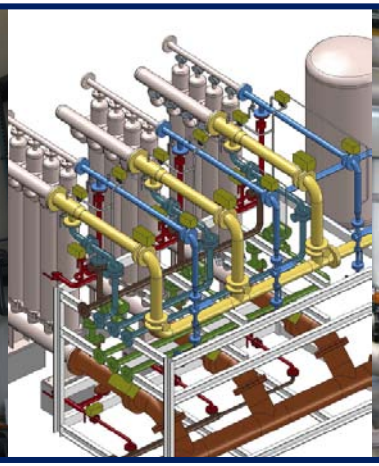
DEMEAU Workshop
Hybrid Ceramic Membrane Systems

June, 11 2015
Trinkwasseraufbereitungsanlage Roetgen Germany






Emiel Nijhuis
RWB, Almelo

DEMEAU Workshop

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- **Introduction RWB and METAWATER**
- The ceramic membrane filtration system
- Drinking water applications
- Water reuse, recycle and/or reclaim applications
- Summary

Company facts

- Founded in 2001, Almelo The Netherlands
- Nett turnover 2014: € 13,7 million
- 64 employees with an average experience of 15 years in water treatment projects
- ISO 9001:2000 and SCC** certified
- Process -, drinking - , waste-water applications

Introduction
METAWATER

1919 Establishment of NGK Insulators, Ltd.

日本ガイシ

1923 Establishment of Fuji Electric Manufacturing Co., Ltd.

富士電機

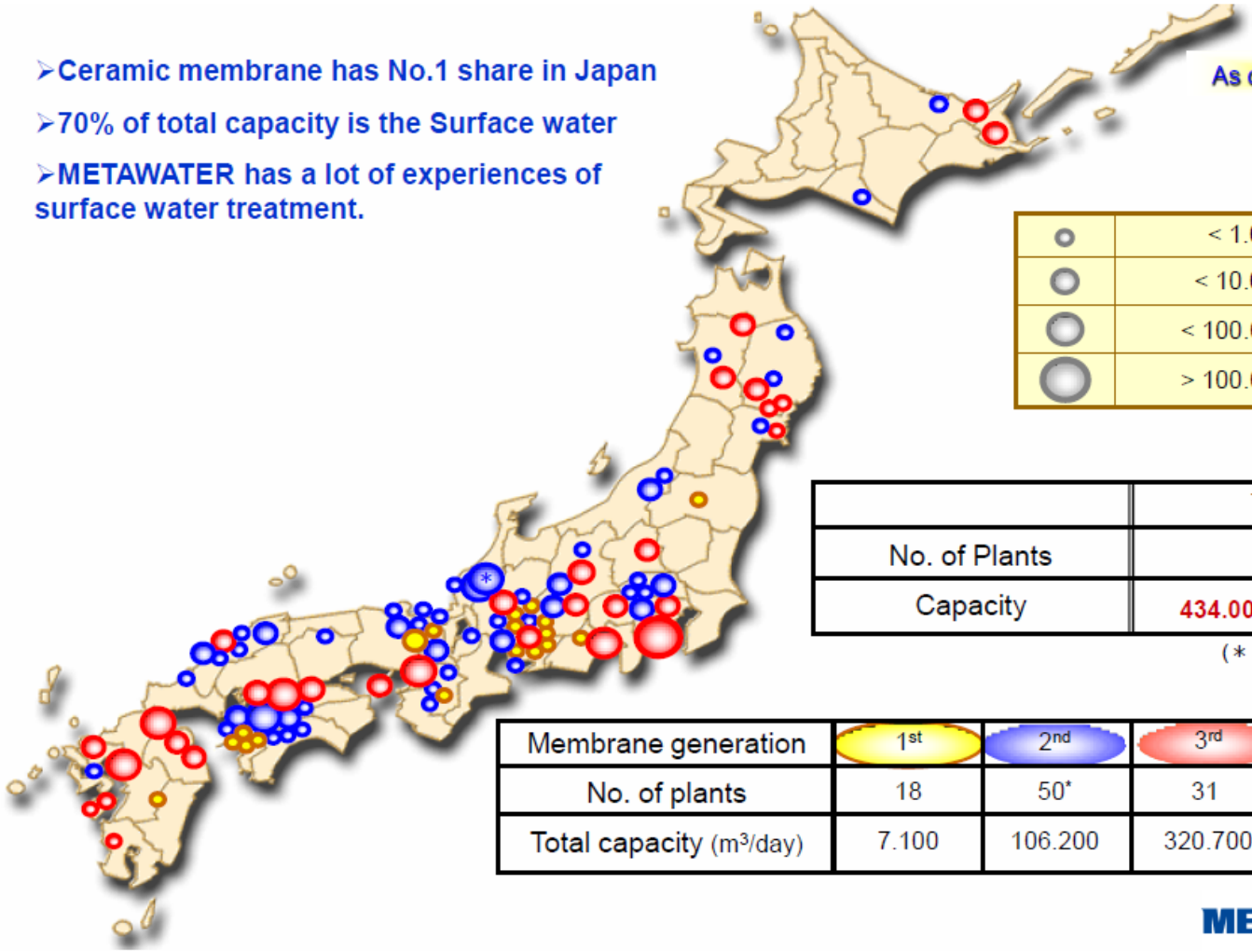
2007 Basic agreement of Business merger

April 2008 **Establishment of METAWATER Co., Ltd.**

- No. of employees
  1.860
- Head office
  Tokyo/Japan
- Branch offices
  Japan (>40)
  Europe, USA, Korea,
  China, Vietnam

Introduction
METAWATER

- Ceramic membrane has No.1 share in Japan
- 70% of total capacity is the Surface water
- METAWATER has a lot of experiences of surface water treatment.



	Total
No. of Plants	99*
Capacity	434.000 m³/day

(＊ : Expansion)

(＊ : Expansion)

Membrane generation	1st	2nd	3rd	Total
No. of plants	18	50*	31	99*
Total capacity (m³/day)	7.100	106.200	320.700	434.000

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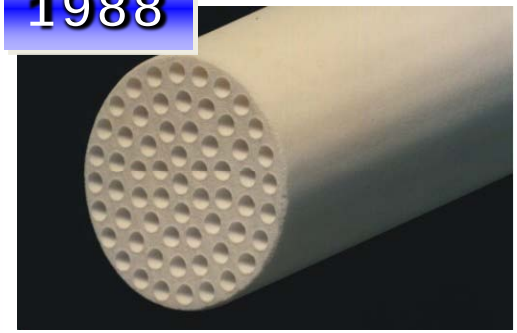
The ceramic membrane filtration system
History

1st Generation

1988



Dimension: 30mmO.D.x1.000mmL
Pore size : 0,1 µm
Mem. area : 0,48m²
Channel : 2,5mmI.D., 61ch

DWTP in Miyazaki (1996, 550m³/day)

2nd Generation

1997

Dimension: 180mmO.D.x1.000mmL
Pore size : 0,1 µm
Mem. area : 15m²
Channel : 2,5mmI.D., 2.000ch

DWTP in Fukui (2001, 38.900m³/day)

