Wastewater reuse schema with innovative Ultrafiltration and reverse osmosis technologies

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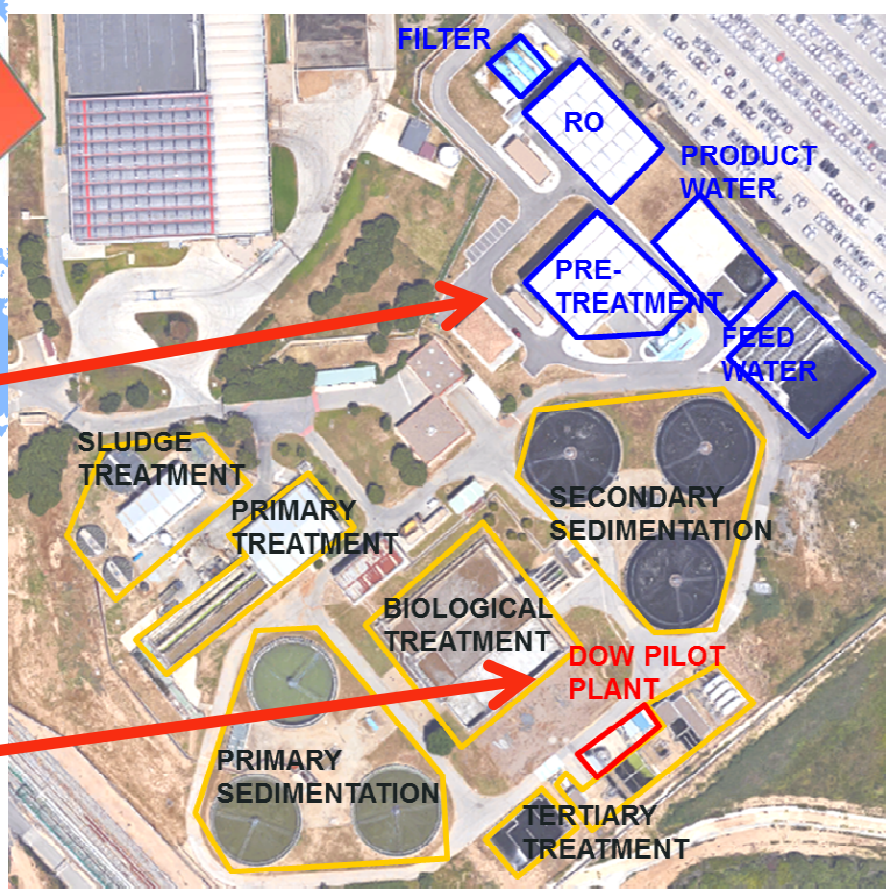
Agenda

- Introduction
- Camp de Tarragona Advanced Water Reclamation Plant
- Pilot plant Ultrafiltration innovation
- Pilot plant Reverse Osmosis fouling resistant elements
- Conclusions

Introduction - Background

- Demonstration case:
- Camp de Tarragona Advanced Water Reclamation
- Water reuse provides cooling water for industrial use
- Pilot plant experiments with innovative membrane technologies



