



***SILHORKO***  
A GRUNDFOS COMPANY

Use of ion exchange resins to remove PFAS

Henrik Tækker Madsen, Application Manager, [hema.dk@silhorko.dk](mailto:hema.dk@silhorko.dk)



AGENDA

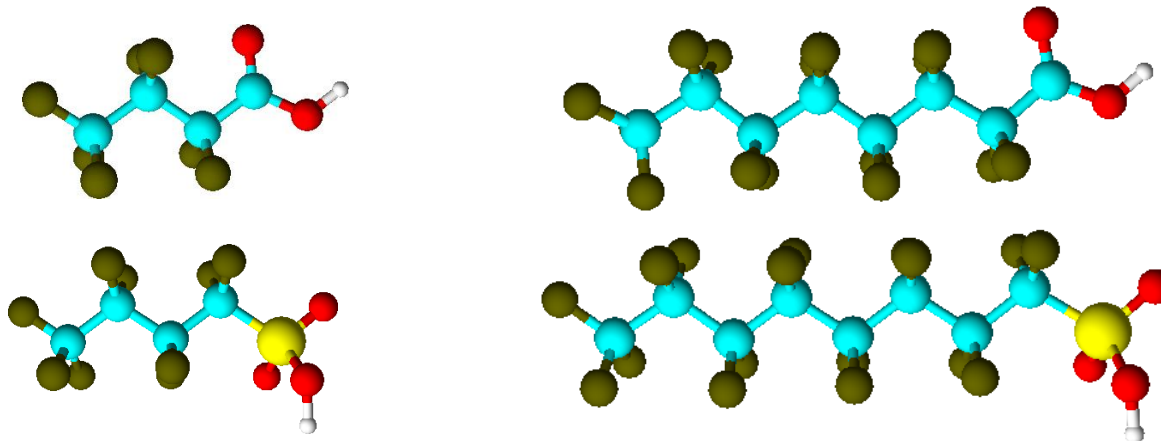
- **What is PFAS?**
- **Methods of treatment**
  - Active carbon
  - Ion exchange
- **Case: Fanø**
  - What was the problem?
  - Results from tests with AC and IEX
  - Status

# PFAS – Physiochemical overview

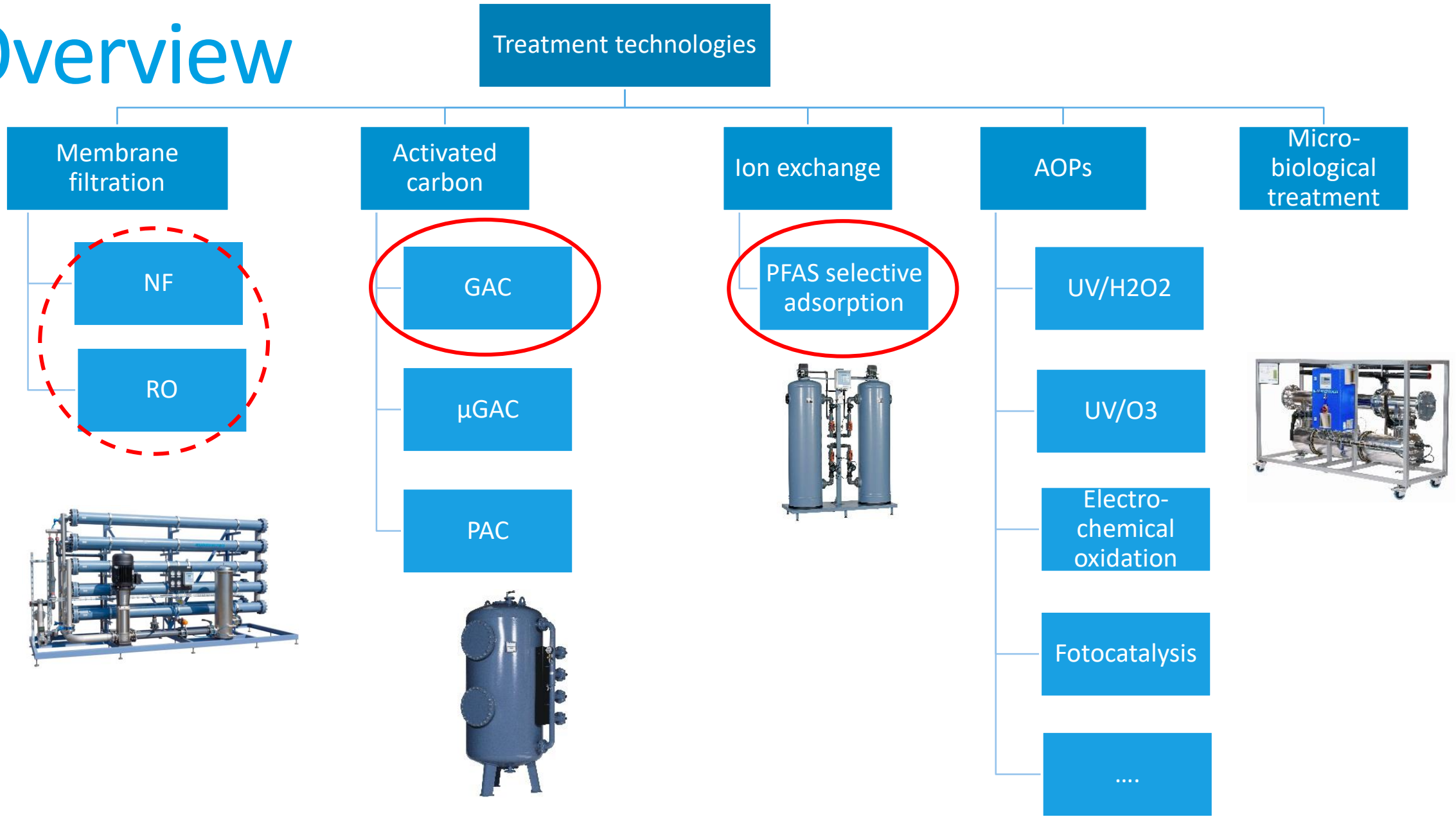
Short	Formula	MW (g/mol)	Md (nm)	LogK <sub>ow</sub>	Charge
PFAS					
PFOS	C <sub>8</sub> HF <sub>17</sub> O <sub>3</sub> S	500.1	-	-	n
PFOA	C <sub>8</sub> HF <sub>15</sub> O <sub>2</sub>	414.1	-	-	n
PFBS	C <sub>4</sub> HF <sub>9</sub> O <sub>3</sub> S	300.1	-	-	n
PFBA	C <sub>4</sub> HF <sub>7</sub> O <sub>2</sub>	214.0	-	-	n