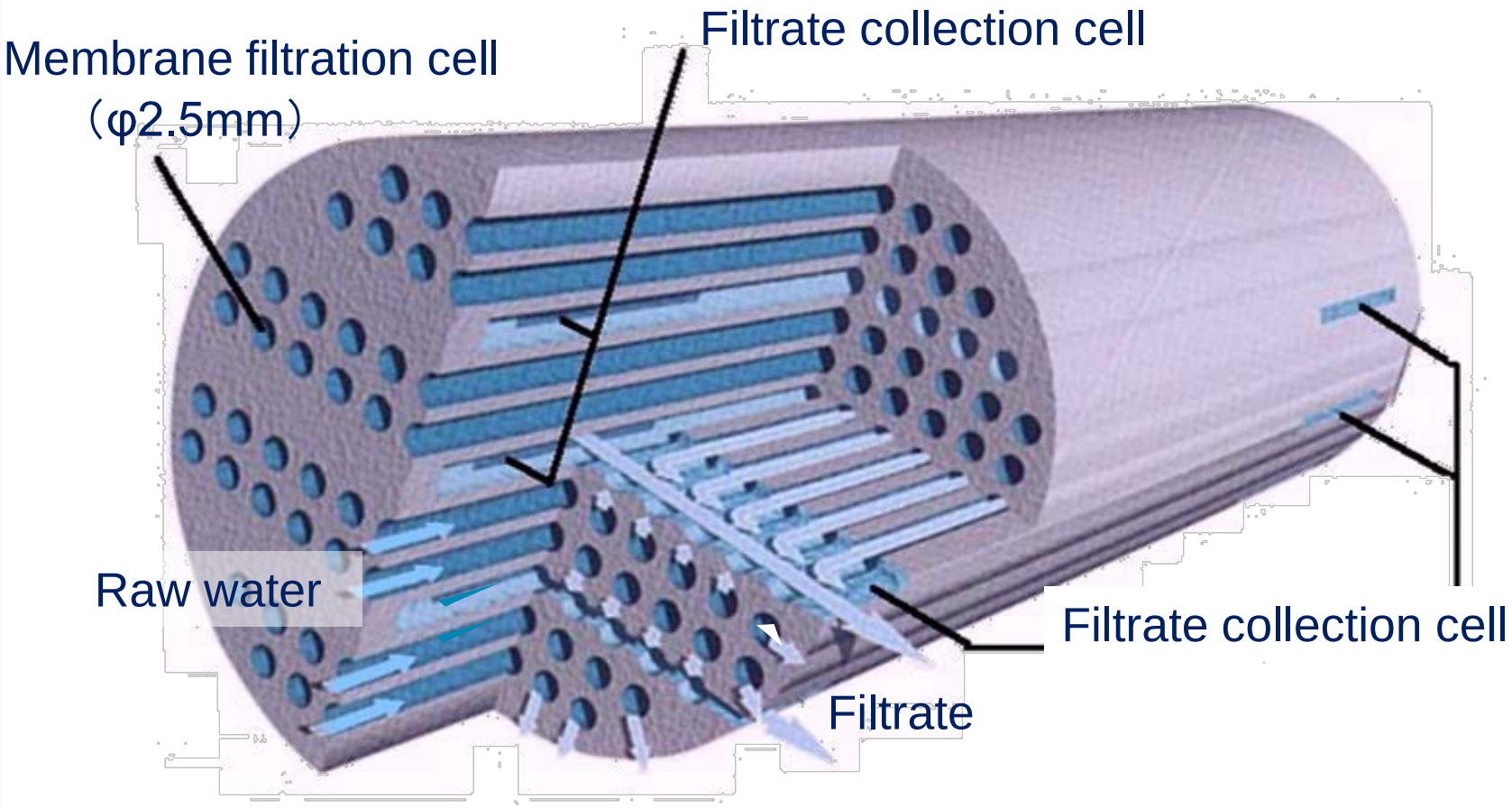
3rd Generation

2002

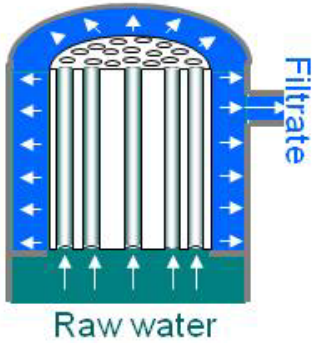
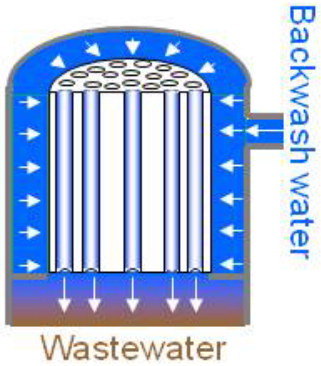
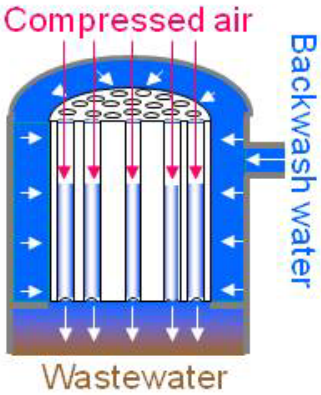
Dimension: 180mmO.D.x1.500mmL
Pore size : 0,1 µm
Mem. area : 25m²
Channel : 2,5mmI.D., 2.000ch

DWTP in Yokohama (171.000m³/day)

