NOVEMBER 2022

GLOBAL RESEARCH AND SCIENTIFIC SERVICE

AS SELLING TOOL

h2o innovation Specialty Chemicals Group

Piedmont GENESYS PWT™

DISTRIBUTOR SUMMIT

NOVEMBER 13-17, 2022

h2o innovation®

Madrid-Spain

GENESYS MEMBRANE PRODUCTS

California-USA

PWT™ Forward thinking chemistry

Manchester-UK

GENESYS INTERNATIONAL

DISTRIBUTOR SUMMIT BILBAO

Global Research and Scientific Service
ONE – GLOBAL – TEAM

Madrid-Spain

Javier Rodriguez

Nuria Peña

Victoria Velasco

California-USA

Sara Alves

Gregory Sato

CJ Evangelista

Manchester-UK

Max Fazel

Mike Sinfield

Amit Sankhe

Specialty Chemicals Factory (California)

- **Location: Vista – California (USA)**
- **Founded in 1998, acquired in 2009 by H2O Innovation**
- **Dendrimer synthesis process**
- **R&D facility - Product development**
- **Laboratory → Autopsies and cleaning studies**

Specialty Chemicals (UK)

- Founded in 2000, Acquired in 2019 by H2O Innovation
- R&D facility - Product development
- QC Laboratory
- March 2022 → Doubled in size to 30,000 ft² with capacity to produce 1,000 tons/year of powder cleaners

R&D Centres (UK and USA)

- RO Pilot plants
- Membrane Cleaning Rig
- Flat sheet test rigs
- Wet laboratory
- Team of research chemists and product developers
- Published Technical Research Papers (around 80)

RESEARCH AND PRODUCT DEVELOPMENT

Scientific Services (Genesys – Madrid – Spain)

- Founded in 2001
- Analytical support and forensics service
- >1.700 autopsies completed
- Membrane Cleaning tests
- Autopsy RO/UF
- Autopsy cartridge filters
- Pre-treatment Evaluation
- Deposit/foulant identification
- Research & New Product Testing
- Technical Research Papers

ALADYR AWARDS 2022
RESEARCH CENTER OF THE YEAR
GENESYS LAB MADRID

ALADYR
ASOCIACIÓN LATINOAMERICANA DE DESALACIÓN Y REUSO DE AGUA

DISTRIBUTOR SUMMIT
BILBAO

Global Research and Scientific Service

Main objective

Development of the best quality and sustainable products

Continuous improvement of the service

Global Research and Scientific Service

as a sales tool

A good service means benefits for customers → **Clients benefits mean profit for our companies**

QUALITY AND EFFICIENT PRODUCTS

TECHNICAL SUPPORT

RESEARCH AND PRODUCT DEVELOPMENT

SCIENTIFIC AND FORENSICS SERVICE

Global Scientific Service

as a sales tool

- ✓ Best way to demonstrate **cleaners and flocculants efficiency**
- ✓ Technical advice / support ⇨ **Added value to chemicals sales**
- ✓ Plants failure resolution ⇨ **Faithful clients**
- ✓ Contact with potential clients ⇨ **Key Accounts**

Global Scientific Service

Science

- ✓ Analyses and tests based on standard methods.
- ✓ Technical papers & technical presentations in national and international congress
- ✓ Cooperation with Universities and Research Centres.

Service

- ✓ Service to H_2O Group
- ✓ External Service for no clients.
- ✓ More than 10,000 samples, including more than 1,700 autopsies from all over the world.

Personalized tests

Personalized attention

DISTRIBUTOR SUMMIT BILBAO

Quiz time

To which laboratory can membranes be sent for cleaning tests service?

Samples range

Water analyses and tests	•RO projection analyses, cooling systems •Particle counting, jar-tests
Membrane analyses	•Diagnosis of mbne failures (RO, UF), cleaning tests •Autopsies: Level I, level II, level III and level IV.
Filter analysis Cartridge / SDIs	• Information about the particles suspended in water • SEM-EDX, ATR-FTIR, …
Fouling / deposits	• LOI: Percentage of organic and inorganic content • SEM-EDX, ATR-FTIR, etc.
Chemical products	• Quality control • Density, pH, active component, etc.
Others	• Pipes and metallic probes (corrosion diagnosis). • Filtration media

Analytical techniques

pH-meter

Ionic chromatography

Particle counter

Volumetry

Conductivimeter

Spectrophotometer

Turbidimeter

Analytical techniques

SEM-EDX

ATR-FTIR

XPS/ESCA

TENSIOMETER

THERMOGRAVIMETRY

Others:

- LC/OCD
- GC/MS
- Confocal microscopy
- 3D microscopy

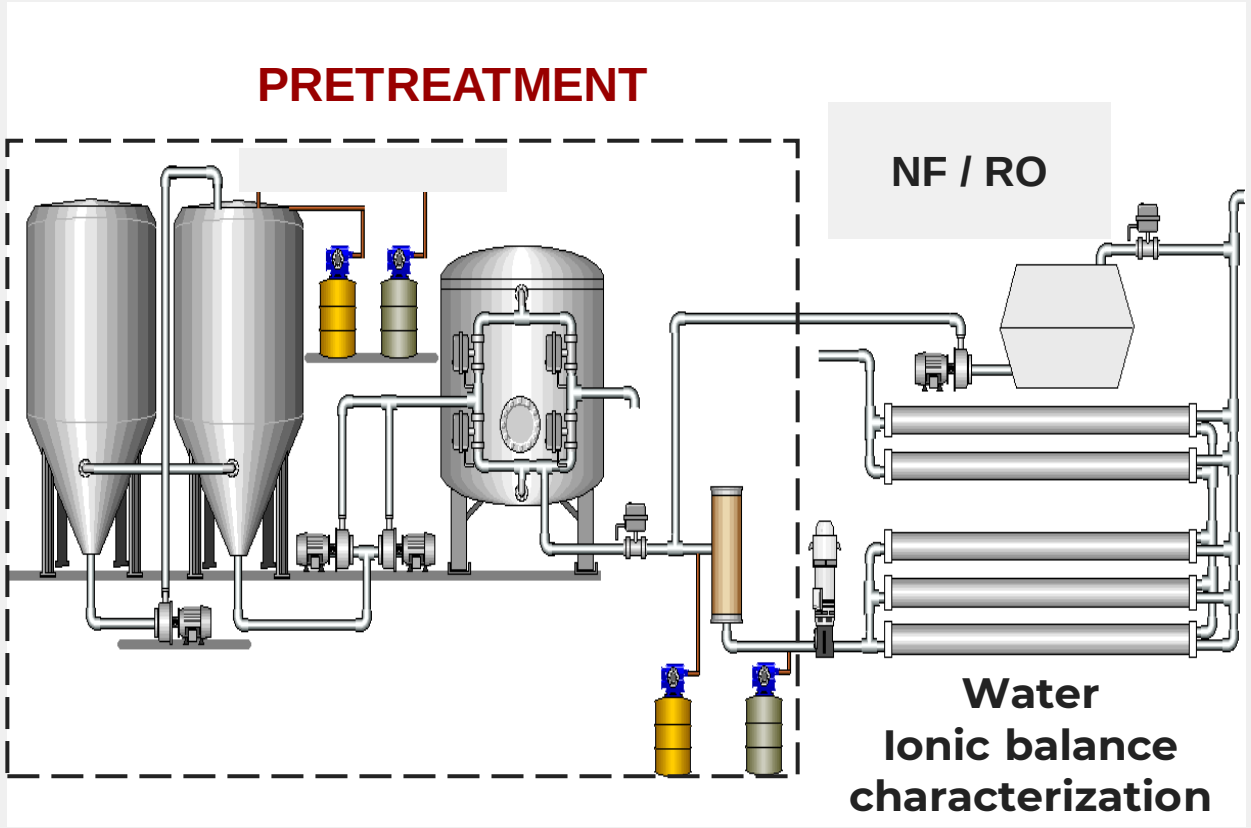
Analytical tests range

Membranes tests rigs

Cartridge filters cleaning rig

Jar-test
Disinfection
Filtration tests

Physical-chemical treatment optimization



Cleaning procedures optimization

MEMBRANE AUTOPSIES (OI / NF/ UF)

