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Ceramic Membrane Pilot Plant for Drinking Water Treatment

Lutra



water
NEW ZEALAND
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Tākina, Te Whanganui-a-Tara Wellington

Contents of this presentation

- What are Ceramic Membranes
- Why relevant for New Zealand
- Our pilot plant setup
- Plant performance

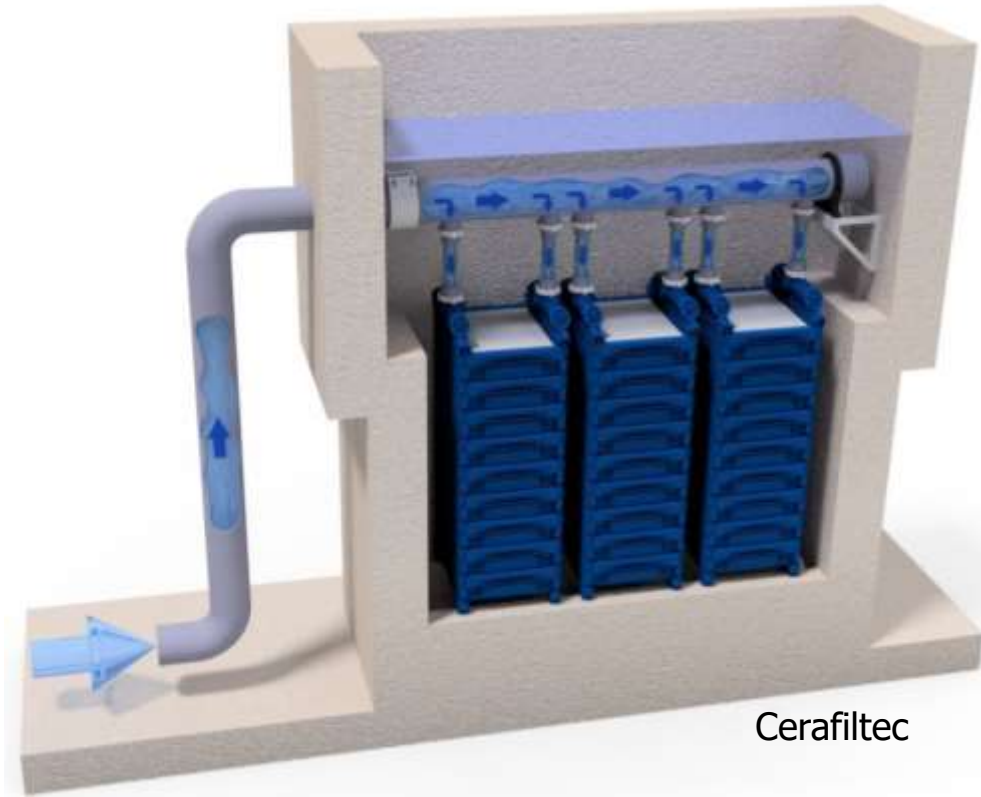
What are Ceramic Membranes?



- Durable and long lifetime
- pH 0 to 14
 - Temp. up to 800 °C
 - Chemically resistant
 - Abrasive feeds
 - Lifespan 15-20+ years



Metawater



Cerafiltec

High flux - 200-400 LMH and more
Over 1,000 LMH in some applications.



PWNT

C-19

C-37

C-90

Where are Ceramic Membranes used?

