1st December 2020

A Dutch Approach to Drinking Water

one-step RO

ATV Soil and Groundwater Meeting

Emile Cornelissen

KWR

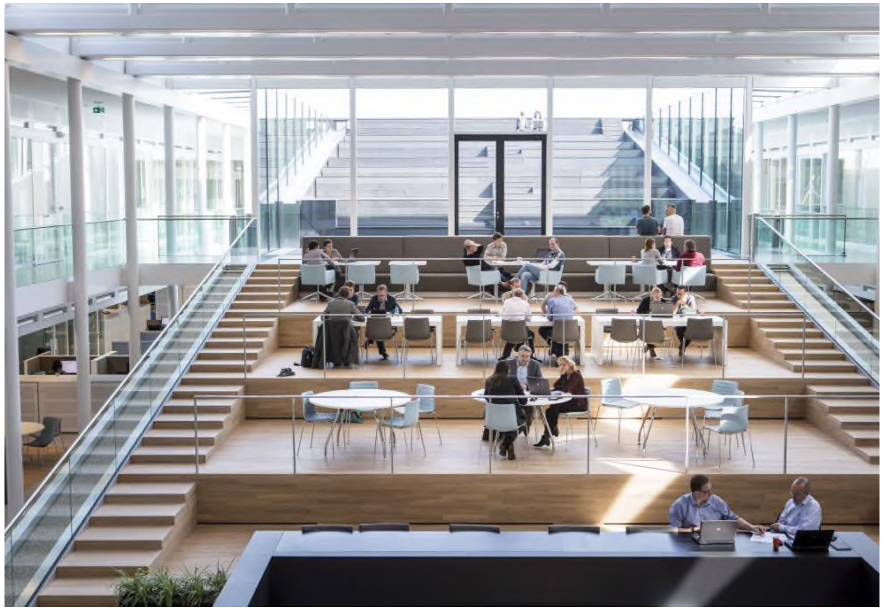
Bridging Science to Practice

UNIVERSITEIT GENT

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Introduction
Two buildings – One mission

KWR – Nieuwegein (the Netherlands)



Ghent university – Ghent (Belgium)

Introduction
Some Figures

KWR – Nieuwegein (the Netherlands) (60%)
- Water Research Institute

180 employees
- 3 departments → Water Systems & Technology
- 12 in water treatment group

Ghent University – Ghent (Belgium) (40%)
- Ranked 61st (Shanghai Ranking Index)

44 k students and 9k staff
- 11 Faculties → Bioengineering
- 40 in Particle and Interfacial Technology Group

Bridging Science to Practice

Drinking Water in The Netherlands

- Safe drinking water at the tap
- High consumers trust & satisfaction
- No chlorination
- Proactive approach
- Inventive & new technologies

Safe drinking water at the tap

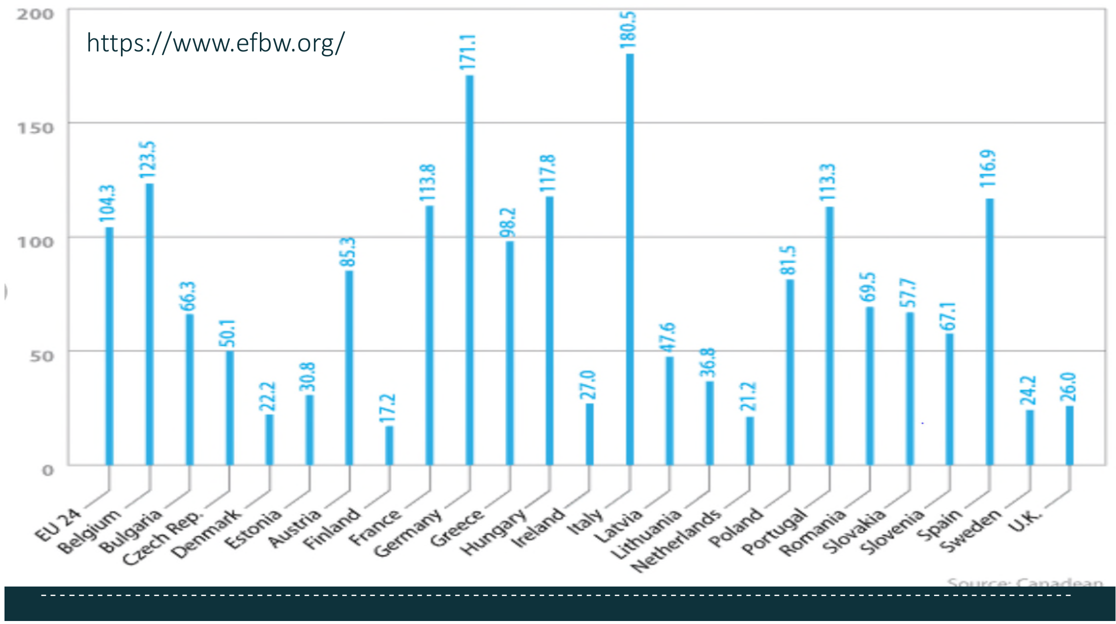
No Chlorine

In the Netherlands because of disadvantages of chlorine (taste, odor, DBP’s)

