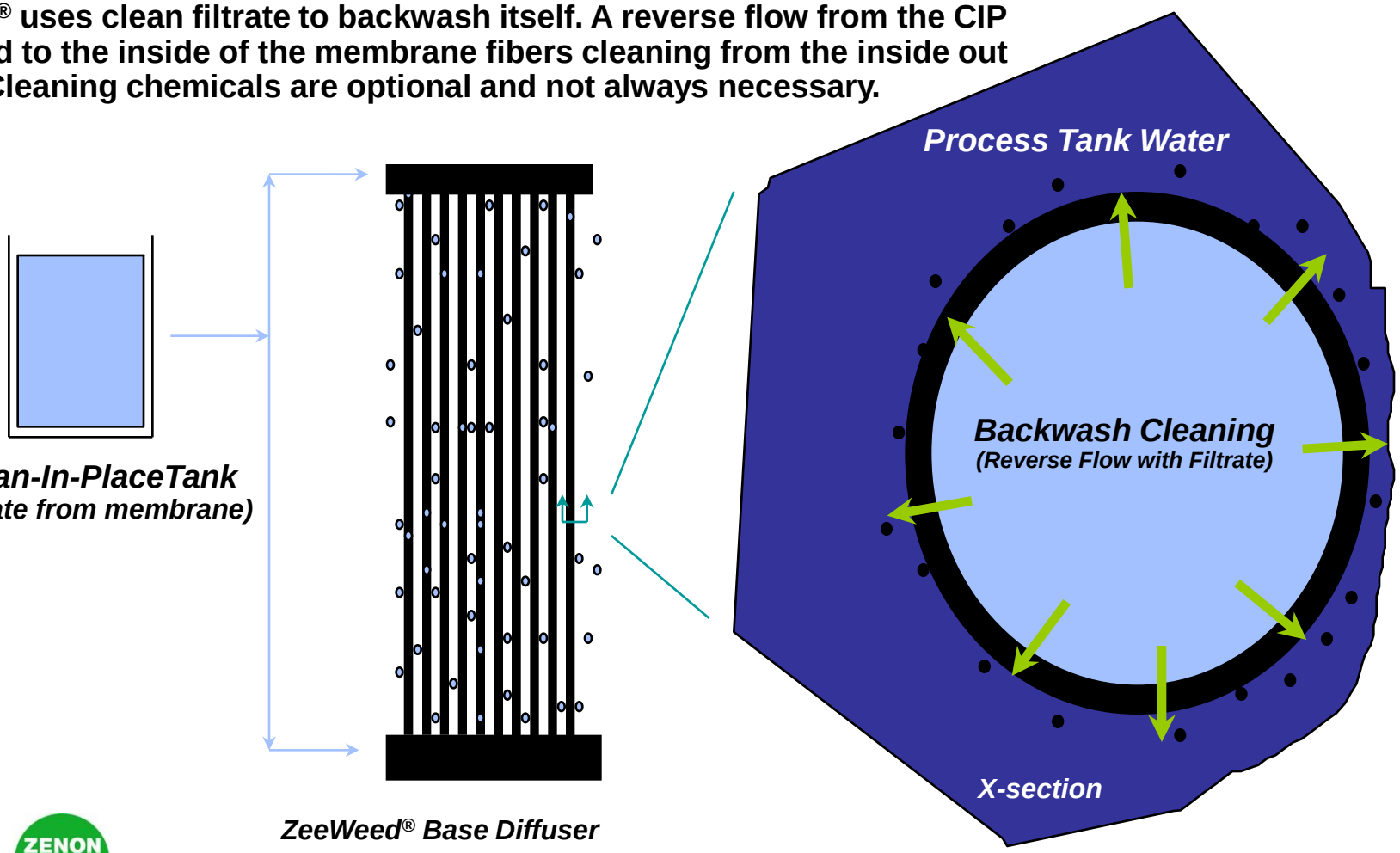
Diameter **Outer = 1.9 mm**
Inner = 0.9 mm