Industrial water and wastewater treatment

- Mining
- Dairy
- Oil and Gas



Municipal drinking water treatment

- 120 MLD Andijk III, Netherlands
- 180 MLD Singapore (Choa Chu Kang Waterworks)
- 130 installations in Japan (in 2015)

Why are Ceramic Membranes interesting for New Zealand



Images from istock photos

Ceramic Membranes and Drinking Water Standard

- Quality Assurance Rules: most water suppliers serving more than 500 people must provide a 3 to 4 log-removal protozoa barrier
- Ceramics provide up to 4-log credits
- Same rules apply for ceramics and polymeric membranes

Excerpt from T3 membrane filtration rules

Certified to comply with **NSF/ANSI 61**: Drinking Water System Components – Health effects (or equivalent)

Certified to comply with **NSF/ANSI 419**: Public Drinking Water Equipment Performance – Filtration (or equivalent)

Daily integrity testing

Filtrate turbidity must not exceed 1 NTU at any time

Filtrate turbidity must not exceed 0.1 NTU for more than 15 consecutive minutes

Performance Parameters

- Flux J – Liters of treated water per membrane area per hour (L/m²/h or LMH)
- Flux J_{standard} at standard temperature (20°C) (LMH)

$$J_{\text{standard}} = J_{\text{measured}} \times 1.03^{(T_{\text{standard}} - T_{\text{measured}})}$$

- Trans membrane pressure (TMP) (mbar, KPa)
- Specific flux J_{specific} or permeability – Flux at 20°C divided by TMP (L/m²/h/bar)

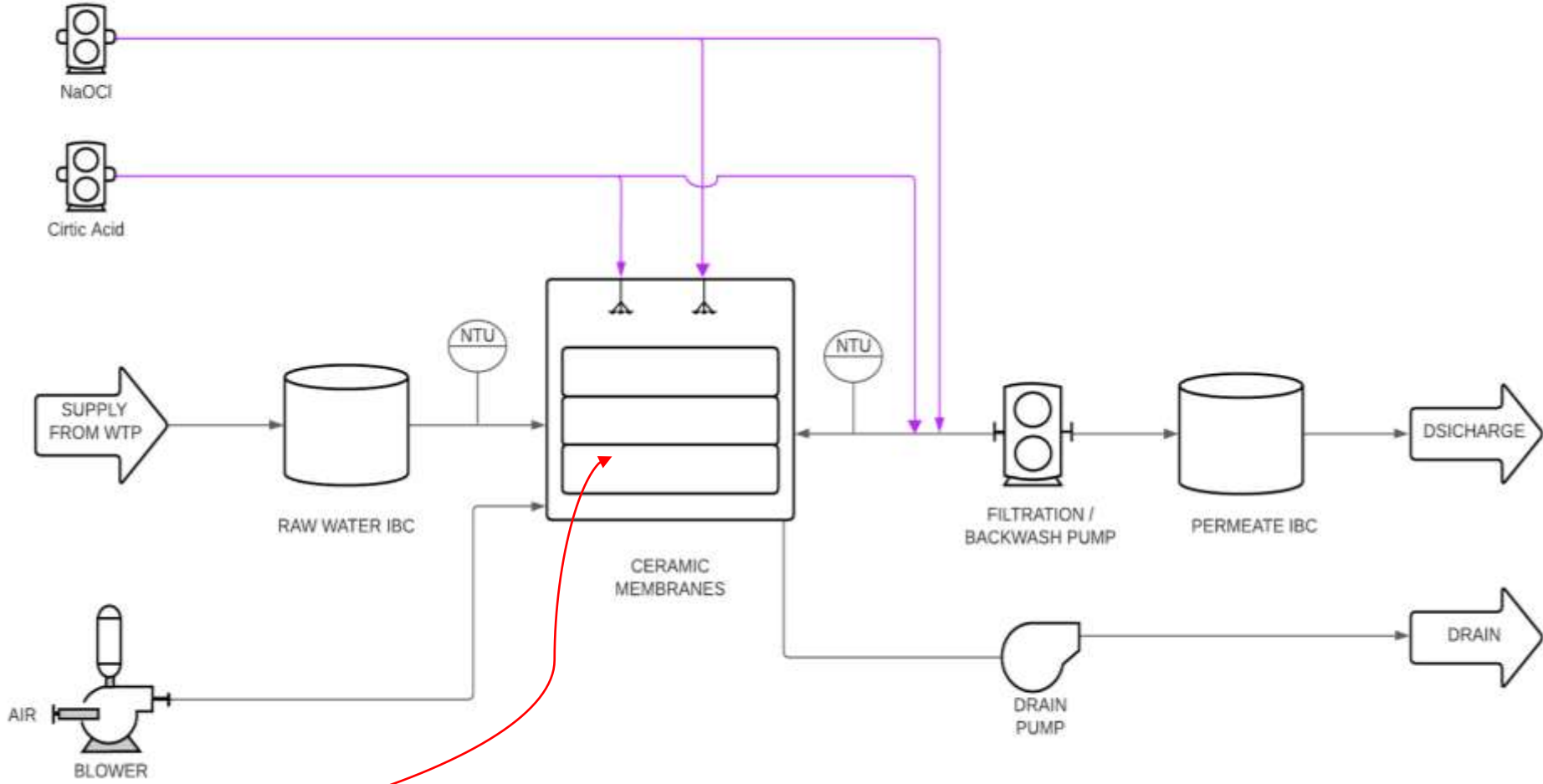
$$J_{\text{specific}} = \frac{J_{\text{standard}}}{\text{TMP}}$$