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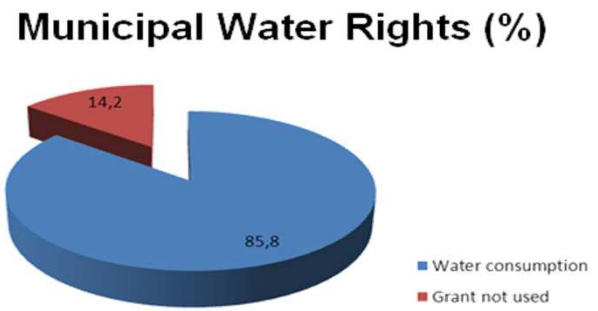
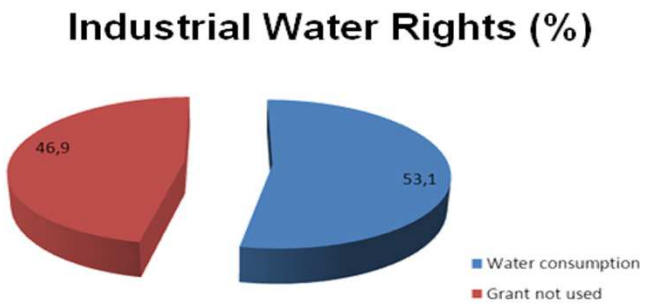
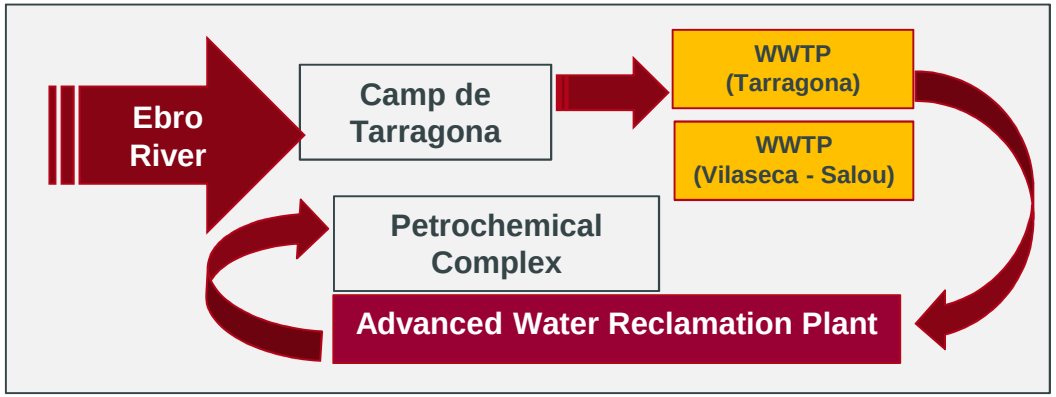
Ebro River, Camp de Tarragona, Petrochemical Complex

- Camp de Tarragona is a seasonal water stressed region that uses Ebro River water for Municipal, Tourism and Industrial applications
- Industrial Water Rights are mainly used in Cooling Towers inside Tarragona Petrochemical Complex

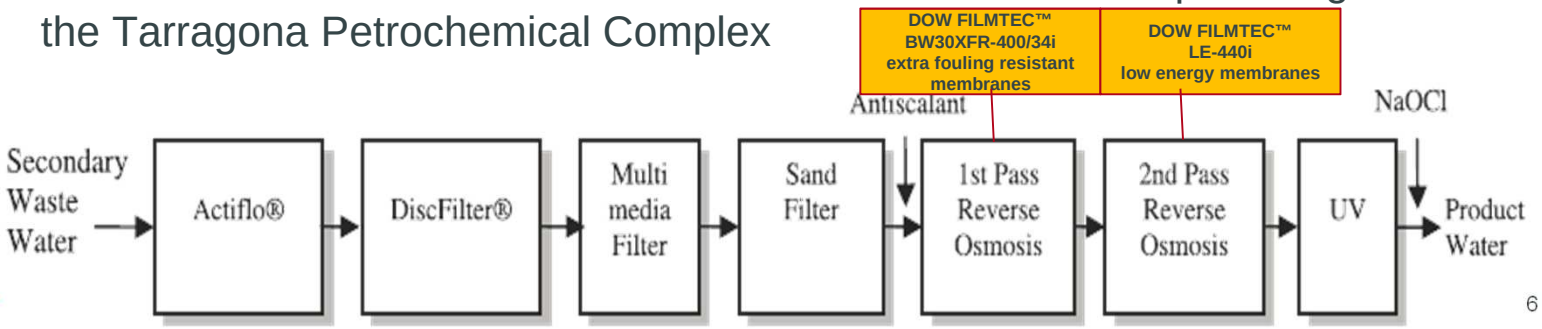




Camp de Tarragona Advanced Water Reclamation Plant



- Reclamation Plant designed for 19,000 m^3/d of permeate water from Tarragona and Vila-seca Wastewater Treatment Plant.
- Owned by ACA (Water Catalan Agency) and operated by Veolia and AITASA
- Reused water is blended with Ebro River water for make-up cooling water for the Tarragona Petrochemical Complex



