Use of Tertiary UF for Water Reuse Reduces Costs and Provides a Reliable Source for Industry

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Water and Wastewater Applications

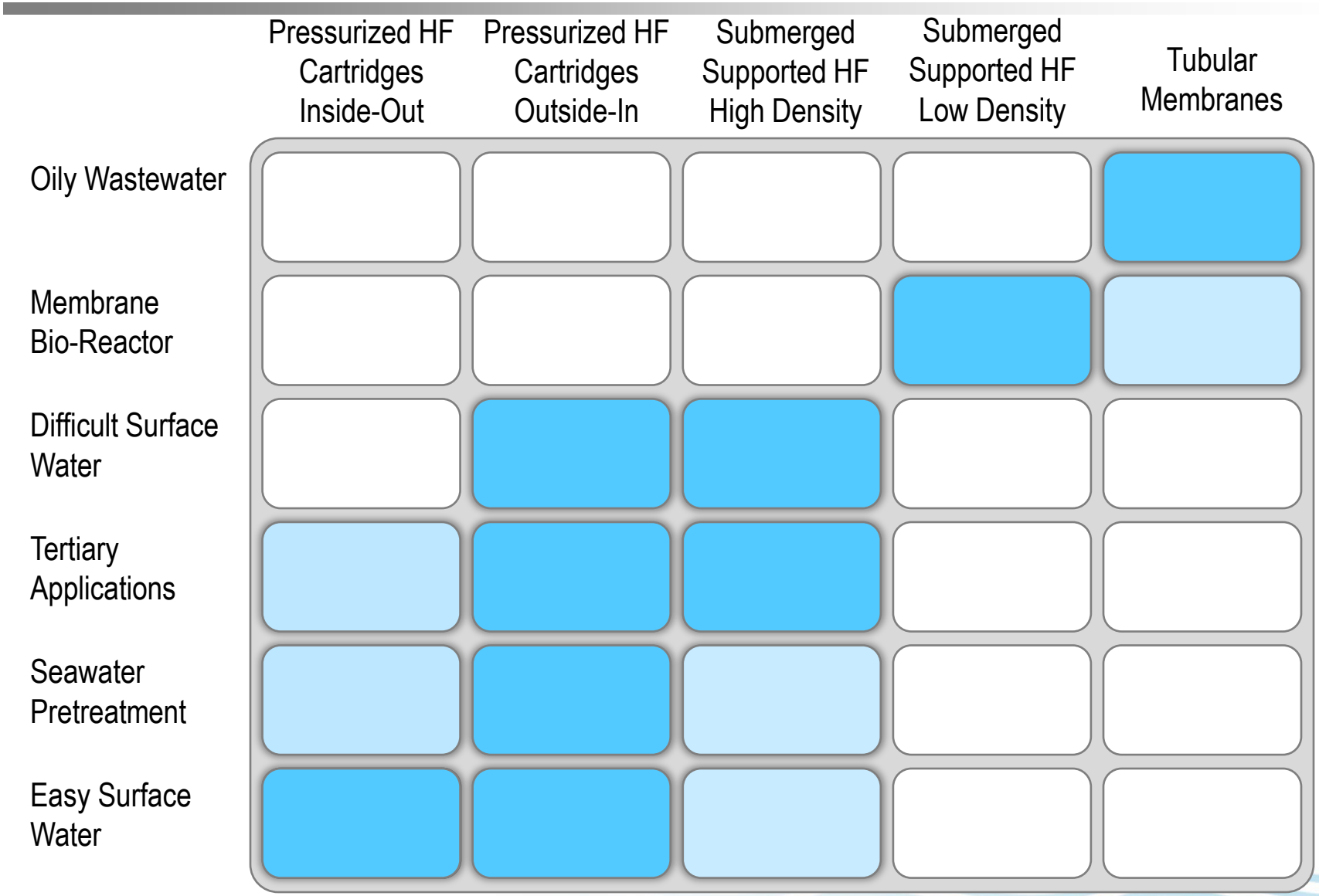
Municipal Water and Wastewater

- **Drinking Water**
  - Seawater Desalination
  - Surface Water
  - Ground Water
  - Brackish Water
- **Wastewater Treatment**
  - Secondary / Tertiary Treatment
- **Water Reuse**

Industrial Water and Wastewater

- **Process Water**
- **Wastewater**
- **Reuse**
- **Cooling Tower Blowdown**
- **Boiler Feedwater**
- **Produced Water**
- **High-Purity Water**
- **Desalination**