Water
Ionic balance characterization

Foulant / damage identification

Suspended matter identification

Cartridge filters analyses

SDI filters analyses

Particles size distribution

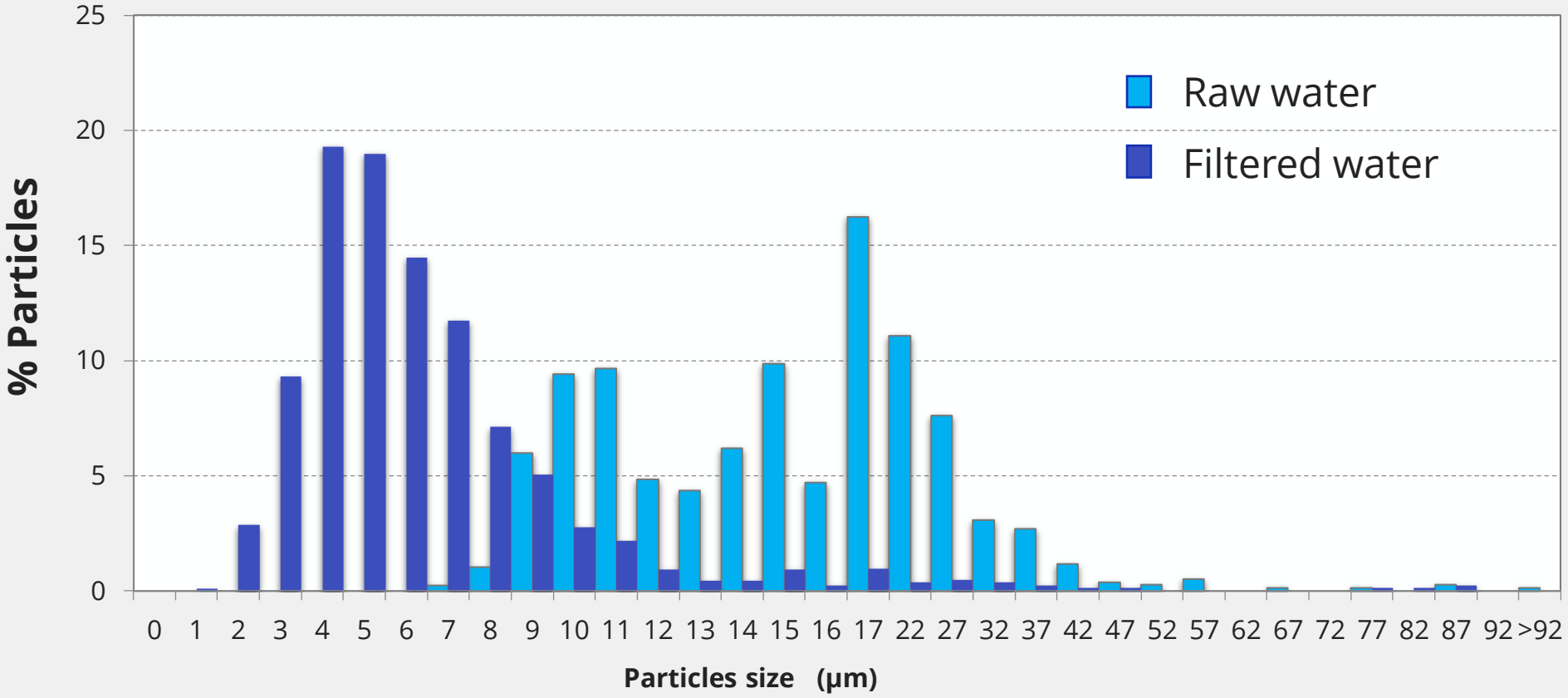
MM5 MEMBRANE MASTER

PWT Prodose
PWT

DISTRIBUTOR SUMMIT BILBAO

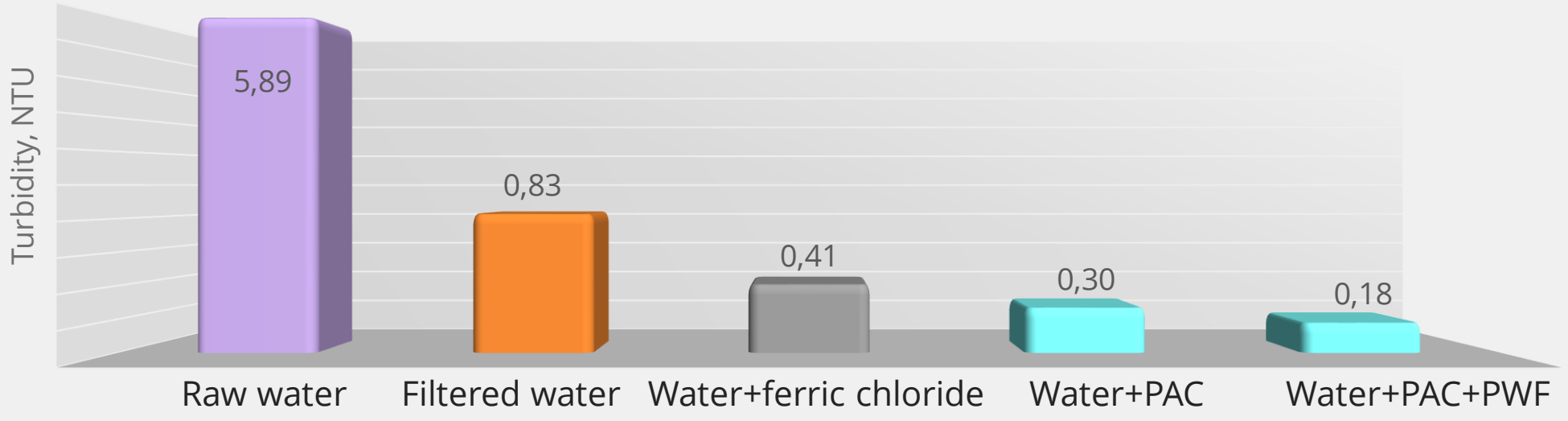
