



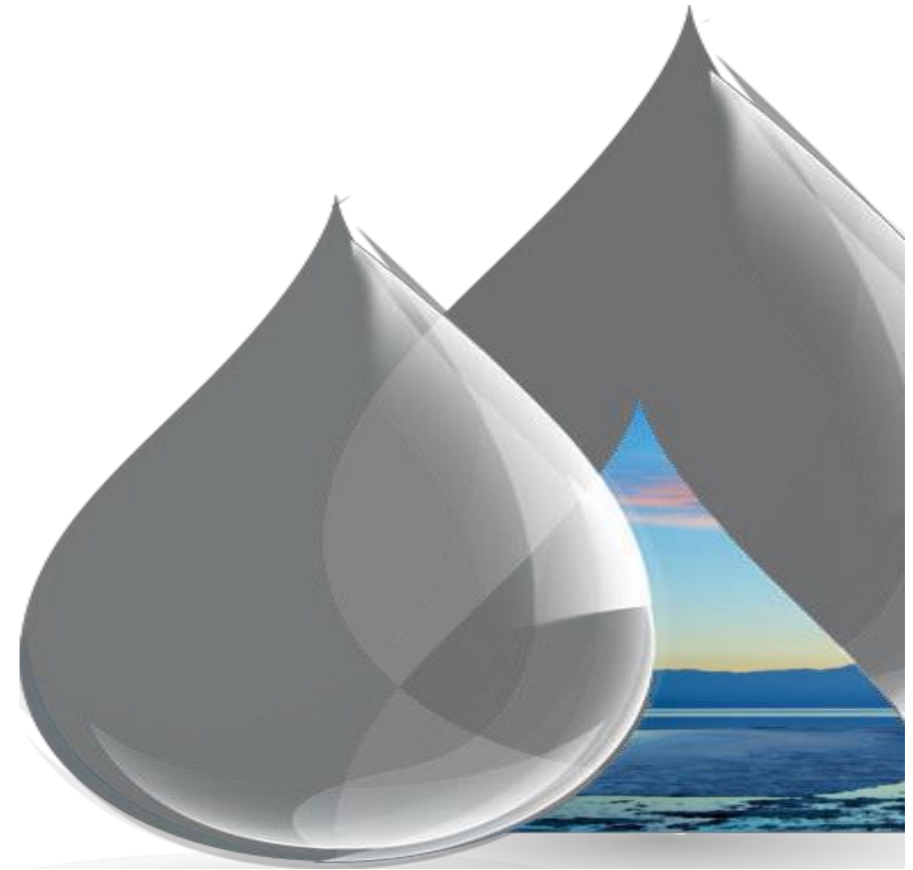
# Innovative Membrane Technologies

02/11/2019

# Lipatech, A Partnership Company

- Lipatech owns global trusted networks in energy, alternative energy and environmental sectors and brings the most advanced technologies and solutions in water treatment, desalination, soil remediation, air pollution control, and smart plants into fast growing markets: China, South East Asia, Middle East. The company also offers the services in business and market development, merge & acquisition, risk analysis and management in the defined regions.
- The company was established in 2003, registered in New York, focusing on partnering with innovative advanced technology companies worldwide to solve complex environmental and energy efficiency issues for a diverse set of clients
- The company focuses on offering clean, energy efficiency, information technology solutions while mitigating for risk in the context of political, economic and social conditions on the ground.
- Lipatech is based in Glen Cove, New York with the field offices in Beijing, Shanghai, Shenzhen, Los Angeles.

**POLYCERA**®  
A WATER PLANET COMPANY



World Leading Ultrafiltration, Nanofiltration and Reverse Osmosis Membranes

# Polycera Membranes

# PolyCera Membranes

- **Nobel Prize winning chemistry, developed at University of California, Los Angeles**
- **From 2013 to 2017, PolyCera was incubated, commercialized and spun out from Water Planet, an award-winning company known for developing and commercializing products that redefine water and wastewater treatment**
  - 2017 GWI, Breakthrough Water Technology Company of the Year
  - 2016 GWI, Technology Idol (Winner)
  - 2015 Cleantech, 100 Ones to Watch
  - 2014 Oil & Gas Awards, Water Treatment Company of the Year
  - 2013 GWI, Technology Idol (Distinction)
- **Key developers of PolyCera:**
  - Prof. Eric Hoek, University of California; Chairman, Founder
  - Prof. Subir Bhattacharjee, University of Alberta; PE, Founder
  - Prof. Richard Kaner, University of California, Founder
- **Leadership: Simon Marshall, CEO and President**

# Problem PolyCera Solves

- **Globally, 80% of industrial wastewater is discharged into the environment untreated, contaminating our finite fresh water reserves**
- **Conventional wastewater treatment technologies have large footprints, are energy and chemical intensive, and may not be sufficient for removing challenging contaminants**
- **Membrane technology dominates all other water treatment applications, so why is only 2% of industrial wastewater treated with conventional membranes?**
- **Conventional polymeric membranes lack robustness and ceramic membranes are too expensive for main stream wastewater applications**



# Ceramic-like Performance

- **PolyCera is an organic metal coating applied to a conventional membrane backing material**
- **PolyCera is delivered in cross-flow, back-washable Spiral Monolith<sup>®</sup> modules, offering flexible operation from dead-end to cross-flow with forward-flushing, back-washing (BW) and cleaning in place (CIP)**
- **This patented material offers a unique, ceramic-like robustness, with an oleophobic and hydrophilic surface, which delivers high permeability, rejection, fouling tolerance and cleanability.**