No persistent disinfectant during distribution

The Dutch secret: safe drinking water without chlorine in the Netherlands

P. Smeets, G.J. Medema, J.C. van Dijk
Delft Technical University
Published: 27 October 2008



Microbial Aspects

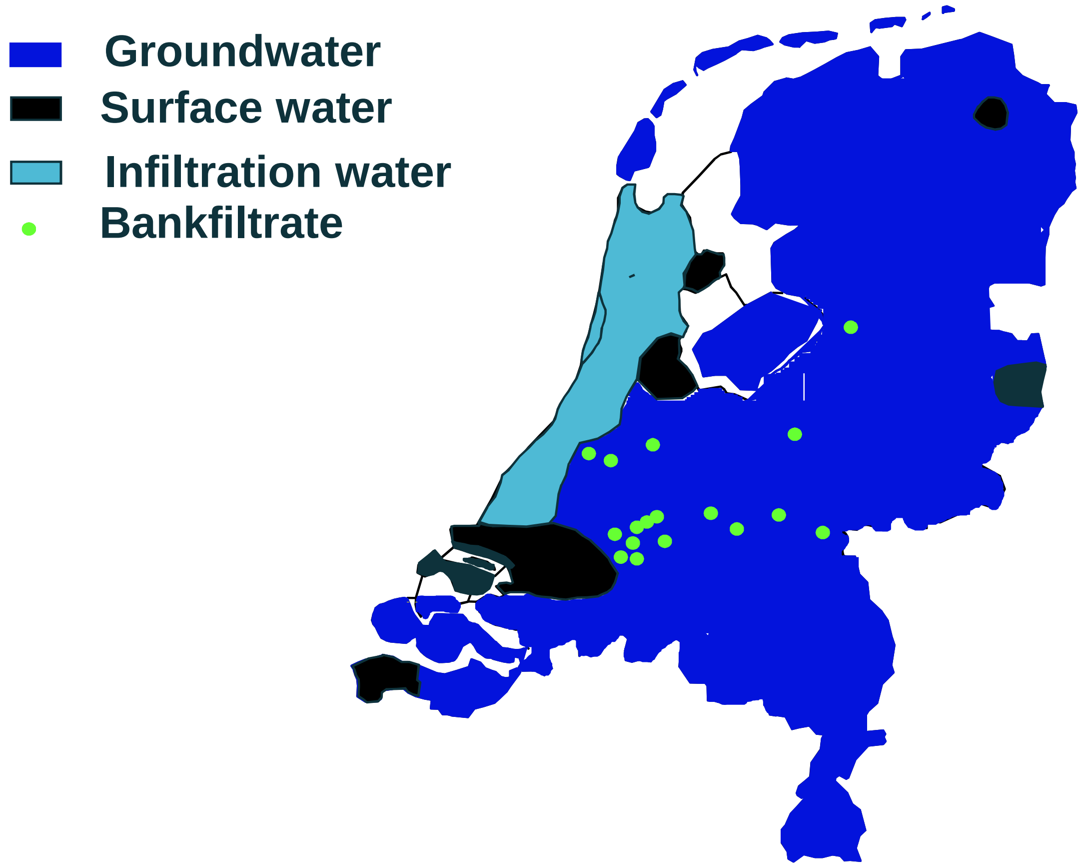
Dutch philosophy:

Surface water (>> pathogens present)

- Multiple barrier for pathogens (>log 8 reduction)
- AOC < 10 µg/l in drinking water
- A sealed distribution system

Groundwater (no pathogens present)

- Reduce possibilities for infection
- AOC < 10 µg/l in drinking water
- A sealed distribution system



Sources for Drinking Water

Organic Micropolutants

Compound	Concentration [μg/L]
Chloroform	0.020
Benzene	0.010
Trichloro acetic acid (TCA)	0.122
Aminomethylphosphonic acid (AMPA)	0.405
Chlortoluron	0.013
Diuron	0.013
Perfluoroctanoic acid (PFOA)	0.004
MTBE	0.157
ETBE	0.077
Iomeprol	0.329
Diatrizoic acid	0.262
Ibuprofen	0.015
Diclofenac	0.060
Carbamazepine	0.082

(Source: RIWA Jaarrapport de Rijn)

Our Mission - Inventive & new technologies

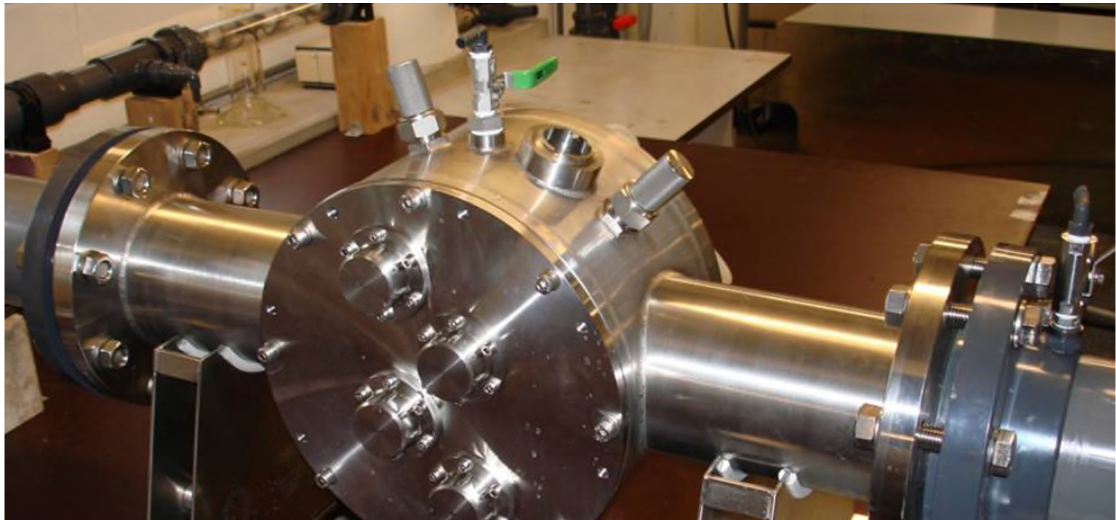
Optimize existing and develop innovative robust integrated treatment techniques/concepts

More efficient water treatment by

(1) Better water quality,

(2) Lower costs, chemicals, energy, fouling and residuals

Plate and frame RO element



UV reactor

one-step RO approach

RO is robust barrier (pathogens, particles, salts, organic micro-pollutants, biological stable water)

Drinking water production from flexible sources (Multi-Source RO)