Operates at -2 psi to -5 psi when filtering and 3 psi on backwash



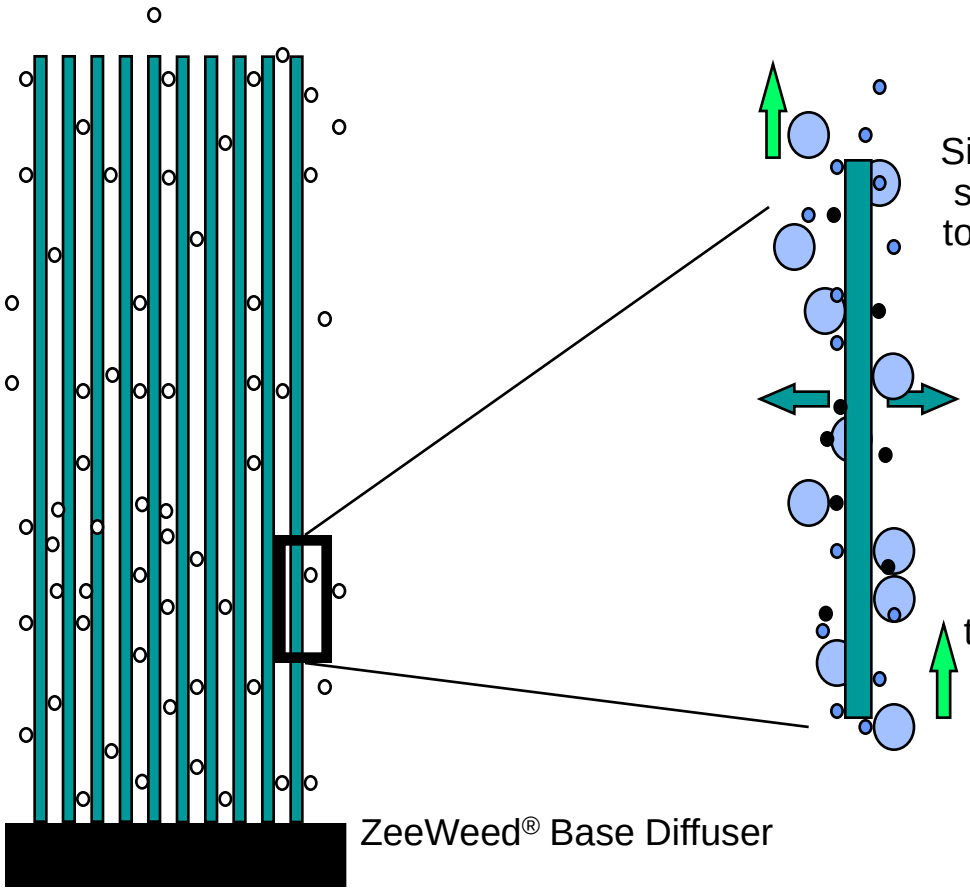
ZeeWeed® Backwash

ZeeWeed® uses clean filtrate to backwash itself. A reverse flow from the CIP tank is fed to the inside of the membrane fibers cleaning from the inside out
Cleaning chemicals are optional and not always necessary.

