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Removal of perfluoroalkyl acids from the drinking water production chain

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Outline

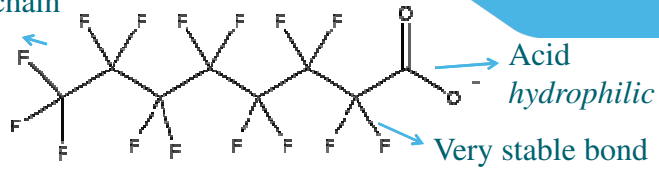
- Introduction
- Sources of PFAA to groundwater
- Behavior of PFAA in drinking water production
- Conclusions

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Perfluoroalkyl acids - properties

Fully fluorinated chain
hydrophobic



Perfluorooctanoic acid (PFOA)

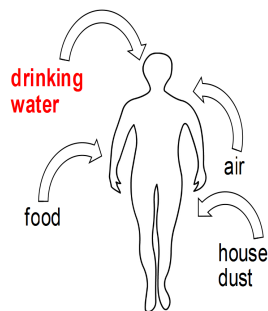
- Chain length varies $n_{\text{CF}_2} + \text{F} = 3$ to 17
- Very persistent, possibly bioaccumulative and toxic.
- Water solubility: 9.5 g/L → high!
- Multiple uses

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Introduction

- PFAA in environmental compartments
 - Surface water, biota, air
 - Human serum
- Exposure pathways
(denHollander, 2010)
 - Drinking water
(Vestergren, 2009)



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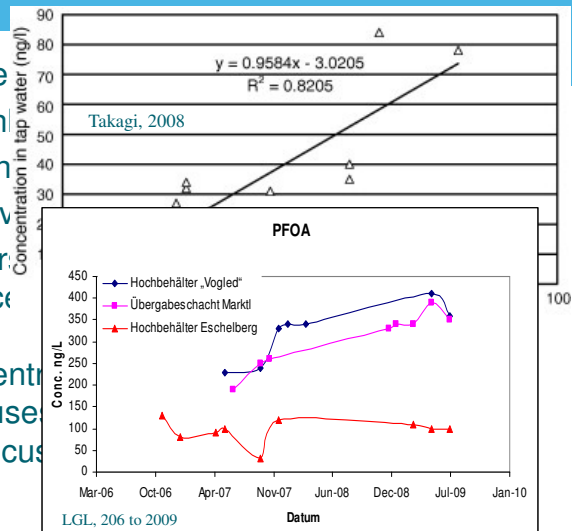
Introduction

Perfluoroalkyl acids in drinking water: Sources, fate and removal.

- Sources: to groundwater and surface waters
- Fate: During treatment
- Removal: Affinity adsorption

Introduction

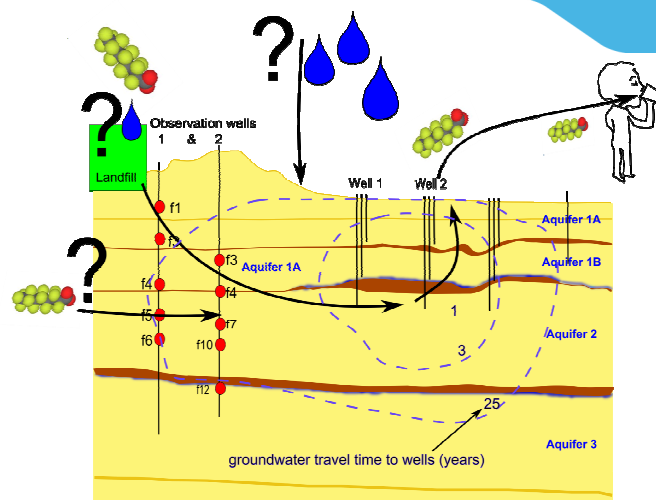
- PFAA in surface
- Surface vs. Drinking water
- Background concentration
 - low ng/L level
- In surface water areas: high concentration
- Unknown concentration
- Info mainly focused on
- Info does not focus on



Sources to groundwater

- Low concentrations in general (ng/L)
- Much less info available
- Sources
 - fire fighting practise
 - Landfills
 - Producing/using companies
 - Drinking water treatment less thorough