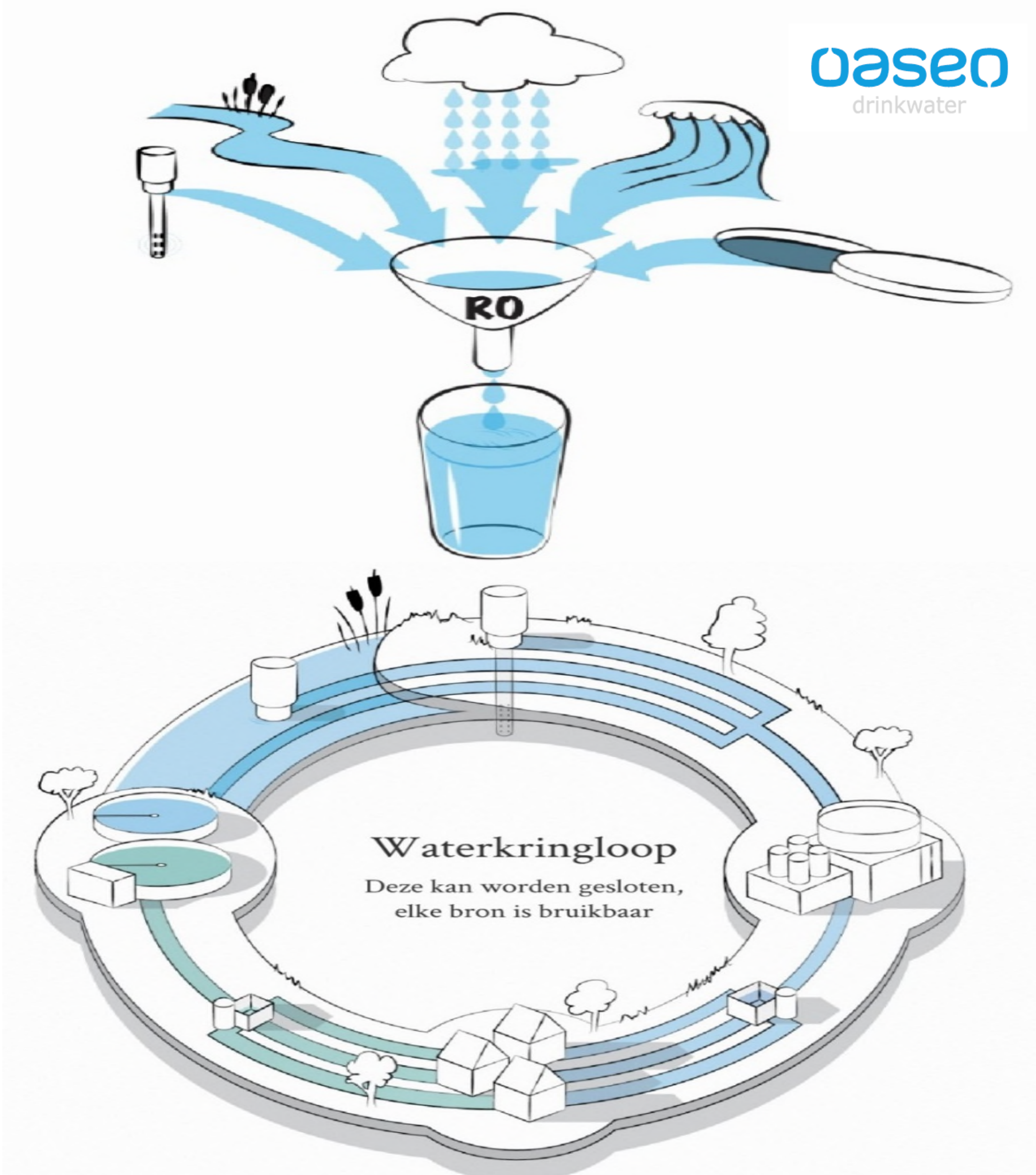
- Less water transport

RO is scalable

- Small decentral RO treatment systems

Minimal pre-treatment to decrease costs

- One step RO



Many challenges and questions for MSRO

- Rejection organic micro-pollutants
- Biological stability
- Pathogen removal

1. Control membrane fouling
2. Concentrate disposal or treatment
3. Membrane integrity

- Re-mineralization permeate (TKI)
- Technical economic evaluation