# Advantages of PolyCera



## 1. High Permeability

- 2-3 x higher permeability than polymeric membranes
- Lower operational pressure, lower energy cost

## 2. Hydrophilic & Oleophobic

- Resistant to fouling by oil, biopolymers, bacteria, clays and colloids
- Easier to clean

## 3. Thermally and Chemically Robust

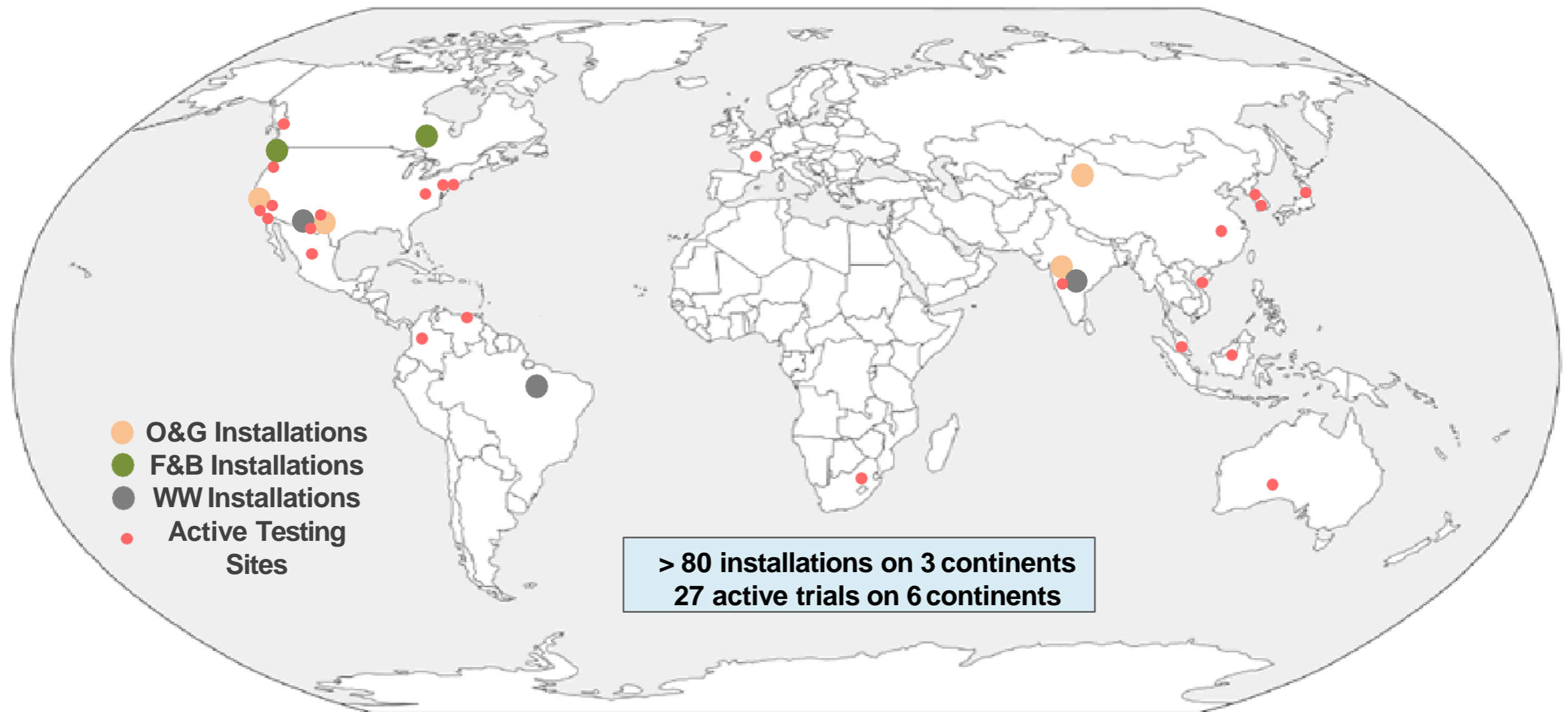
- Applicable for challenging streams
- Easier to clean and long lasting

## 4. Cross-Flow and Back-Washable

- Less membrane area, reduced CapEx
- Higher production, lower OpEx
- Less chemical usage, less membrane degradation

**The result is lower capital cost, energy demand and operating cost – providing the lowest total cost of any commercially available membrane**