Typical Membrane Configurations for Water Treatment



Pretreatment Guidelines

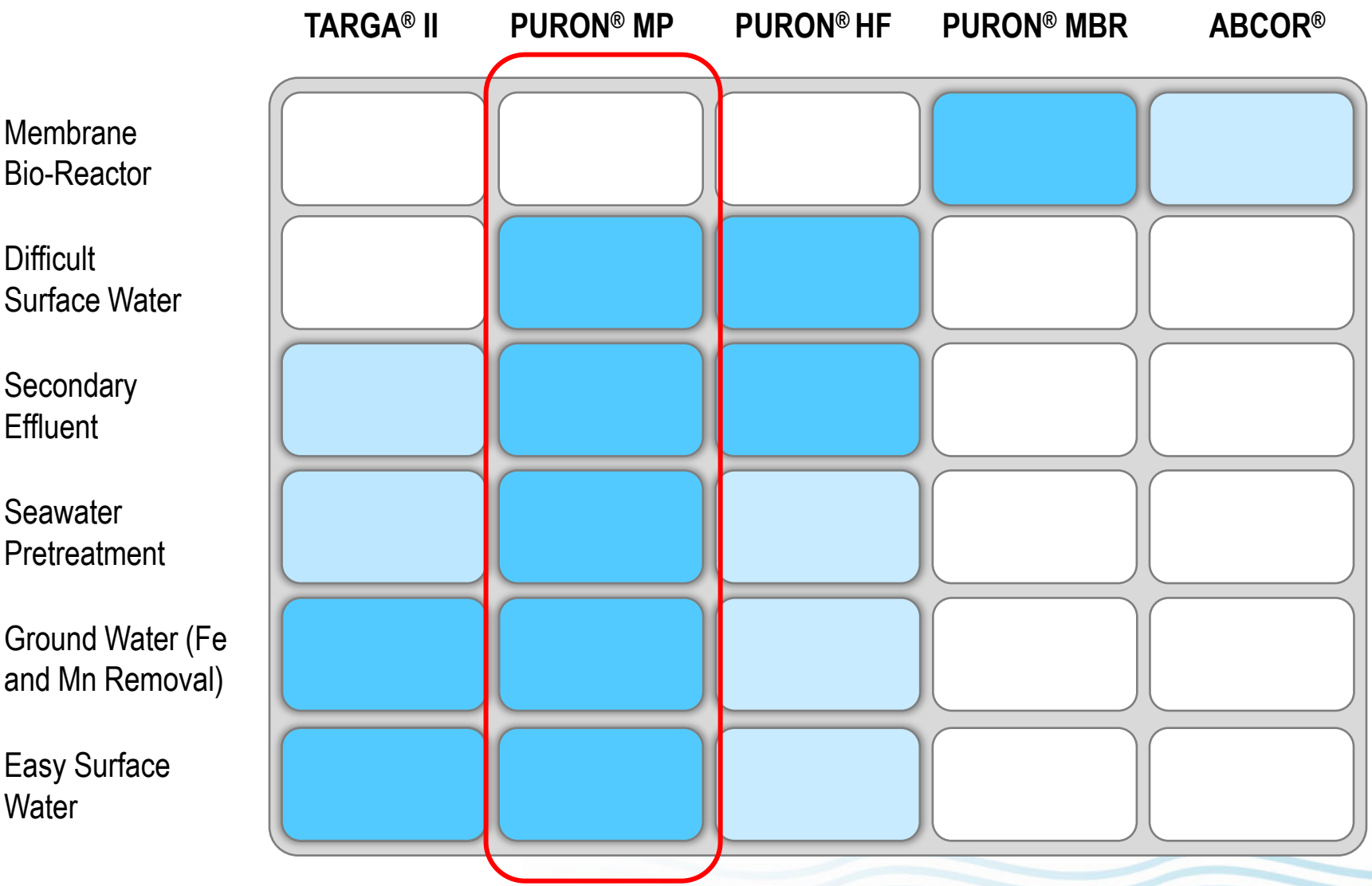
Clarification / Sedimentation

- Most filtration systems require coagulation and clarification prior to filtration.
- Coagulation chemicals are a large operational cost.
- Clarification systems require constant monitoring by operations to maintain good quality.
- Clarification systems do not handle rapid changes in feed water well and are prone to carryover during such events, leading to problems in downstream filtration equipment.
- Many facilities would see a great monetary benefit from being able to bypass clarification if the downstream equipment could be relied upon to still produce the required quality.

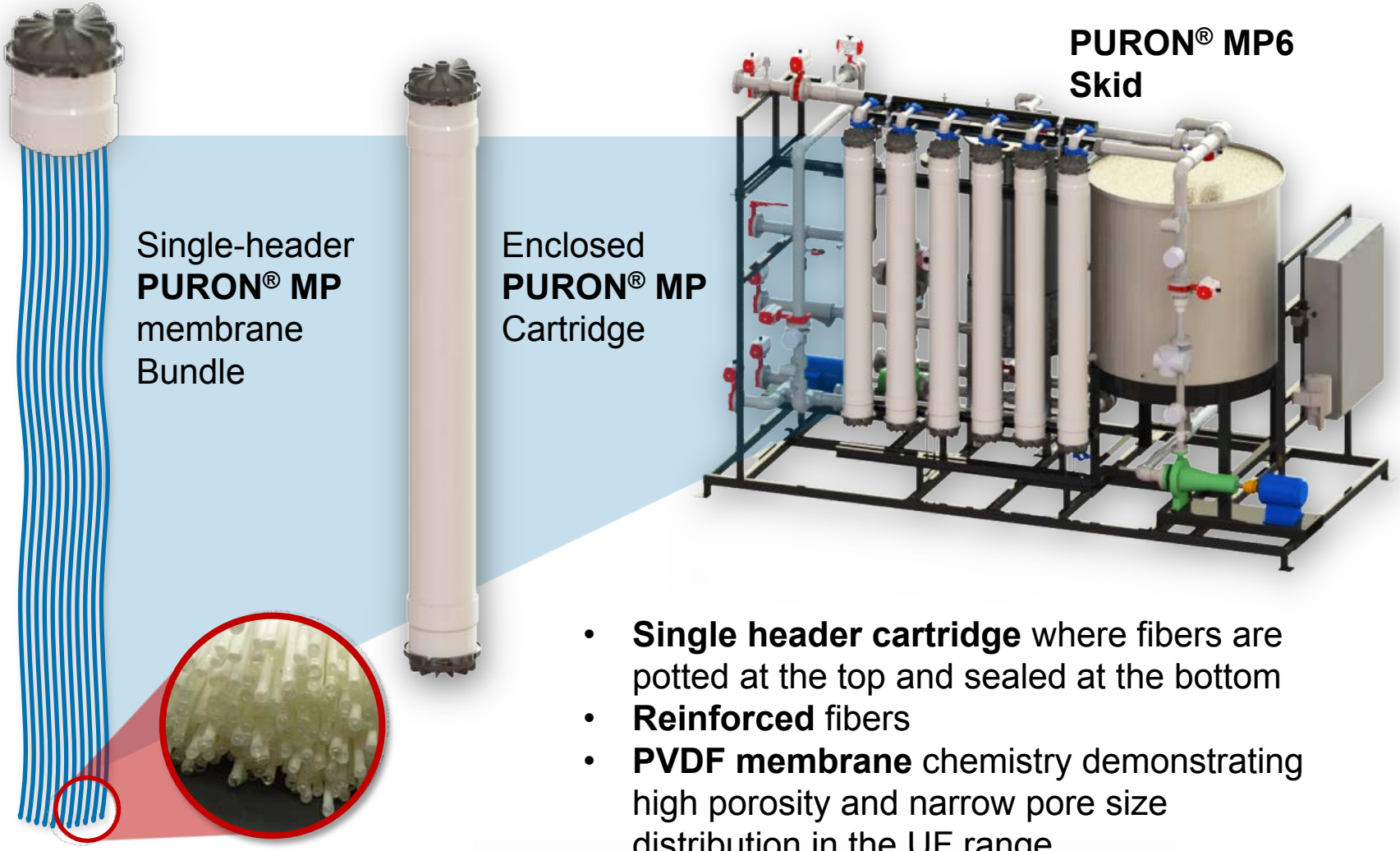
PURON® MP

What is it?

PURON® MP
Where is it used? Target Applications?



PURON® MP - What is it?