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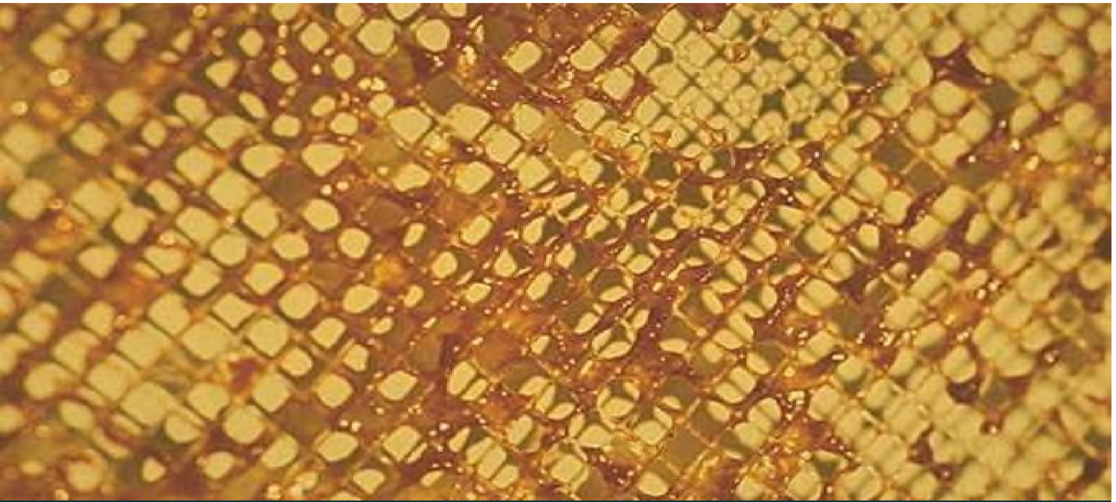
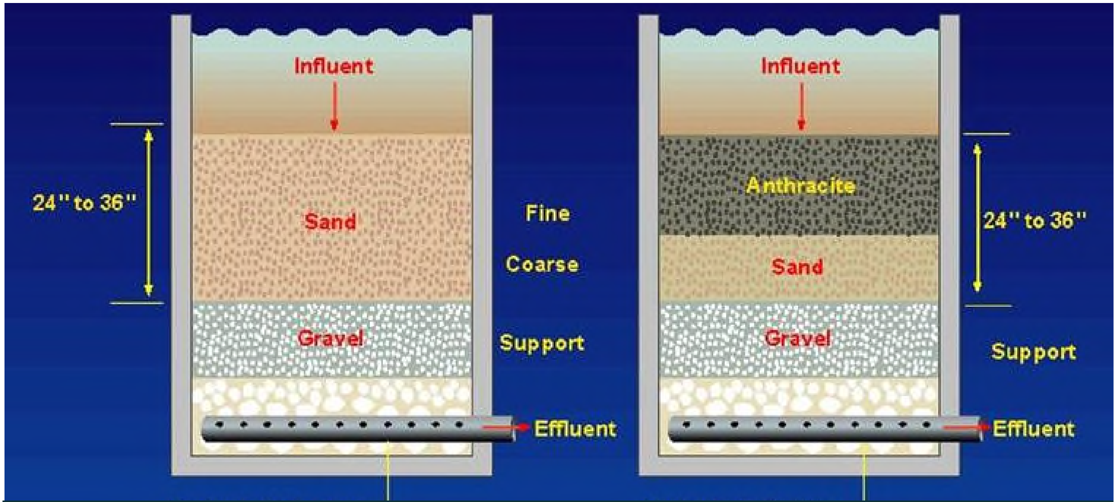
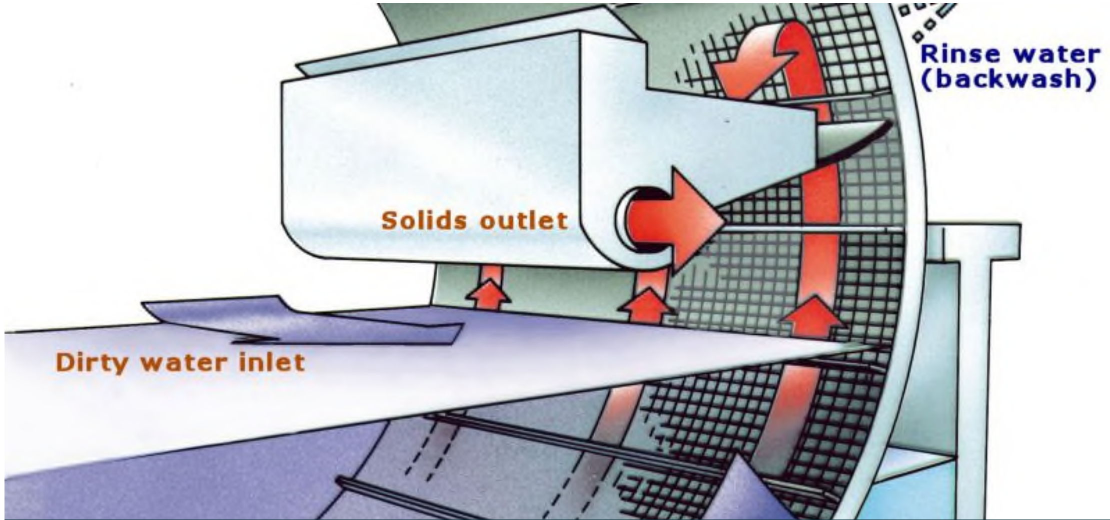


Feed Spacer Fouling



Pretreatment using Dual Media Filtration

Pretreatment using Ultrafiltration



Pretreatment using (micro)sieves

Source Water

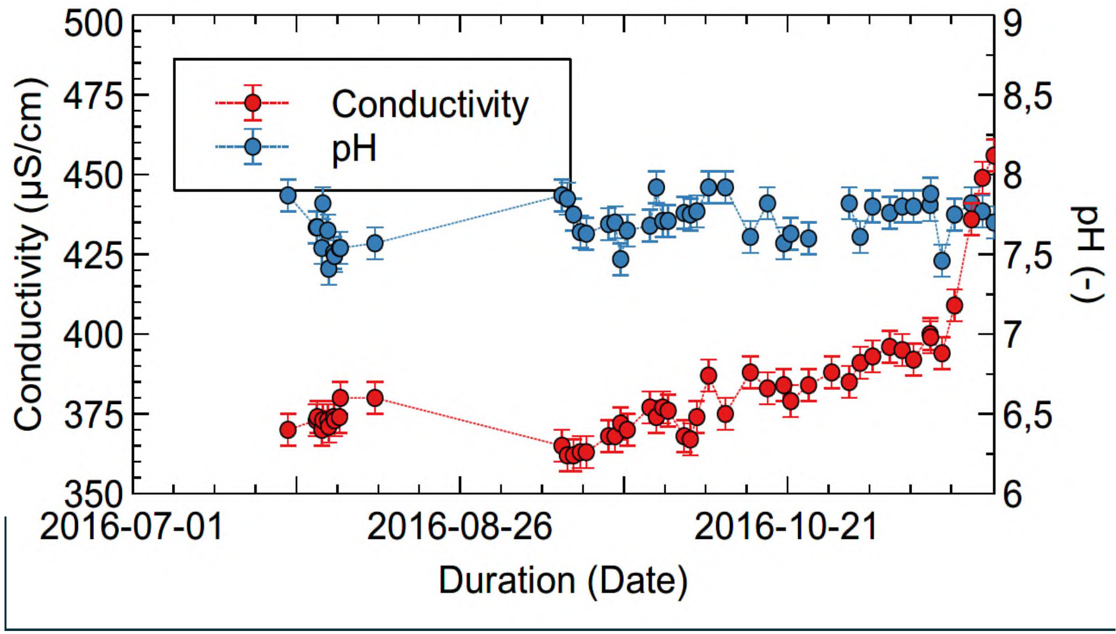
Dissolved organic carbon : 6.1 mg-C/l

Predominantly humic acids : 65-75%

Biopolymers : 13% of 0.7 mg-C/l

Seasonal variations (March-November)