# Applications and Installations





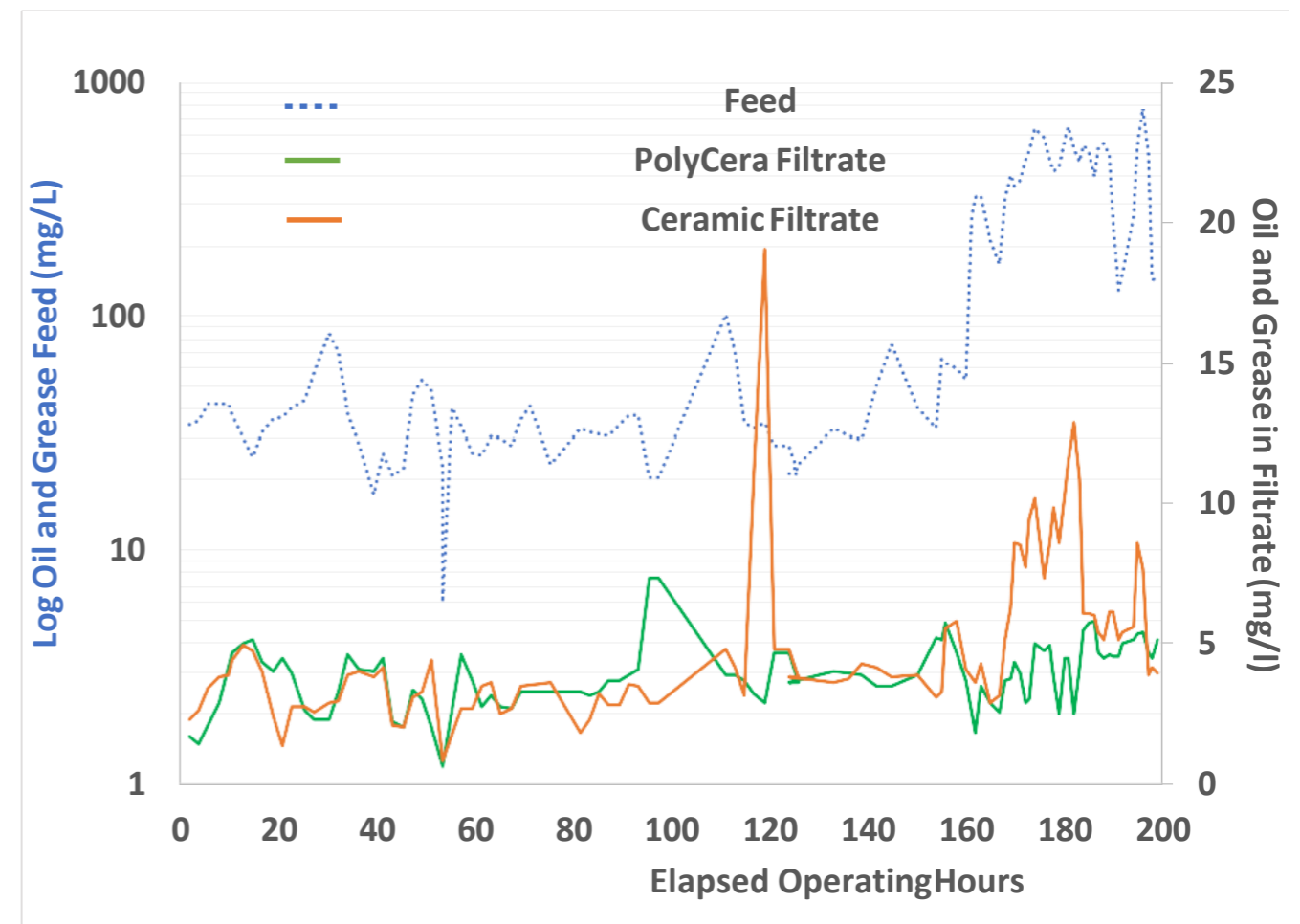
# PolyCera vs Ceramic

## Produced Water



### PolyCera membrane provided:

- ~99% O&G and turbidity removal
- 73% Lower specific energy cons. (SEC)
- 90% Recovery
- 0.0073 kWh/m<sup>3</sup> SEC
- 13% Lower backwash frequency



- *PolyCera Titan* membranes deliver more water at a lower cost

# Centralized General Wastewater

## 33 m<sup>3</sup>/day Facility

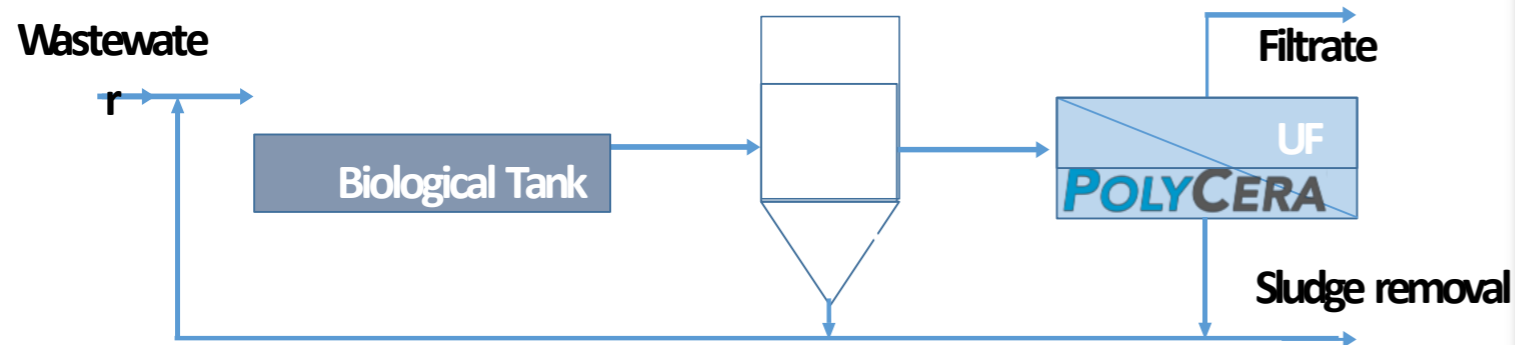


Feed Water Quality	
Oil	up to 500 mg/l
TSS	up to 500 mg/l
Turbidity	300 NTU
pH	5-10
TDS	brackish to brine