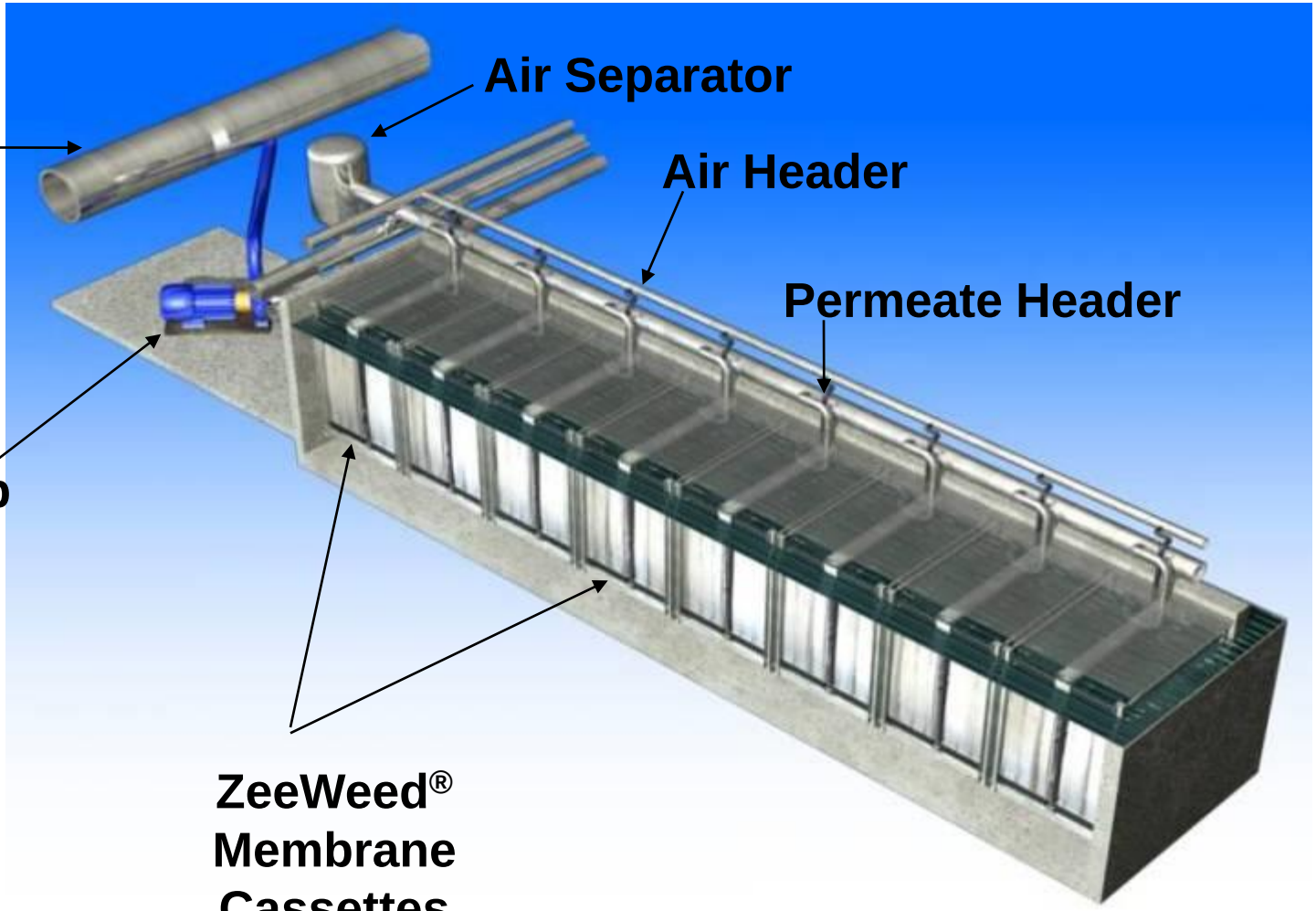


ZeeWeed® Cleaning Shear

Outside Face of ZeeWeed is kept free of solids build-up by the action of a rising solids/air/liquid stream around the face of the membrane fibers. This rising stream produces a Cleaning Shear at the face of the membrane due to Membrane Oscillation and airlift effect of the rising stream.