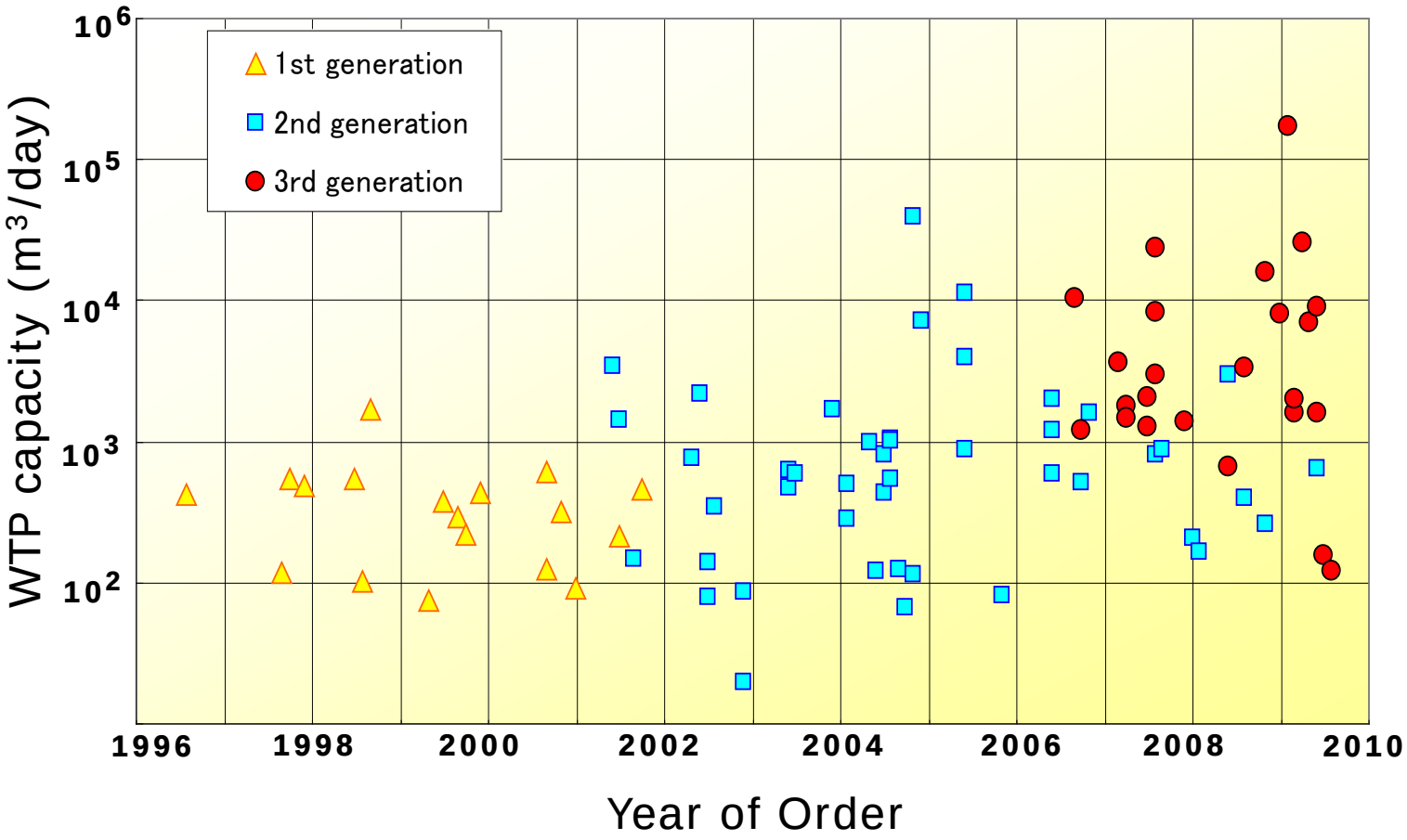
The ceramic membrane filtration system
Membrane