Case study



Groundwater: Case study

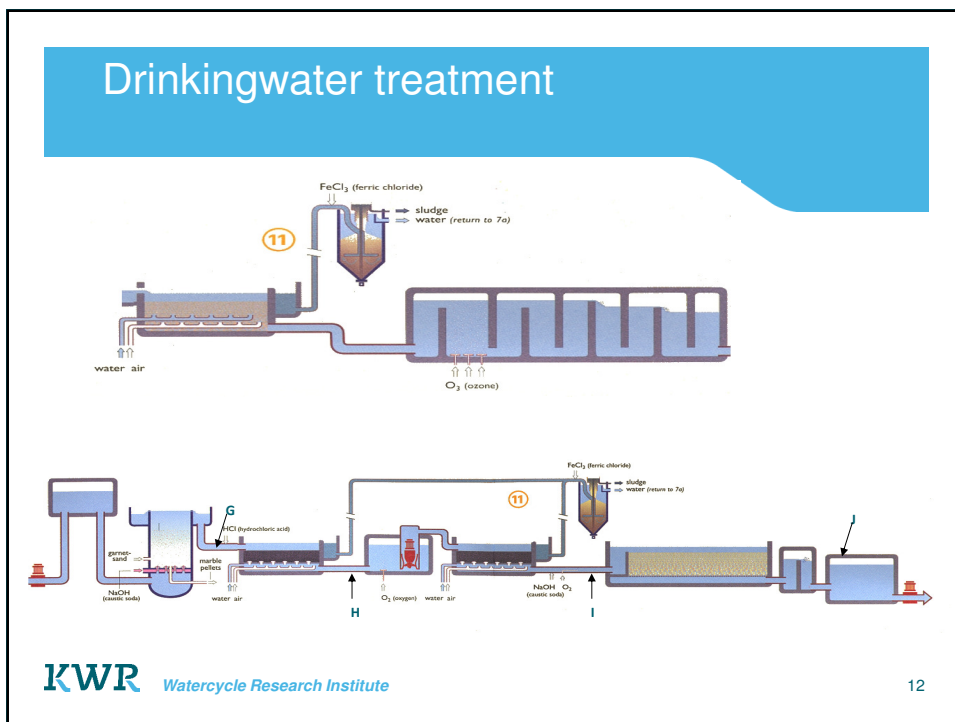
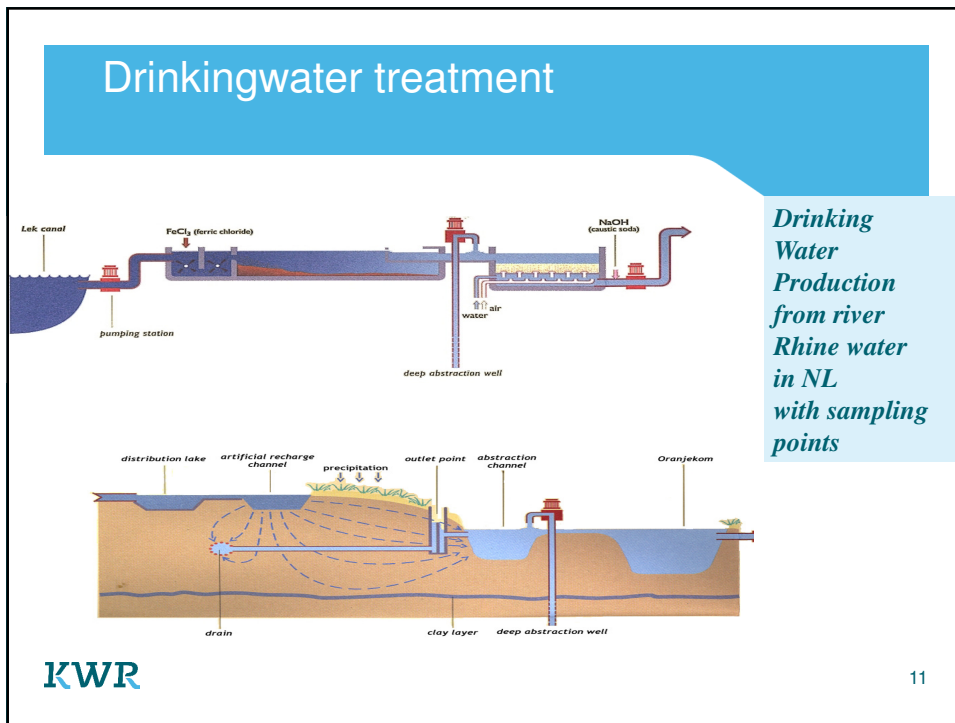
- Chain length dependent behaviour
 - PFOS not mobile
- Point source: Landfill
- Diffuse source: Rainwater
- PFOS mobility
- Removal from groundwater...?

