

2017
**Membrane
Technology**
CONFERENCE & EXPOSITION



ILCA[®]: In-line Coagulation and Adsorption for Pre-treatment to Ceramic Microfiltration

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Acknowledgements

- PWN Water Supply Company North-Holland, Netherlands
- Metawater, Japan
- RWB, Netherlands
- Het Waterlaboratorium, Netherlands
- Rob Kooijman PWNT, Netherlands

Interreg

2 Seas Mers Zeeën

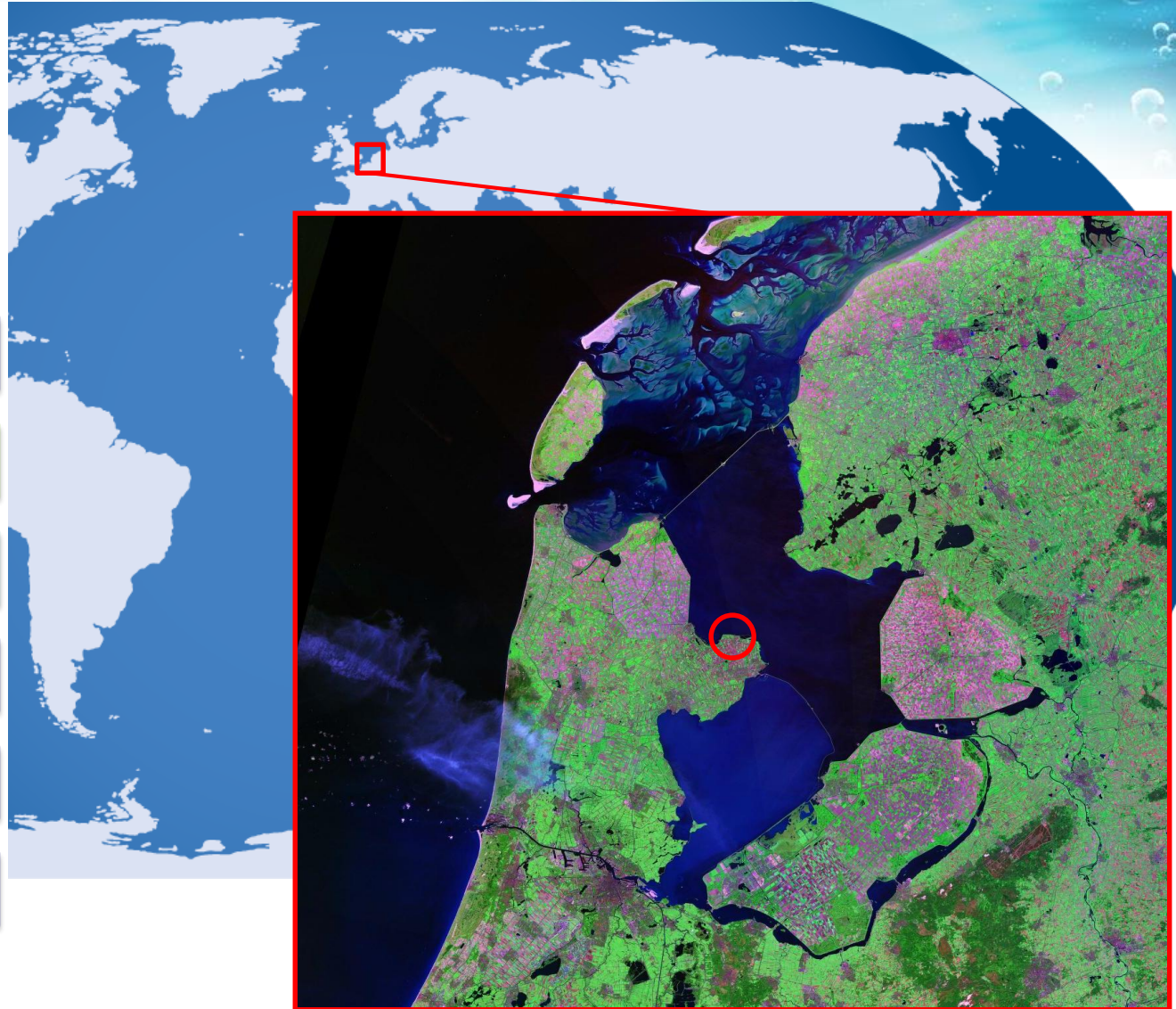
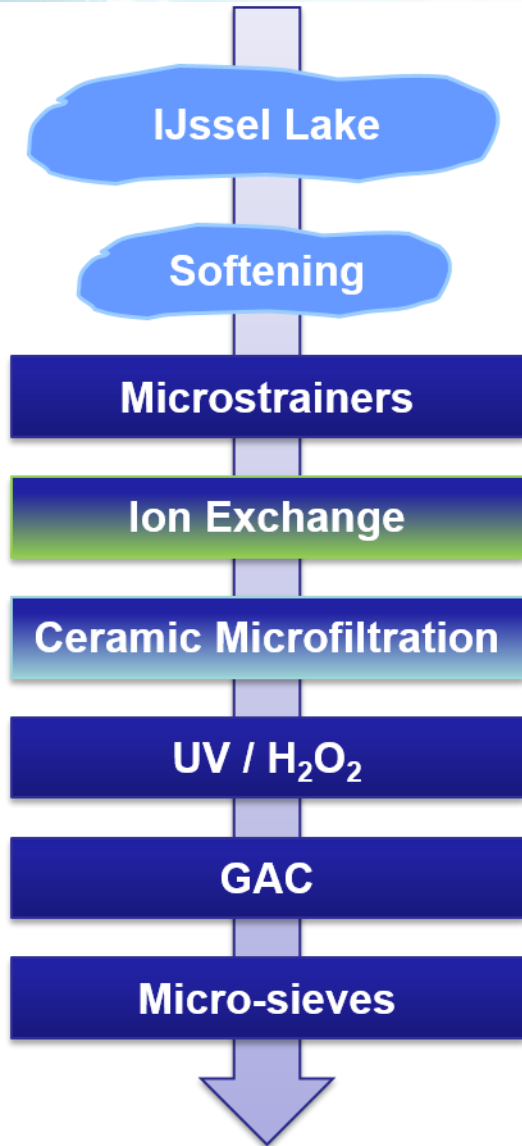
DOC2C's