Cooling Towers Concentration Cycles

- The Cracker cooling tower ran on 100% Ebro river water at 4 cycles prior to the gradual change to feed 40% RO permeate (160 m^3/h) operating at 7 cycles
- At current 40% blending (from 4 to 7 concentration cycles), no increase of scaling and/or corrosion tendency has been detected (just on the contrary).
- Chemical usage could be decreased by 23% and wastewater by up to 49%
- Depending on season → more than 200 m^3/h freed up for municipality
- Target: 90% of water demand of chemical complex served with reclaimed water

Compound	Ebro	RO Permeate	Ebro x 4	Permeate x 7
Conductivity (µS/cm)	950	19	3,800	135
Cl (mg/L)	260	2.9	1,040	21
$CaCO_3$ (mg/L)	95	< 0.1	380	< 1.0
SO_4 (mg/L)	160	0.02	640	0.07
NH_3 (mg/L)	0.1	< 0.8	0.4	< 5.0
PO_4 (mg/L)	0.1	< 0.002	0.4	< 0.02
TOC (mg/L)	1.2	< 0.3	4.8	< 2.0

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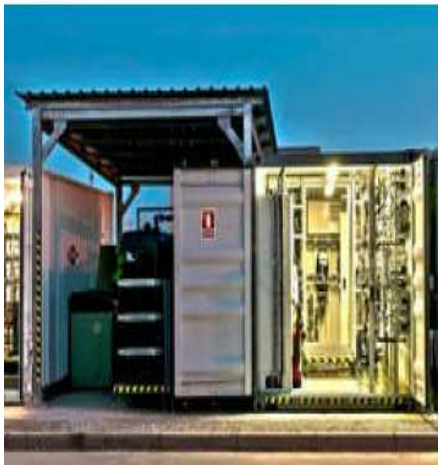
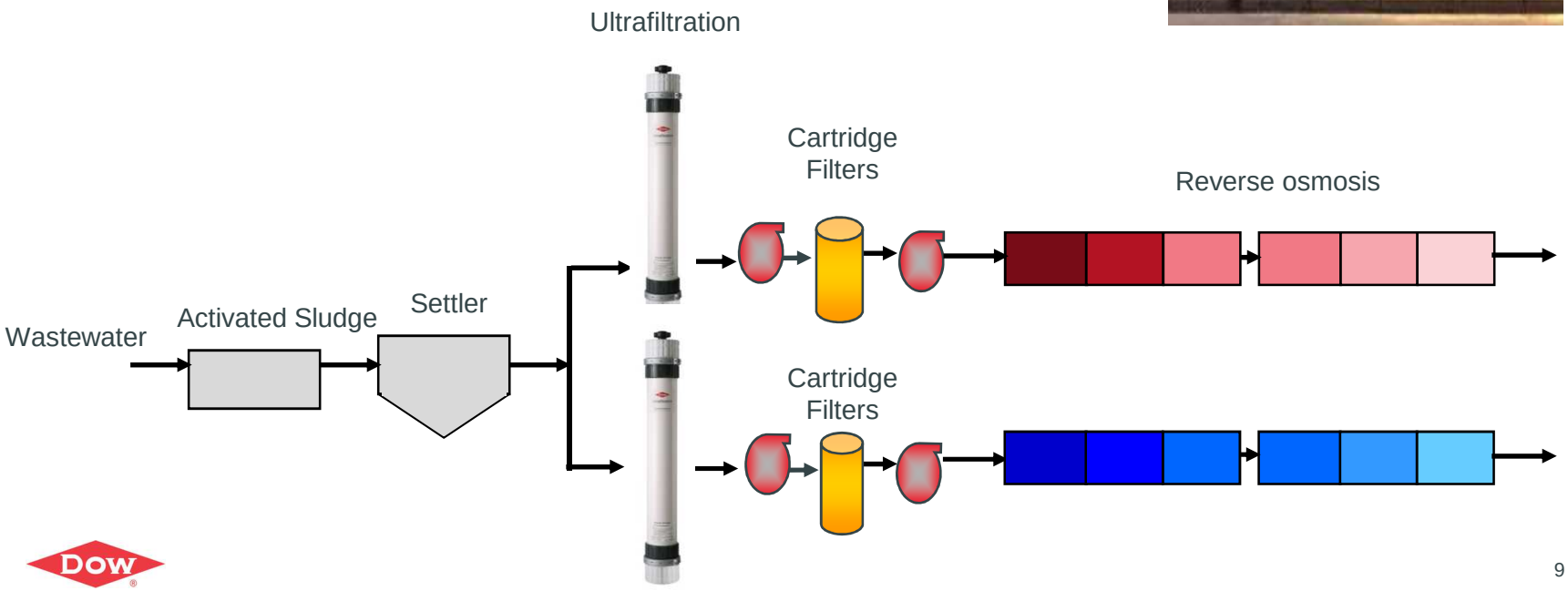
Pilot plant