## PFAS characteristics

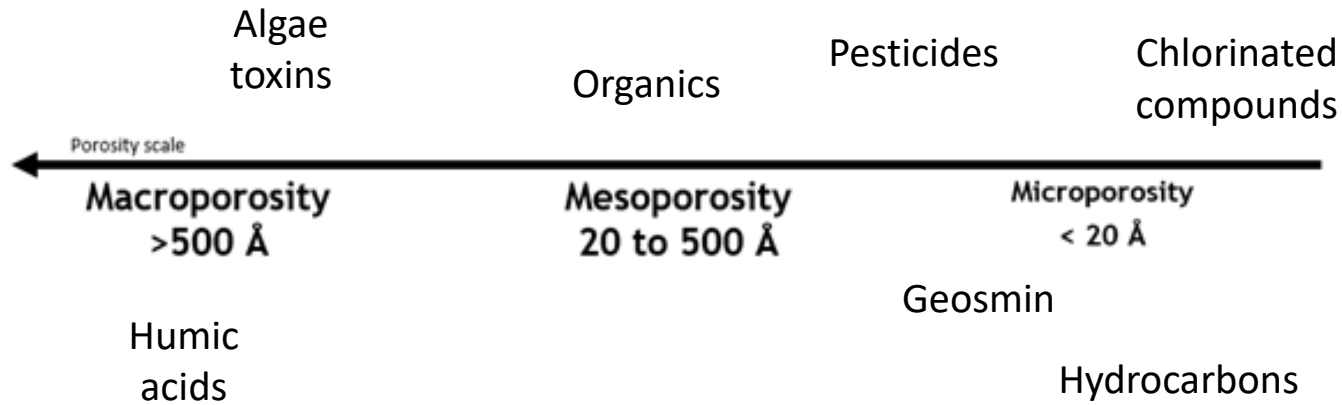
- Non-polar fluoro-carbon-chain (the "tail")
- Polar and ionic functional group (the "head")
- **Variation in behaviour with "tail" length**
- Functional group is typically either carboxylic acid or sulfonic acid (A/S)



# Overview



## ”Carbon is not just carbon”



## Activated carbon

Removal through adsorption



Preference for long chain  
PFAS

Large molecules use macropores

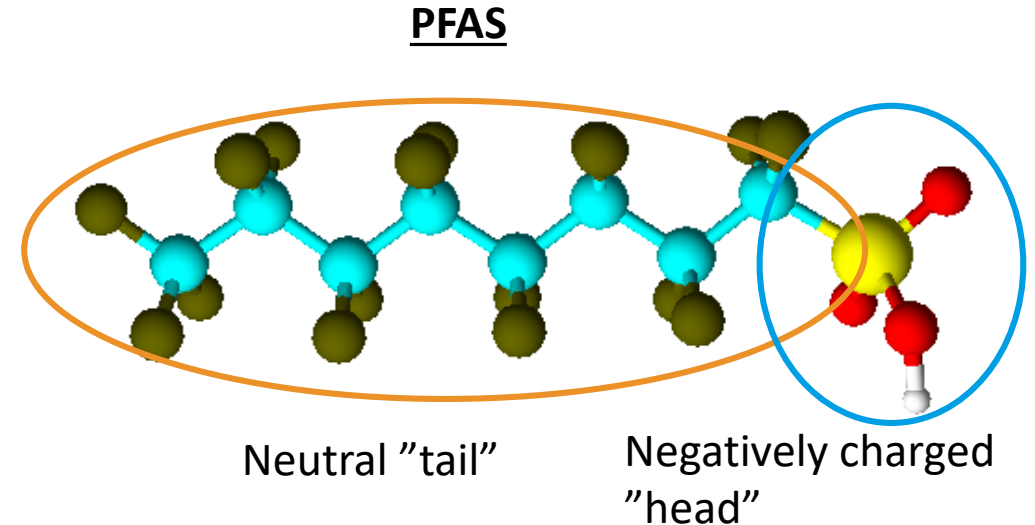
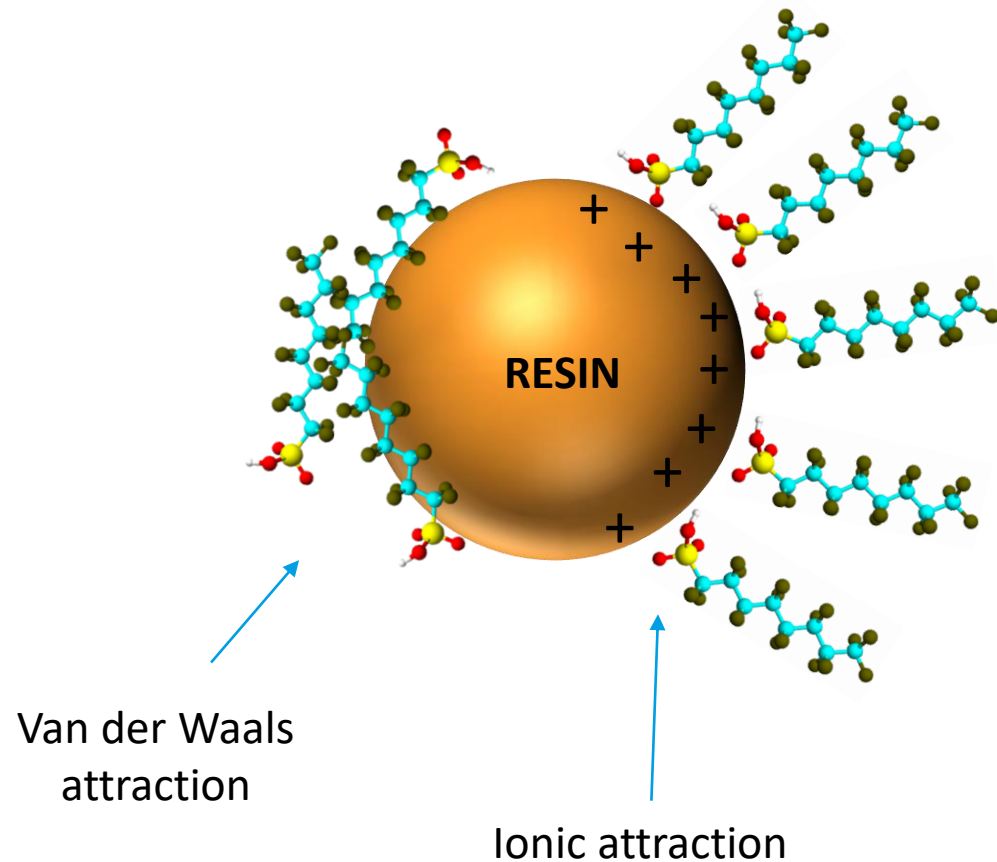
Small molecules use micropores