European Regional Development Fund



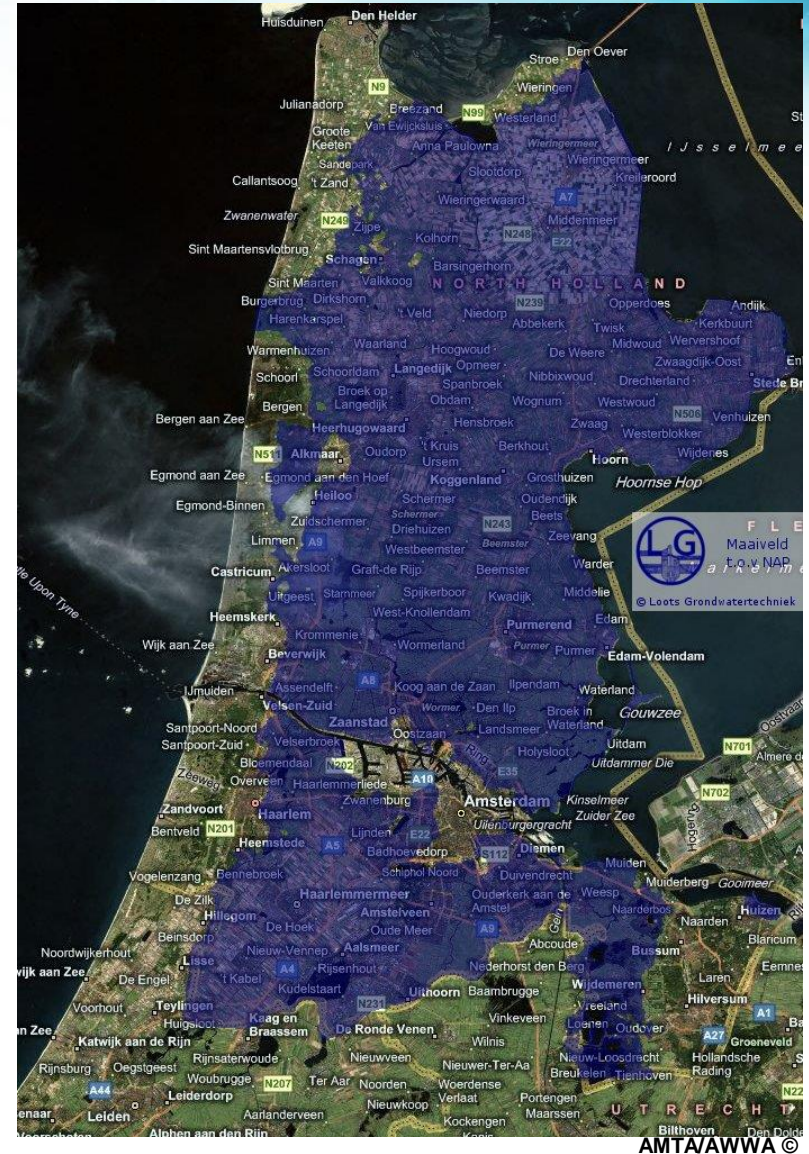
EUROPEAN UNION

Background

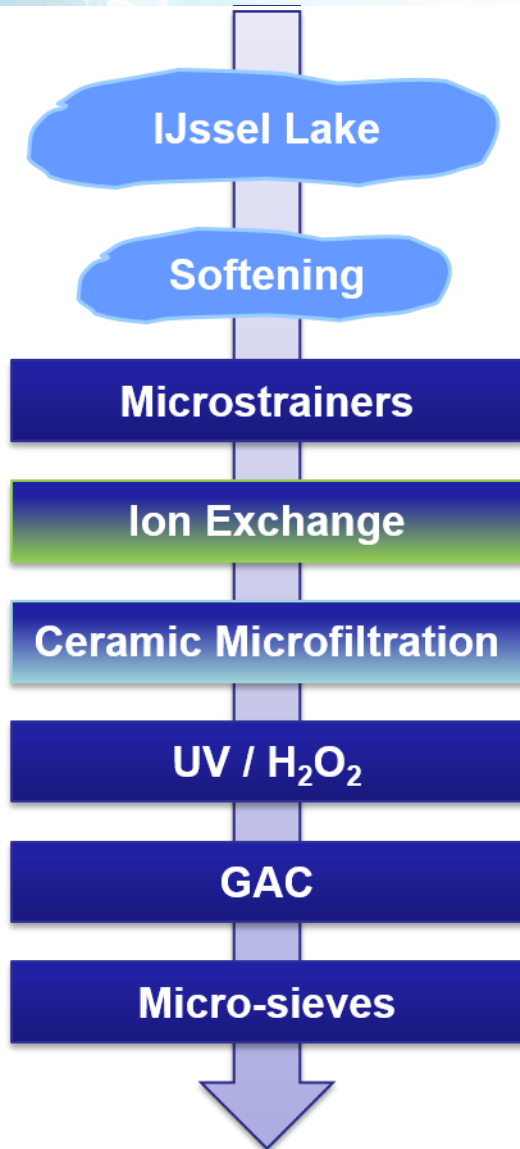


Water source challenge

- most Provence below sea level
- Salty groundwater
- IJssel Lake only available source
- dominantly fed by the river Rhine
- under the influence of industry, recreation, population
- high contamination level (delta of Europe)



Water treatment line



SIX[®] Suspended Ion Exchange

IJssel Lake

Softening

Microstrainers

SIX

Ceramic Microfiltration

UV / H₂O₂

GAC

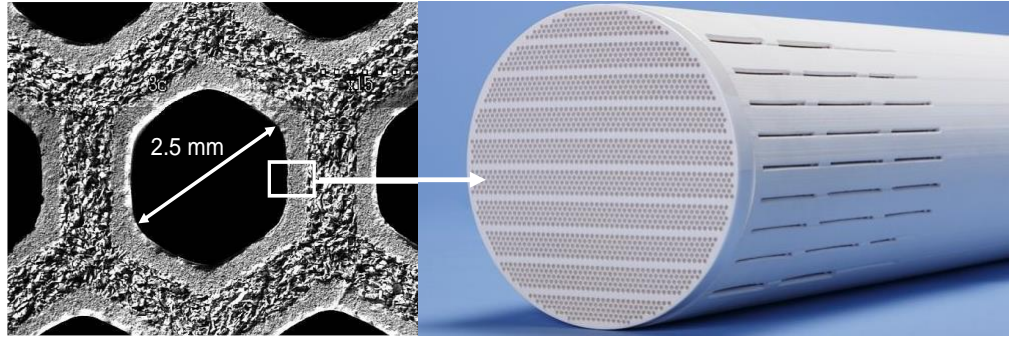
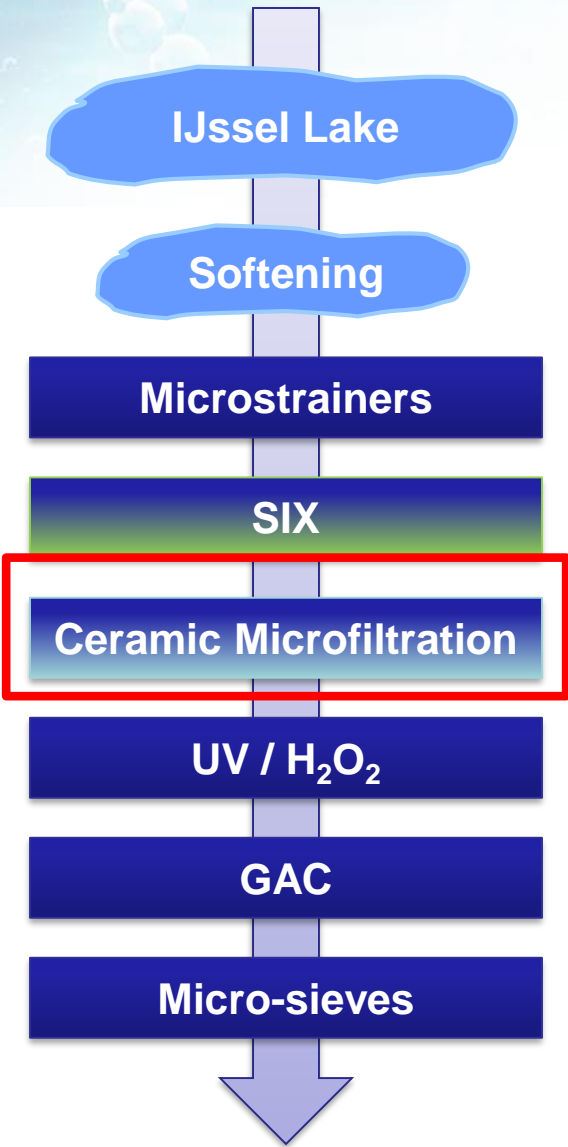
Micro-sieves

- anion exchange resin (Lewatit S5218)
- concentration 18 ml/l
- contact time 30 minutes
- 30 g/l NaCl for regeneration