Particles size distribution

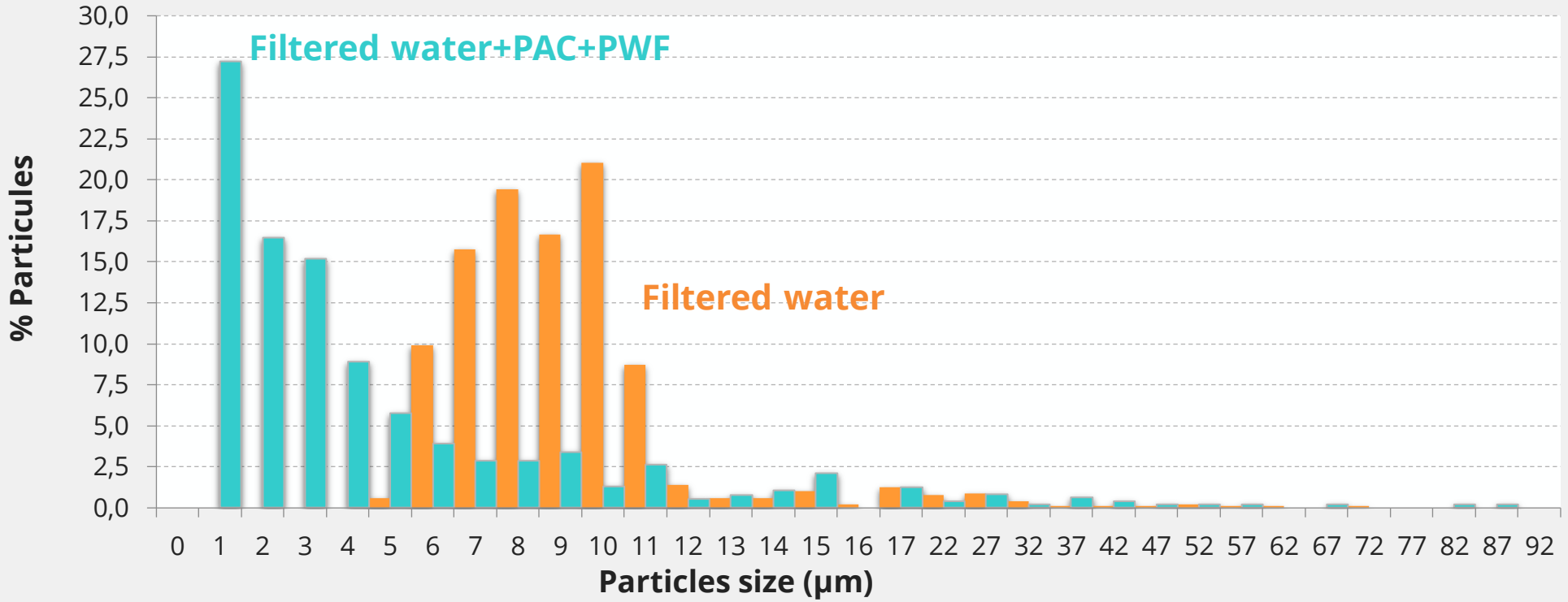
Filtration efficiency
Filter size selection



Size range (µm)	≤ 50	≤ 20	≤ 10	≤ 5	≤ 2	≤ 1	Turbidity, NTU
Raw water	98.8	83.6	16.7	0.0	0.0	0.0	**5,89**
Filtered water	**99.5**	**98.2**	**91.7**	**50.6**	**3.0**	**0.1**	**0,66**