ZeeWeed® 500 – the System



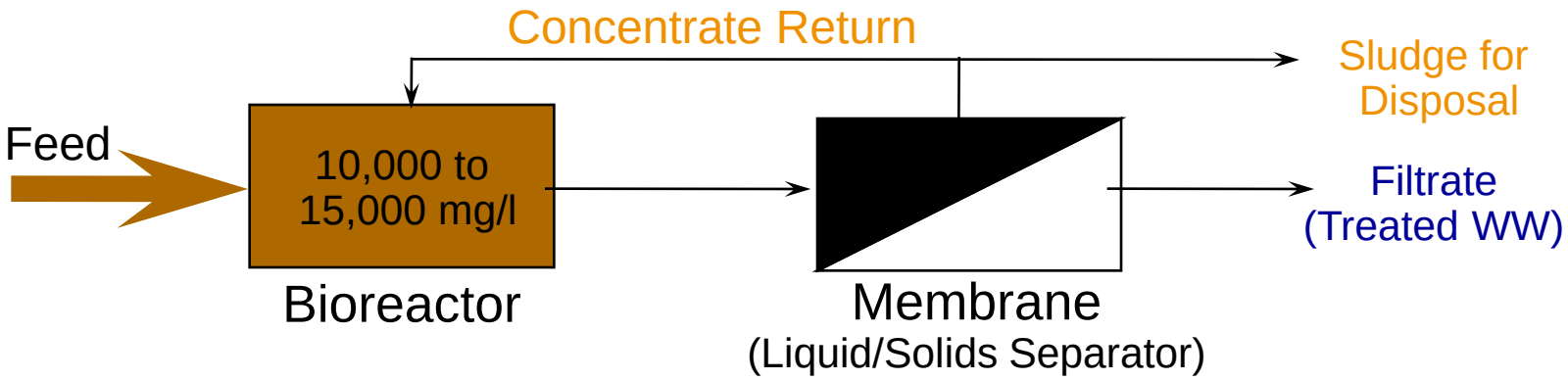
Benefits of Immersed ZeeWeed® Technology

- “Outside-in” permeation means that fibres don’t get plugged
- Low energy requirements (80% less than Tubular)
- Suitable/cost effective for high flow rates
- Membrane can be immersed directly in tank (minimizes footprint requirement, making it easy to retrofit)
- High packing density design
- Very strong fibre design (no worries of breakage)
- Membrane can be cleaned “in-situ”

ZENON Packaged Wastewater Plants

Temporary Treatment

ZENON
Membrane Bioreactor (MBR)



Hi-Rate Bioreactor

- large capacity throughput
- compact footprint
- advanced treatment
- simpler more reliable process (de-emphasizes biological component)

Absolute/Positive Filter

- high degree of organisms/solids control
- consistent effluent quality
- lower operator attention - less components

Mixed Liquor vs. ZeeWeed® Permeate

Key Applications/Strike Zone - WW

- Food and Beverage
- Pharmaceutical
- Petrochemical
- Chemical
- Automotive
- Oil and Gas

ZENON Positioning

- Plant retrofits/upgrades lend themselves well to MBR
  - Easy to do
- Extensive widespread Industrial experience by ZENON
  - Lots of quality sites to visit
- < 2 year payback on Capital Investment
  - It is important for the customer to fully understand how much they are spending for their current method of disposal
- Minimal operator attention required
  - Most Industrial facilities don't have dedicated wastewater operators, so MBR plants run unmanned most of the time

How We Win

- Low price or Life Cycle Cost doesn't always win
  - Clients are willing to pay for value added while minimizing fear, uncertainty and doubt about future sewer use requirements and by-laws
- Consulting Engineers are less involved in the process
  - Industry gurus are key and direct selling is preferred
- Successful pilot testing increases the probability of winning the job significantly
  - We win 90+% of the jobs that we pilot
- Clients that are truly interested in our technology don't mind paying for pilots
  - We very seldom give them away for free. Payment for pilot testing is a very good project qualifier

How We Win

- Clients typically want one-stop-shopping and single point liability
  - ZENON typically provides all of the MBR equipment package (Equalization, Aeration Tanks, Membranes, Controls, MCC etc.) and takes full process responsibility
- Most Industrial projects are Design/Build or Turnkey, but can also do Supply Only and DBOOM
- Most of our clients have done business with us several times
  - Industrial customers are very loyal and thus we use a repeat business model (if something isn't broken then they don't want to fix it)



Design/Build Experience

- Canadian Natural Resources Ltd. (Alberta)
- Basic American Foods (Oregon)
- Southern Company Plant McIntosh (Alabama)
- Southern Company Plant Harris (Alabama)
- ATCO Battle River Generating Station (Alberta)
- TransAlta Wabamum Generating Station (Alberta)
- Field (British Columbia) Sewage Treatment
- Unifine Richardson (Ontario)
- Brescia WWTP (Italy)
- General Motors (Ontario)
- Ford Motor Company (Mexico)
- Violet Reinforcements (Mexico)
- Zobelsreuth Drinking Water Plant (Germany)