Our pilot plant



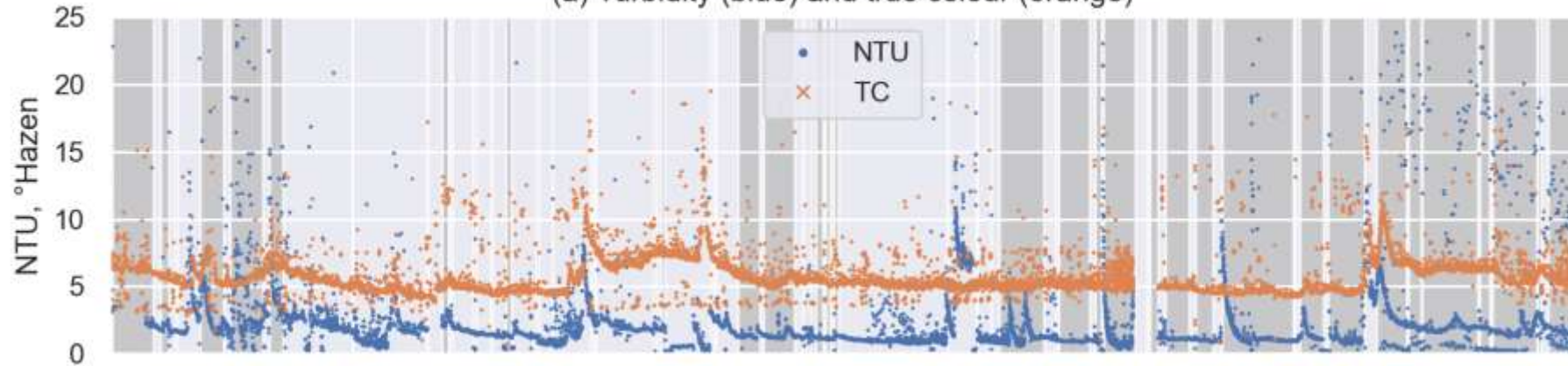
Membrane Material	Pore Size	Surface area
Silicone Carbide	0.3 – 0.5 μm	18 m ²