Fun fact:

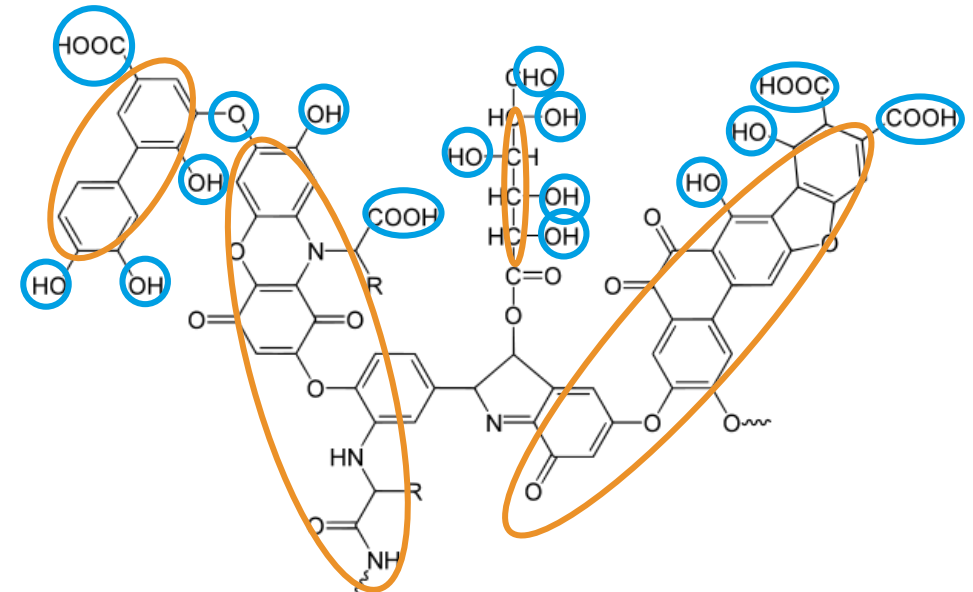
*5 g activated carbon has the same  
surface area as a football field*

# PFAS removal by IEX

A combination of two mechanisms



## Humics acids as a competing adsorbant



# Selective Ion Exchange

## Advantages

- Simple installation
- Very high water recovery
- Removes the contamination selectively
- The contaminants are bound to the resin
- No reject-water with elevated level of contamination

## Disadvantages

- Expensive resin
- The capacity is consumed, the resin must be replaced
- Handling/disposal of spent resin
- Pretreatment may be required

# *Case Fanø*



# PFAS on Fanø

HIGH VISIBILITY CASE



**PFAS VÆK PÅ FANØ**

NYHEDERNE



**Information**  
**Nyt vandrensningsanlæg fjerner PFAS fra drikkevand**  
Arbejdet med vandrensningsanlægget begyndte i september 2022. Det står nu færdigt på Fanø.

ING/WATERTECH

BRANCHENYT

## Så er ionbytter-anlægget på Fanø i gang med at rense PFAS-drikkevand



SØREN DUCH-HENNINGS  
Produktspecialist, Silhorko Eurowater

NYHEDERNE

NYHEDER DEN KØBENHAVNSKE TIDNING

### Nu kan Fanø borgere snart drikke vand uden PFAS

**FANØ POSTEN**  
- hele øen rundt!

Så har Fanø Danmarks reneste vand

### Første anlæg i Danmark: Ny metode til at fjerne PFAS fra grundvandet

SE

### Her renser de drikkevandet for PFAS

Fanø har netop indviet et vandrensningsanlæg, der fjerner PFAS i drikkevand

AF RIZBU

EN DEL AF WATCH MEDIER

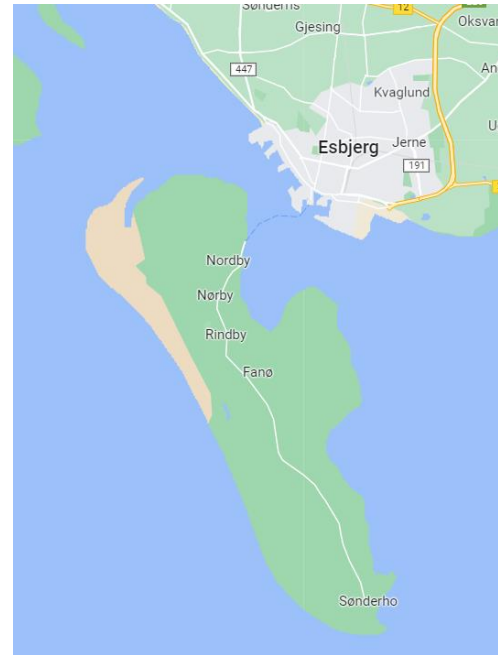
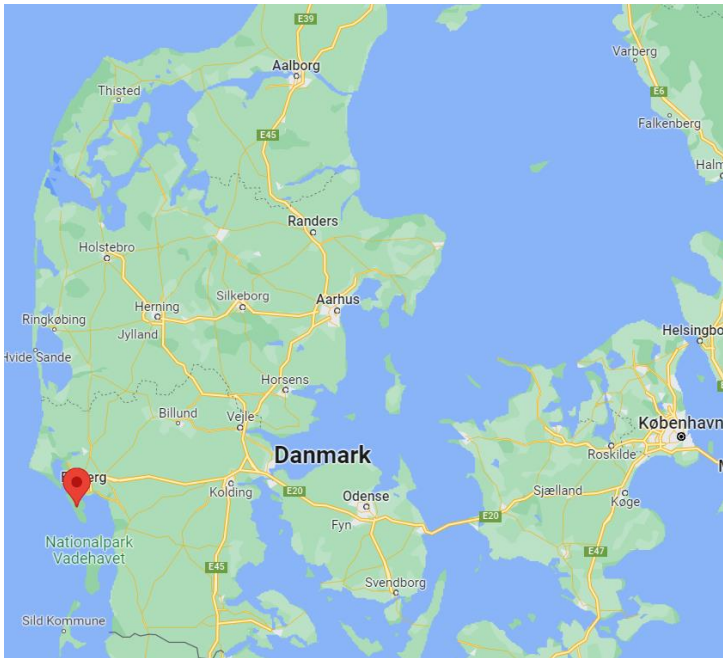
## CLEANTECHWATCH