**Application: Merchant facility treating trucked in wastewater from multiple sites.  
Operating since February 2018, expanding to 100 m<sup>3</sup>/d by Q4 2018**



# Mobile Tertiary Wastewater Treatment



## PolyCera membrane provided:

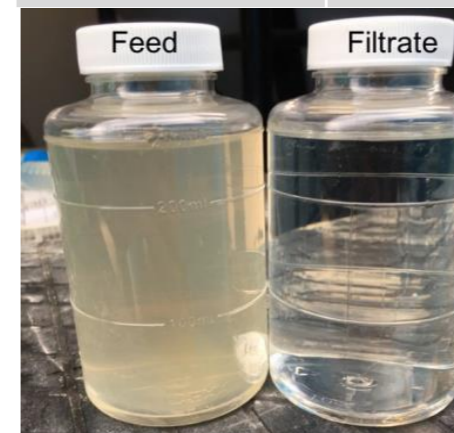
- 54% Lower SEC
- 42% Lower OPEX
- <0.1 NTU Filtrate turbidity
- >5 log Removal of coliform bacteria
- Meets Texas Type 1 reclaimed water quality
- Operating for over 18 months

50 installations and contracts for over 100 mobile units



## Feed Water Quality

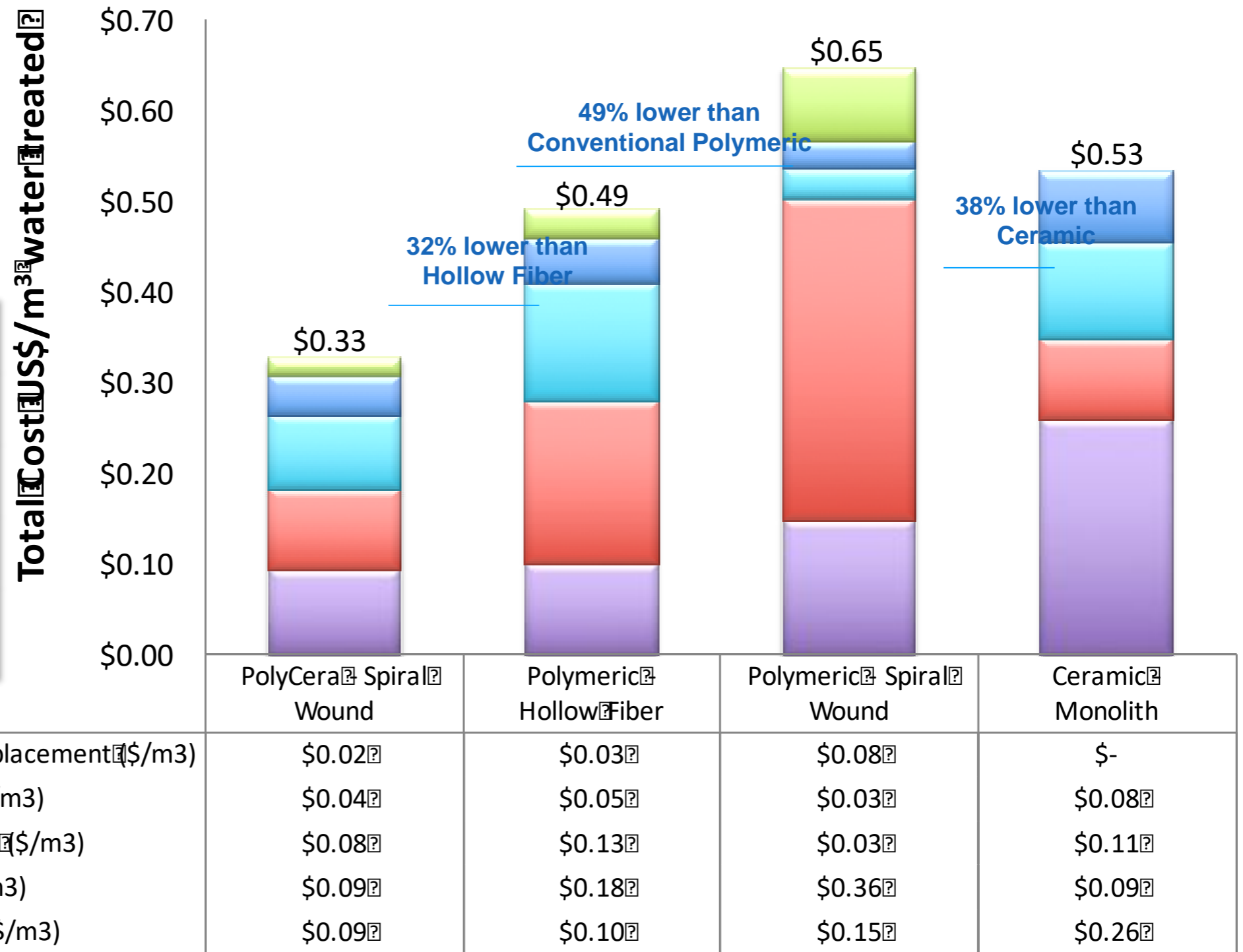
Turbidity	78.6 ± 7 NTU
E. coli	250,000 CFU/100mL
TSS	20.8 ± 8 mg/L