Pilot plant set-up

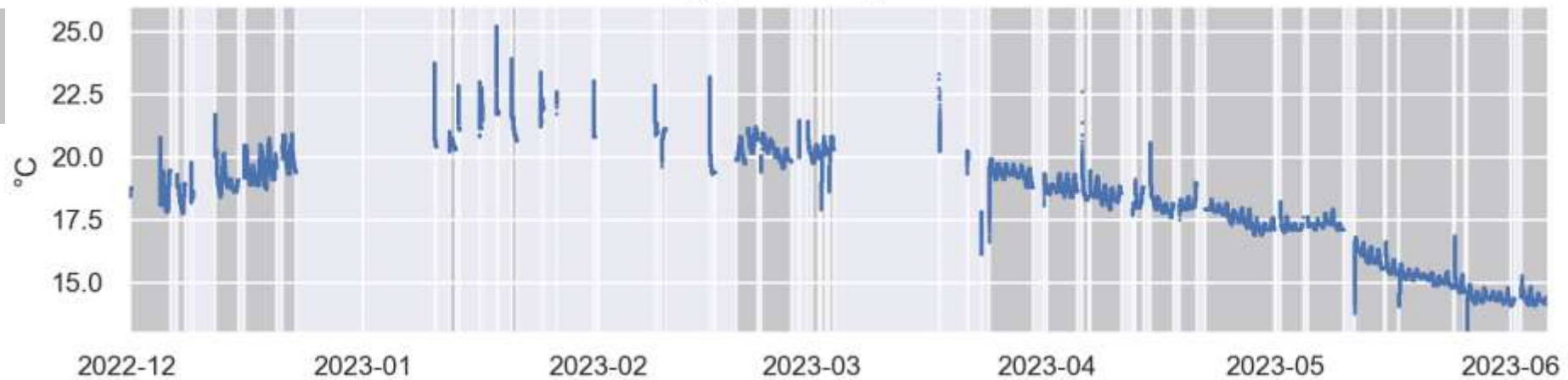


Set-up - Raw water conditions

(a) Turbidity (blue) and true colour (orange)