MILJØTEKNOLOGI AFFALD VAND RÅDGIVNING REGULERING

04.04.2023 | kl. 14:17 | MILJØTEKNOLOGI

### Fanø Vandværk har taget længe ventet renseteknologi mod PFAS i brug

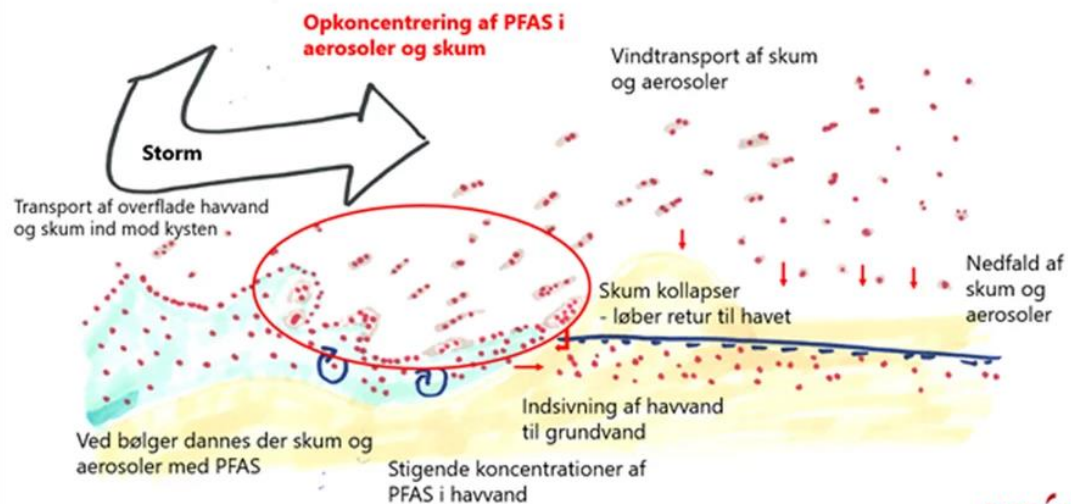
Et vandbehandlingsanlæg baseret på ionbytningsteknologi er netop sat i drift på øen. Analyser viser, at der ingen målbar PFAS er tilbage i vandet.



## THE PROBLEM

- Isolated island
- Several wells on the island, all contaminated
- Contamination ~4 ng/L

## Spredning af PFAS fra havet til land under storm



Source: NIRAS  
<https://www.niras.dk/indsigt/pfas-i-havet-en-kilde-til-forurening-paa-landjorden/>

## THE POTENTIAL SOLUTIONS

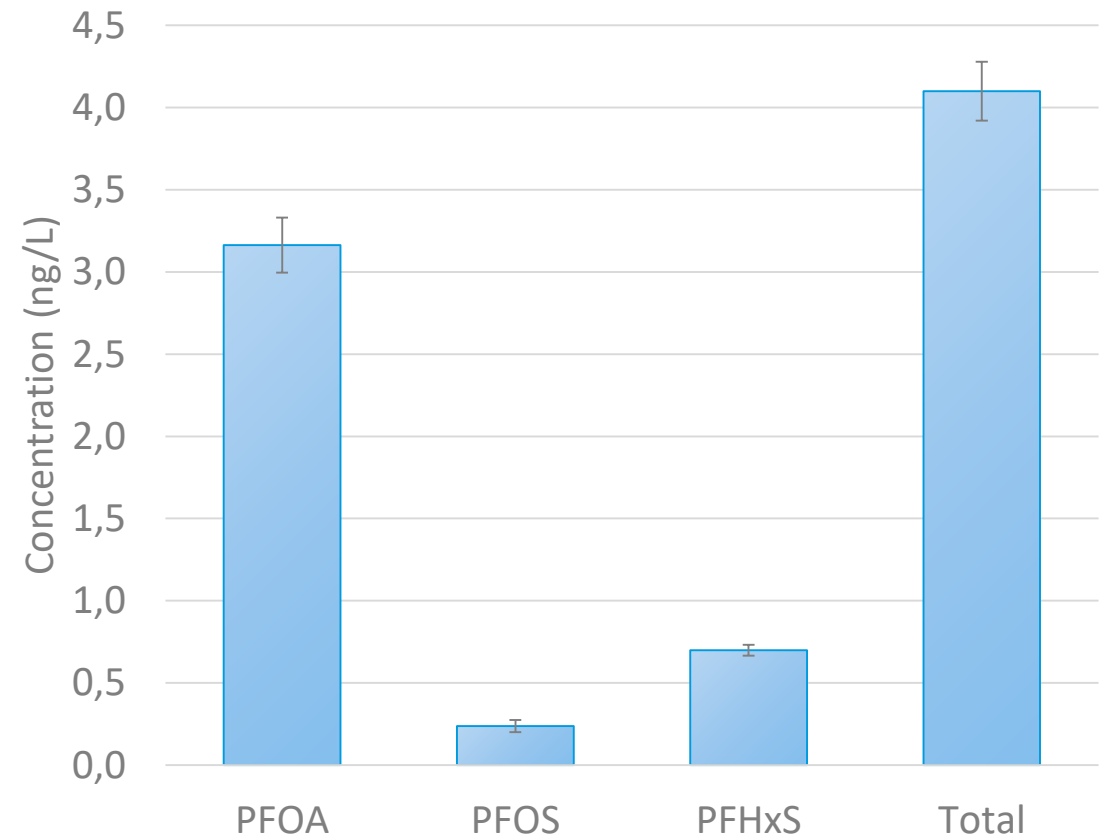
1. Import drinking water from the mainland Esbjerg
2. Treat water for PFAS