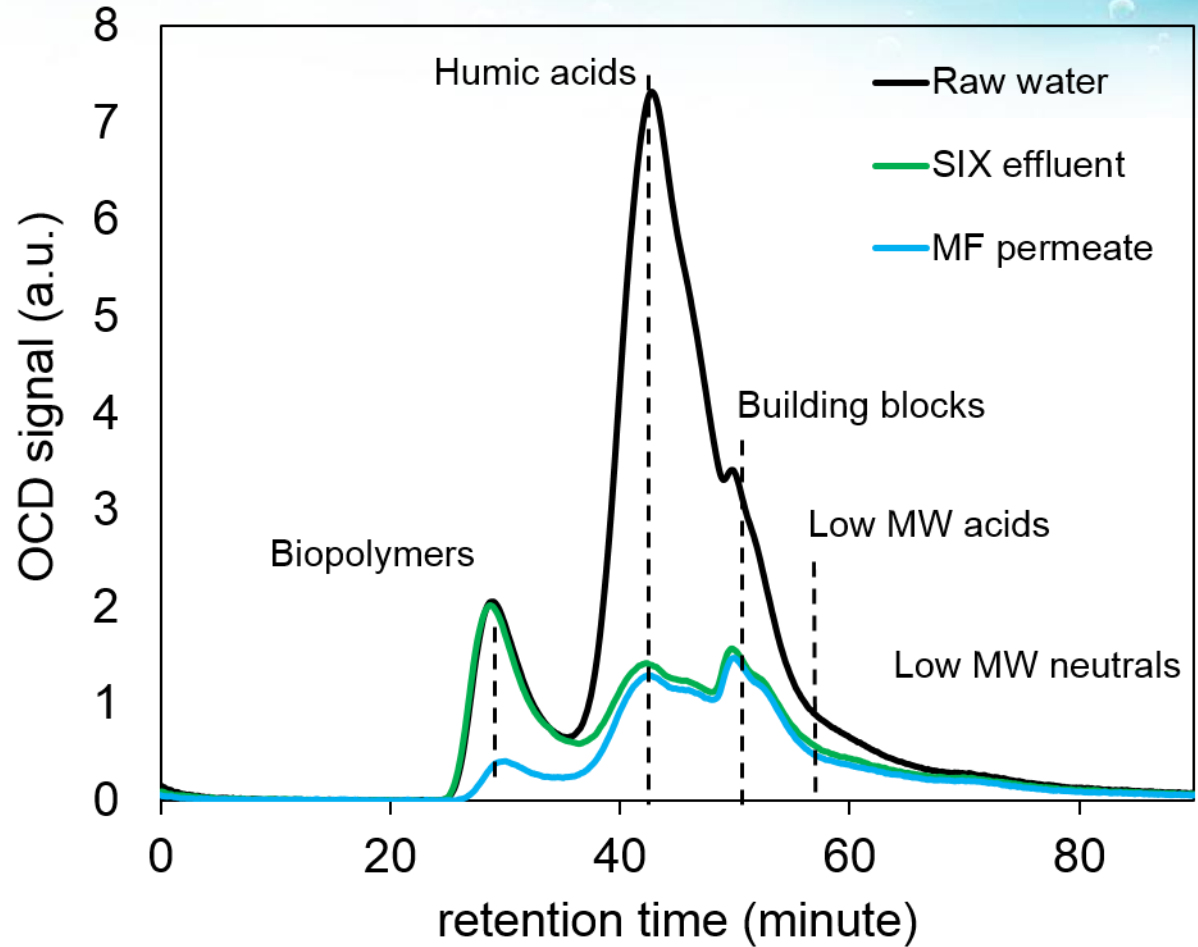
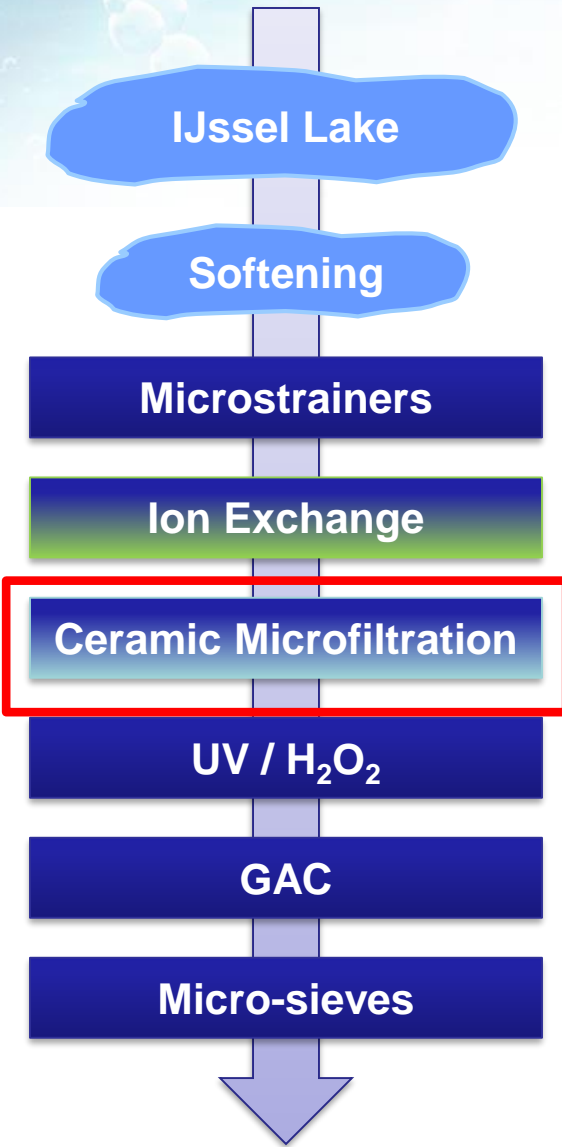


Performance evaluation SIX[®]-CeraMac[®] in comparison with conventional pre-treatment techniques for surface water treatment
Galjaard, G., Martijn, B., Koreman, E., Bogosh, M., Malley, J.
DOI: 10.2166/wpt.2011.066