# Lowest Total Cost of Ownership

## 20-50% Lower Cost than Anything

Industrial Wastewater	
Throughput	100 m <sup>3</sup> /h
TSS	100 mg/l
Oil & Grease	<50 mg/l
Plant Design Life	10 Years



# Status of Development and Future

- **~80 installations on 3 continents; continue to expand the range of applications for PolyCera ultrafiltration membranes**
- **Applications: difficult to treat wastewater and process separation**
- **Target markets: retrofits and new builds**
- **PolyCera nanofiltration (NF) membrane full scale production trials in progress (scheduled for release in second half of 2018)**
- **PolyCera chlorine tolerant reverse osmosis (RO) membrane undergoing laboratory trials (scheduled for release 2019)**
- **PolyCera hollow fiber product development under discussion**

# Summary

- **PolyCera robust ultrafiltration membranes, are designed for the most challenging applications, delivering the highest quality filtrate and process separation with unrivaled reliability at the lowest total cost**
- **PolyCera membranes:**
  - offer high hydrophilicity, oleophobicity, permeability and robustness
  - have excellent fouling tolerance and can be cleaned easily
  - offer significant CapEx and OpEx reduction
- **We can discuss specific applications within your businesses**
- **Work directly with you or your preferred system integrators to support system design with PolyCera technology**
- **We can deliver all standard form factors for immediate module replacement programs and new build installations**

# Product Specifications

	Hydro	Titan
Nominal Pore Size/ Molecular Weight Cut Off	<b>20 nm/ 100 kDa</b>	<b>5 nm/ 70 kDa</b>
Continuous Operating pH	<b>1.0 – 12.0</b>	<b>1.0 – 13.5</b>
Cleaning pH	<b>1.0– 13.5</b>	<b>1.0– 13.5</b>
Continuous Operating Temperature	<b>5 – 50 °C</b>	<b>5 – 70 °C</b>
Cleaning Temperature	<b>5 – 70 °C</b>	<b>5 – 85 °C</b>
Maximum Free Oil & Grease	<b>≤5 ppm</b>	<b>≤500 ppm</b>
Maximum Feed Pressure	<b>120 psi / 8.3 bar</b>	<b>120 psi / 8.3 bar</b>
Typical Total Suspended Solids	<b>≤500 mg/l</b>	<b>≤500 mg/l</b>
Continuous Free Chlorine*	<b>&lt; 6 ppm</b>	<b>&lt; 2 ppm</b>
Total Free Chlorine	<b>300,000 ppmh</b>	<b>100,000 ppmh</b>