## Danish Legislation

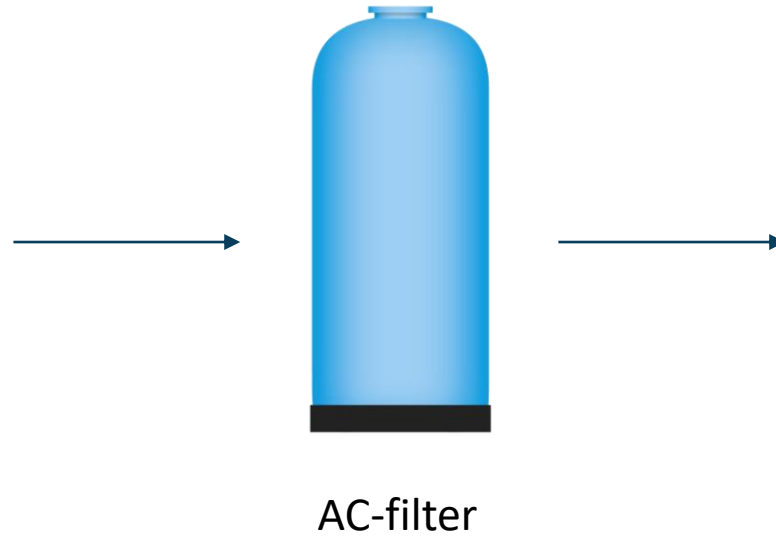
- *Allowed level: 2 ng/L ( $\Sigma$  PFOA, PFOS, PFHxS, PFNA)*
- *Sum of other PFAS: 100 ng/L*