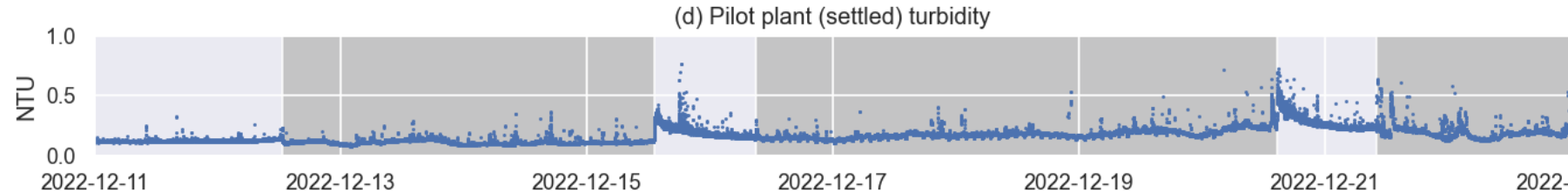
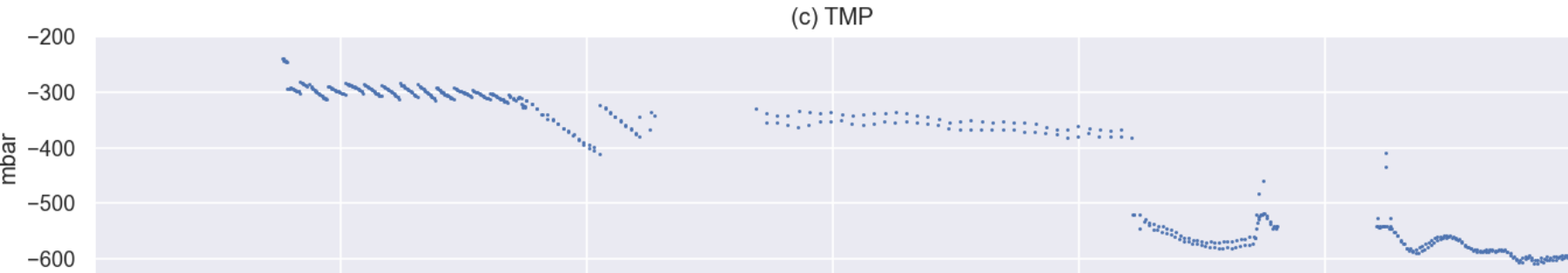
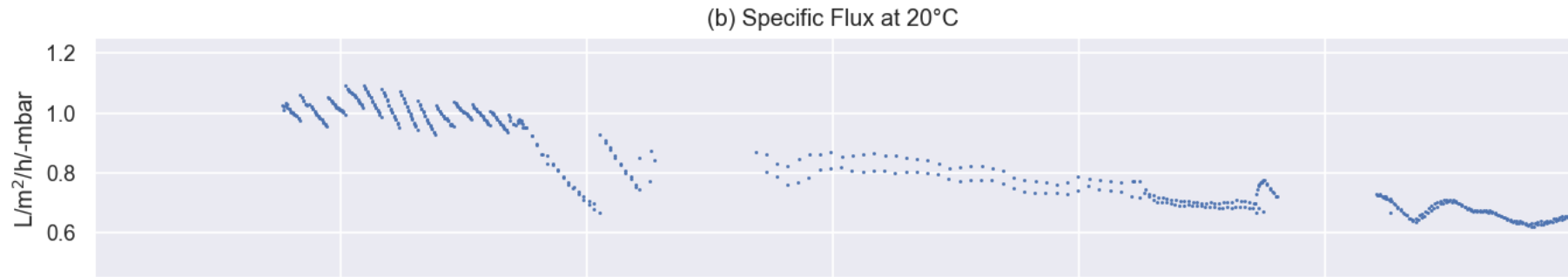
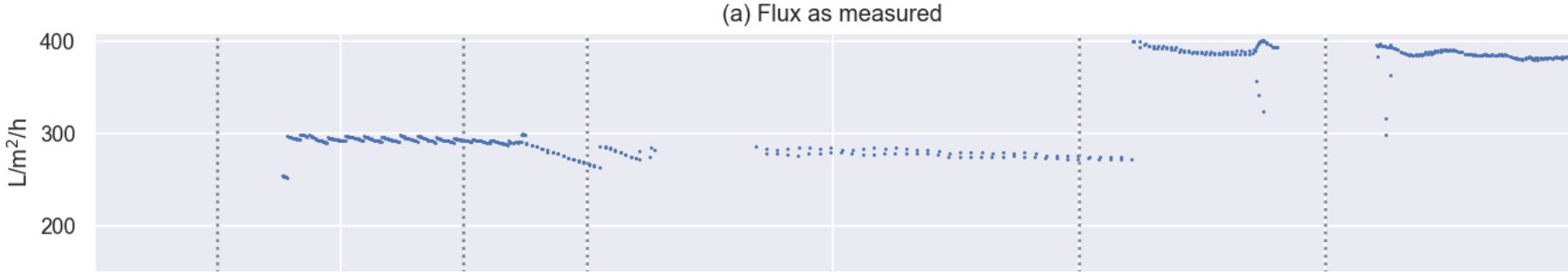
(b) Water temperature