\* Avg. 5 year working life

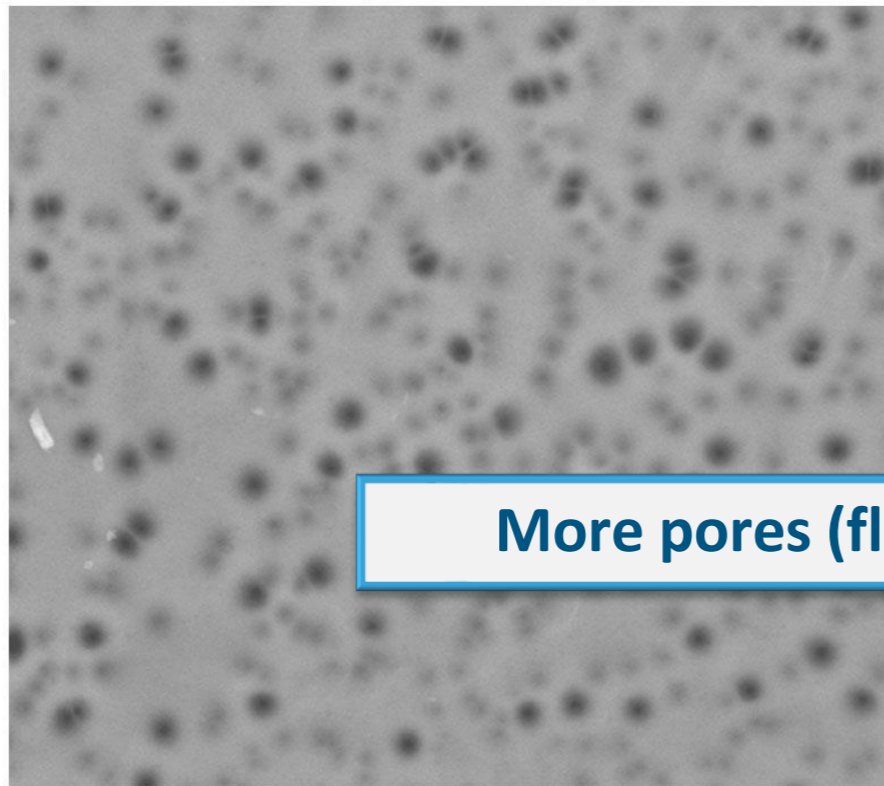
# 1. High Permeability

Lower energy, lower cost

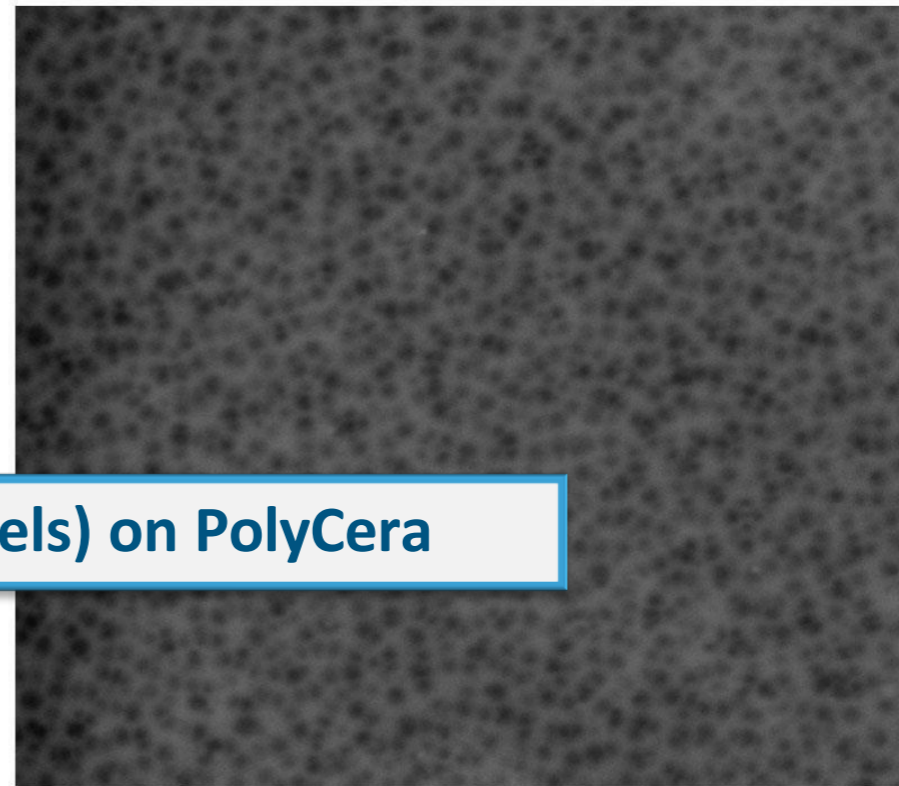
**POLYCERA**<sup>®</sup>

membranes produce 2 to 3 times more water than conventional polymer membranes at the same applied pressure

Conventional PVDF 100kDa -  
Surface



PolyCera 100kDa (Hydro) -  
Surface



More pores (flow channels) on PolyCera  
surface

(Tested with DI water under controlled conditions, actual performance varies with feed water quality)



## 2. Hydrophilic & Oleophobic

### Higher Oil & TSS Fouling Tolerance

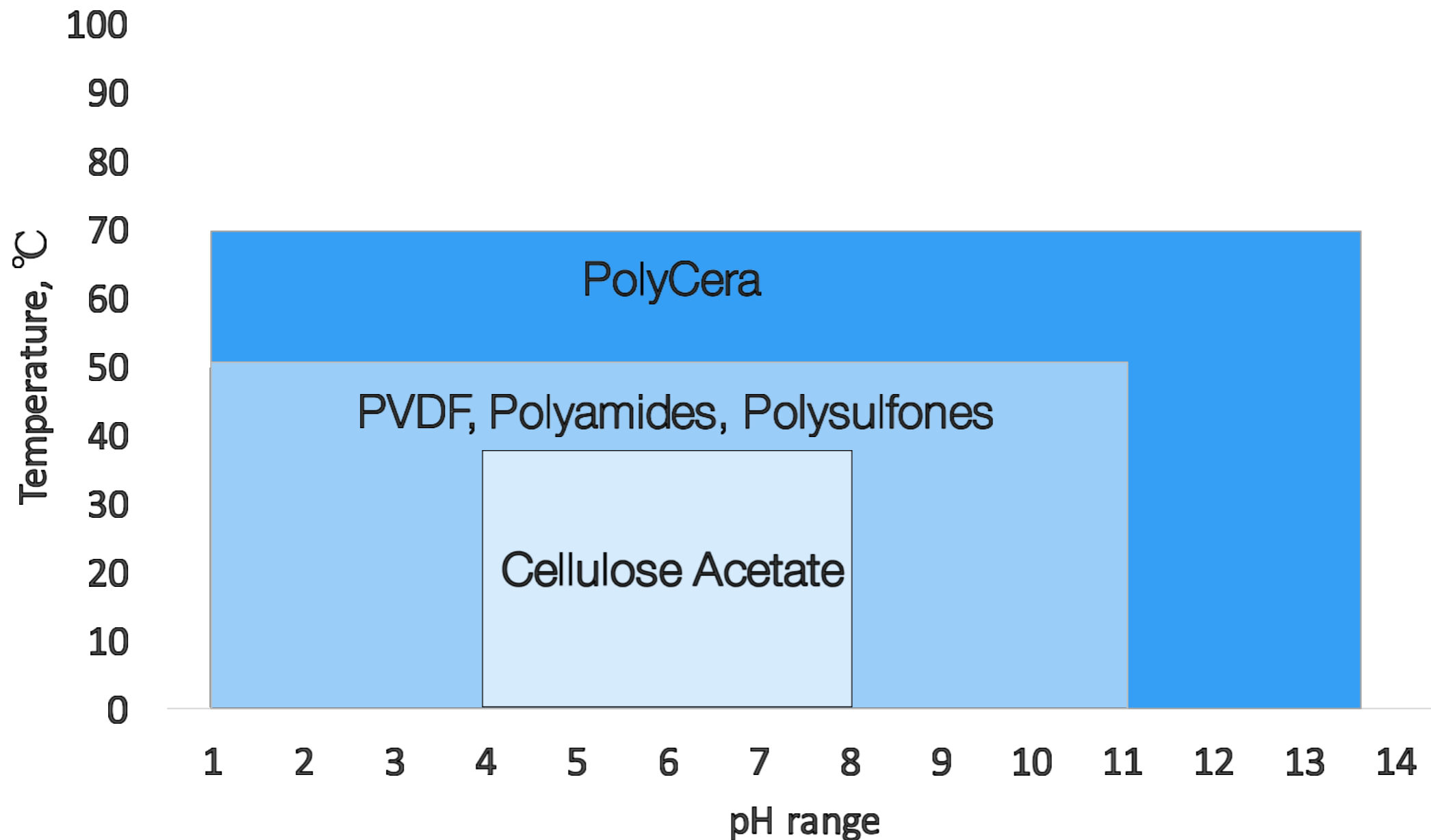
Membrane Material	Water Affinity	Oil Affinity	Fouling Propensity	Cost of Implementing
<b>POLYCERA<sup>®</sup></b>	<b>Attracts water</b>	<b>Repels oil</b>	<b>Fouling resistant</b>	<b>Low</b>
Metal-nitrides	Attracts water	Repels oil	Fouling resistant	High
Metal-oxides				
Polysulfone	Repels water	Attracts oil	Fouling prone	Highest
PVDF				