## Contamination

- *Total: ~4 ng/L*
- *Compounds: **PFOA**, PFOS, PFHxS*

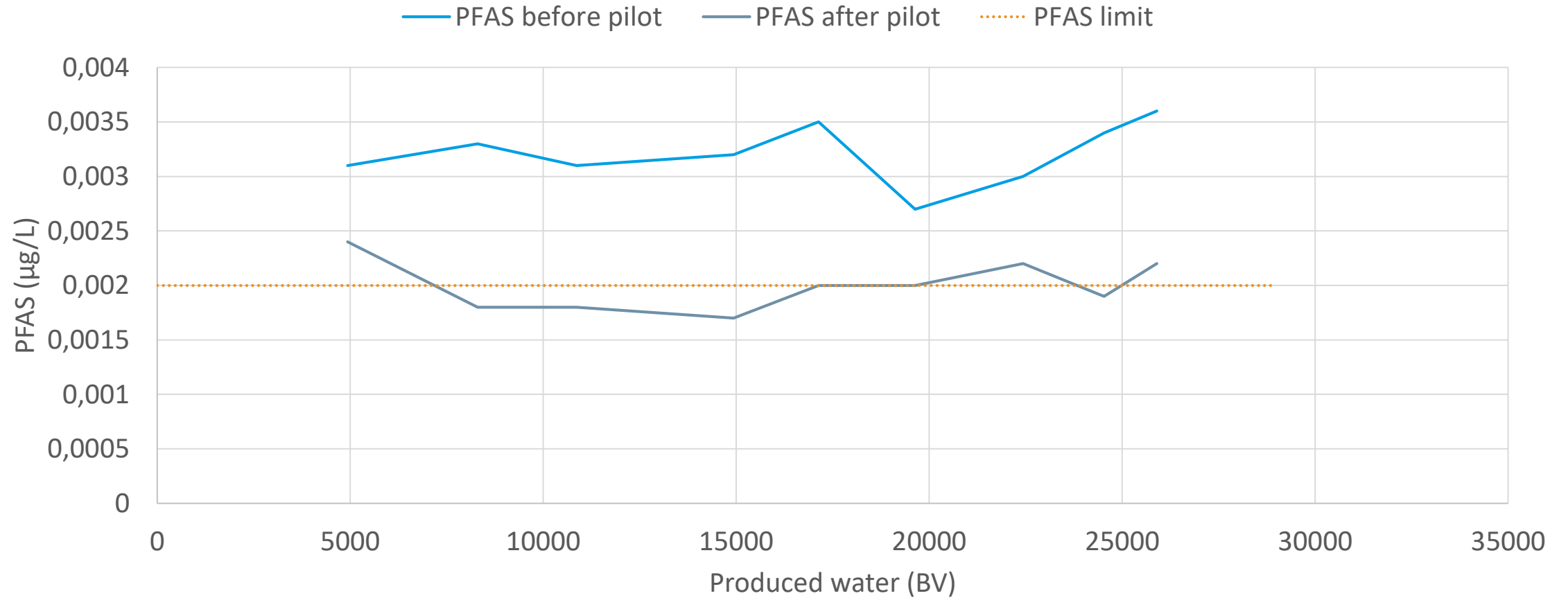


Closer look at the contamination



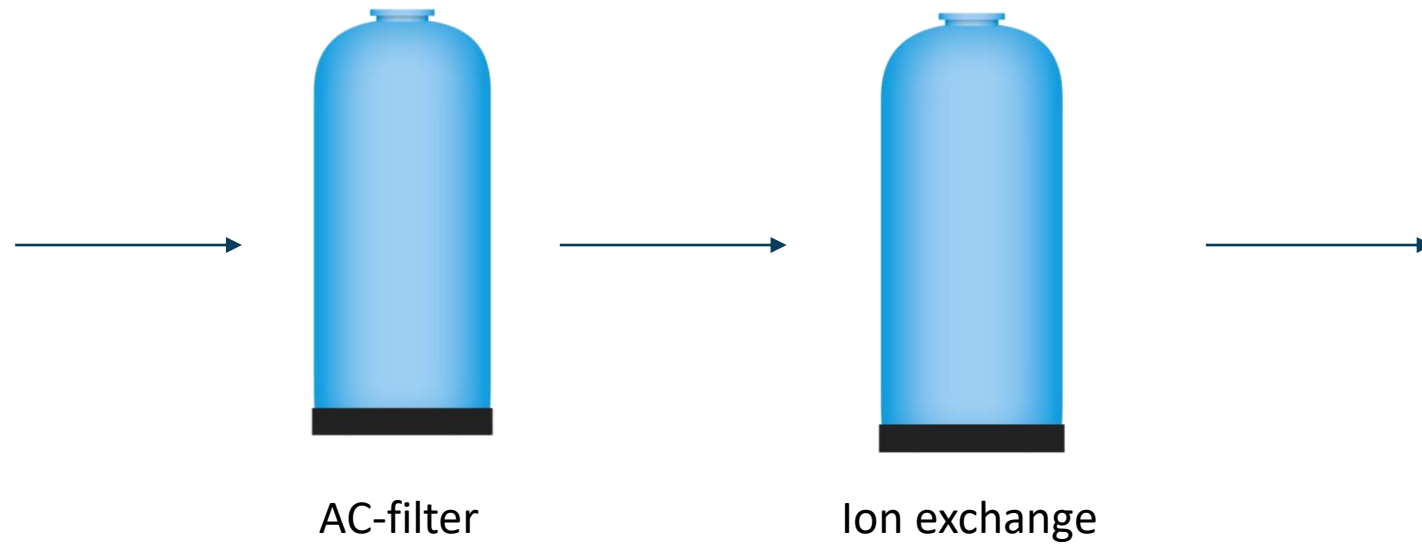
## Case: PFAS on Fanø

Test 1



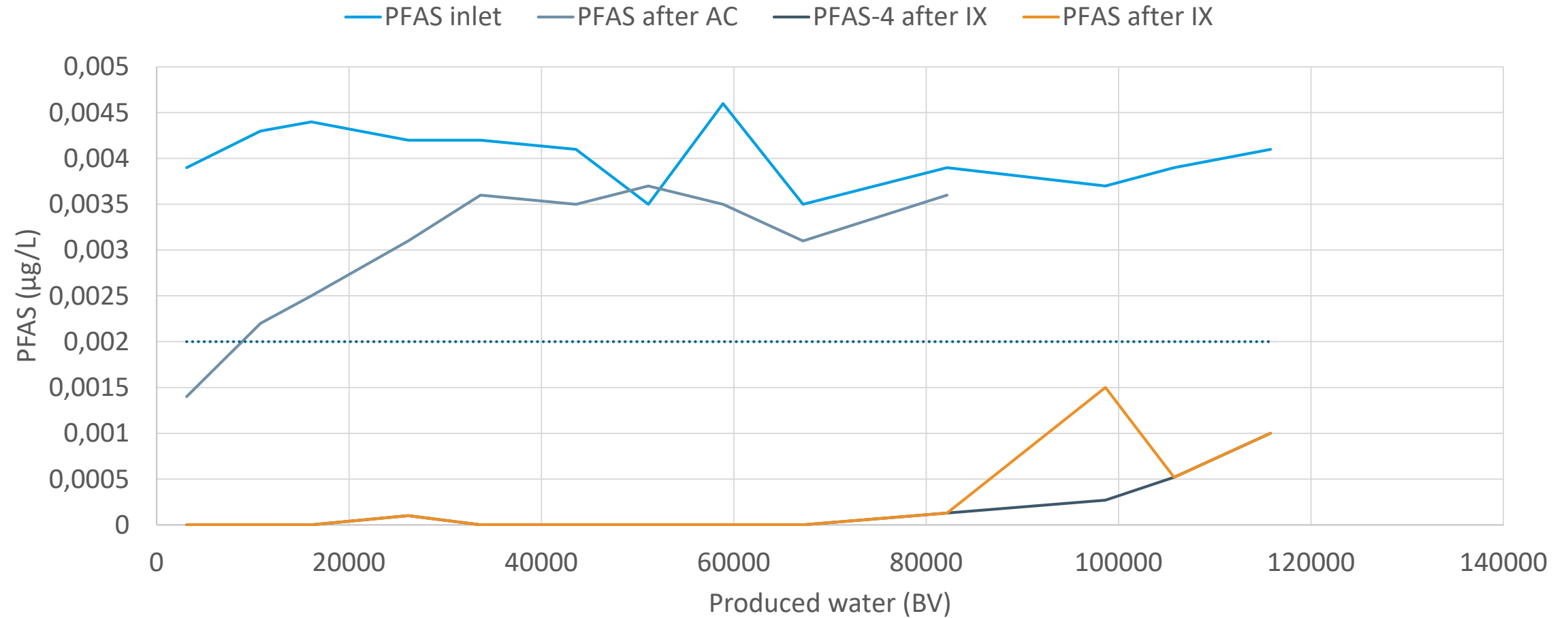
## Case: PFAS on Fanø

Test 1: AC