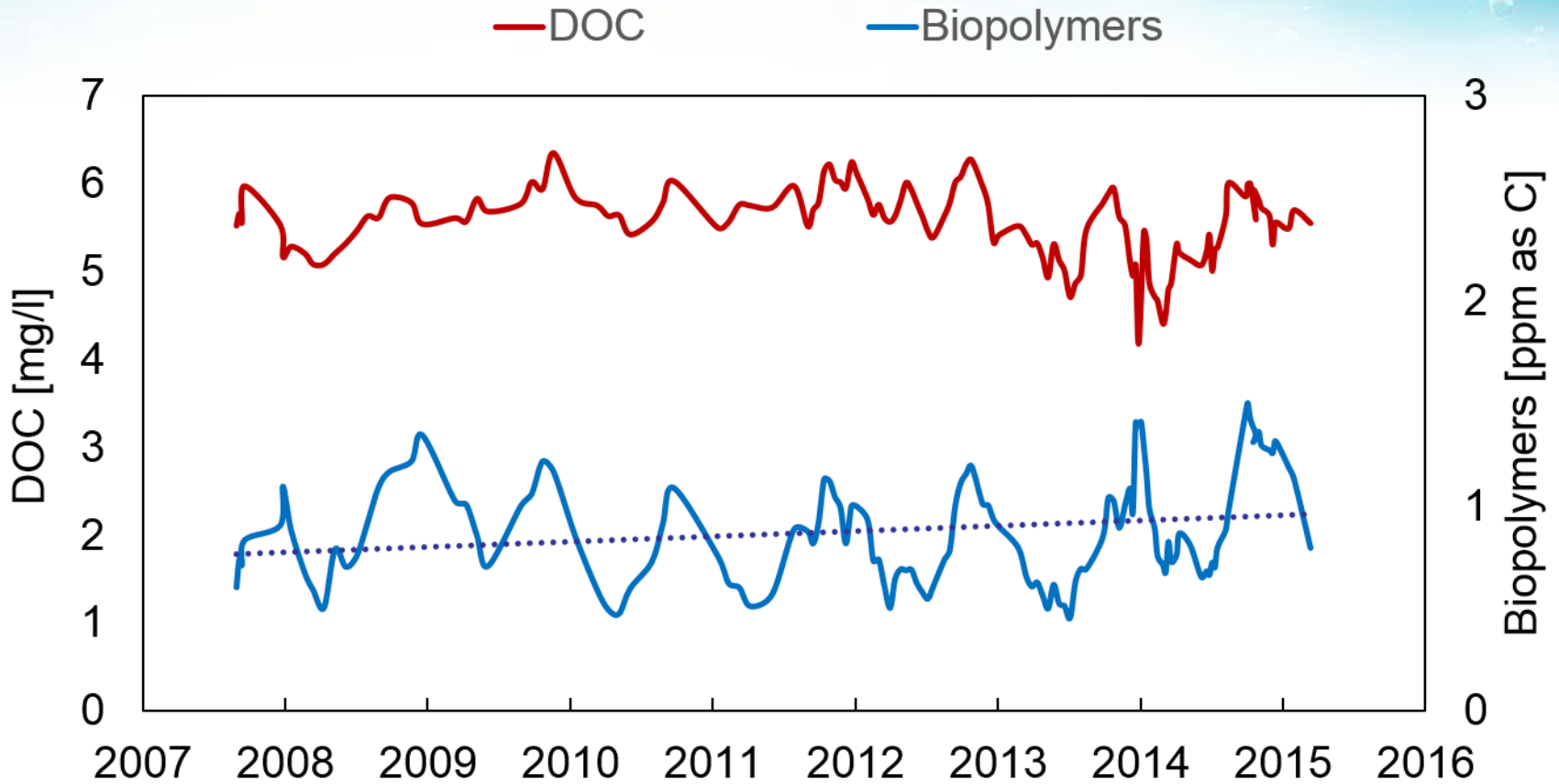
CeraMac[®] Ceramic Microfiltration



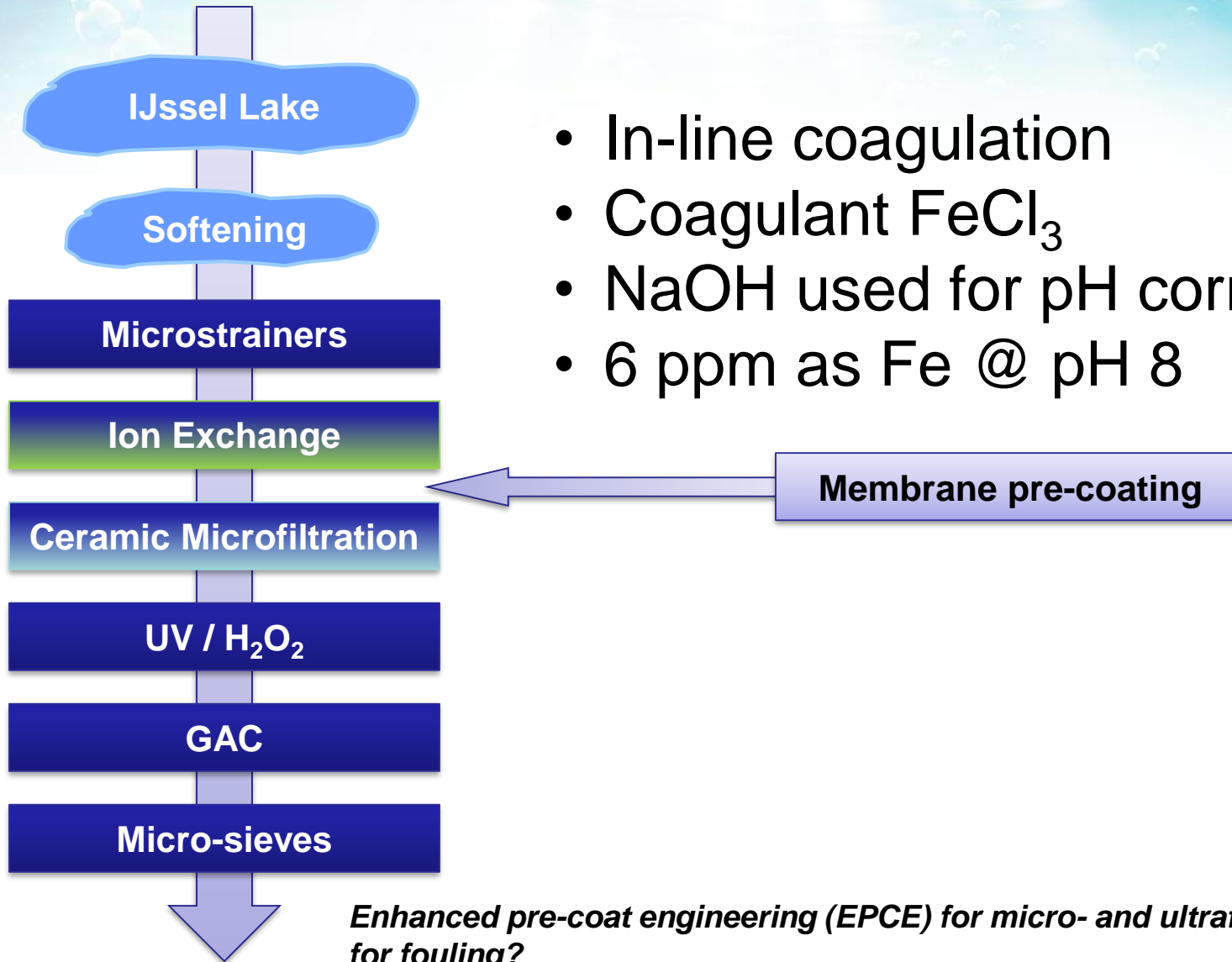
DOC removal



Water quality changes



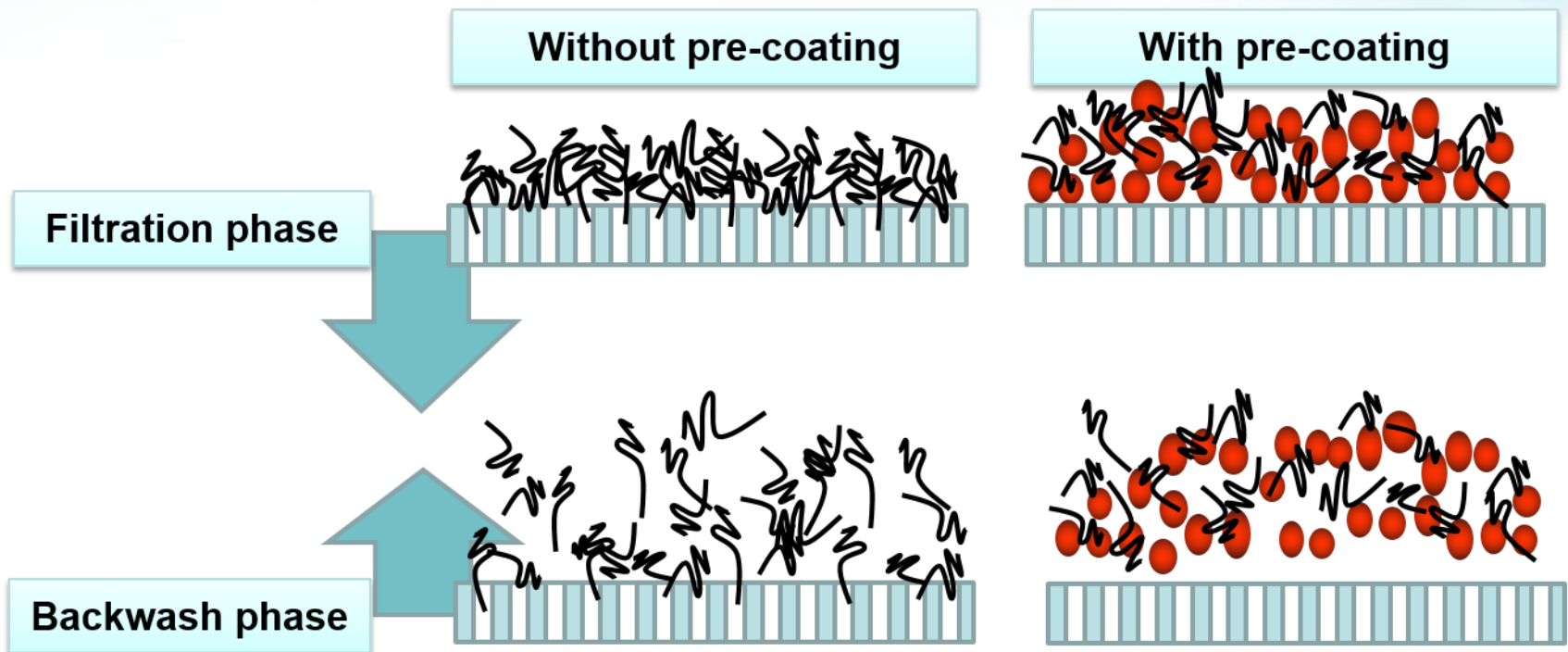
Additional step for fouling control



Enhanced pre-coat engineering (EPCE) for micro- and ultrafiltration: The solution for fouling?