- Hydrophilic (attracts water) and oleophobic (repels oil) surfaces are more fouling-resistant and easy-to-clean
  - Conventional polymers are hydrophobic and fouling prone
    - PolyCera is super-hydrophilic and super-oleophobic

# 3. High Thermal & Chemical Stability

Easier to Clean, Longer Lasting

**POLYCERA**<sup>®</sup> *Spiral Monolith*<sup>®</sup> modules tolerate the widest pH and temperature operating windows



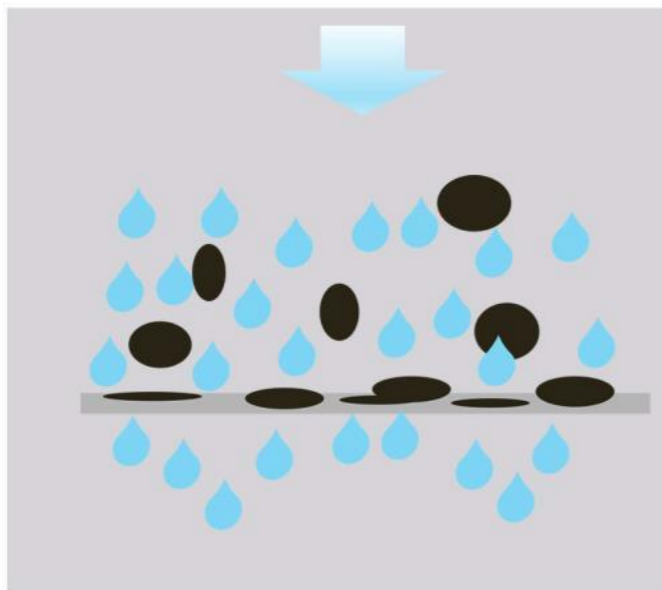
# 4. Cross-Flow & Back-Washable

## Higher Fouling Tolerance

**POLYCERA**<sup>®</sup>

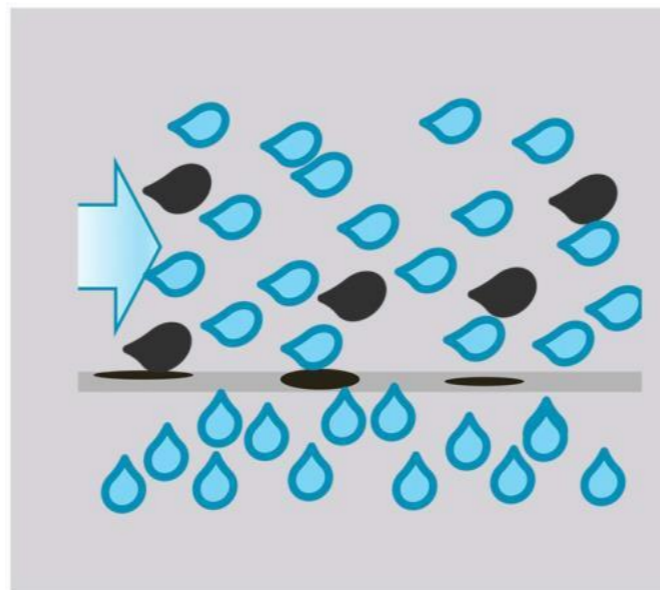
*Spiral Monolith*<sup>®</sup> modules ...cross-flow and  
back-washable just like ceramics