Locally Available Lake Water



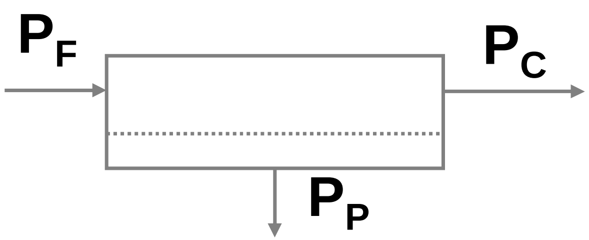
1. Control of Fouling

Many strategies

- Minimal pre-treatment
- Low flux operation
- Periodical air/water cleaning
- CIP treatment

Focusing on:

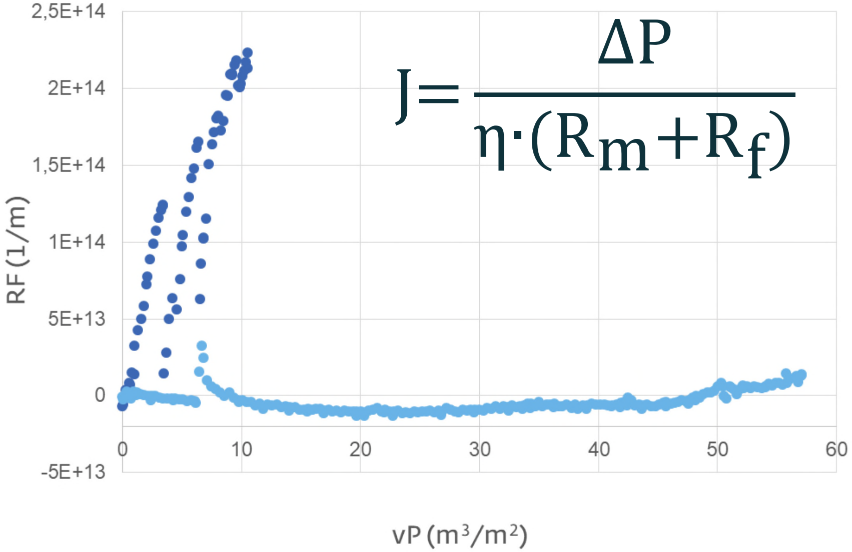
- Fouling resistance increase (fouling)
- Pressure drop increase (clogging)



Ultrafiltration Pentair XIGA-40 (after 250um)

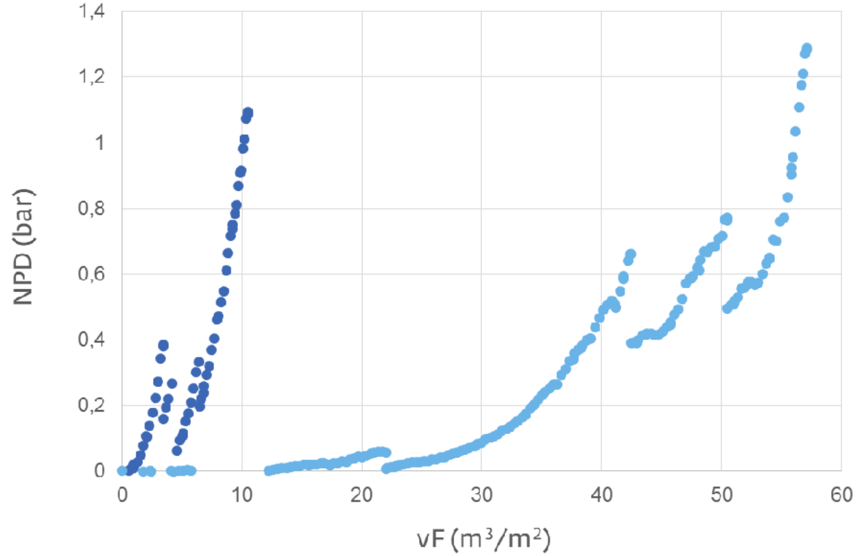
25um screen filtration (after 250um)

Results - Effect of pre-treatment (**UF** versus **screen**)



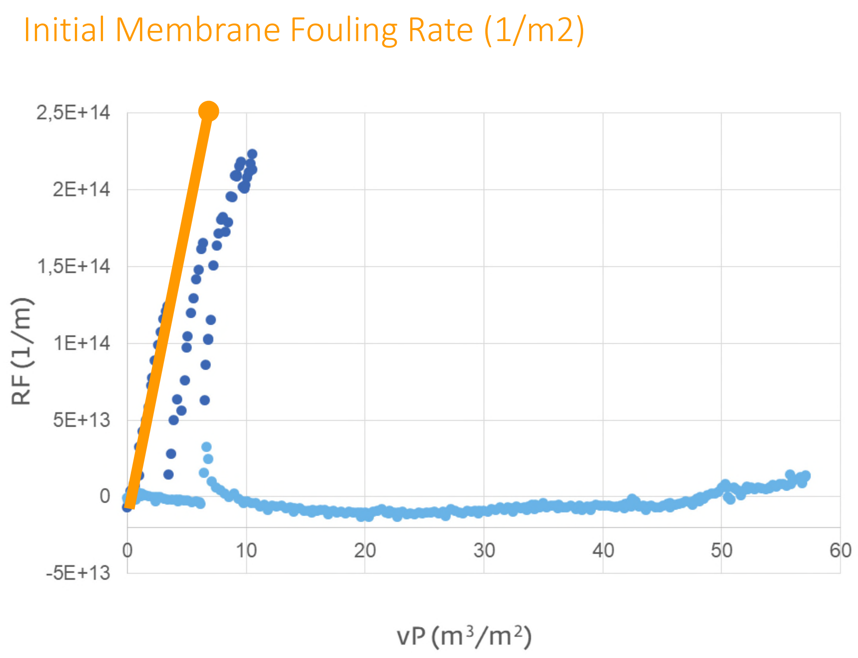
$$J=\frac{\Delta P}{\eta\cdot(R_m+R_f)}$$