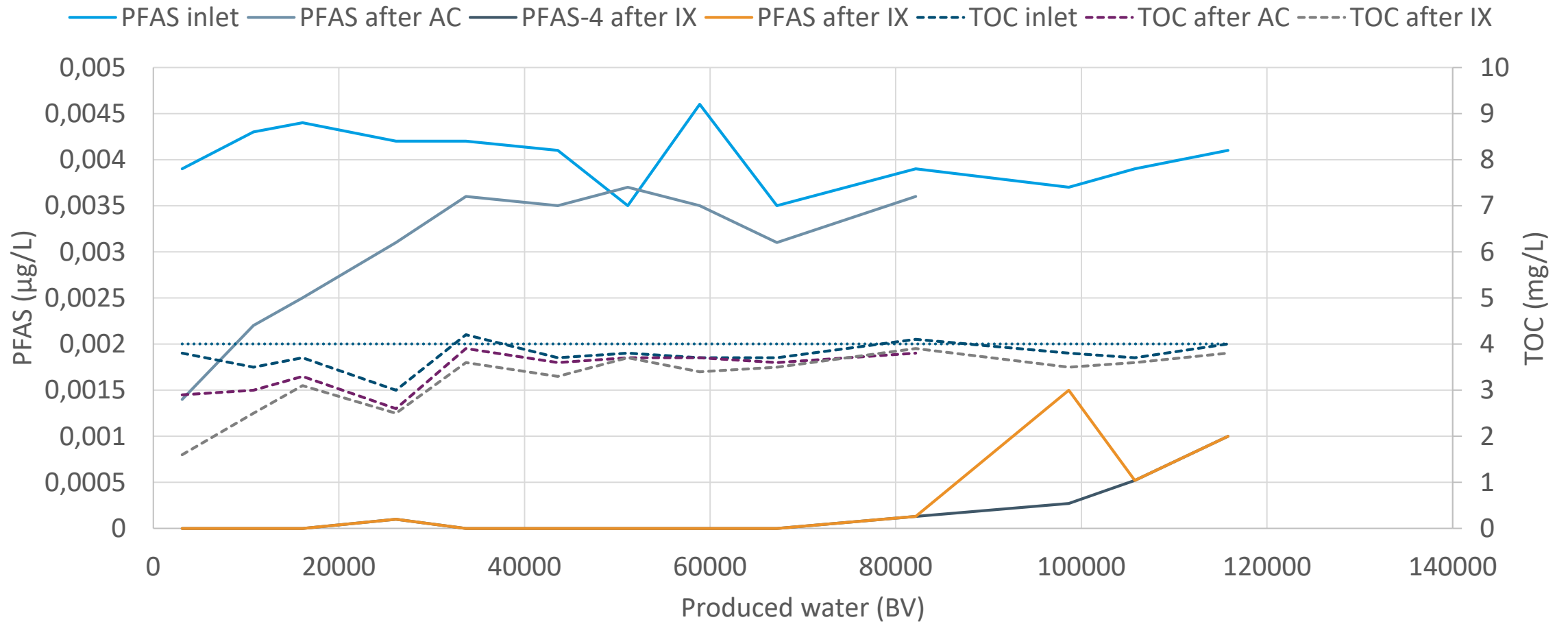
## Case: PFAS on Fanø

Test 2



## Case: PFAS on Fanø

Test 2, AC+IX

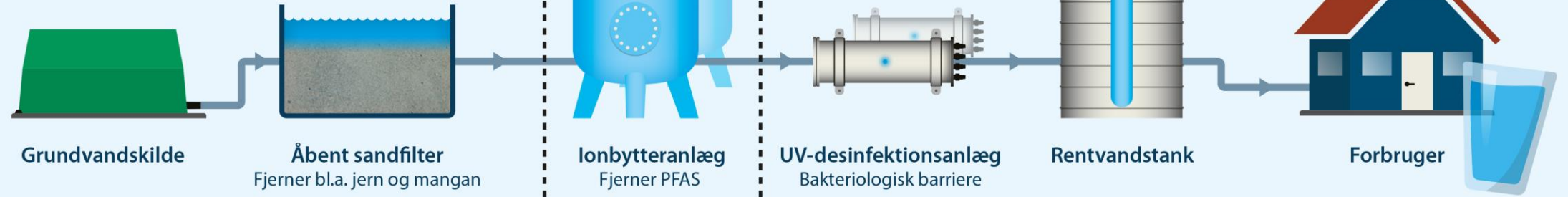


# Case: PFAS on Fanø

Test 2, AC+IX



## Fanø Vandværk



## PFAS i vandet

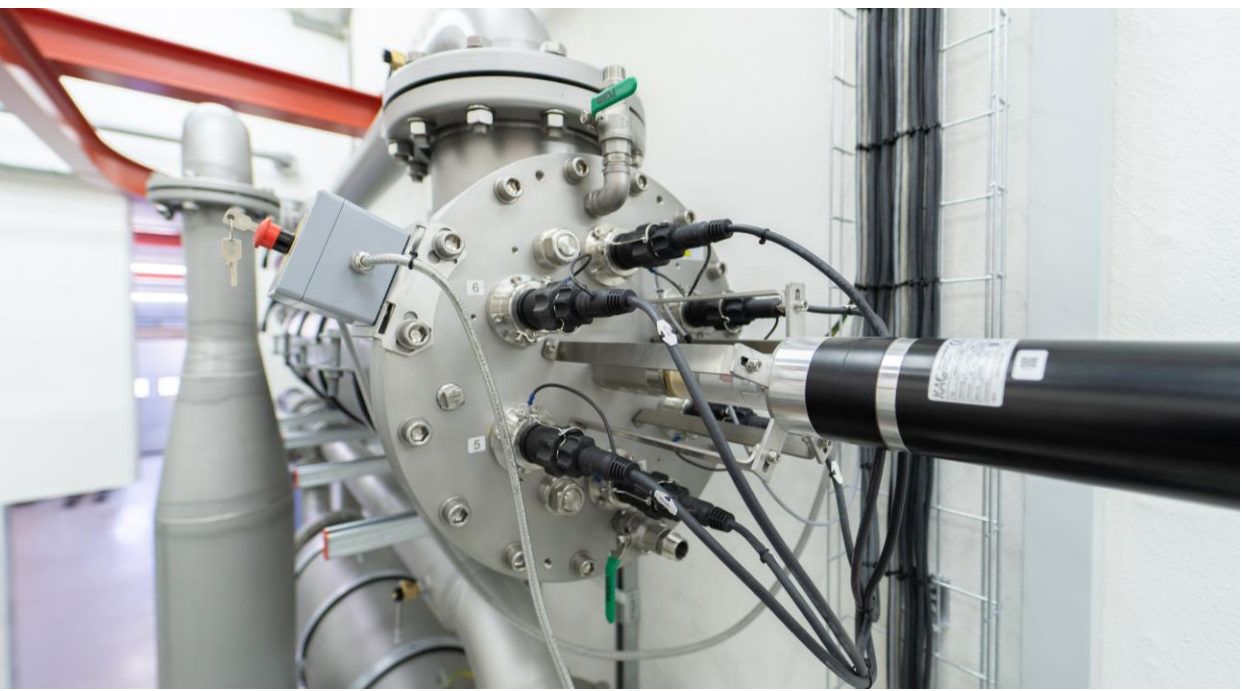
PFAS  
grænseværdi  
2 ng/L

4,4 ng/L

< 0,4 ng/L\*  
(ikke målbart)