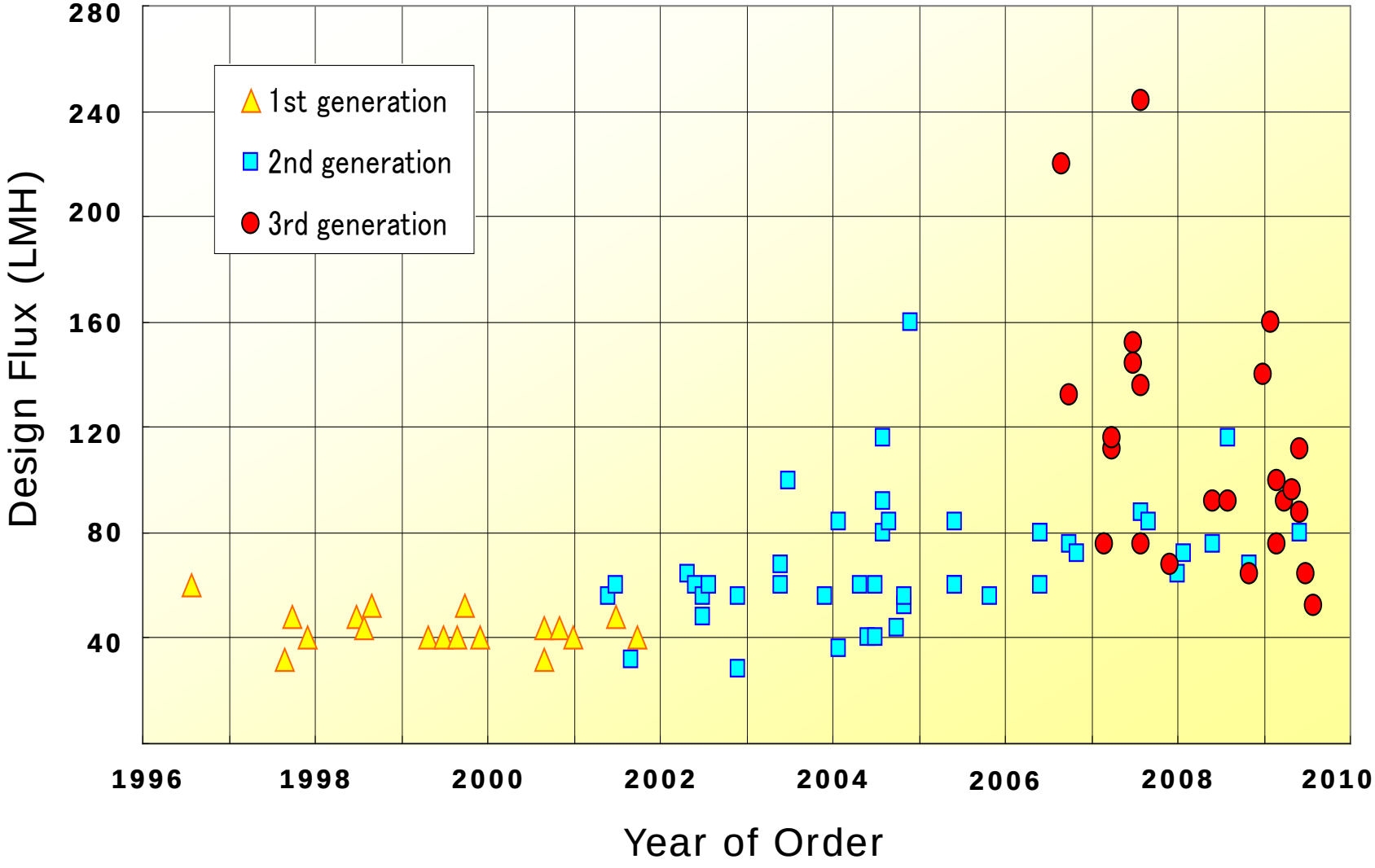
The ceramic membrane filtration system
Backwash