- **Single header cartridge** where fibers are potted at the top and sealed at the bottom
- **Reinforced** fibers
- **PVDF membrane** chemistry demonstrating high porosity and narrow pore size distribution in the UF range

PURON® MP – Product Strengths Excellent Chemistry and Morphology

- PVDF chemistry
- 0.03 micron pore size
- Not all PVDF membranes are the same. Fiber pore size and pore size distribution were optimized leading to morphology that demonstrates low fouling tendency and excellent cleanability

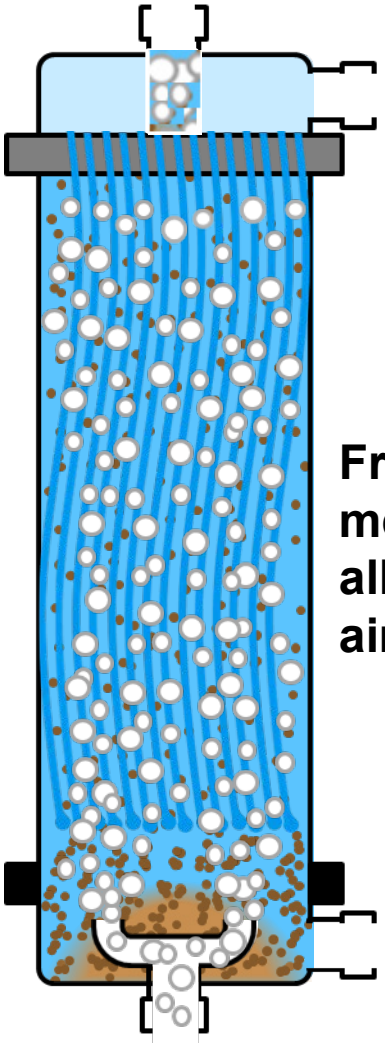
PURON® MP
No Bottom Potting

- Air scour is effectively distributed around each fiber
- Solids are easily drained away after air scour in absence of a bottom potting

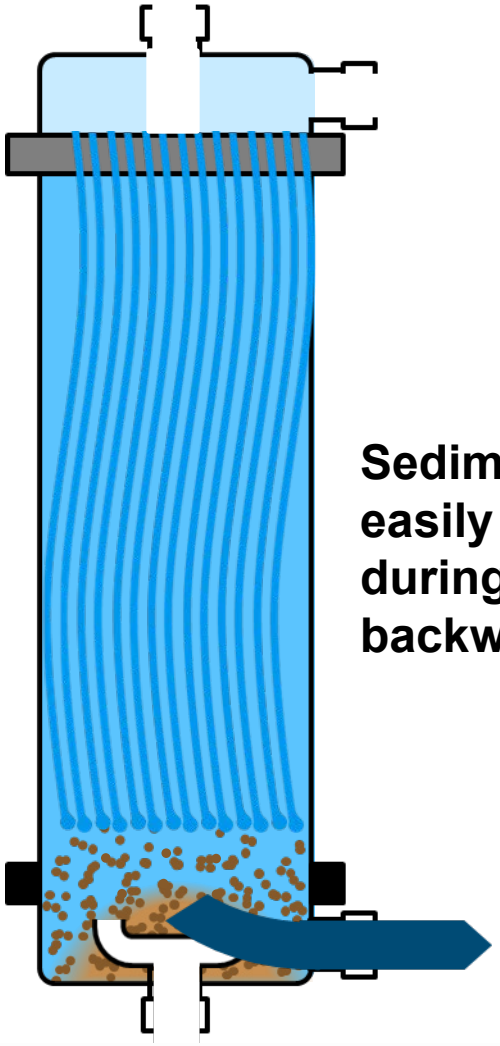
PURON® MP – Product Strengths Supported Fiber

- The only pressurized cartridge product in the market that uses supported fiber
- Eliminates downtime for fiber repair
- Virtually indestructible fiber
- One of the largest fiber diameters used in a cartridge configuration, yet provides large membrane area and high membrane packing density

PURON® MP
Cartridge Features



Free floating membrane fibers allow more complete air scouring



Sediment is easily removed during backwash

Operational Advantages of the PURON® MP Configuration

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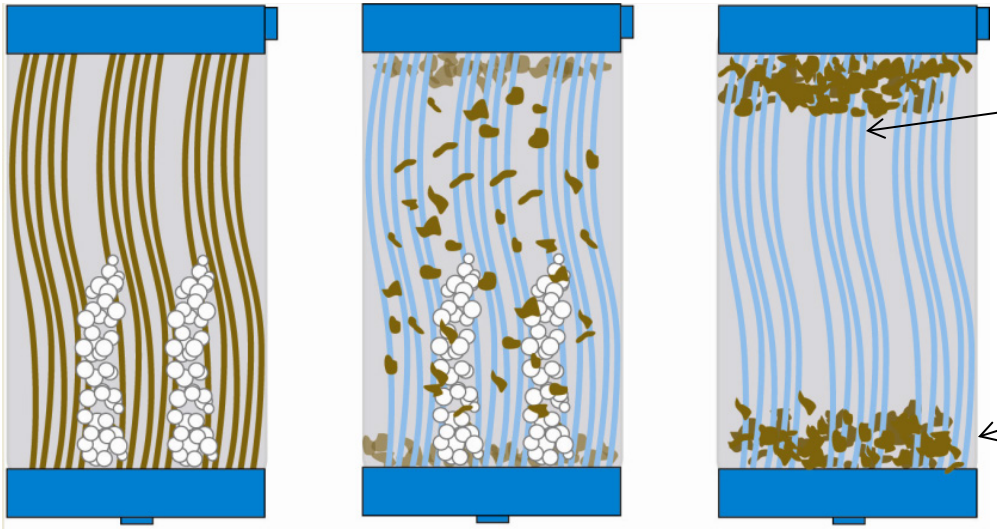
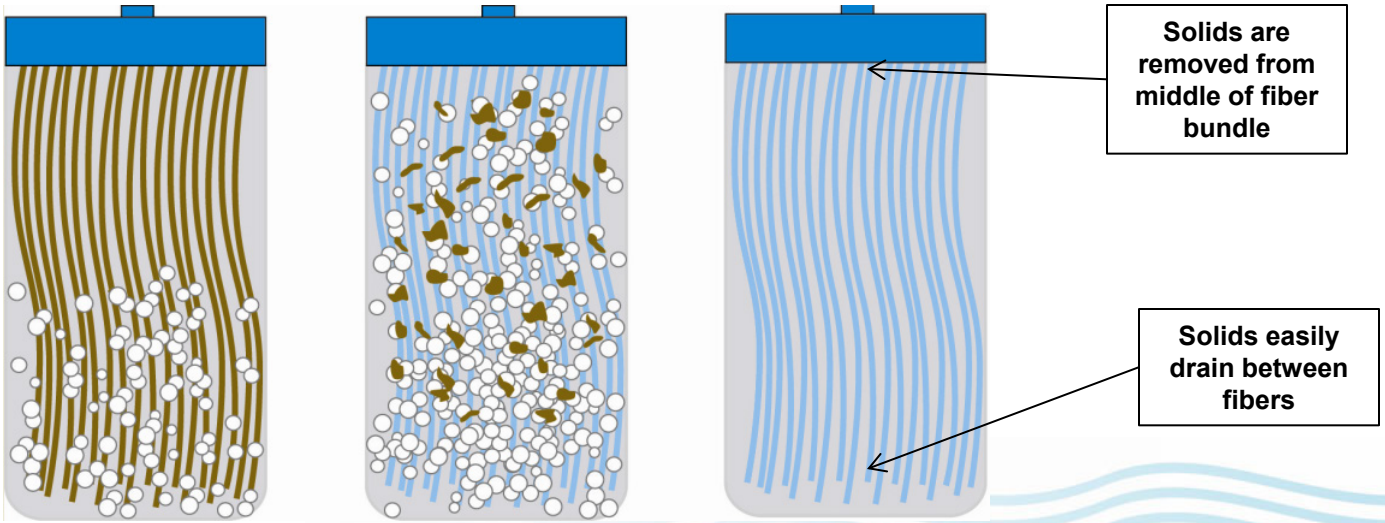
Top and Bottom potting