grey area : pilot plant was operating

Results – Peak Flux Rate up to 400 LMH

grey dotted bars :
change of
operational
parameter



grey area : pilot
plant was
operating

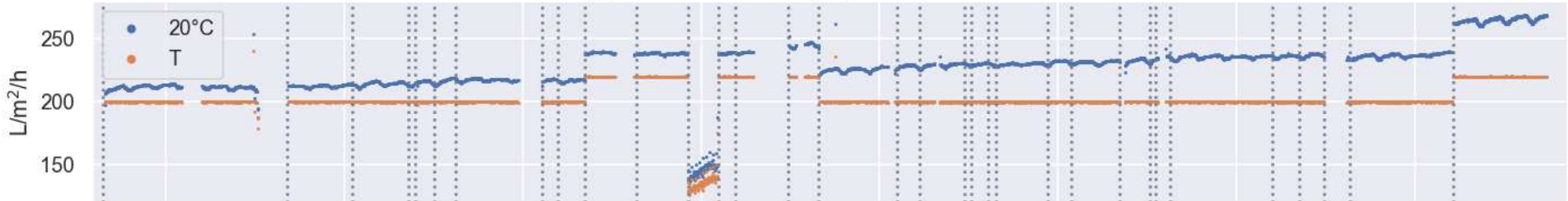
Results – Sustainable Operation I

grey dotted bars :
change of
operational
parameter

green area :
sustainable
operation

grey area : pilot
plant was
operating

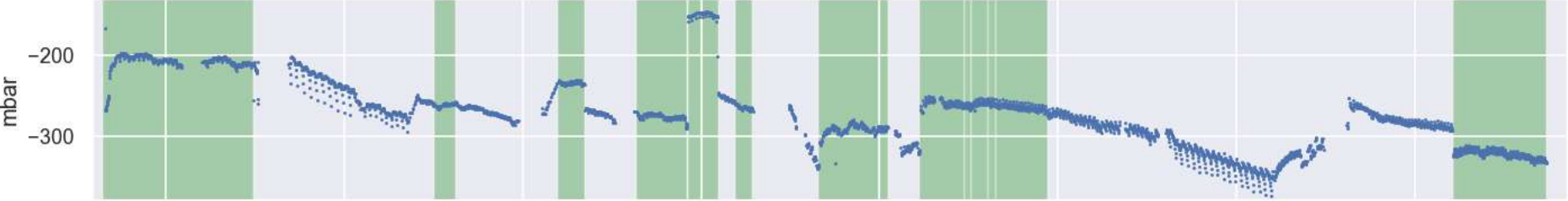
(a) Flux as measured ("T") and at standard 20°C



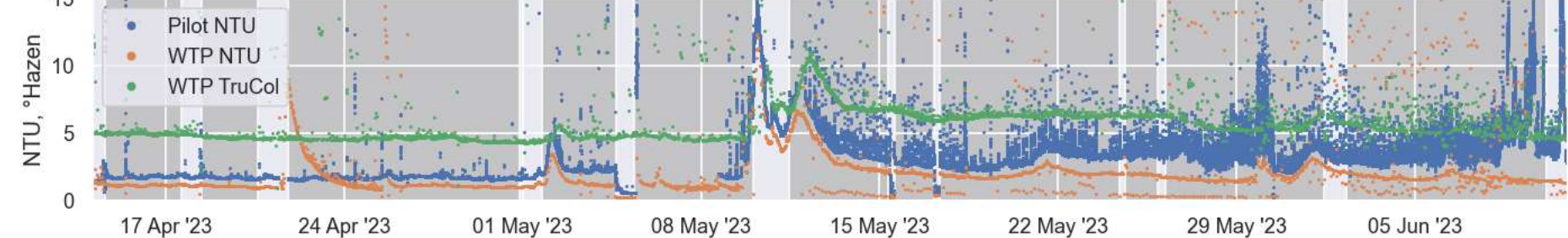
(b) Specific Flux at 20°C



(c) TMP



(d) Pilot plant feed turbidity; raw water turbidity and true colour



Results – Sustainable Operation II

Setting	Combination 1	Combination 2	Combination 3
Flux rate (LMH)	200	220	220
Filtration (F) length (minutes)	30	30	15
Backwash (BW) settings	30 seconds, at double the flux rate	30 seconds, at double the flux rate	30 seconds, at double the flux rate
Chemical clean	within every 2.5- to 3-hour period	within every 3-hour period	within every 2.75-hour period
Chemical clean method	both CapClean and CEB were used	CapClean only in this period	CEB only in this period
Performance outcomes			
Treated turbidity	< 0.04 NTU	< 0.04 NTU	< 0.04 NTU
Production efficiency with 80% water recovery	95 to 96%	97.1%	96%
Hypochlorite base product usage (13% w/w)	140 to 200 mL/d	200 mL/d	145 mL/d
Citric acid (100%) powder usage	34 to 56 g/d	50 g/d	36 g/d

Results – Pilot vs Full-scale

Pilot trial – 8 chemical washes per day. Alpha Street WTP pre-treatment not optimised for membrane plants.