	Filtration process	Backwashing process	
		1st step: backwash	2nd step: discharge
Schematic diagram			
Operation Mode	Dead-end filtration	backwash by filtrate	Discharged by air flush
Pressure	5 - 100kPa	max. 500kPa	max. 200kPa
Duration	1 - 6hr	2 - 20 sec.	a few seconds
		less than 1 min. (in total)	

The ceramic membrane filtration system
Capacity



The ceramic membrane filtration system
Design Flux



The ceramic membrane filtration system
Benefits

- No membrane breakage / longduring100 % integrity
- Long service life / 10 year -100 % guarantee
- Low CIP frequency
- Robustness against raw water fluctuations
- High recovery rate & easy handling of backwash waste
- Less malfunction and break down
- Low power consumption and low O&M cost
- Excellent chemical resistance
- High reduction of bacteria and viruses in combination with PACl

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- Questions

Drinking water applications

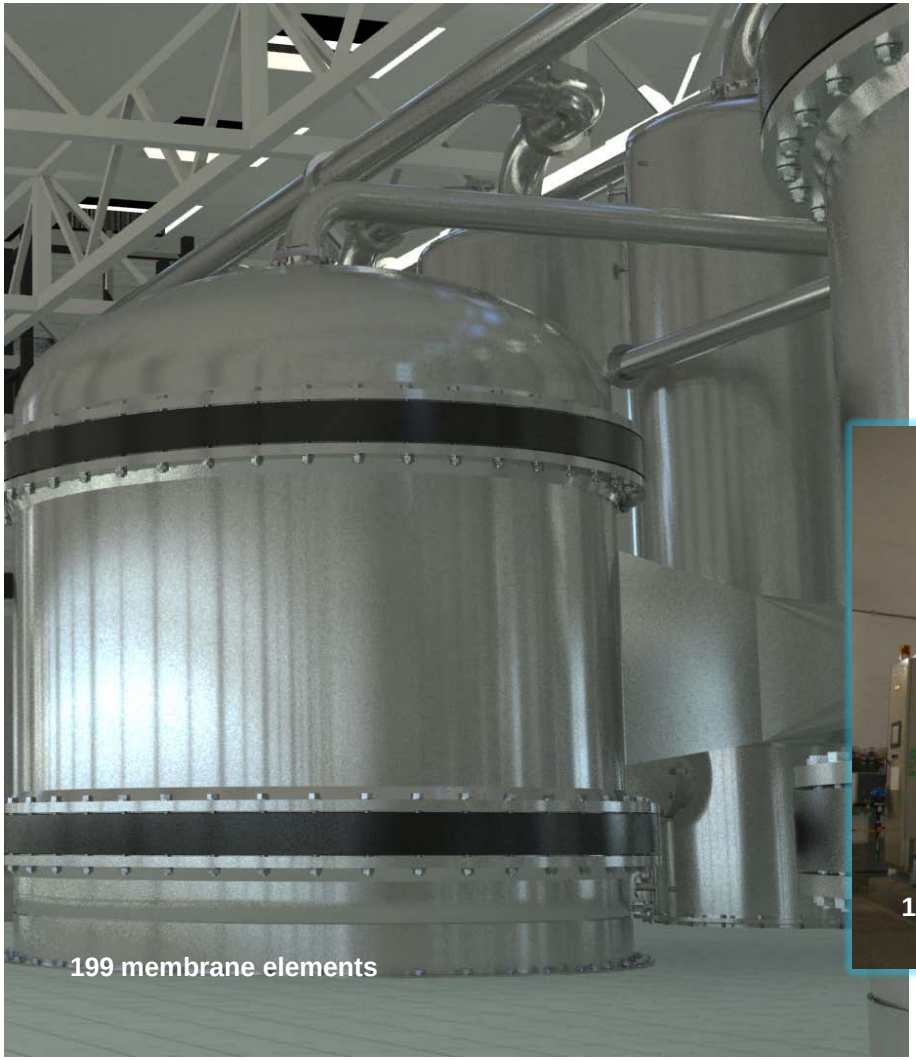
Andijk 3, pilot phase 1 (2006)