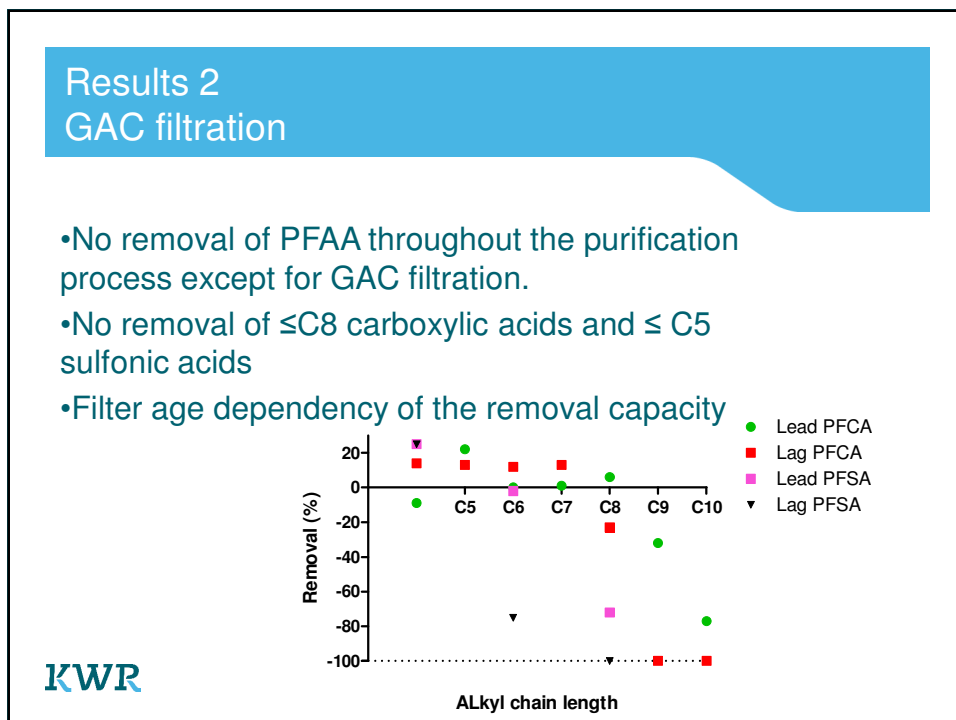
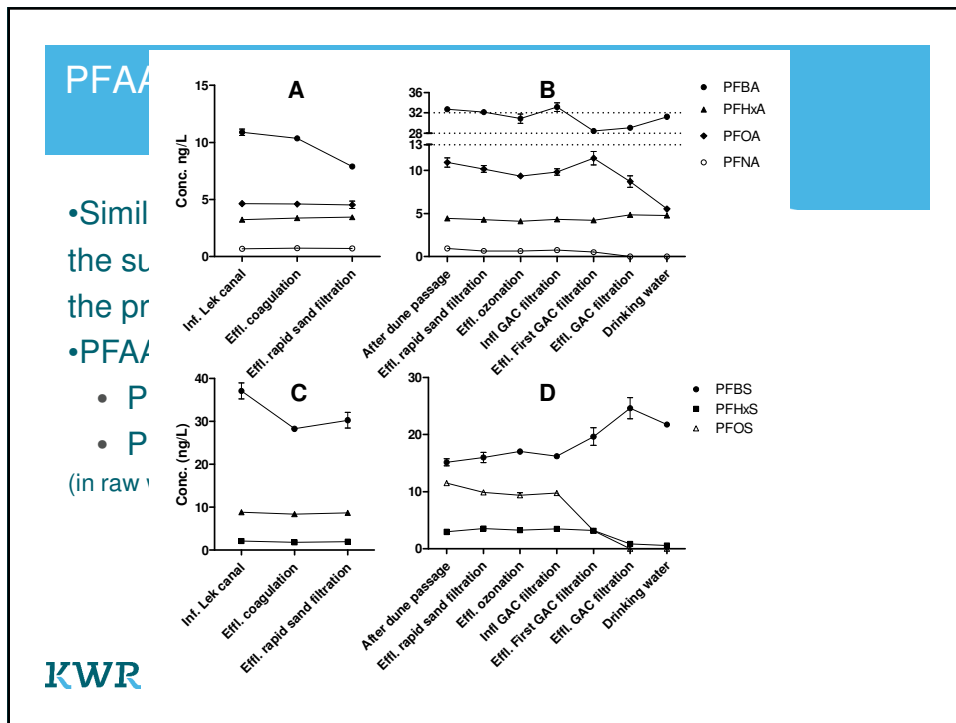
Fate: During treatment