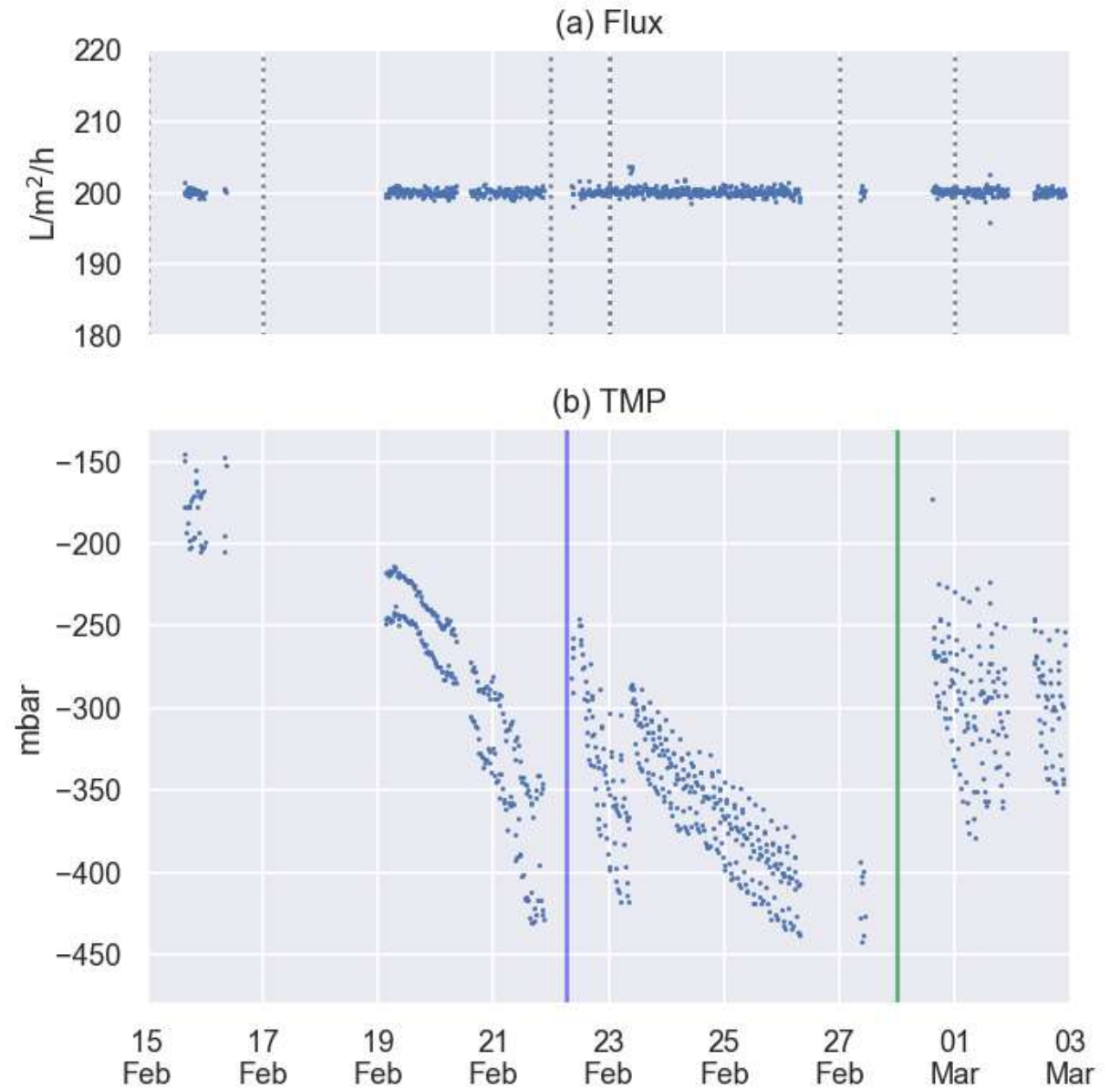
Full scale ceramic membrane plants with optimised pre-treatment – 1 to 2 chemical washes per day

→ Pre-treatment is very important for the performance of (ceramic) membranes.