Galjaard et al, Water Science and Technology: Water Supply 2001

Pre-coating mechanism model



 Biopolymers

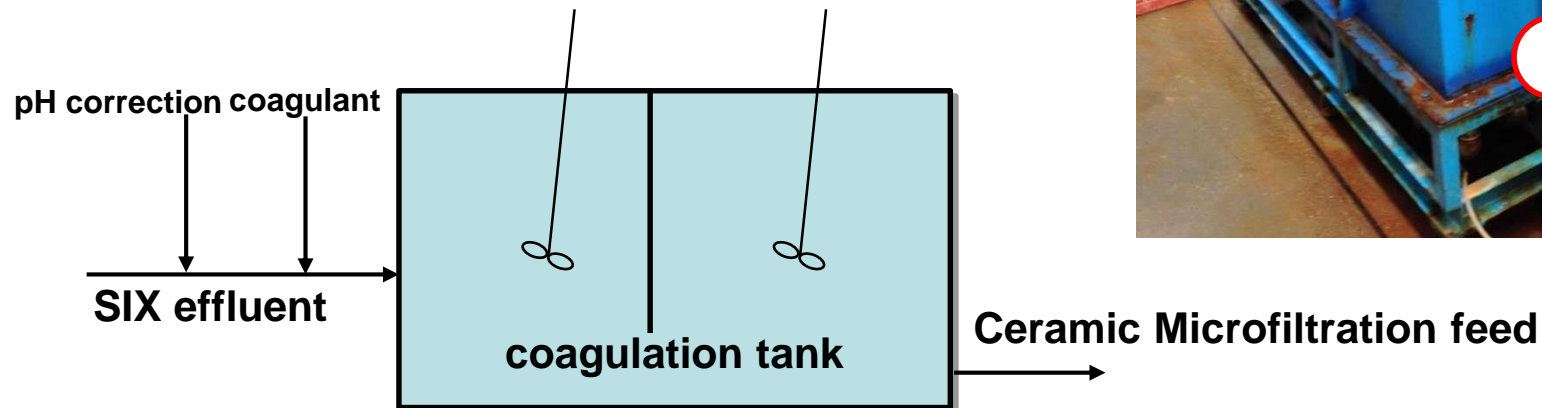
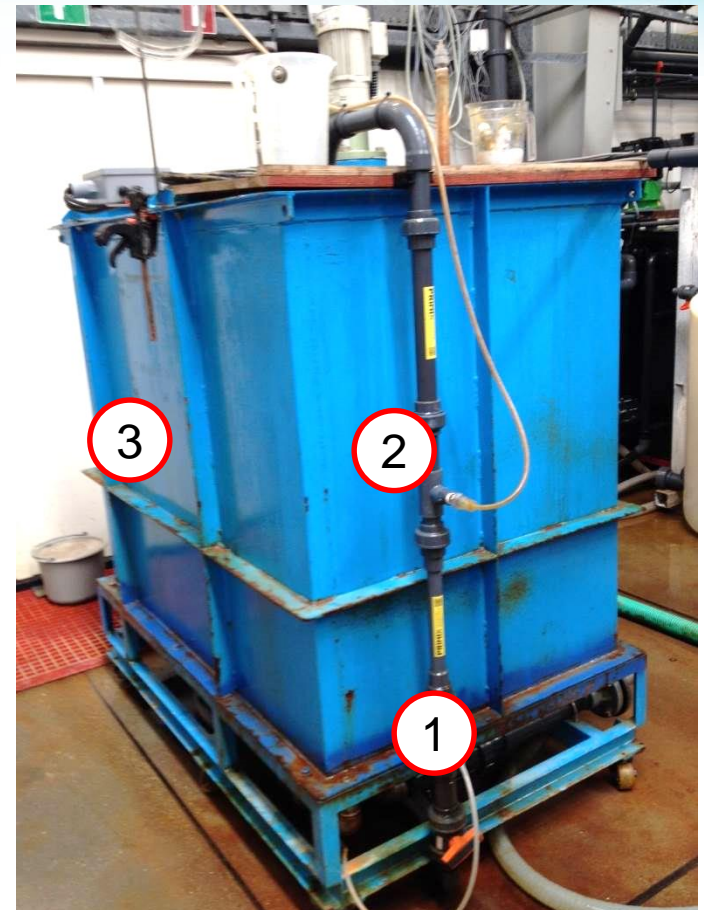
 Iron hydroxide particles

Objectives

- Feasibility of pre-coating for additional fouling control for ceramic microfiltration of surface water
- Comparison of conventional in-line coagulation system with the ILCA[®]

In-line tank coagulation/flocculation (TC)

- Volume $\sim 0.9 \text{ m}^3$ (243 gal)
 - Contact time 18 minutes
1. pH correction
 2. coagulant dosing
 3. flocculation (115 and 70 rpm)



In-Line Coagulation Adsorber (ILCA[®])

- Volume ~0.18 m³ (48 gal)
- Contact time 3.6 minutes
- Plug-flow conditions
- Specifically designed mixing inserts

Flow [m ³ /h]	G-value [s ⁻¹]	Contact time [s]	G _T value [-]
3	65	223	14521
4	97	165	16005
5	135	132	17820
6	178	110	19580
6.5	200	102	20400
7	224	95	21280



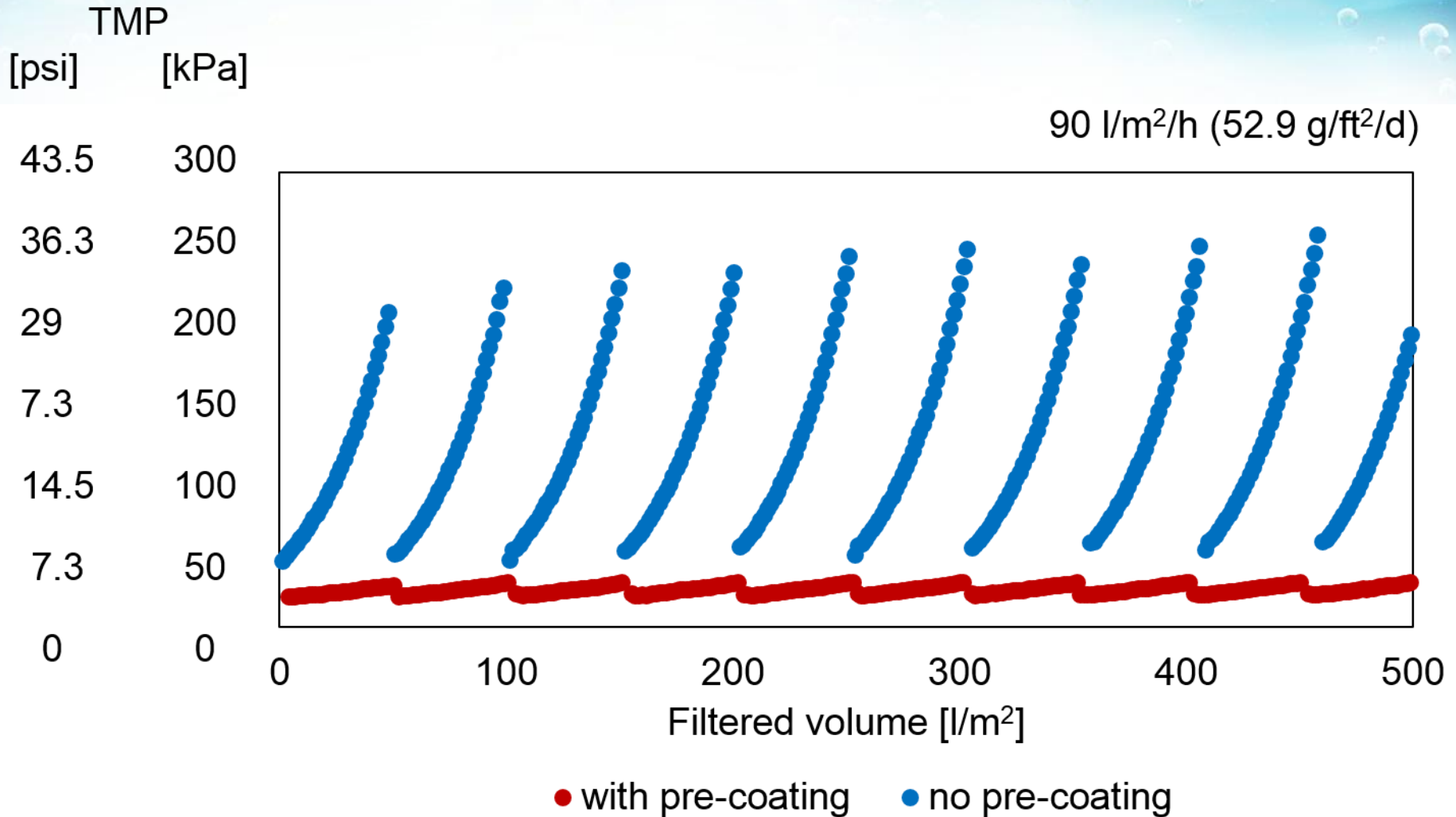
Filtration conditions

- **1st phase:** influence of filtration flux on membrane operation at 90, 150 and 200 l/m²/h (52.9, 88.2 and 118 g/ft²/d) [TC]
- **2nd phase:** influence of filtration time @ 120 l/m²/h (70.6 g/ft²/d) [TC]
- **3rd phase:** comparison of TC and ILCA systems @ 120 l/m²/h (70.6 g/ft²/d) and 60 minutes BW interval