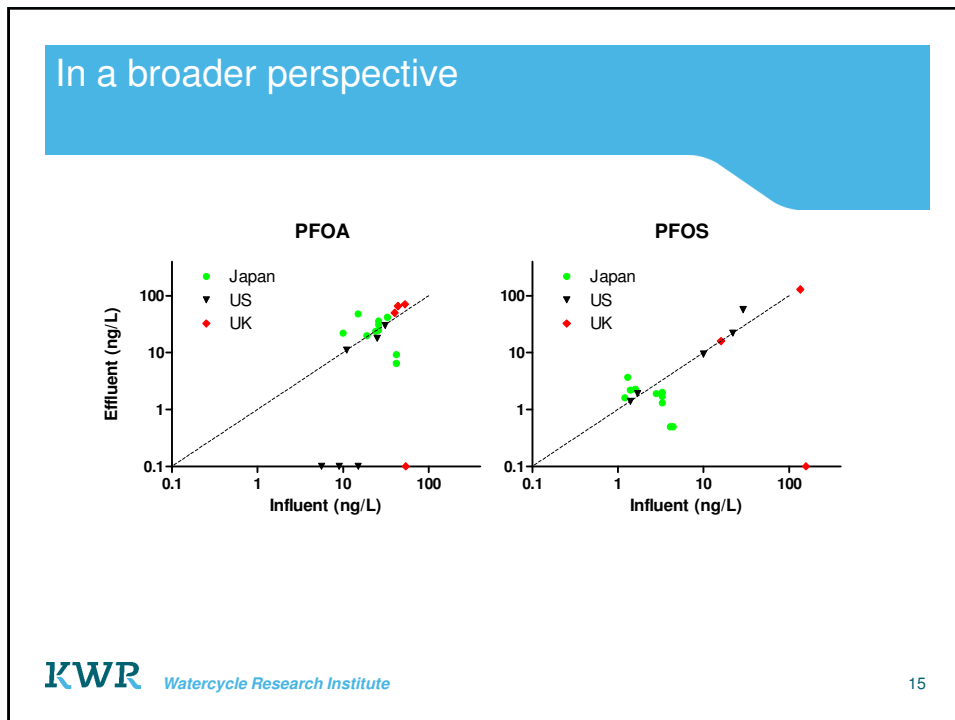
- Drinking water production of Amsterdam
- Two sampling rounds
- Hydrological retention time taken into account
- More than 60 samples analyzed in duplicate over two seasons



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- ### Conclusions
- From all tested processes only GAC removes PFAA
 - No removal of short chained PFAA
 - PFBS which is used PFOS substituent
 - PFHxA which is partly replacing PFOA
 - Margins to existing guidelines are large
 - 300 ng/L PFOS + PFOA
 - PFBA 7000 ug/L (Wilhelm, 2010)
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