- Wastewater treatment plant Vilaseca, Spain
- Wastewater mixture municipal and industrial wastewater
- Pilot installation: 2 parallel full scale UF modules:
  - DOW™ Ultrafiltration SFP-2880 module
  - new DOW™ Ultrafiltration SFP-2880XP module





Ultrafiltration performance

- Side-by-side comparison of new DOW™ Ultrafiltration SFP-2880XP and DOW™ Ultrafiltration SFP-2880
- Lower normalized TMP for high permeability fibers between 45 and 60 L/m²h
- Approximately equal normalized TMP at 60 LMH DOW™ Ultrafiltration SFP-2880XP and 50 LMH for DOW™ Ultrafiltration SFP-2880

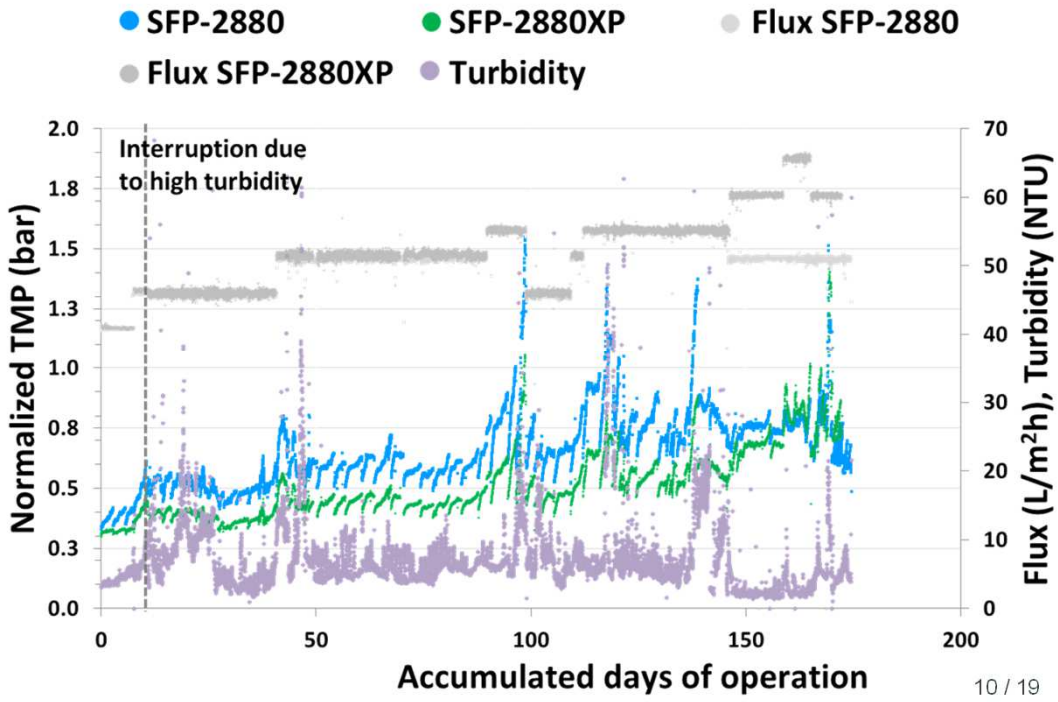
Operational Conditions:

Flux: 40 to 65 LMH
Backwash flux: 95-100 LMH
No CEB
Short CIP every 1-3 days

Recovery:

45 LMH	87.4%
50 LMH	88.6%
55 LMH	89.7%
60 LMH	90.5%
65 LMH	91.2%

$$Recovery = \frac{Filtrate\ flow}{Feed\ flow}$$



Ultrafiltration performance

- Side-by-side comparison of new DOW™ Ultrafiltration SFP-2880XP and DOW™ Ultrafiltration SFP-2880
- Confirming higher permeability of XP-fibers

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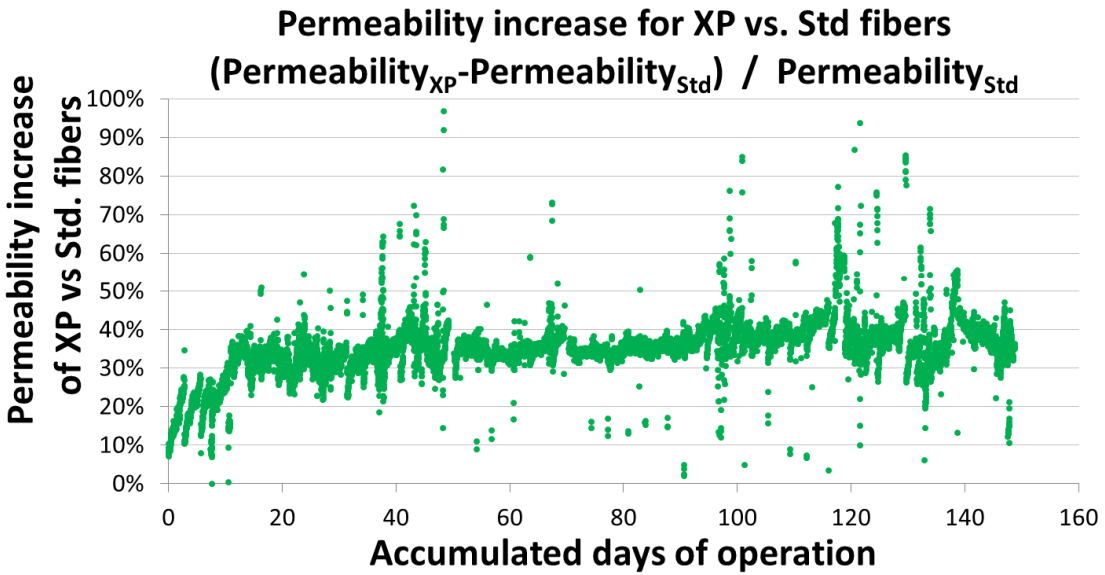

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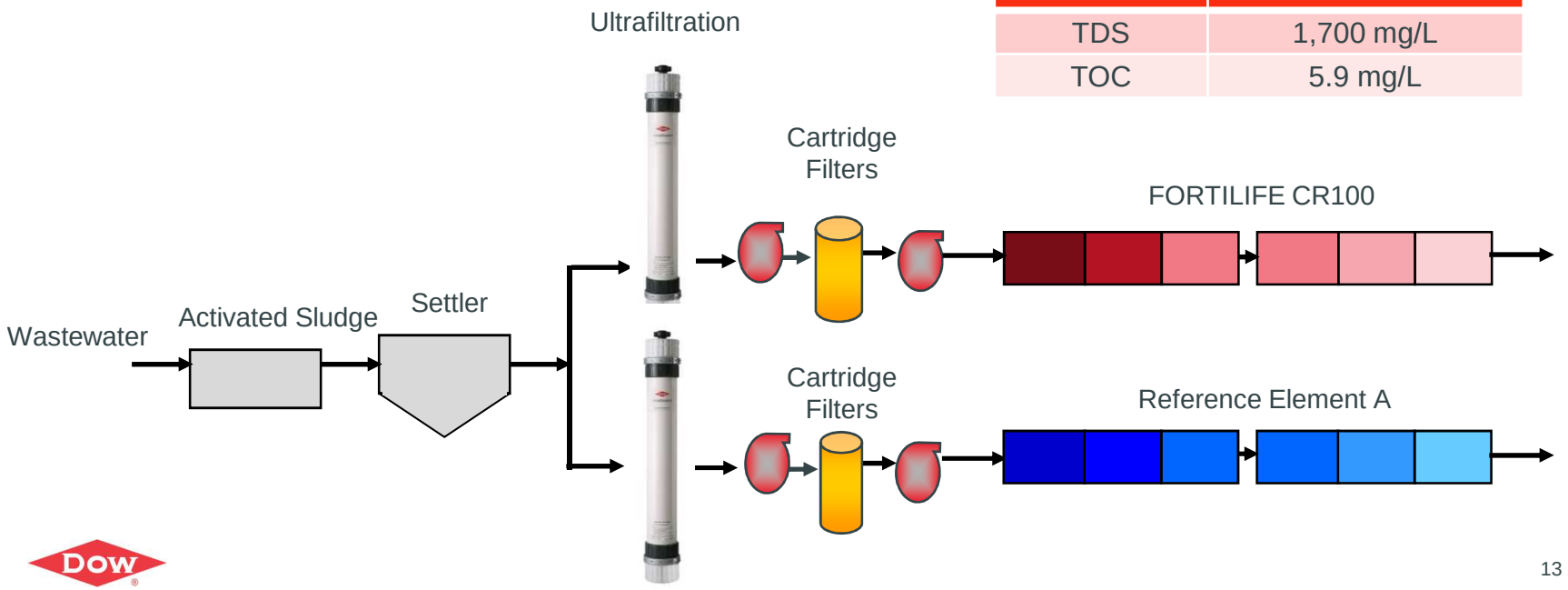
Pilot plant