What does this mean for a buyer of (ceramic) membranes?

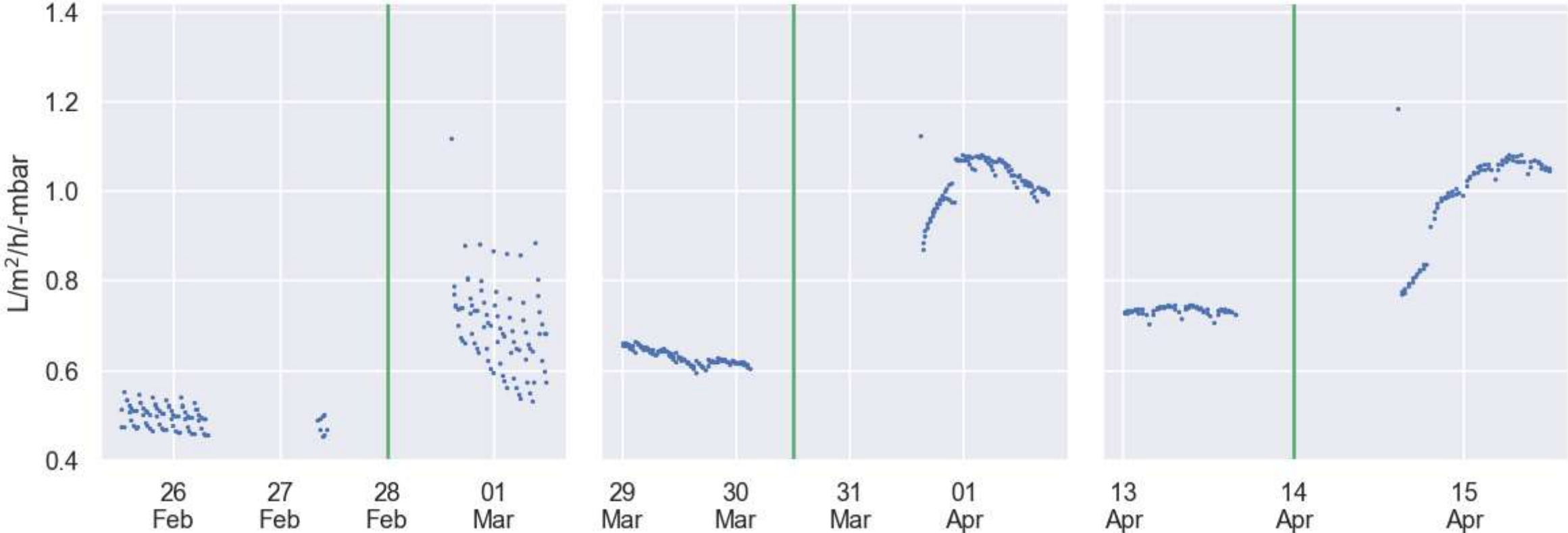
- Supplier needs to provide performance guarantees
- Supplier needs to specify or provide pre-treatment
- Good raw water quality data is needed

Sludgeepocalypse



Results – Recovery Soaks

Recovery of Specific Flux at 20°C



Operational Experience



Conclusions



Acknowledgements



Sludgepocalypse



Integrity Test

- Non-Destructive Performance Test (NDPT)
 - 3 minute pressure decay test
 - To find out...
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- https://www.cerafiltec.com/wp-content/uploads/2023/03/NSF-419-DIT_CFT-0000-SBMSEC4-2022.pdf