Drinking water applications

Andijk 3, pilot phase 2 (2009) C-19

Drinking water applications

Andijk 3, pilot phase 3 (2012) C-200



Drinking water applications

Andijk 3, 2014 (The Netherlands)

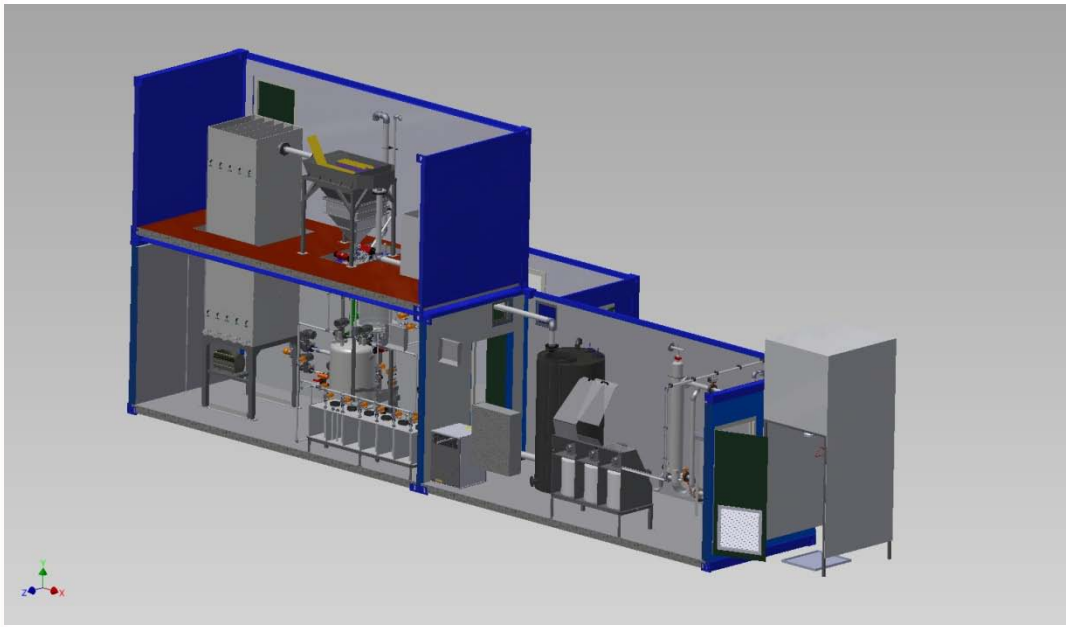
Drinking water applications
Andijk 3, innovative

CeraMac®
an innovative ceramic block design

- reduced foot print
- reduced use of stainless steel
- reduced number of valves
- lower energy consumption (backwash)
- higher productivity at short backwash intervals

Drinking water applications

South West Water (UK),
Pilot Six® - CeraMac ® (2013-2014)



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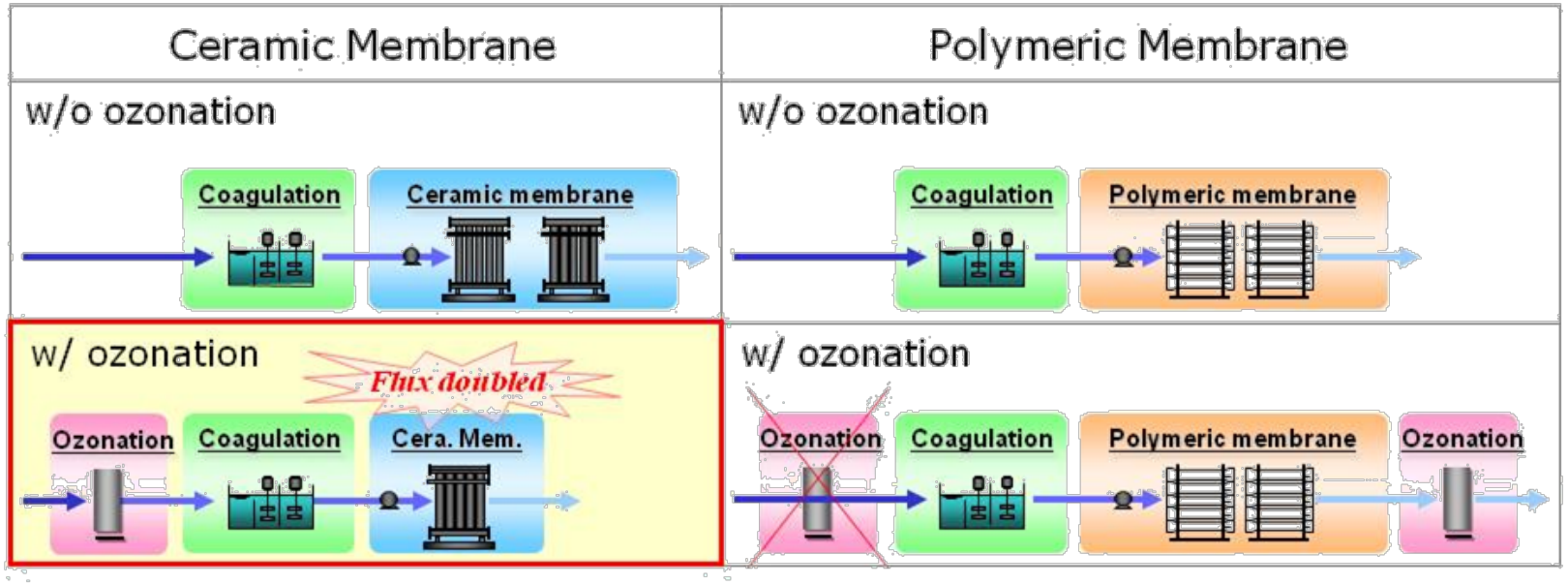
Water reuse, recycle and / or reclaim
Technologies