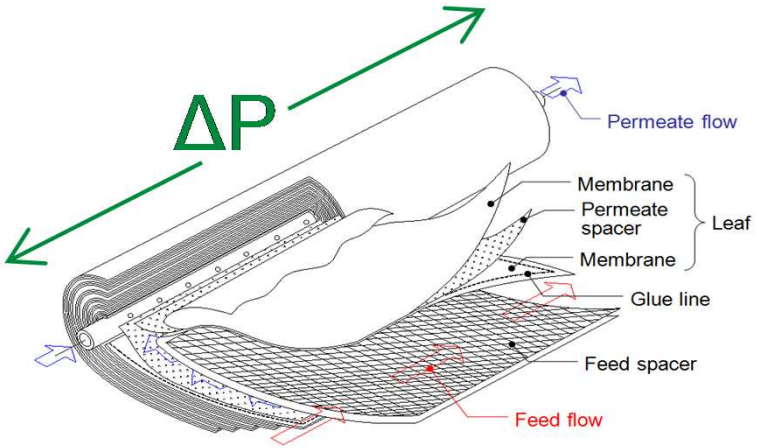
- Wastewater treatment plant Vilaseca, Spain
- Wastewater mixture municipal and industrial wastewater
- Pilot installation: 2 parallel lines with 6 4-inch RO elements:
  - FORTILIFE™ CR100
  - Reference Element A

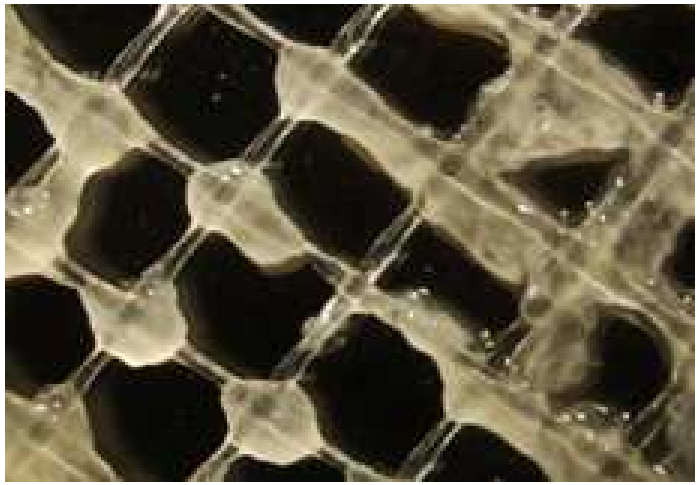
Parameter	Concentration
TDS	1,700 mg/L
TOC	5.9 mg/L