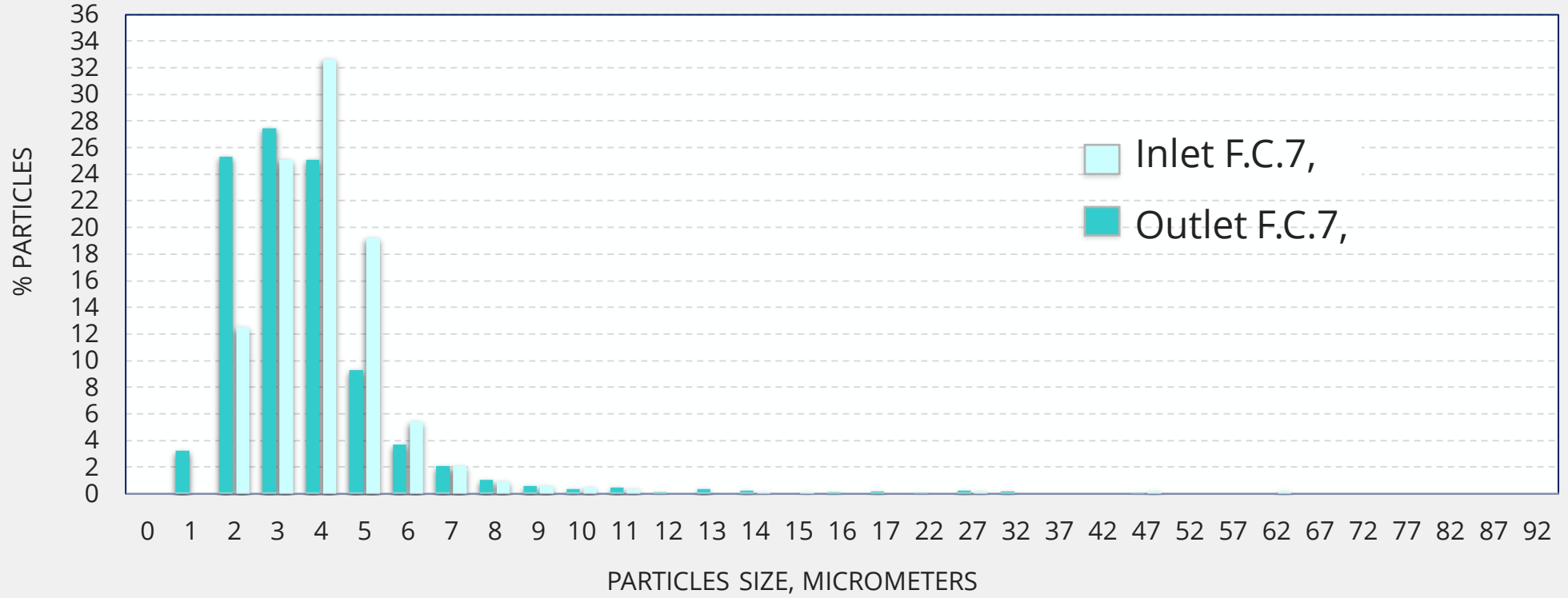
Pretreatment optimization





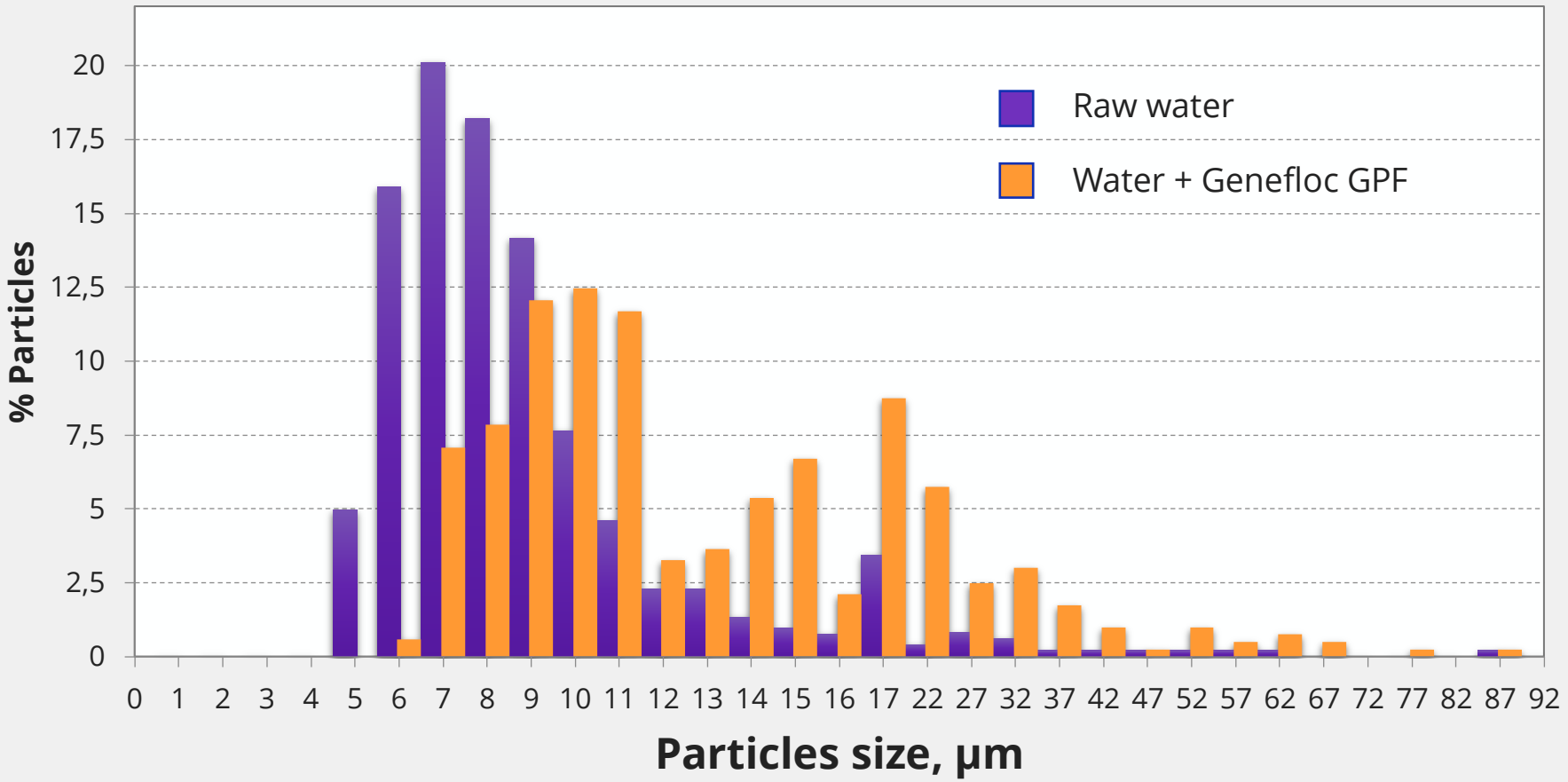
Particles size distribution

Filtration efficiency
Filter size selection

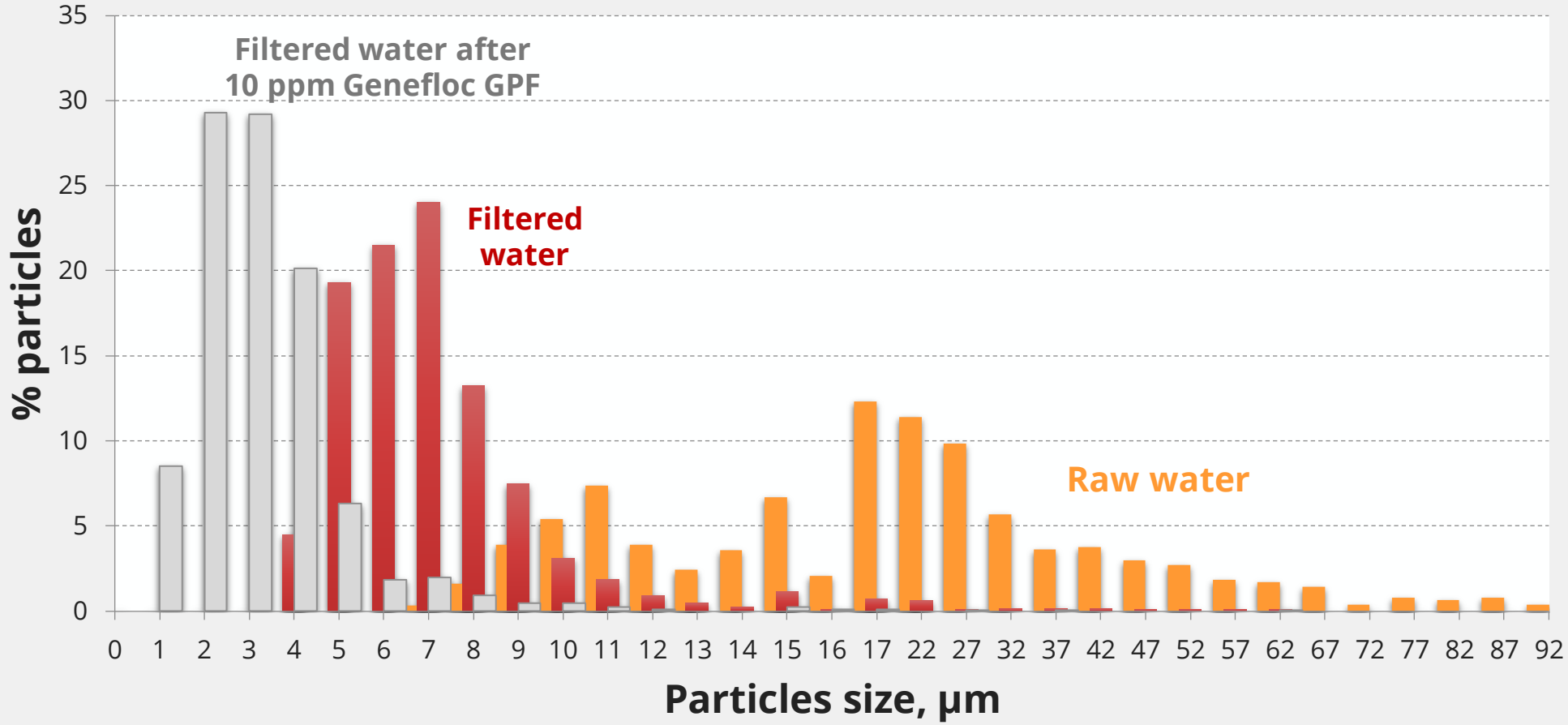


Size range (µm)	≤ 90	≤ 50	≤ 25	≤ 10	≤ 5	≤ 2	≤ 1	Turbidity, NTU	Number of particles/mL
Inlet F.C.7	100	99,8 %	99,4 %	98,9 %	89,4 %	12,5 %	No detected	0,60	9.927*
Outlet F.C.7	100	100	99,5 %	98,0 %	90,3 %	28,5 %	3,2 %	0,55 (-8%)	9.490* (-4%)