Competitive Landscape

Membranes vs. Conventional Technology

Conventional Treatment

- Mature19th century technology
- Large land requirement
- Coarse filtration, no physical barrier
- Need multiple steps for coarse filtration
- Labor and chemical intensive
- Dependent on chlorine for disinfection

Membrane Treatment

- Modern, continuously improving technology
- Compact footprint; Allows for expansion
- Physical barrier means reliable filtration
- Single step provides superior filtration
- Fully automated with minimal chemicals
- Disinfects by physical removal of micro-organisms

Conventional Technologies

Wastewater

- Trickling Filters
- Oxidation Ditch eg. Eimco Carrousel
- Rotating Batch Contactors (RBC)
- Sequencing Batch Reactors (SBRs)
- Anaerobic Treatment
- Fixed Film Technologies
- Biologically Aerated Filter (BAF)

RBC

Oxidation Ditch

Where do membranes fit?

- **High quality permeate required (regulation, or reuse etc.)**
- **Small plant footprint - no room for expansion**

MBR Membrane Competition

Hollow Fiber

USFilter Memjet

Mitsubishi

Asahi

Koch / Puron

Flat Plate

Kubota

Tubular

Koch

Dynatec / NORIT

How to Beat Kubota

- Flat plate chlorinated PE MF (0.4 µm)

How to beat Kubota

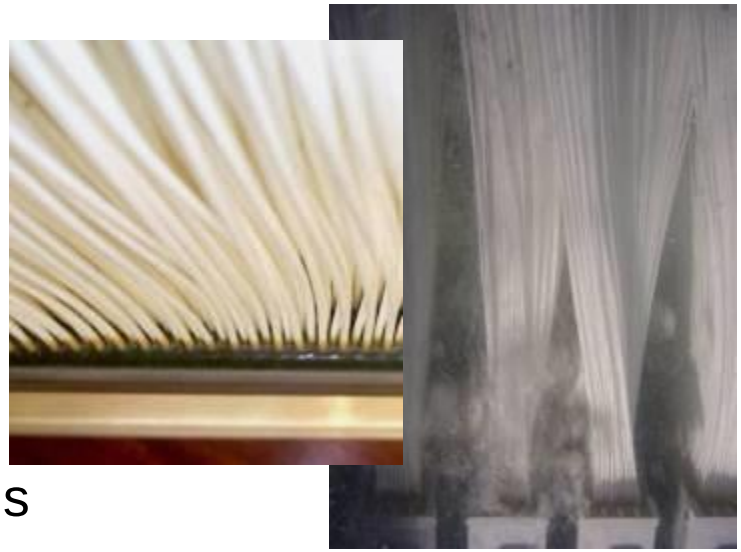
- ZENON has a much better product
  - No biolayer required to operate
  - Easier to clean
  - Lower O&M
  - Smaller footprint
- ZENON has unparalleled MBR experience
  - largest operating industrial MBRs
  - Significant experience with difficult-to-treat wastewaters
  - Most experienced support for industrial WW projects

USFilter Memjet

- O/I HF UF PVDF (0.05µm)

How to Beat USFilter Memjet

- Reinforced vs. unsupported fiber
- Defined spatial distribution vs. randomly potted fibers
- Aggressive, high energy jet aeration leads to fiber breakage, added complexity
- Experience:
  - Limited to no industrial WW experience
  - Earliest plant ~ 2002 vs. 1993 for ZENON
  - High fiber breakage in pilot studies & full-scale municipal installations



MRC Sterapore

- O/I horizontal hollow fiber, PE chemistry
- MF (0.4µm pores) vs. ZENON UF (0.035µm)