Cost reduction mechanism



Water reuse, recycle and / or reclaim

Operation results

Effect of pre-ozonation and coagulation

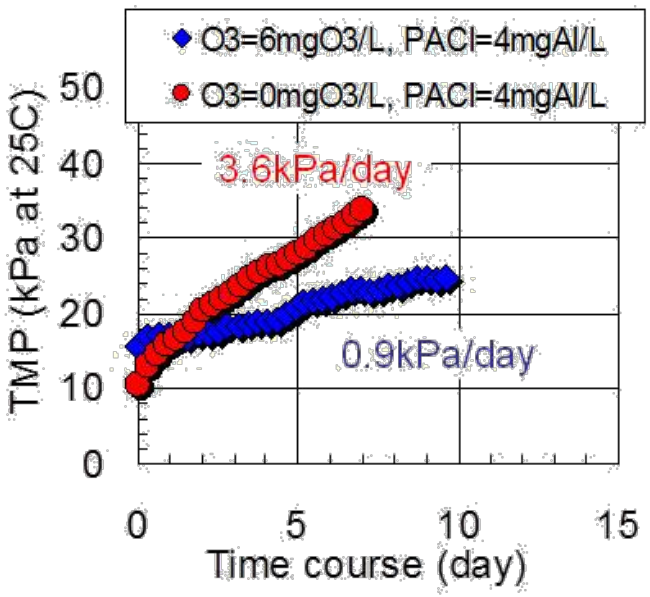


Fig.1 Pre-ozonation effect on TMP increase rate

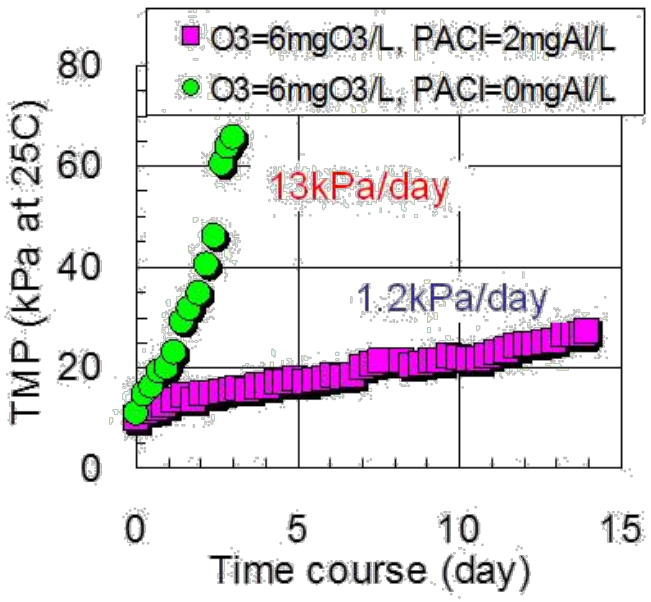


Fig.2 Coagulation effect on TMP increase rate

- TMP increase rate became 1/4 by pre-ozonation.
  - ➡ Design condition : pre-ozonation

- TMP increase rate became 1/10 by coagulation.
  - ➡ Design condition : coagulation