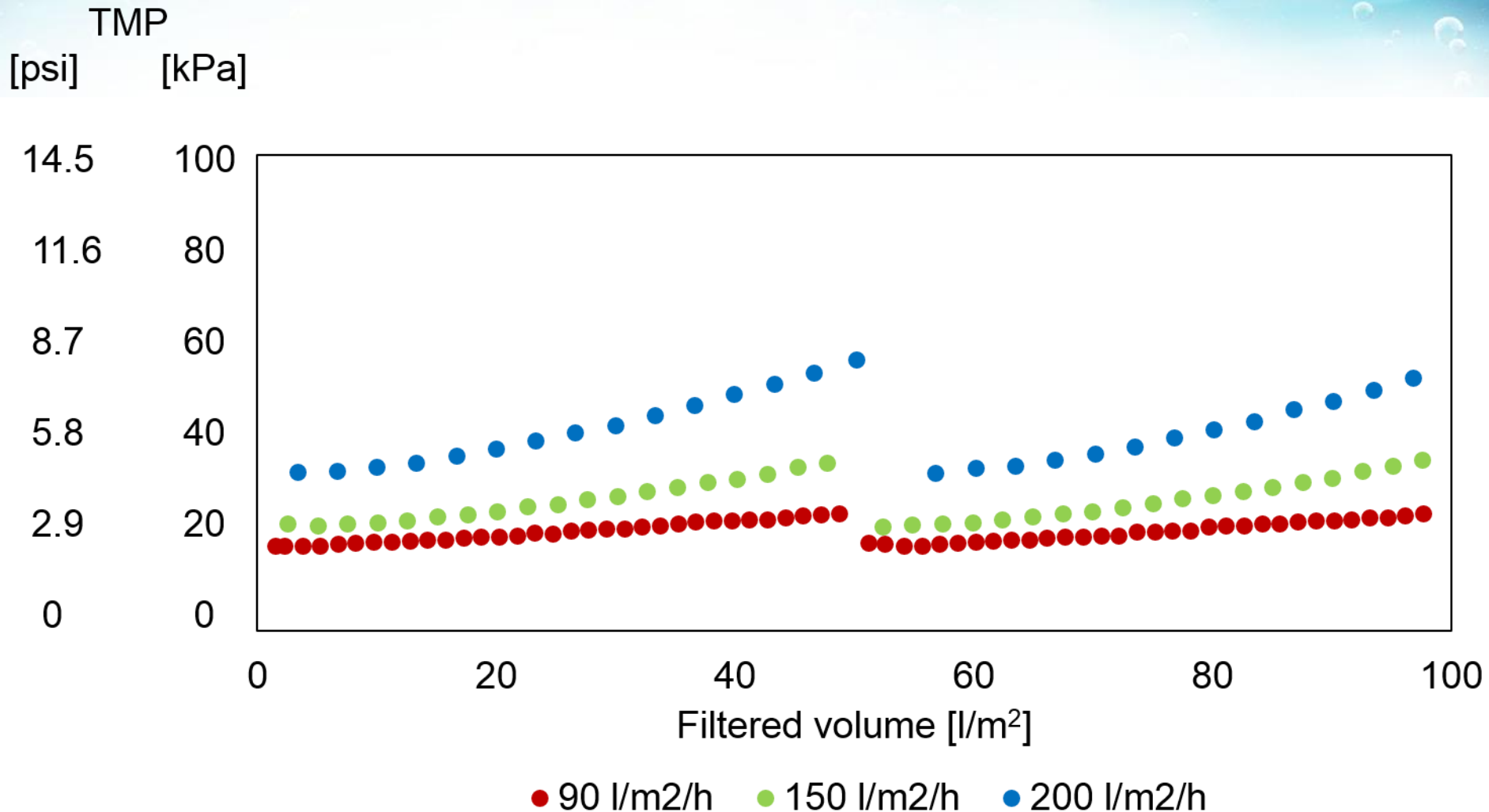
Cleaning regime

- filtration load until backwash (BW)
 - 50 l/m² (1.23 g/ft²) 1st 2nd phase
 - 120 l/m² (2.95 g/ft²) 3rd phase
- chemically enhanced backwash (CEBW) after 19 BWs
 - acidic CEBW with oxidant (pH 2.5, 100 mg/l H₂O₂)
 - alkali CEBW (100 mg/l NaOCl)

Pre-coating influence on TMP



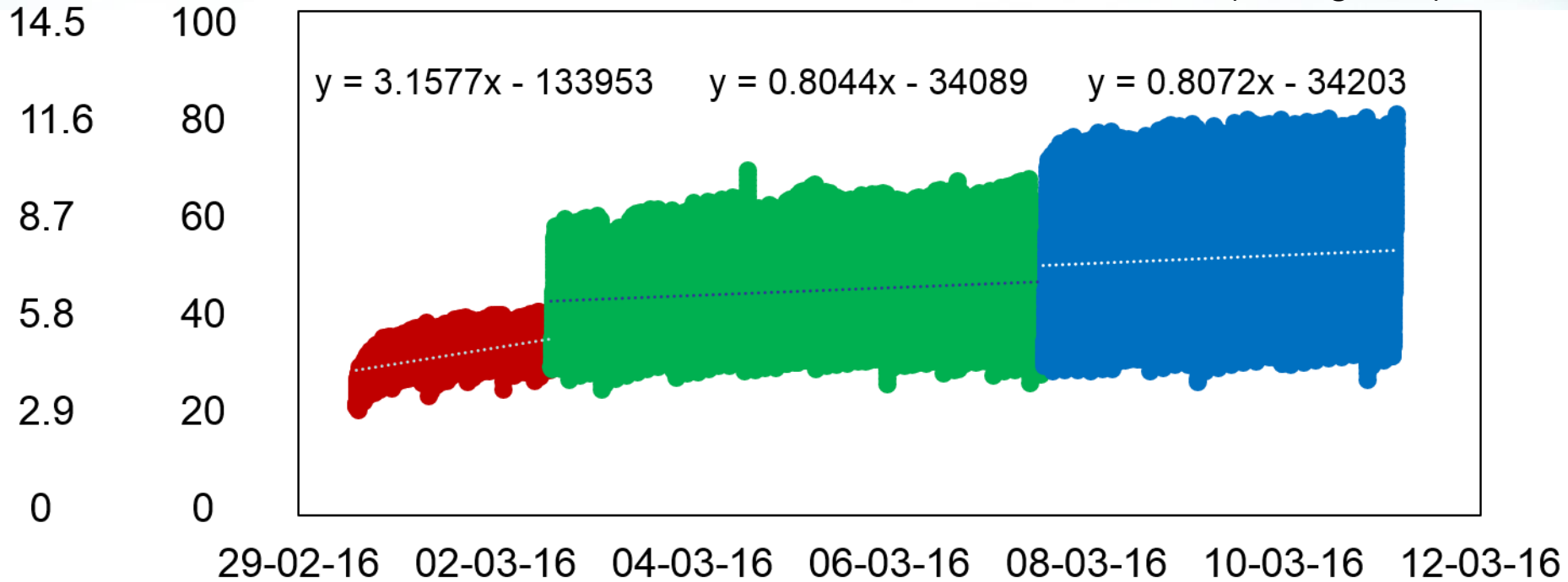
Filtration flux influence on TMP



Filtration time influence on TMP

TMP @ 10°C
[psi] [kPa]

120 l/m²/h (70.6 g/ft²/d)