Dead-end



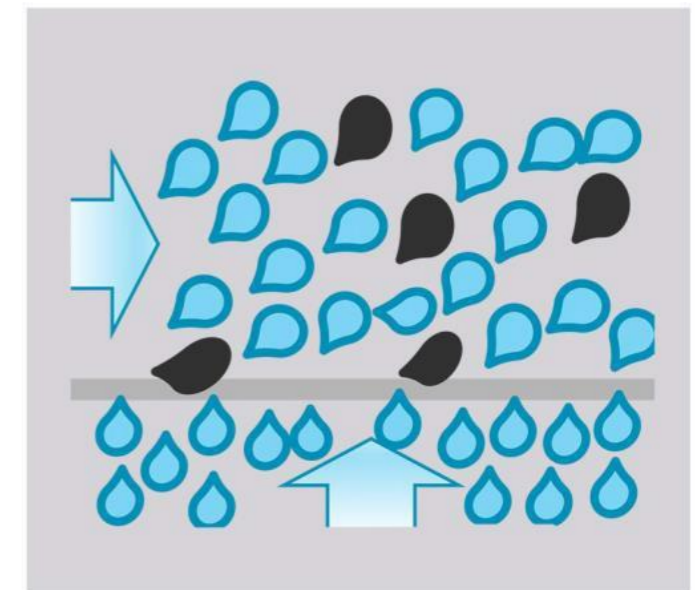
- High fouling rates
- Difficult to clean
- Short membrane life
  - High OpEx

Cross-flow



- Low fouling rates
  - Less frequent cleaning
- Average membrane life
  - Low OpEx

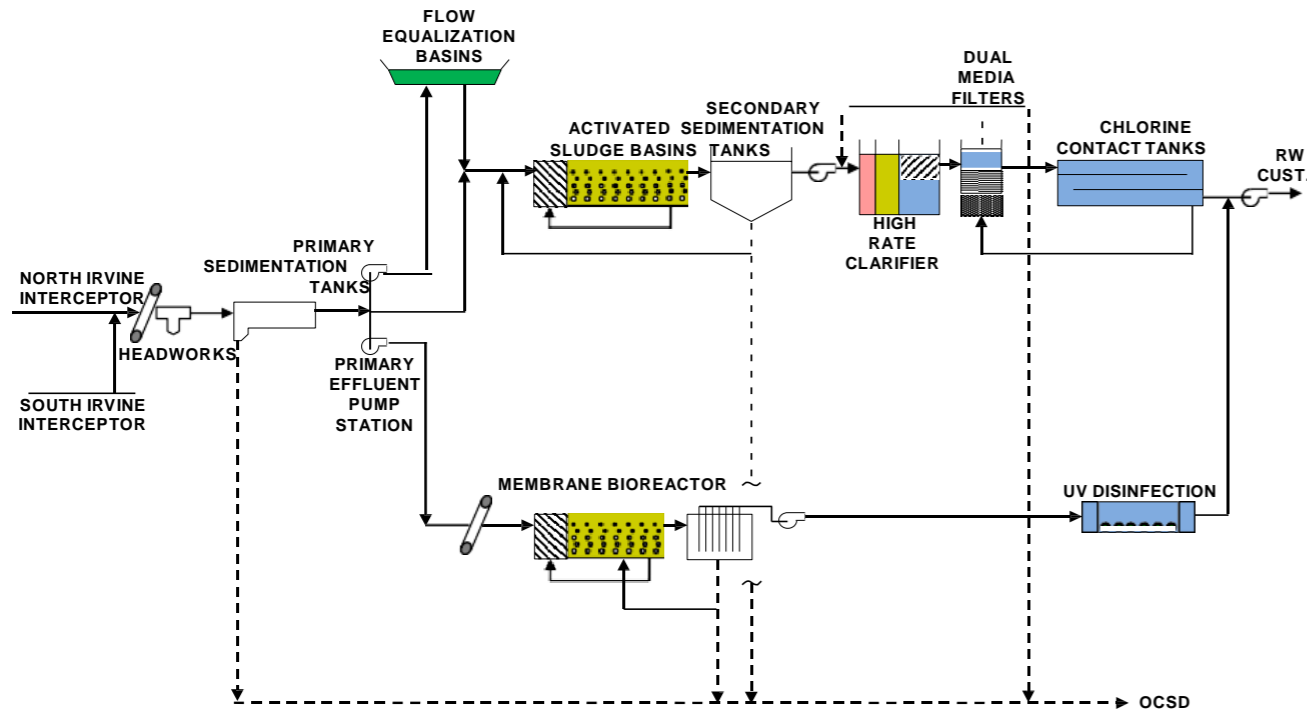
Back-washable



- Lowest fouling rates
- Higher production
- Extended membrane life
  - Lowest OpEx

# PolyCera vs PVDF

## Tertiary filtration of secondary effluent



	Feed Water	PC Filtrate	PVDF Filtrate
TSS (mg/L)	2.0 ± 1.2	N.D. (<0.5)	N.D. (<0.5)
Turbidity (NTU)	4.7 ± 3.8	0.16 ± 0.02	0.16 ± 0.02
TOC (ppm C)	5.4 ± 0.24	5.7 ± 0.64	5.3 ± 0.45
pH	6.9 ± 0.38	6.7 ± 0.27	6.7 ± 0.35

### PolyCera membrane provided:

- **23% Higher Water Recovery**
- **20% Lower Energy Demand**
  - **38% Lower OPEX**
  - **Better cleanability**

# *Thank you!*

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**Representative of Polycera Membranes**