Top potting only



PURON® MP – Product Strengths
Superior Cartridge Design

- Single header design with open bottom allows efficient solid removal during cartridge drain cycle
- Efficient aeration and excellent air scouring distribution
- High packing density
- Top, central vent port eliminates interior fiber bundle sludging
- Operation in dead end mode allows simple cartridge design and compact rack design

PURON® MP
Product Differentiators

KOCH MEMBRANE SYSTEMS

Supported Fiber

- The only pressurized supported fiber cartridge in the market
- Eliminates fiber breaks

Superior Cartridge Design

- Removal of bottom potting allows for improved aeration and solids draining
- Top, central vent port eliminates interior fiber bundle sludging
- Allows for simple system design only using “dead-end” flow configuration

High Flux and Solids Tolerance

- Sustainable flux rates up to 60 gfd (100 lmh)
- Solids loading up to 100 mg/L and frequent spikes of 250 mg/L TSS. Can tolerate excursions up to 8000 NTU*
- Ability to operate at high recovery and handle clarifier upsets

Excellent Membrane Chemistry

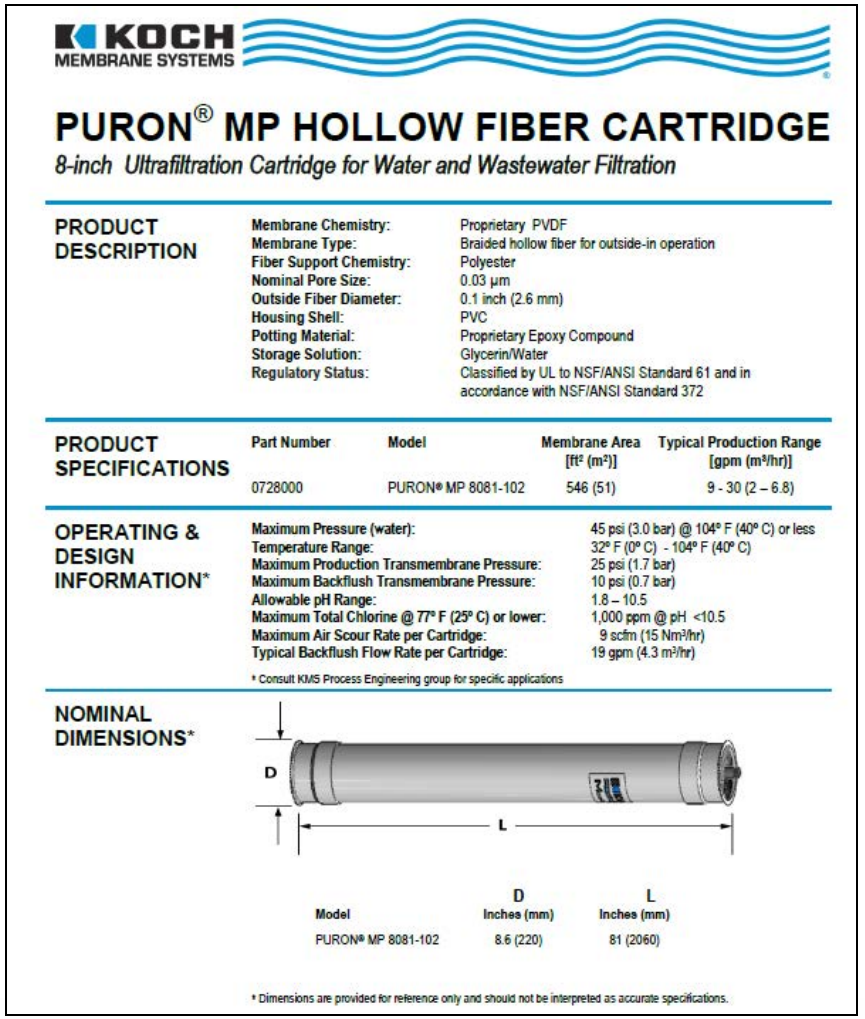
- Low fouling PVDF Chemistry
- 0.03 µm pore size
- Higher flux as a result of reduced fouling

* Some adjustments to operating parameters may be necessary

PURON® MP
8” Diameter Cartridge Main Properties

Product Overview

- **Membrane Area:** 546 ft^2 (51 m^2)
- **Pore Size:** 0.03 µm
- **Membrane Chemistry:** PVDF
- **Filtration Class:** Hollow Fiber UF
- **Feed Flow Path:** Outside-In
- **Wet New Cartridge Weight:** 105 lbs (48 Kg)
- **Height:** 81 inch (2 m)
- **Max Chlorine Cleaning Conc.:** 1000 ppm Free Cl



KOCH MEMBRANE SYSTEMS

PURON® MP HOLLOW FIBER CARTRIDGE

8-inch Ultrafiltration Cartridge for Water and Wastewater Filtration

PRODUCT DESCRIPTION

Membrane Chemistry:	Proprietary PVDF
Membrane Type:	Braided hollow fiber for outside-in operation
Fiber Support Chemistry:	Polyester
Nominal Pore Size:	0.03 µm
Outside Fiber Diameter:	0.1 inch (2.6 mm)
Housing Shell:	PVC
Potting Material:	Proprietary Epoxy Compound
Storage Solution:	Glycerin/Water
Regulatory Status:	Classified by UL to NSF/ANSI Standard 61 and in accordance with NSF/ANSI Standard 372

PRODUCT SPECIFICATIONS

Part Number	Model	Membrane Area [ft² (m²)]	Typical Production Range [gpm (m³/hr)]
0728000	PURON® MP 8081-102	546 (51)	9 - 30 (2 – 6.8)

OPERATING & DESIGN INFORMATION*

Maximum Pressure (water):	45 psi (3.0 bar) @ 104° F (40° C) or less
Temperature Range:	32° F (0° C) - 104° F (40° C)
Maximum Production Transmembrane Pressure:	25 psi (1.7 bar)
Maximum Backflush Transmembrane Pressure:	10 psi (0.7 bar)
Allowable pH Range:	1.8 – 10.5
Maximum Total Chlorine @ 77° F (25° C) or lower:	1,000 ppm @ pH <10.5
Maximum Air Scour Rate per Cartridge:	9 scfm (15 Nm³/hr)
Typical Backflush Flow Rate per Cartridge:	19 gpm (4.3 m³/hr)

* Consult KMS Process Engineering group for specific applications

NOMINAL DIMENSIONS*

Model	D Inches (mm)	L Inches (mm)
PURON® MP 8081-102	8.6 (220)	81 (2060)

* Dimensions are provided for reference only and should not be interpreted as accurate specifications.