Particles size distribution Jar-test

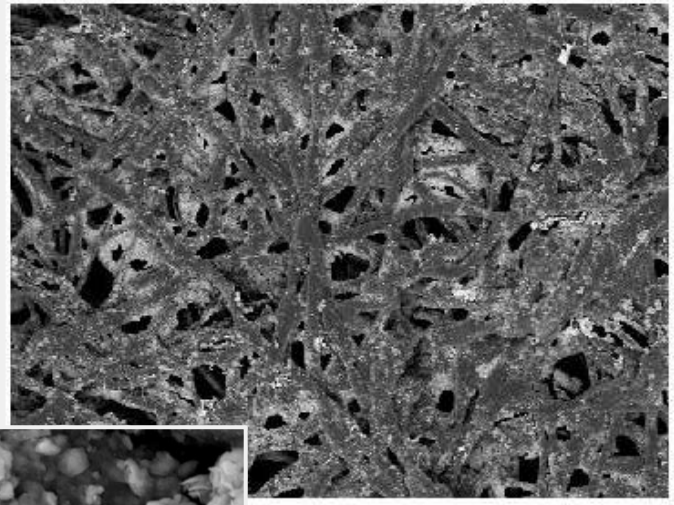


Particles size distribution Jar-test

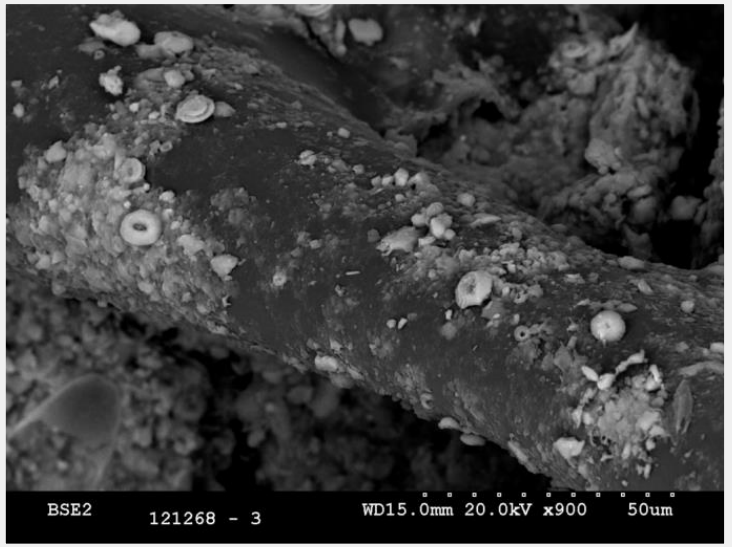


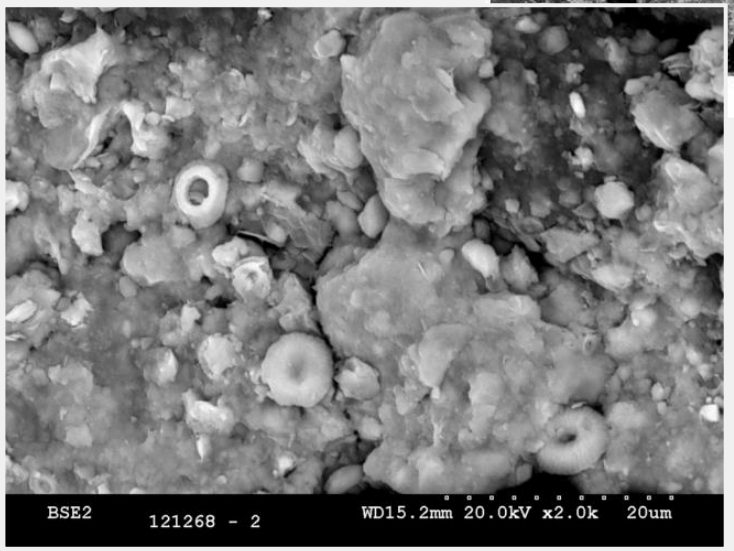
Suspended matter identification: Cartridge filters

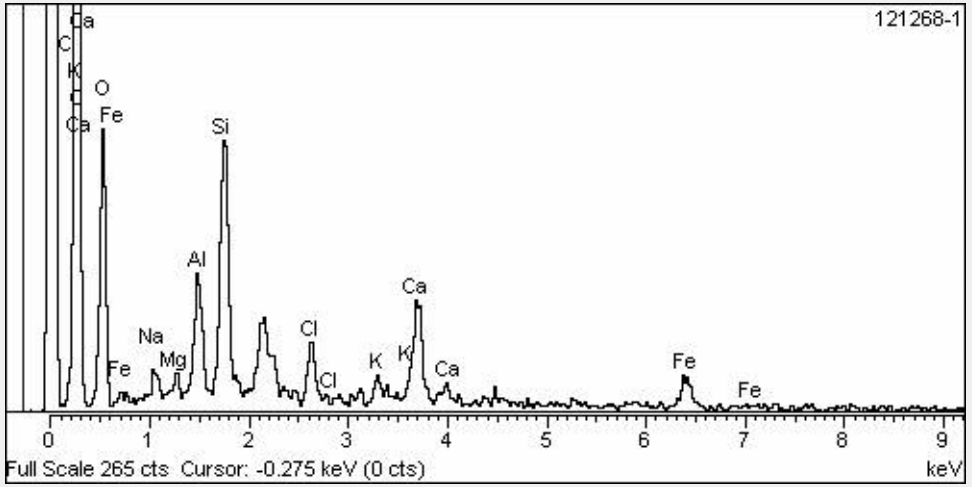
Suspended matter identification: Cartridge filters