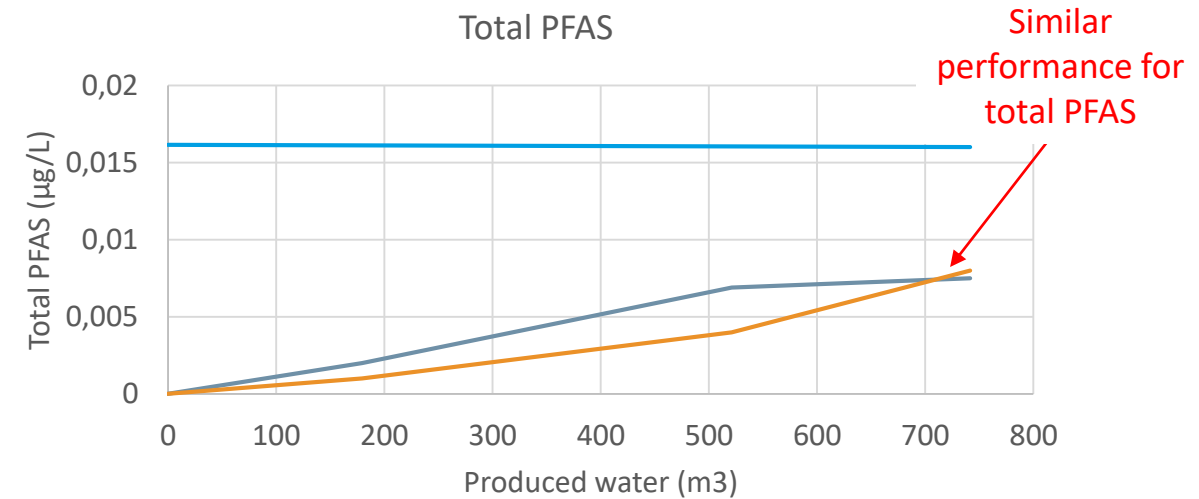
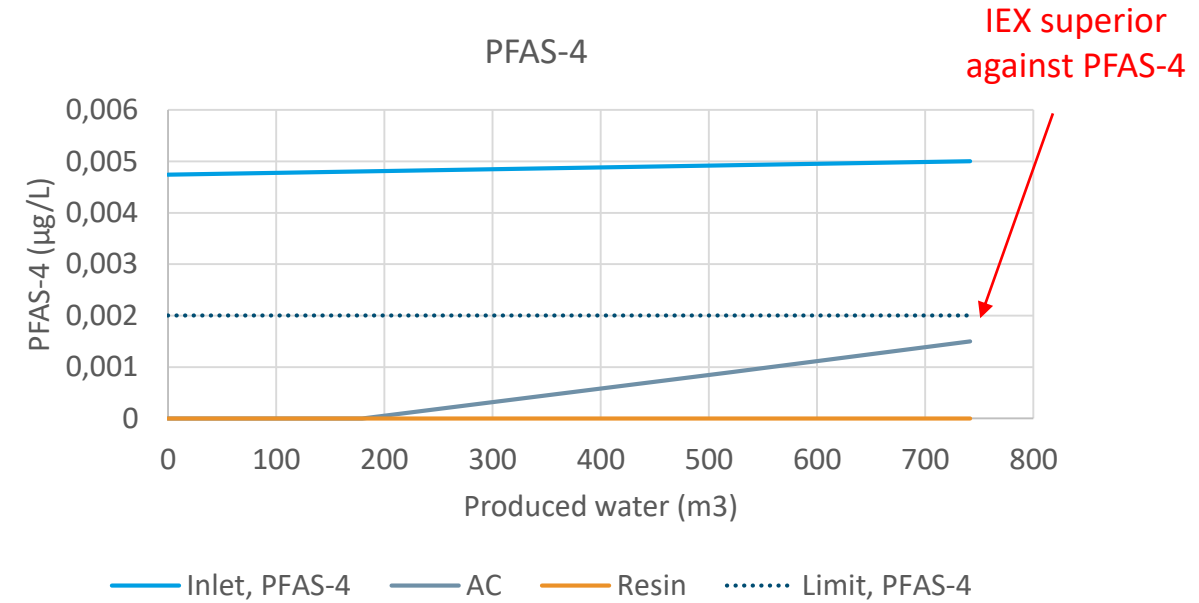
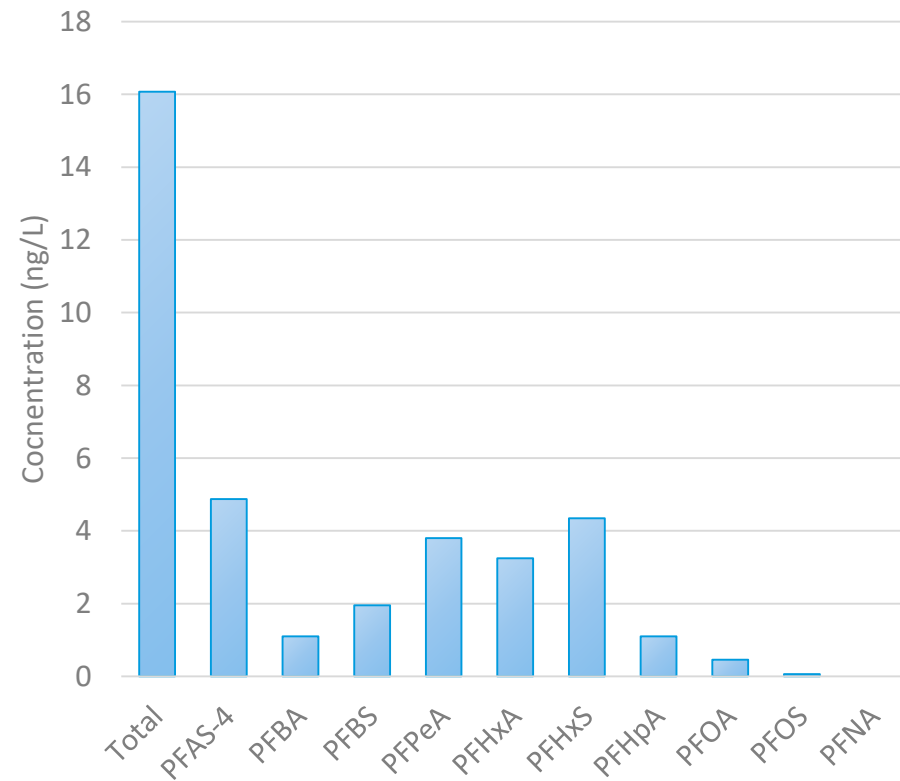
\* Målingerne er foretaget på PFAS-4, der er en kombination af stofferne PFOA, PFOS, PFNA og PFHxS. De har hver især en detektionsgrænse på 0,1 ng/L, og alle fire stoffer er under denne værdi på Fanø Vandværk.

Final design



*END*

# One solution fits all?



CONFIDENTIAL INFORMATION

— Inlet, total PFAS — AC — Resin