PURON® MP

Where is it used?
Target Applications?

Common Applications for Water Filtration

- Wastewater
  - Secondary treated water
  - Tertiary treated water
  - Industrial wastewater
- Surface Water
  - Removal of solids, turbidity, organics, bacteria and color (coagulation may be required for high removal rates)
- Ground Water
  - Iron and Manganese Removal to less than 0.05 mg/L (after oxidation)
  - Ground water under the influence, filtration for virus and bacteria removal
- Seawater (pretreatment to RO)
  - Removal of solids and turbidity
  - Produce low SDI water
- Pretreatment to RO

PURON® MP
Drinking Water Treatment Standards

- Drinking Water Standards and regulations vary in different regions
- Water turbidity is often used as a measure of water quality. Maximum turbidity may range between 0.2 and 0.5 NTU
- Water color is often used as a secondary requirement. Typical maximum color for drinking water is 15 CU
- Effluent quality of conventional technologies (multimedia filtration, clarifiers, DAF) is highly dependent on the feed quality, resulting in high effluent turbidity when feed turbidity is high
- The PURON® MP Ultrafiltration technology provides a physical barrier with narrow distribution of pore size, resulting in consistent low effluent turbidity independent of feed quality

PURON® MP
Drinking Water Applications

- Product is NSF61 listed confirming construction materials and manufacturing practices are compliant with drinking water requirements
- Pilot tests demonstrated that the product can meet most drinking water criteria
- Pilot data shows 4-6 log removal of 3-micron particles in all applications
- CDPH Approval is pending for drinking water
  - All testing has been successfully completed

PURON® MP

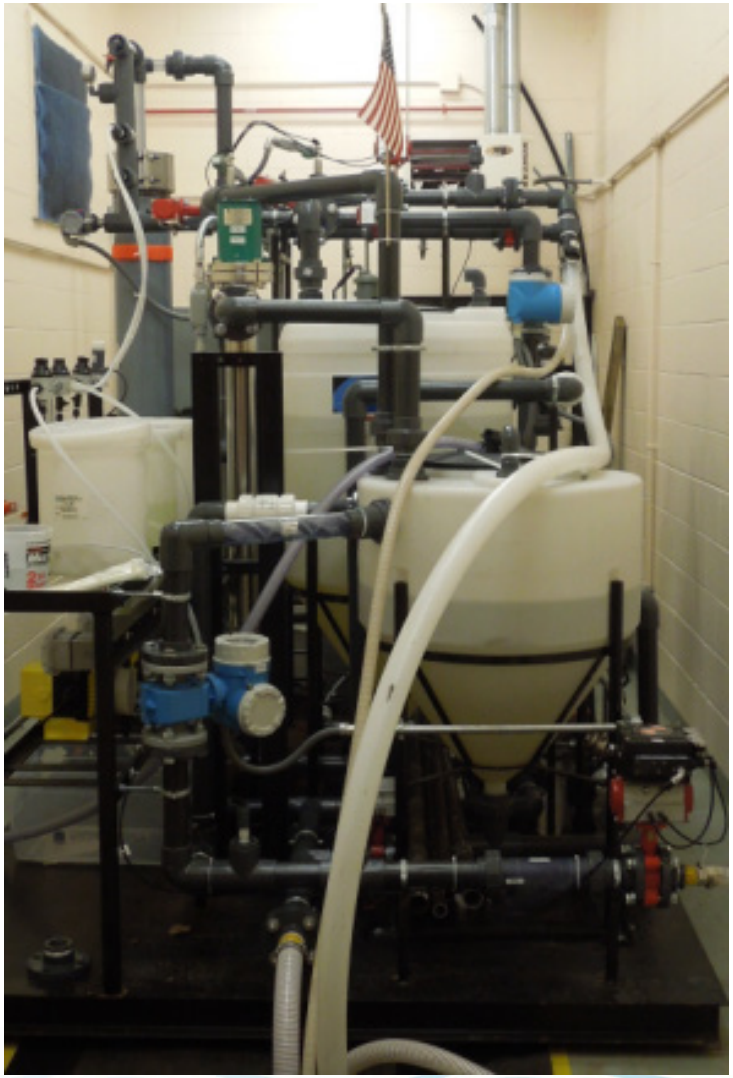
Performance Data

PURON® MP
More than 25 Pilots and Full Scale Installations Worldwide

- Applications:
  - Municipal Wastewater
  - Industrial Wastewater
  - Surface water
  - Cooling Tower Blowdown

PURON® MP 8 inch Ultrafiltration Pilot

- All but one pilot used full scale 8-inch cartridges
- All pilots ran in Dead End mode at a constant flow with automatic controls, backflush and cleaning
- Pilot projects included a variety of applications including:
  - Surface water
  - Municipal secondary and tertiary water treatment
  - Industrial wastewater from pulp and paper, cooling tower blowdown and produced water