Biofouling

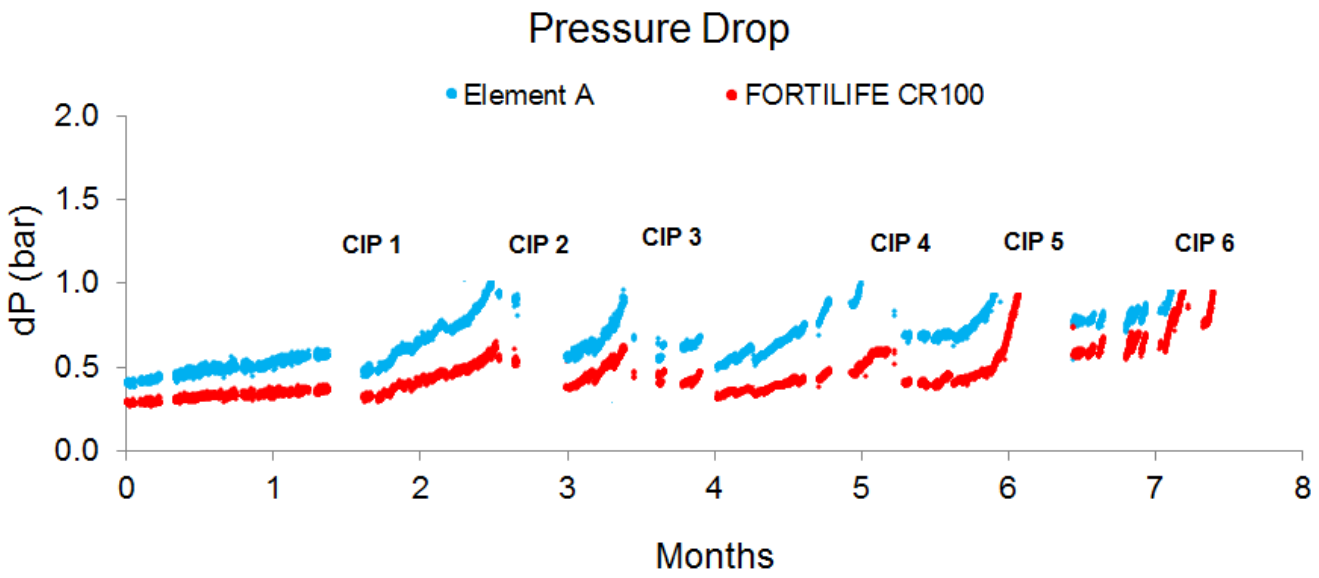
- Biofilm growing in the element creates a pressure drop rise which impact energy use and can result in mechanical damage.
- System dP limits are put in place to protect the system and recover performance.





FORTILIFE™ CR100 Comparison with Element A

- FORTILIFE™ CR100 has a 30% lower pressure drop than Element A
- Fouling periods 4, 5 and 6 demonstrate a delay for FORTILIFE™ CR100 to reach the 1 bar differential pressure cleaning trigger resulting in an average 29% reduction in cleaning frequency.



CIP	Reduction
4	17%
5	30%
6	39%
Average	**29%**

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Conclusions

- Reuse case:
  - Reclaimed water used in the industry → positive environmental impact
  - Stable operation of the cooling tower with up to 40% RO blending/ Cooling Tower Blowdown discharge reduced by 49% and chemical usage reduction of 23%
  - Reclaimed water from after Reverse Osmosis → no health concerns compared to conventional pre-treated river water
- Ultrafiltration:
  - 20 to 40% of TMP reduction for new XP fibers for fluxes between 45 and 55 L/m^2h
  - Sustainable operation was demonstrated using an advanced cleaning strategy without chemically enhanced backwashes but short chemical cleanings
- Reverse Osmosis:
  - DOW FILMTEC™ FORTILIFE™ CR100 offers less cleanings
  - DOW FILMTEC™ FORTILIFE™ CR100 offers lower dP operation

Thank You

FORTILIFE™ CR100 Comparison with Element A

- Flux and recovery were matched through out the trial
- In the first half of the trial the flux and recovery were 19 L/m^{2}h and 44%, and in the second half they were 15 L/m^{2}h and 34%, respectively.