Fouling resistance

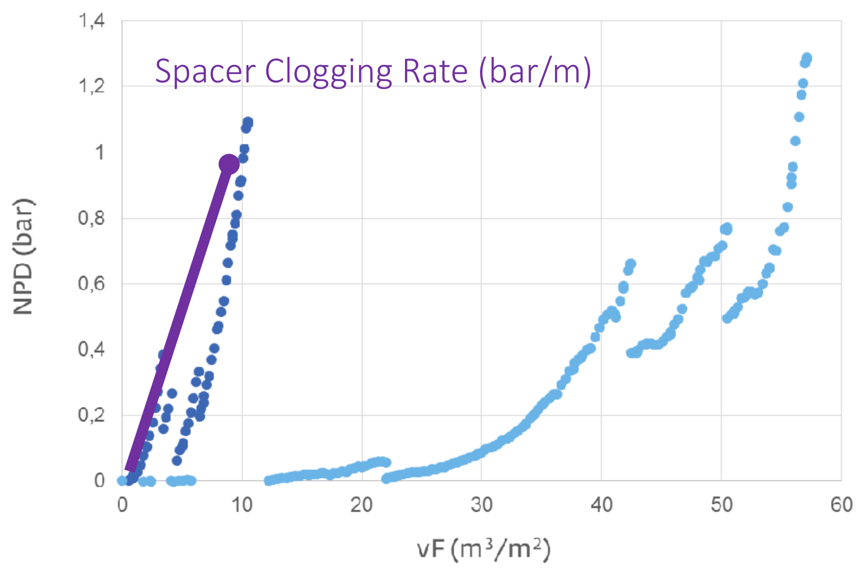


Pressure drop (clogging)

Results - Effect of pre-treatment (UF versus screen)



Fouling resistance



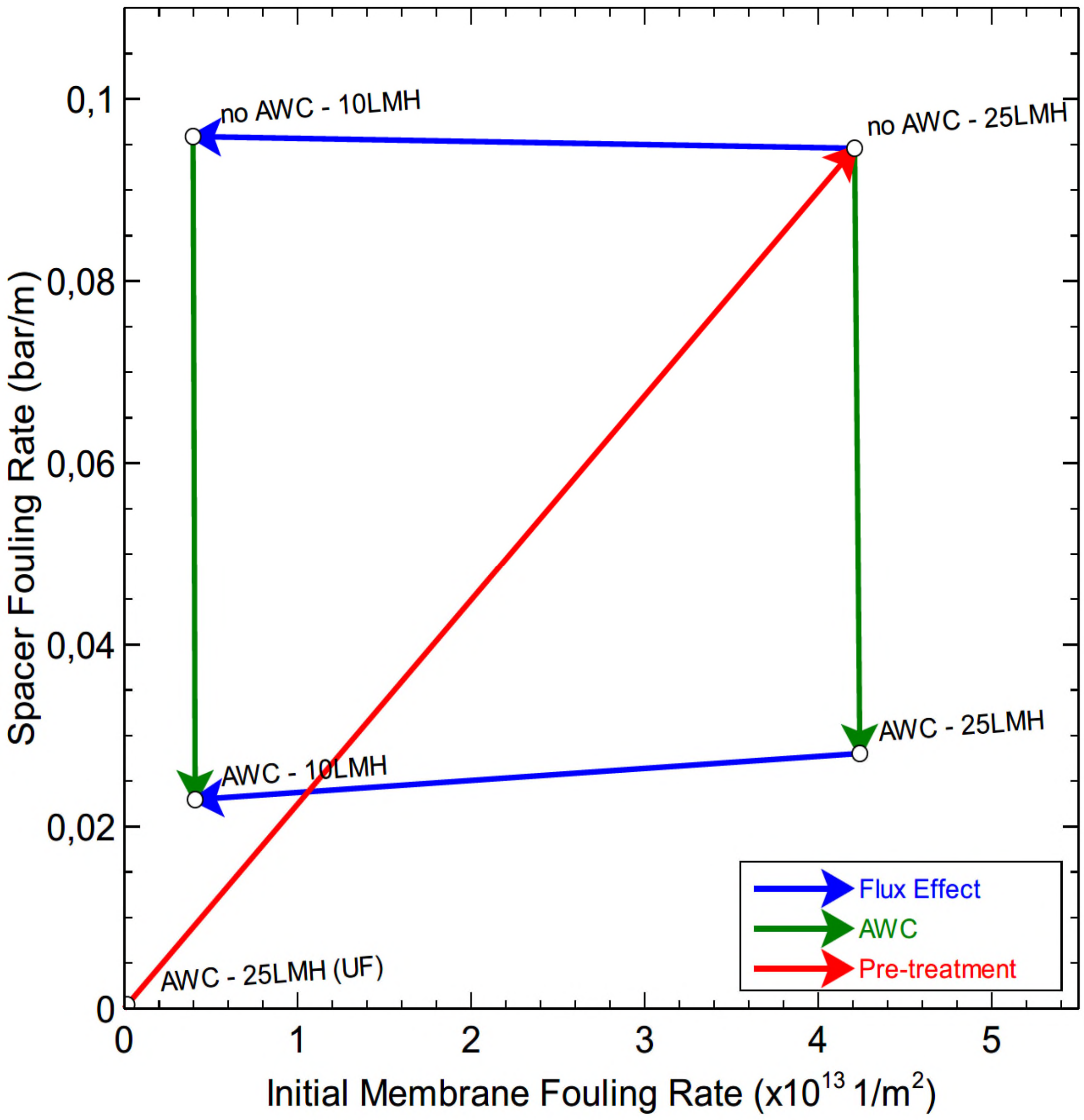
Pressure drop (clogging)