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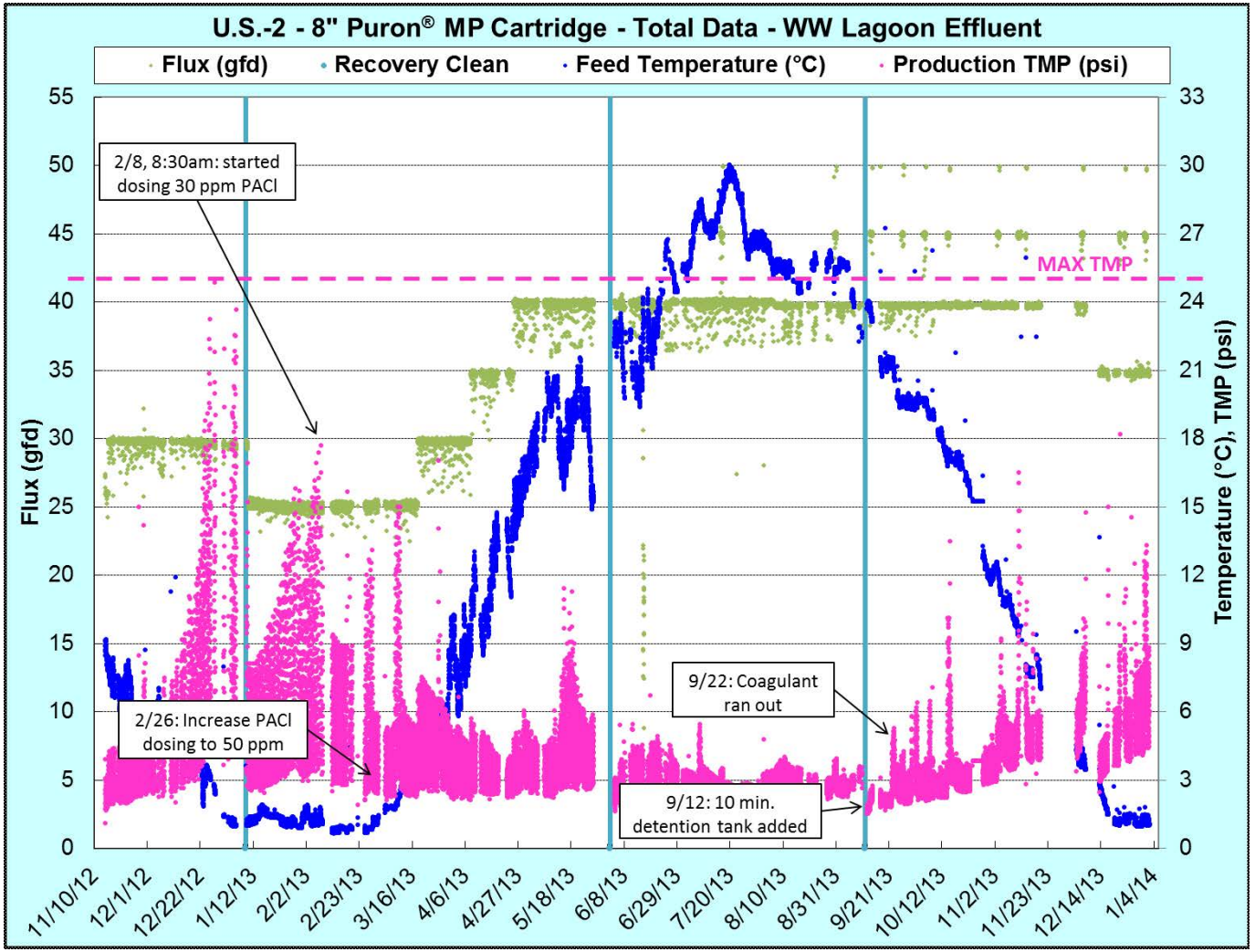
Wastewater Pilot Project Summary

Pilot #	Site Location	Application Type	Flux (normalized to 20°C)	Feed Properties and Other Comments
Pilot 2	USA-2	Secondary Effluent	40 gfd (68 lmh)	Typical feed shows turbidity between 2.5 and 15 NTU with peaks up to 40 NTU, 12-15 mg/L TOC. 50 – 100 ppm PACl (controlling to UV254)
Pilot 5	Australia	Secondary Effluent	40 gfd (68 lmh)	Typical feed shows turbidity between 1 and 15 NTU. Regular high algae >20,000 counts. No coagulation.
Pilot 10	USA-3	Tertiary Effluent	50 gfd (85 lmh)	Feed Turbidity 1-10 NTU peaks up to 50 NTU. $FeCl_3$ coagulation was trialed for phosphate removal. (TARGA® II piloted previously was unsuccessful due to FOG excursions)
Pilot 13	USA-5	Industrial Secondary Effluent	40 gfd (68 lmh)	Feed Turbidity 0.2 – 1 NTU with peaks up to 2 NTU. $FeCl_3$ trialed to coagulate small solids.

PURON® MP Performance – Secondary Effluent
Pilot 2: USA-2 Pilot Test

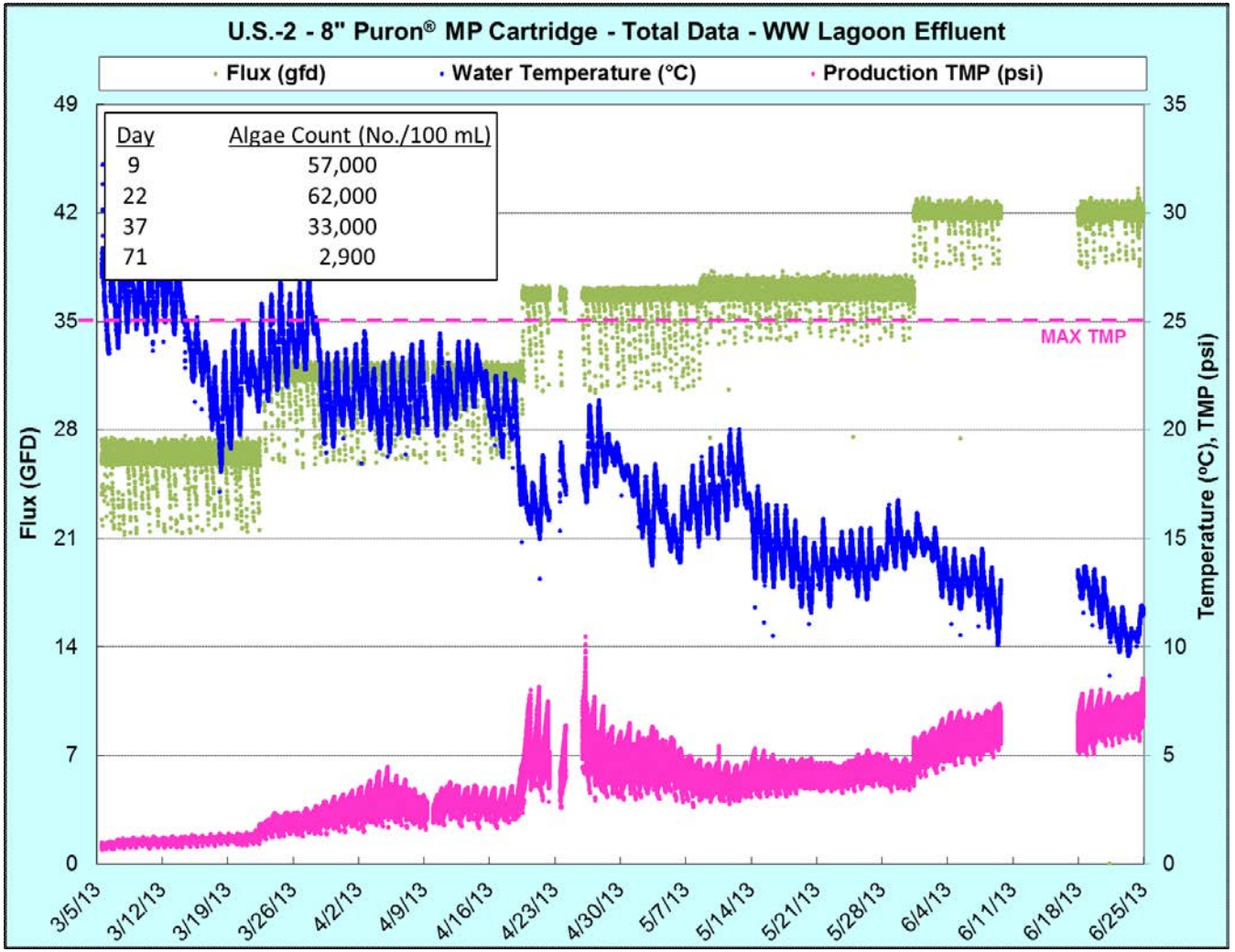
- Stable performance at 40 gfd with 94% Recovery
- Adding coagulant allowed operation at higher fluxes and better organics removal