Water reuse, recycle and / or reclaim
Singapore demoplant

Water reuse, recycle and / or reclaim
Singapore demoplant

Phase 1: clarified water

- September 2011 – Februari 2012

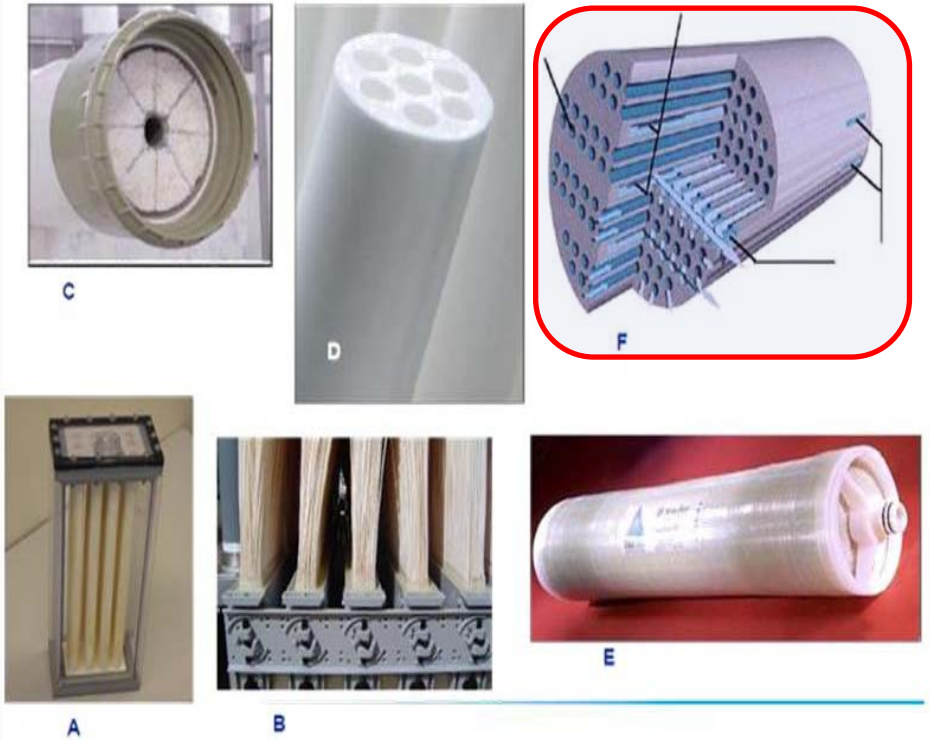
- Found optimal operation;
  - flux : 200 lmh
  - BW-frequency : 2/h
  - EBW-frequency : 2-3/d (NaOCl 100 ppm)
  - : 0-1/d (HCl pH=2 with 100 ppm H2O2)
  - CIP frequency : >90 days
  - water recovery : >95%

Phase 2: clarified water with O3

- July – December 2012
- Target ozone concentration on membrane surface 0,5 mg/l
- Ozone dose 1,3 – 1,8 mg/l

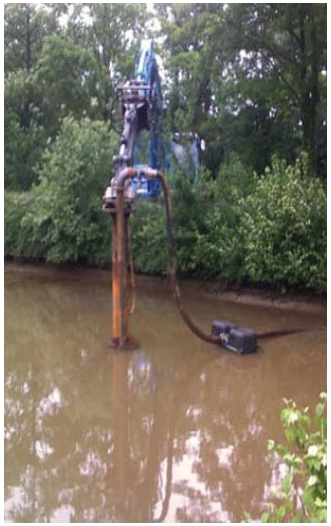
- Found optimal operation;
  - flux : 350 lmh
  - BW-frequency : 2/h
  - EBW-frequency : 0-1/d (HCl pH=2 with 100 ppm H_2O_2)
  - CIP frequency : >90 days
  - water recovery : >95%

RE-use of backwashwater PS Wierden
Comparative pilot test 2009



Re-use of backwash water
Comparative study of 6 MF/ UF membranes

Water Re-use 3.0
Vitens PS Wierden



conventional

water re-use 1.0

water re-use 2.0

water re-use 3.0

Process parameters

- Iron content feed: 80 – 200 mg/l
- Iron content permeate: < 0,03 mg/l
- Turbidity: < 0,2 FNU
- Microbiological analyses: according to Dutch regulations
- E-coli reduction: > log 4
- Recovery: >98 %
- Flocculant dosing: 2-4 mg/l
- Flux nominal 85 lmh
- Flux maximal 115 lmh

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Summary

Ceramics the best option in different applications!

- Start with a cost – benefit analysis
- Proven technology in drinking water
  - No membrane breakage / 100 % integrity
  - Low CIP frequency and low O&M costs
- First full scale water reclaim projects
  - High flux especially with dosing of O_3
  - 10 year 100 % guarantee
  - Robust system during fluctuations
- CeraMac®
  - Reduced foot print / valves / stainless steel
  - High productivity at short backwash intervals

Future options for ceramics

- Oil contaminated water
- Ballast water
- Manure / digestate treatment
- Swimming pools
- MBR side stream applications

Full scale design based on pilot tests!