How to Beat Sterapore

- Reinforced vs. unsupported fiber
- Stretched MF pores vs. rounded UF pores (deep pore fouling, long-term pore integrity?)
- Experience:
  - Limited industrial US WW experience
  - Earliest US plant ~ 2000 vs. 1993 for ZENON
  - Most plants performing poorly

Tertiary Membrane Competition

NORIT

Pall Microza

USFilter CMF

USFilter CMF-S

Hydranautics
HydraCAP

Koch

Case Studies

- MBR
- Tertiary Treatment
- Re-use

Basic American Foods, Blackfoot, Idaho

- Key Project Design Issues:
  - Design Flow Rate -1.5 MGD
  - Treating wastewater from potato processing
  - Nitrification/Denitrification for direct discharge
  - Complete Design/Build project
  - Commissioned in March 2003

Basic American Foods, Blackfoot, ID
Erection of Bioreactor Tank

Basic American Foods, Blackfoot, ID
Installation of ZeeWeed® Tank

Richardson Foods, St. Mary's, Ontario

- Turn-key project by ZENON
- 40,000 USgpd
- Highly variable waste depending on what products they are running
- Includes DAF pretreatment to remove oils and greases and reduce the load to the bioreactor (COD about 10,000 mg/l after DAF!)
- Completely containerized at ZENON thereby minimizing site costs
- Consistently produce very high quality effluent

Richardson Foods, St Mary's, Ontario

- Permeate Numbers are as follows:
  - COD < 200 mg/l
  - BOD < 10 mg/l
  - TSS < 3 mg/l
- Since sewer use permit requires 300 mg/l BOD and 350 mg/l TSS, they blend waste sludge with permeate to minimize haulage costs

Syndial Porto Marghera – 12.55 MGD
Petrochemical Refining

Overview
- ZeeWeed® MBR for the treatment of petroleum wastewater
- Commissioned in September 2005
- ZENON's largest industrial MBR
- ZeeWeed® 500 membranes

Key Features
- Two denitrification tanks, two aerobic reactors, and eight ZeeWeed® UF trains
- Wastewater is treated to meet required limits and is discharged directly into the Venice lagoon

Marathon Ashland Petroleum – 50,000 GPD
Petrochemical Refining

Overview
- ZeeWeed® MBR for the treatment of petroleum wastewater
- Commissioned in August 2003
- ZeeWeed® 500 membranes

Key Features
- Single train bioreactor and ZeeWeed® UF membrane tank
- Consistently removes COD, BOD, TSS, “BTEX” compounds, and heavy metals to acceptable levels for discharge

Point Judith Fisherman's Co-op

- MBR system treats waste from squid processing
  - High strength waste:
    - **Flow- 43,000 USgpd**
    - **COD- 8,000 mg/l**
    - **BOD- 5,000 mg/l**
    - **TSS- 300 mg/l**
    - **TKN- 300 mg/l**
    - **P- 80 mg/l**
- Containerized Pre-Engineered/Factory Assembled Design
- Nitrification/Denitrification

Point Judith Fisherman's Co-op

Point Judith Fisherman's Co-op

Bell Carter Olive

- 800,000 USgpd
- Utilizes existing aerated lagoons
- Once fully commissioned, plant ceased discharge to the local POTW and discharged directly to river (saved flow charges, and had received capital refund)
- Containerized, Pre-Engineered, Factory Assembled Design

Bell Carter Olive Co.

Bell Carter Olive Co.

Bell Carter Olive Co.

Bell Carter Olive Co.

Tertiary/Reuse References

Yanshan Petrochemical – 6.9 MGD

Petrochemical Refining

Overview

- ZeeWeed® UF for tertiary treatment and reuse of petroleum wastewater
- Commissioned in July 2004
- ZeeWeed® 500 membranes

Key Features

- Four trains ZeeWeed® UF
- ZeeWeed® permeate feeds RO for demineralized process water
- Permeate TSS ＜1 mg/l
- Permeate Turbidity ＜0.2 NTU
- Permeate SDI ＜3

New England Power Plant

- Tertiary ZeeWeed® system to treat effluent from local POTW for feed to Demin System at Power Plant (supplied by USF!)
- Supplied as temporary system while they were “sorting out issues” with existing disc filter
- Delivers 1000 gpm of feed with SDI < 3
- Has been in operation for over 3 years now (@ $45,000 per month)!