Results

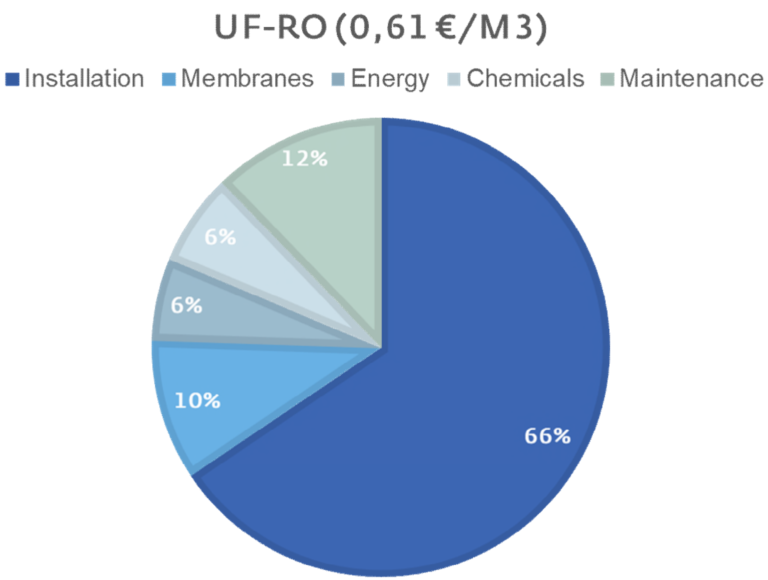
Effect of

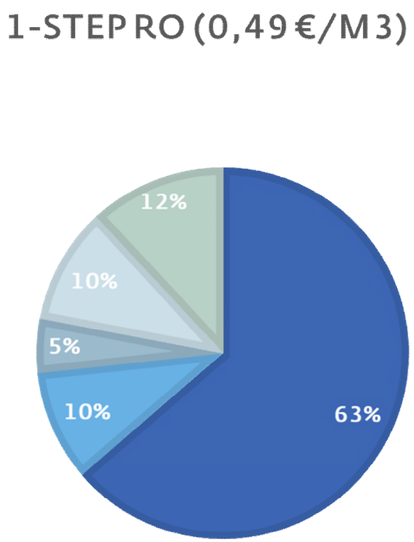
- pre-treatment,
- air/water cleaning
- flux

- Initial UF operation at 0
- Substantial fouling and clogging after screen
- Air/water cleaning only impacts clogging
- Flux only impacts fouling