● 25 minutes

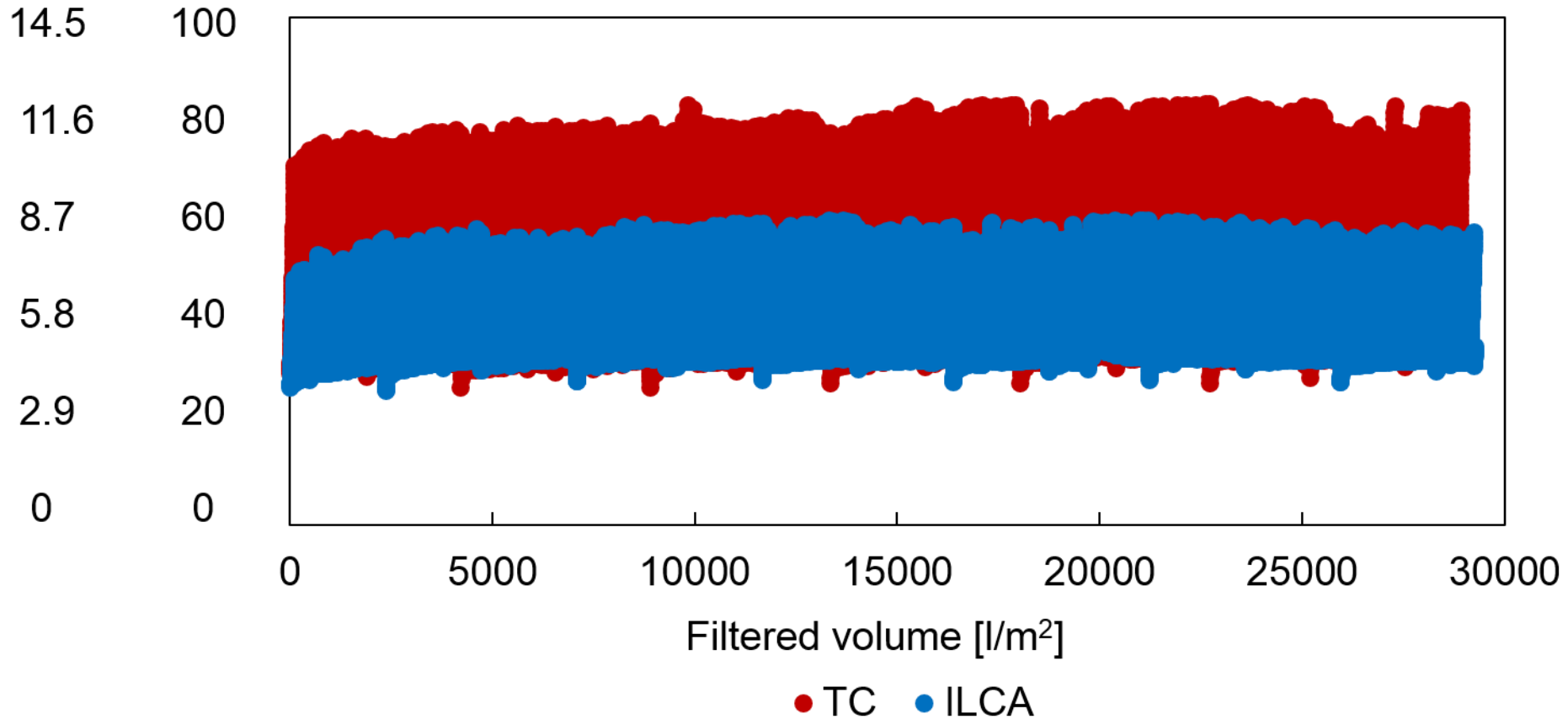
● 50 minutes

● 60 minutes

TMP comparison

TMP @ 10°C
[psi] [kPa]

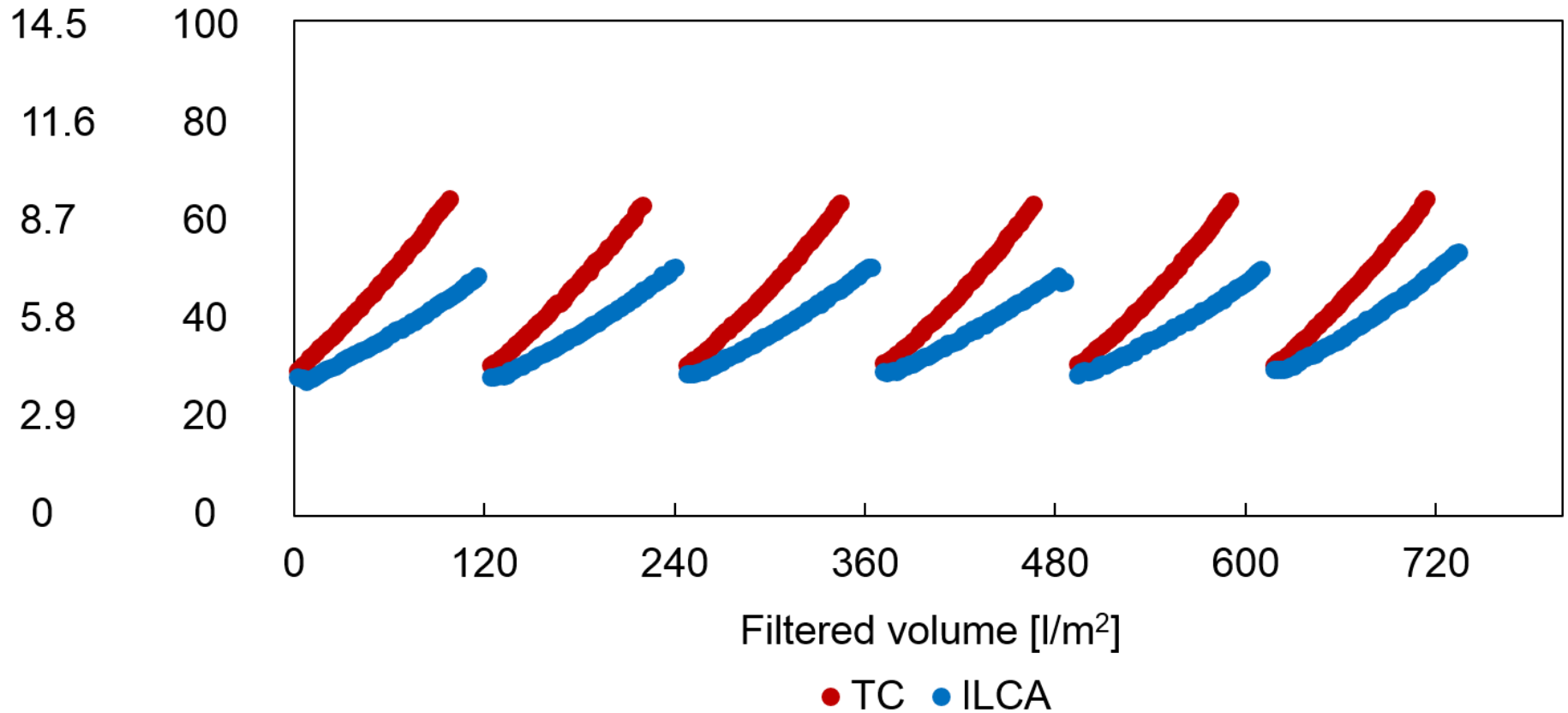
120 l/m²/h (70.6 g/ft²/d)



TMP comparison

TMP @ 10°C
[psi] [kPa]

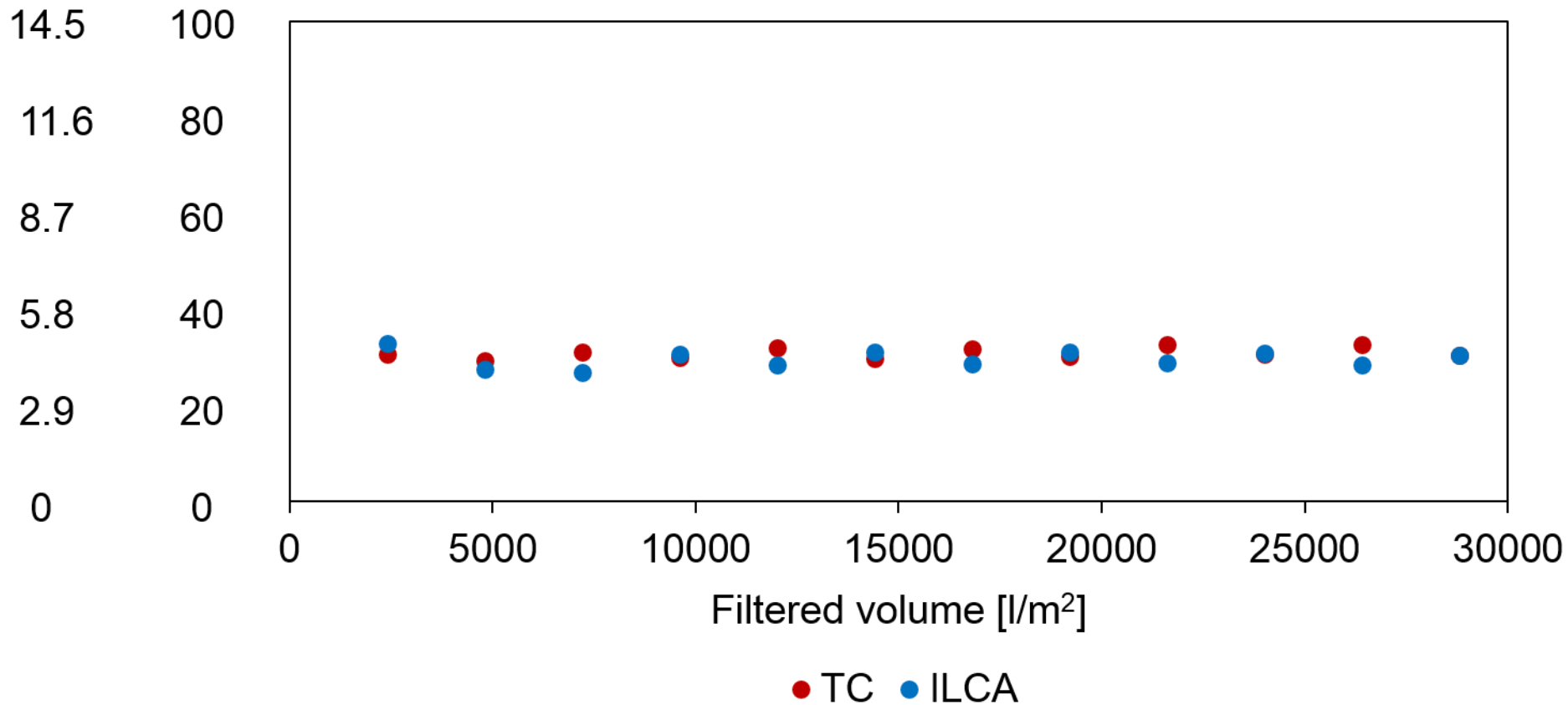
120 l/m²/h (70.6 g/ft²/d)