ADM, Decatur Illinois

- 5 MGD tertiary ZeeWeed® System to recycle secondary effluent to cooling towers
- Piloted on site for approximately 6 months on various applications
- Currently being expanded to 6 MGD
- Provided savings in cooling tower chemicals of > $ 1 M per year and in the words of the operator; Brad Crookshank, “The cooling towers have never run better”

ADM, Decatur Illinois

ADM, Decatur Illinois

PEMEX Project, Minatitlan Mexico

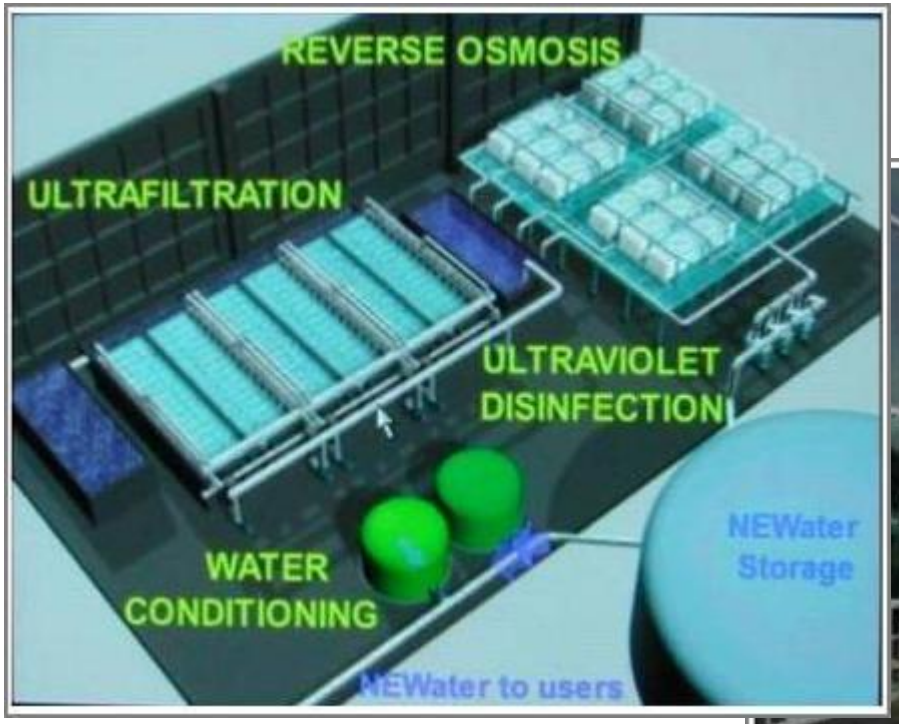
- One of Mexico's largest Refineries (173,200 bpd)
- Wastewater treatment allows for recycle
- Design wastewater flow rate of 300 lps (7 MGD)
- Treatment includes:
  - Dissolved air flotation
  - Conventional Biological Treatment
  - ZeeWeed Tertiary Filtration
  - Reverse Osmosis
- Overall water recycle efficiency is approximately 70% based on RO permeate

PEMEX Refinery Minatitlan Mexico

Membranes Immersed in Process Tank @ 85,000 mg/l FOG After Upset!

Cassette Fully Restored After Recovery Cleaning!

Bedok, Singapore
Driver: Water Re-Use



Bedok, Singapore
Driver: Water Re-Use

- 11.25 MGD (42,700 m^3/d) capacity
- Commissioned November 2002
- Features:
  - Treat secondary effluent from municipal WWTP
  - Pre-treatment to RO for water re-use
  - Supply high quality product water to wafer-fab industry
  - 5 ZeeWeed® trains
- Design performance:
  - Turbidity < 0.2 NTU
  - SDI < 3
  - 90% Recovery
- Plant now open for tours

Regional Qualification of Leads