Feed Data (ppm):	Turbidity: 2.5-30 NTU, 105 NTU peaks	TOC:12-15	Iron: 0.1

PURON® MP Performance – Secondary Effluent
Pilot 5: Australia Pilot Test

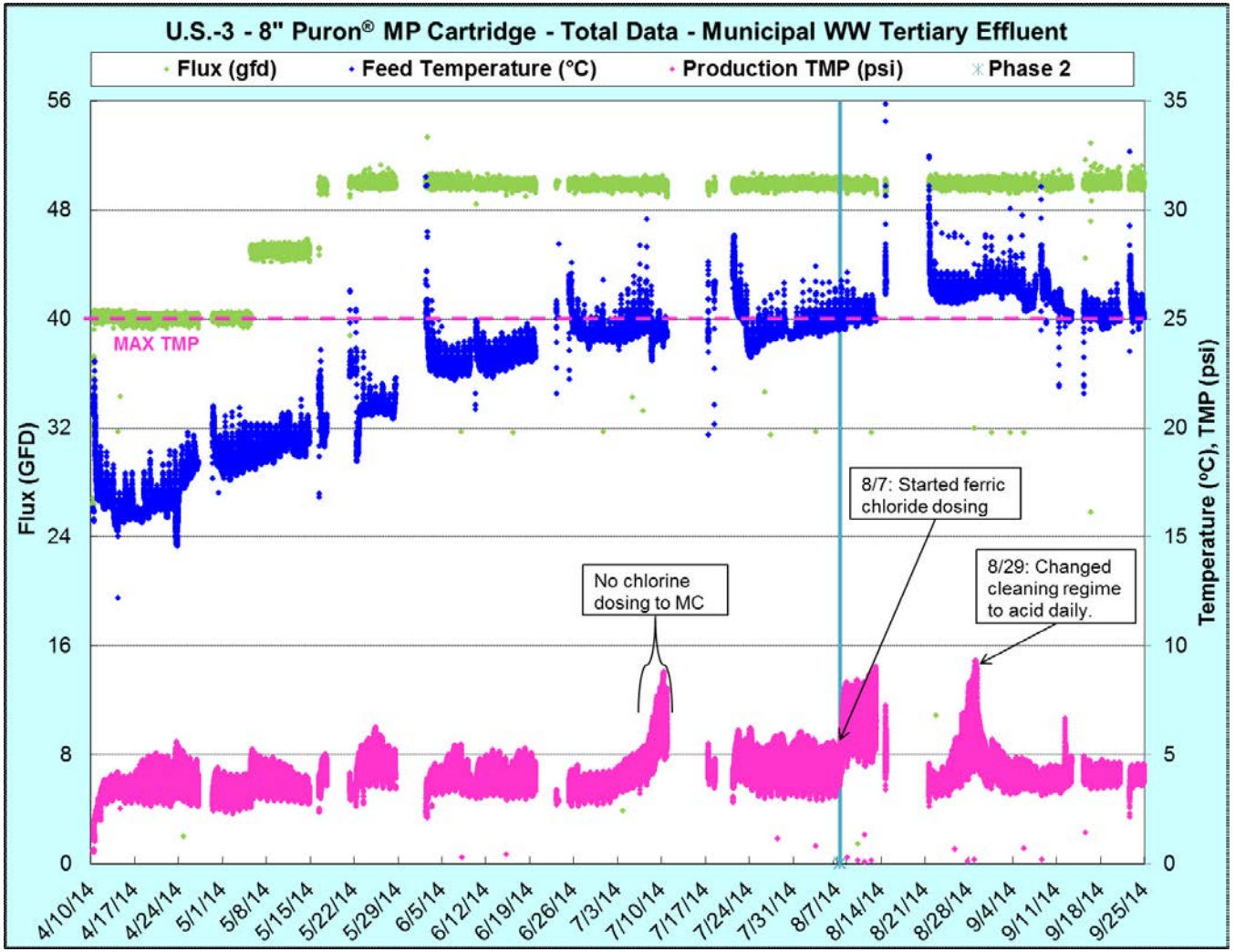
- Stable performance at in the presence of high TOC and algae, up to 60,000 counts per 100 mL



Feed Data: Turbidity: 1-15 NTU, with known algae counts >60,000/100 mL

PURON® MP Performance – Tertiary Effluent
Pilot 10: USA-3 Pilot Test

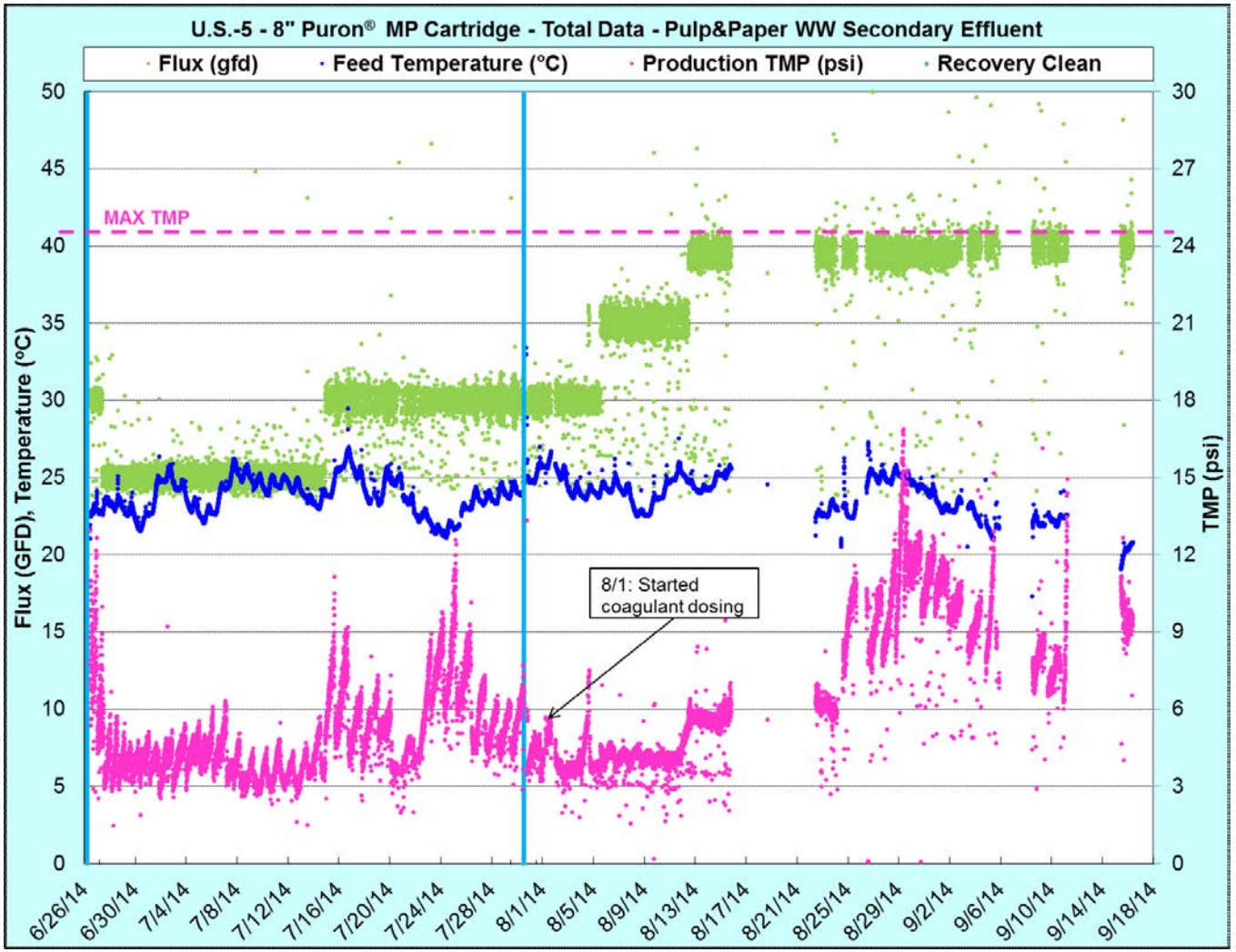
- Stable performance at 50 gfd with 96% Recovery
- $FeCl_3$ dosing trialed for phosphate removal



