Ceramic microfiltration; a novel and compact process for the treatment of surface water

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South West Water
Contents

• Motive and opportunity

• ILCA and Ceramic microfiltration

• DOC, membrane fouling and DBPs

• Full scale application
Acknowledgement
Who We Serve

South West Water

[Map showing locations such as Barnstaple, Exeter, Plymouth, Penzance, Truro, and surrounding areas in the UK.]

[Logos and text indicating European Regional Development Fund, 2 Seas Mers Zeeën, DOC2C’s, Water Technology, South West Water, Provincie Noord-Holland, De Watergroep, Université de Lille, TU Delft]
Motive
Opportunity

• Previous research at Mayflower

• DOC2C’s goals

• Need to upgrade the existing treatment facility
Treatment goals...

• Absolute Barrier to Cryptosporidium
• DOC / disinfection by product reductions
• Very compact, forward looking design
• Highly automatable, robust and efficient process
• Environmental impact/sustainability
• Keep consumer bills down in long term
Ceramic membranes

- Filtration area 25m², 180mm x 1500mm
- Size of monolith cost effective
- Al₂O₃ base layer, mysterious top layer = 0.1um
- Close to 100 plants, no integrity failures
- High solids loading /algal laden source??
- Mechanical wash at high pressure
- Chemical cleaning options?
- Cost and recovery issues when applied traditionally
Membrane fouling (previous research)

- Most important remove high MW compounds within DOC
- Good removal of these fractions lead to reduced / acceptable fouling
- Successful with coagulation for high SUVA river sources
- What about low SUVA/high algae sources?
Raw water algae concentrations...

Total Algae (Cells/ml)

- Aphanizomenon flos-aquae
- Anabeana sp.
- Gomphosphaeria sp.

Date:
- 15-02-2015
- 06-04-2015
- 26-05-2015
- 15-07-2015
- 03-09-2015
- 23-10-2015
- 12-12-2015
- 31-01-2016
Pilot process

Piloting evaluation
June ‘15 – August ‘16

NaOH
HCl
Coagulant

NaOCl
HCl/H₂O₂
Ozone?

Backwash Tank

CeraMac Vessel

Backwash Waste

Argal/College No.4 Reservoirs

Raw Water Tank

In-line Coag
12 months of piloting testing

- 23 membrane test runs
- Membrane cleaning
- PACl vs. ferric sulphate
- DOC removal and DBPFP
- O3 mini CIP (10 min cleans) and prolonged CIP
Critical flux testing

a) 150 l/m²h low algal loading
b) 200 l/m²h low algal loading
c) 200 l/m²h high algal loading
d) 250 l/m²h high algal loading

Adapted from Floris et al. 2017
Alternative CIP approach

Specific Flux (lmh/Bar at 10°C) vs. CIP circulation time (minutes)

- **O3 CIP ~10mg/l**
- **Caustic NaOCl CIP pH 12 1000mg/l**
Ozone vs chlorine CEB’s

Coagulation pH out of range

Ozone CEBs

Chlorine CEBs

Date

0
10-12-2016
12-12-2016
14-12-2016
16-12-2016
18-12-2016
20-12-2016

TMP (kPa)

0
50
100
150
200
250
LC-OCD organic removal

Retention time (minute)

OCD relative signal response

- Argal raw water
- WTW Filtered
- CeraMac Outlet PACl
- CeraMac Outlet Ferric

Humic Substances (HS) - ~1000 Daltons

Biopolymers - >20000 Daltons

Building Blocks - 300-550 Daltons

LMW acids / HS - <350 Daltons

LMW Neutrals <350 Daltons
By products

The bar chart shows the levels of Total THMFP (µg/l) and DOC (mg/l) at various sampling points:

- Argal Raw: High levels of Total THMFP and DOC
- WTW Combined Filtered: Moderate levels of Total THMFP and DOC
- CeraMac Permeate PACI: Moderate levels of Total THMFP and DOC
- CeraMac Permeate Ferric: Low levels of Total THMFP and DOC

The chart indicates a general trend of decreased THMFP and DOC levels as the water moves through the treatment process.
Footprint reduction and buildability
Acknowledgments...
Good, safe, drinking water that has the trust of our consumers