TMP after CEBW

TMP @ 10°C
[psi] [kPa]

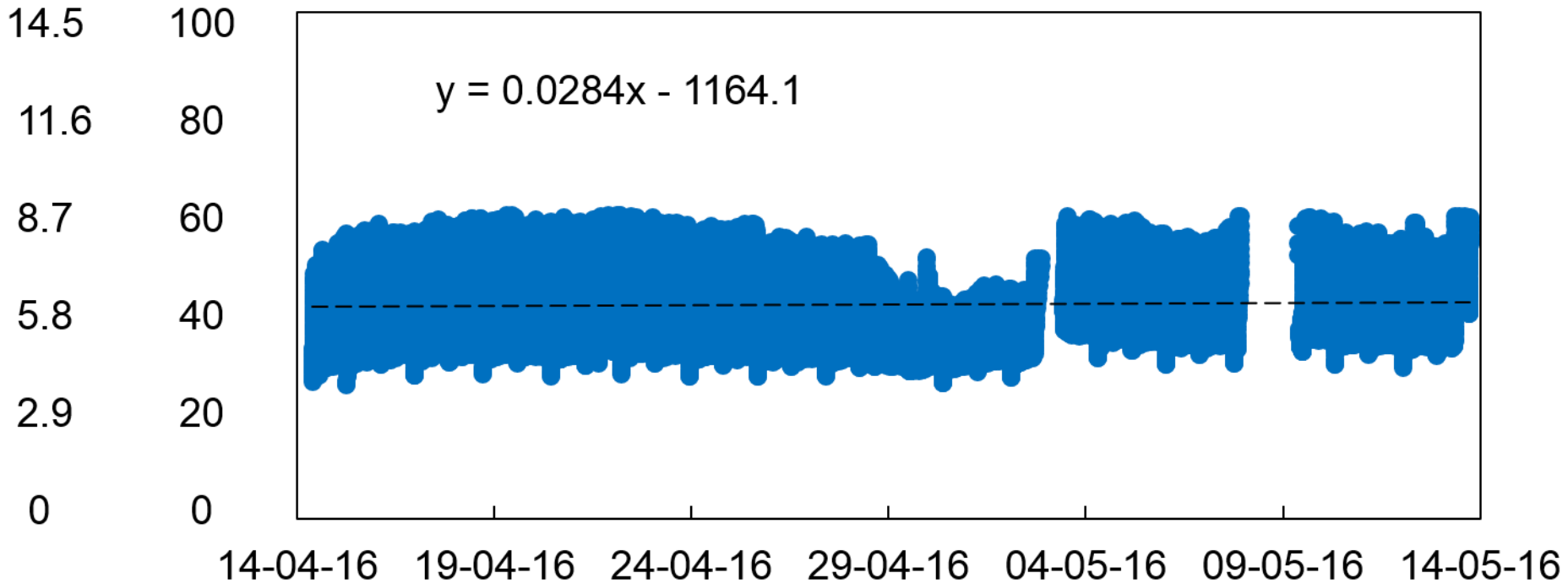
120 l/m²/h (70.6 g/ft²/d)



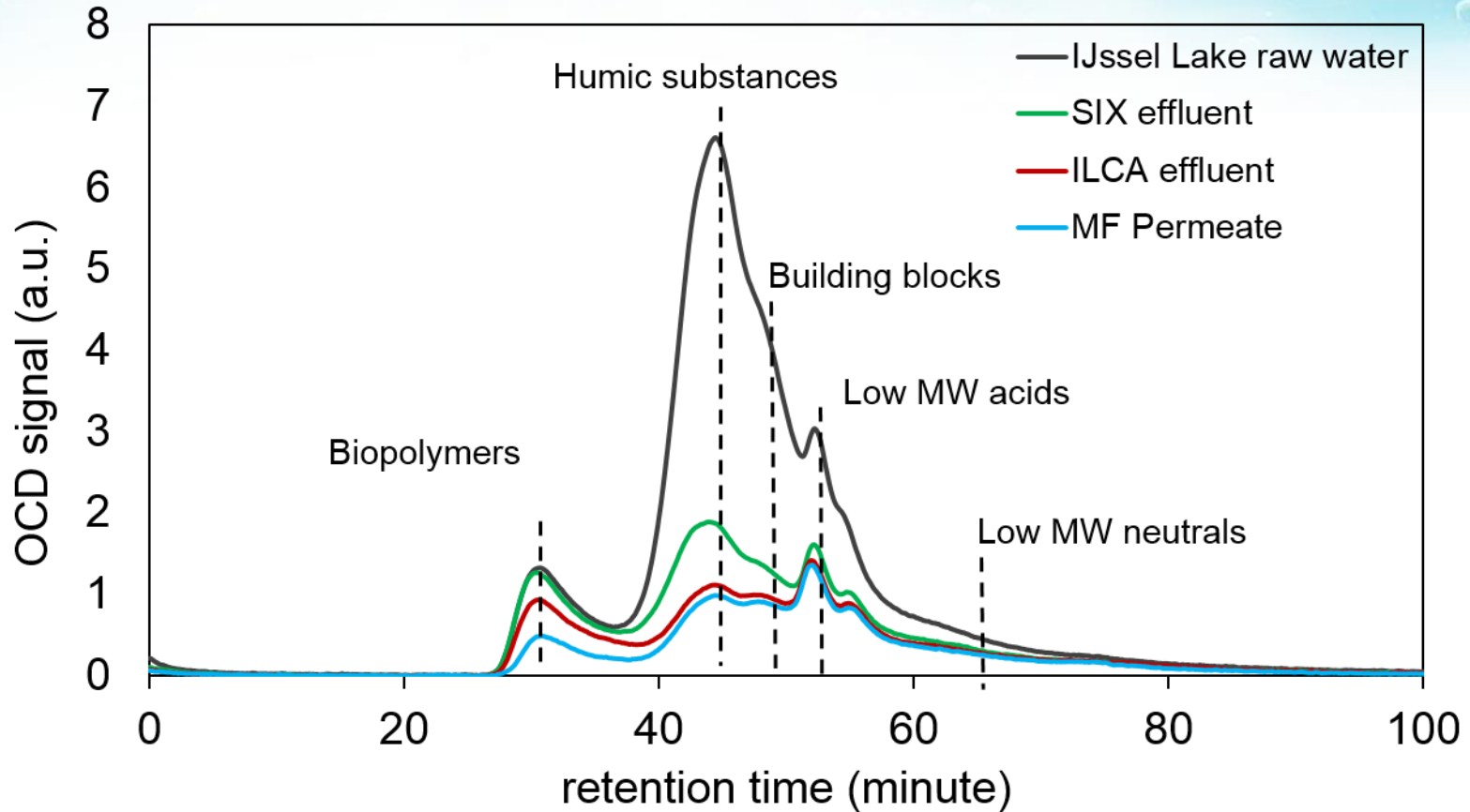
Month TMP development

TMP @ 10°C
[psi] [kPa]

120 l/m²/h (70.6 g/ft²/d)



DOC fractions



Conclusions

- Pre-coating is a good strategy for fouling control by biopolymers during MF
- ILCA[®] is a good alternative to the conventional TC systems
 - It provides comparable ceramic MF operations
 - Less footprint and shorter contact time
 - Constant G_T value independent of the flow
 - Easy to scale-up
 - No mechanical/moving parts (less maintenance)
 - Can be combined with adsorbent