Municipal tertiary WW, Turbidity 10 NTU average, peaks up to 50 NTU

PURON® MP Performance – Secondary Effluent
Pilot 13: USA-5 Pilot Test (Industrial Wastewater)

- Stable performance at 30 gfd with 92% Recovery
- Higher flux of 35 gfd with $FeCl_3$ dosing



Industrial Secondary Wastewater, Turbidity 0.2 – 2 NTU (small pulp and paper fines)

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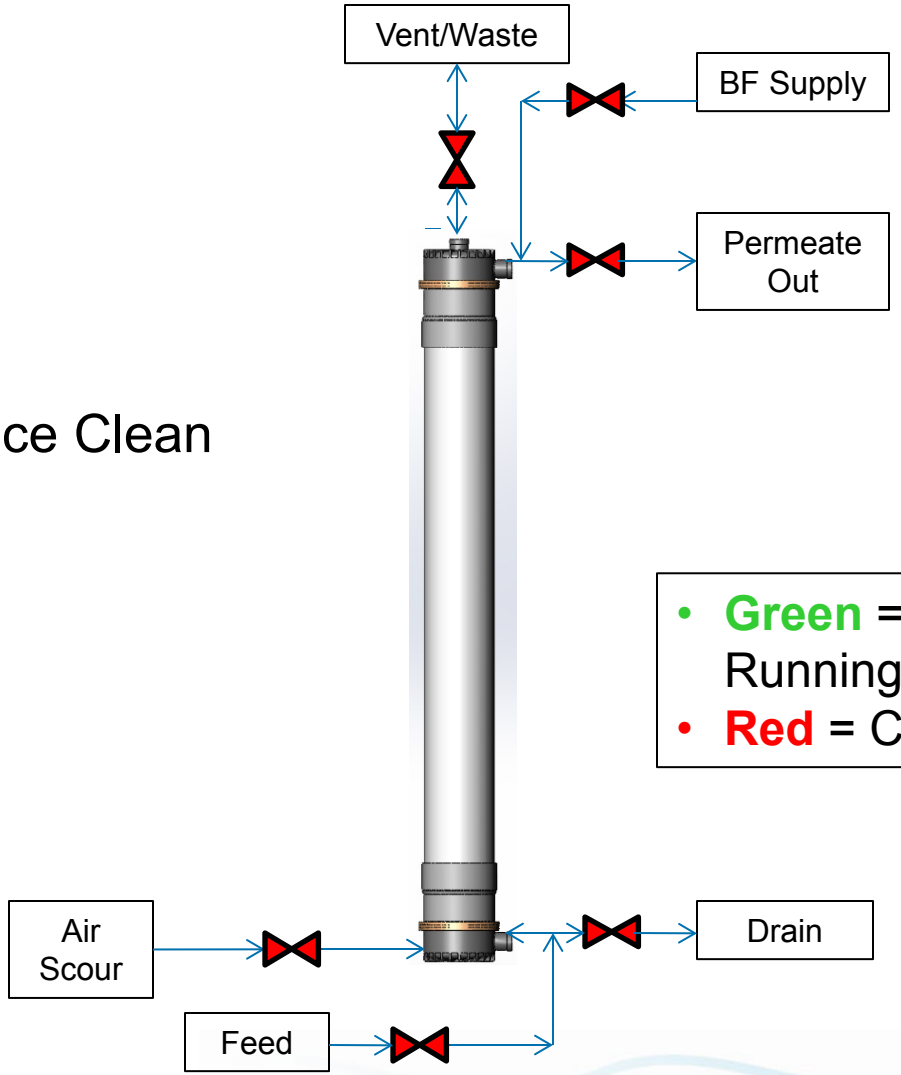
How does it work?

PURON® MP Operating Modes

- Production
- BackFlush
- Clean/Maintenance Clean
- Rinse



- **Green** = Open or Running
- **Red** = Close

* Only major or pertinent valves/pumps are shown

PURON® MP

Competitive Landscape

PURON® MP
Typical Operating Benefits

	PURON® MP	Typical Inside-Out UF Membrane
Power	>20% savings	High solids/difficult applications often require higher TMP operation and recirculation pumps
Cleaning Chemicals	>60% savings	Often needs chemicals in the backwash cycles in addition to regular cleanings
Pretreatment	Usually not required	Clarification/Sedimentation required for many applications

Summary

- The PURON® MP ultrafiltration product simplifies the filtration process by eliminating pretreatment, and does not require the significant civil works that a submerged system would need.
- The piloting work for the PURON® MP cartridge provided the necessary data to prove the high solid tolerance of the product and validate the design fluxes.
- The PURON® MP product is available for small and large scale projects. Supporting documentation and design tools are ready for use for skid sizes ranging from 3,000 ft^2 up to 45,000 ft^2 of membrane area. These skids can be combined into trains to achieve any flow rate.
- The PURON® MP product can significantly reducing plant operating costs and still maintain a consistent and high quality permeate.