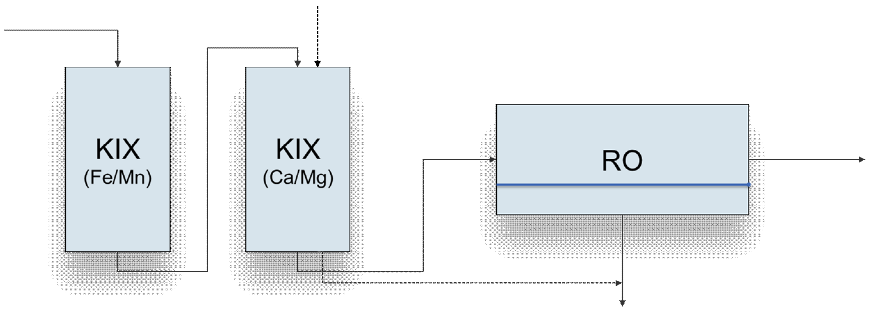
Business Case 1-step RO





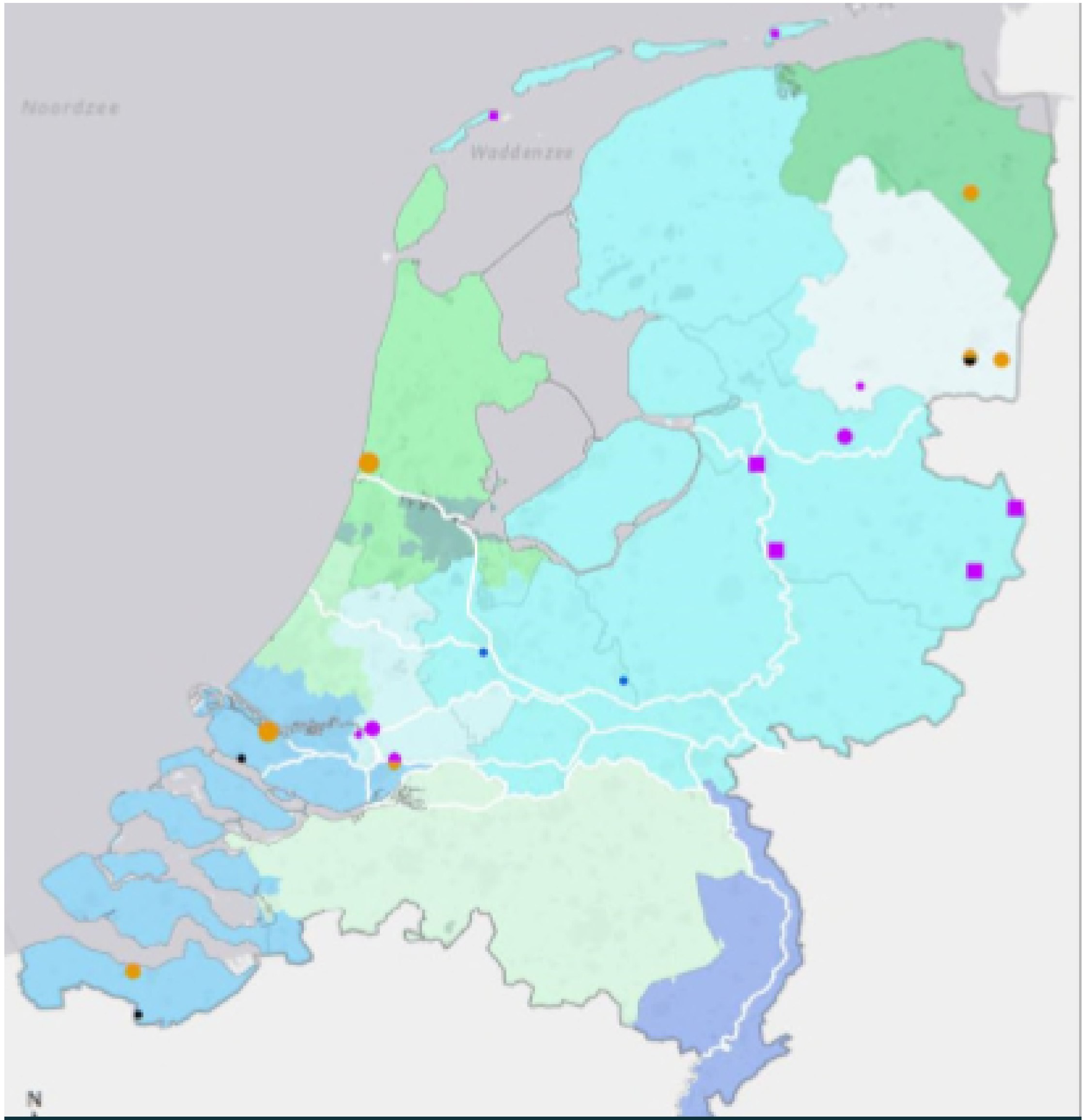
2. Concentrate Disposal or Treatment

Minimization of the concentrate streams, using high recovery RO systems



Disposal or treatment of RO concentrates

- Mostly discharge
- More research to treatment of concentrate streams (further B(T)O research ?)



Overview of NF/RO installations in the Netherlands (BO 2019)

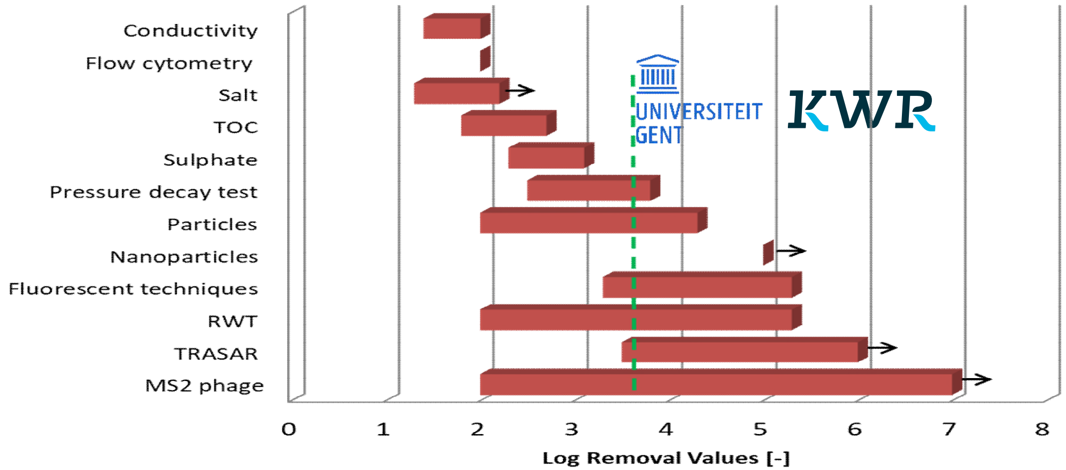
3. New Virus (NV) method for Membrane Integrity

A new method is developed to determine a LRV of >7

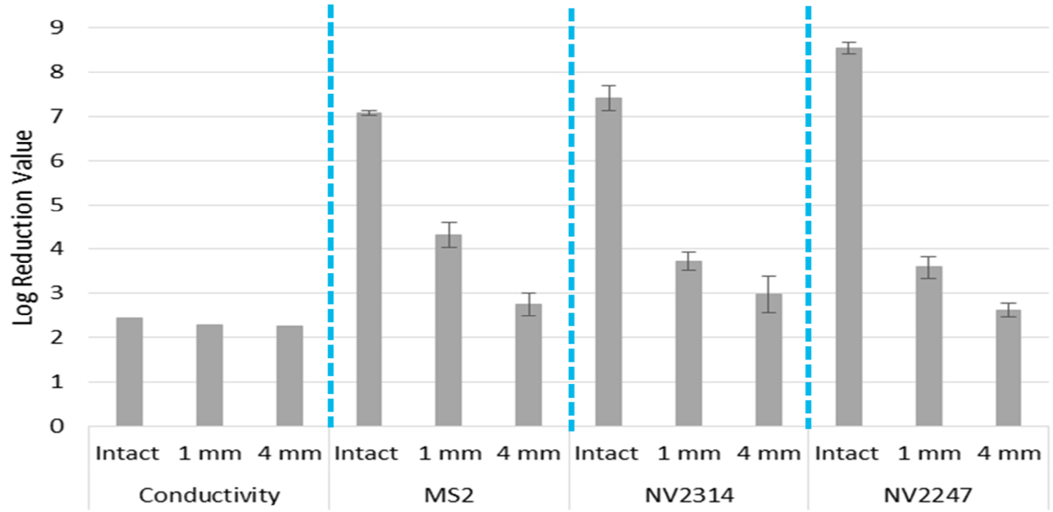
Now still a lab-based method

- Develop an on-line method

New TKI project (2019-2022)



Overview of state of the art membrane integrity methods



Results of NV measurements

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