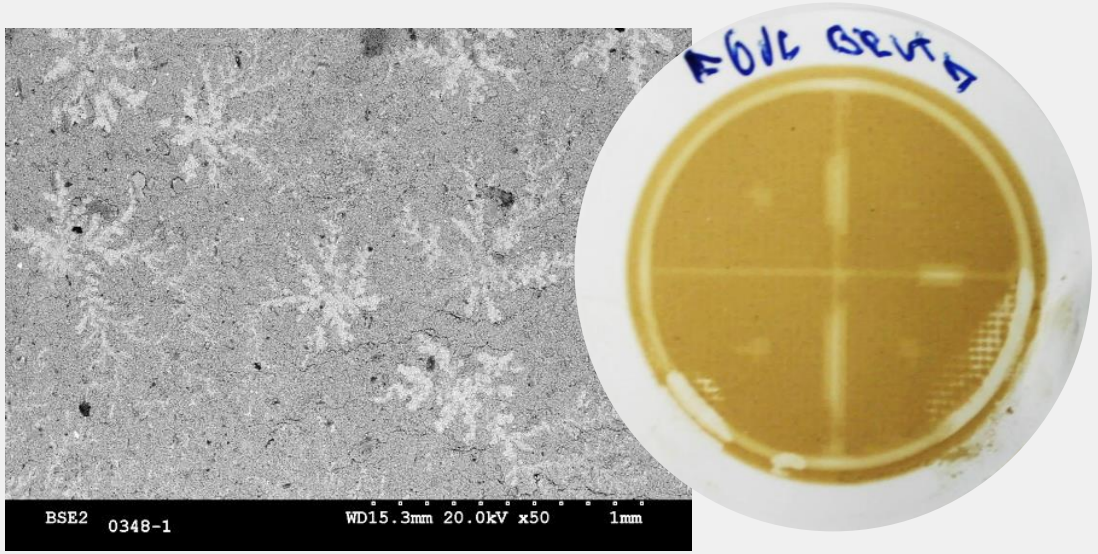
Electron Image 1

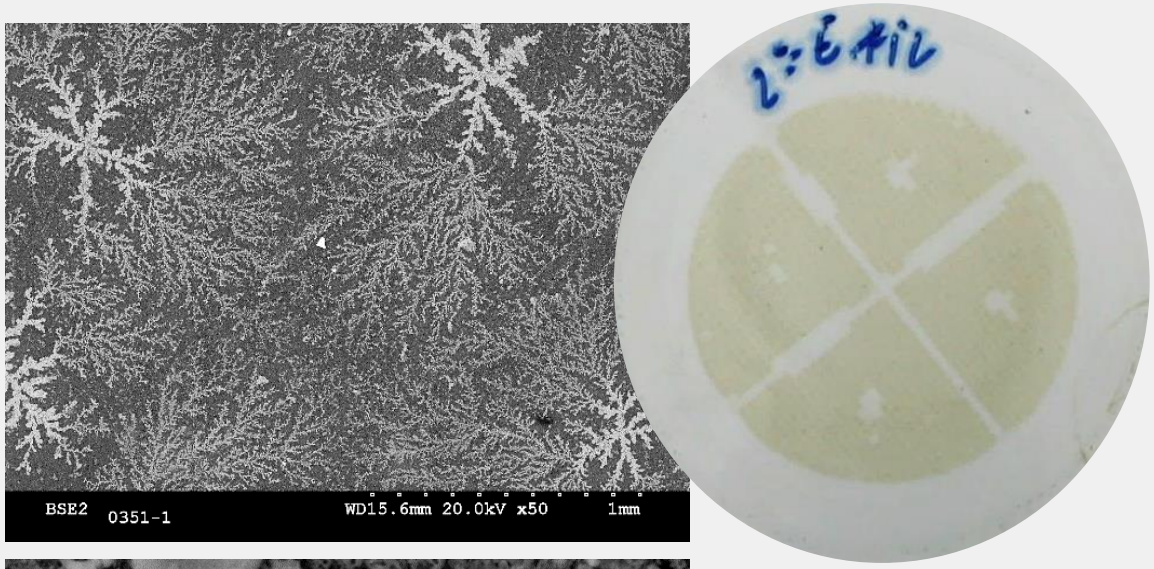


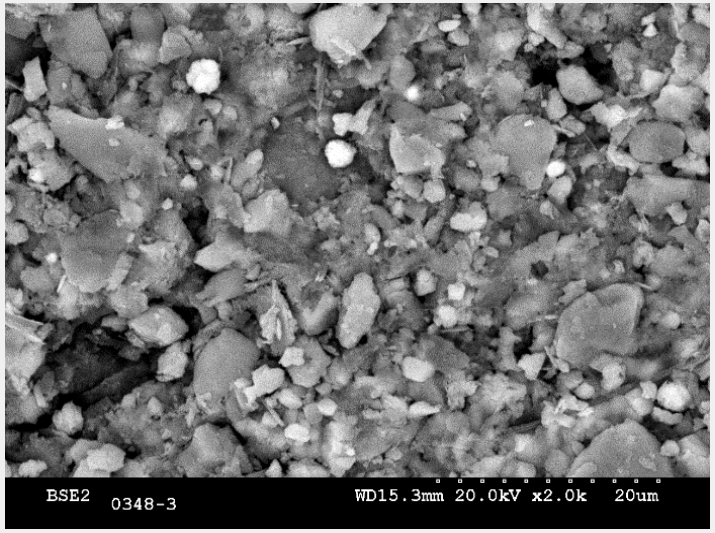


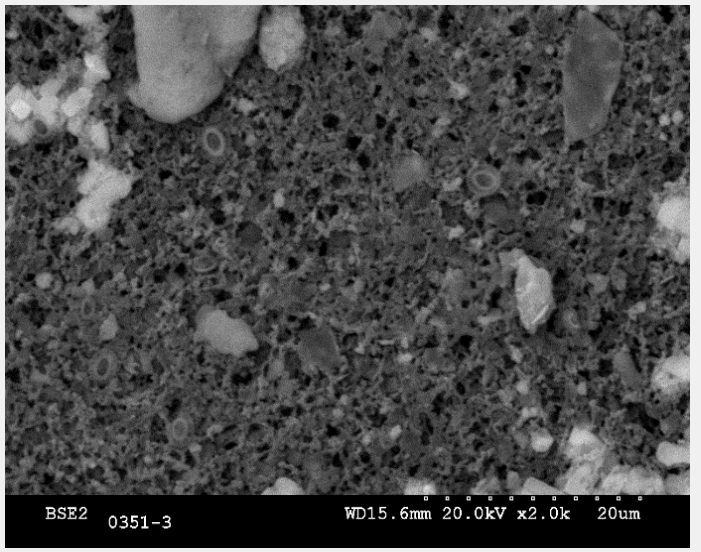


Suspended matter identification: SDI filters





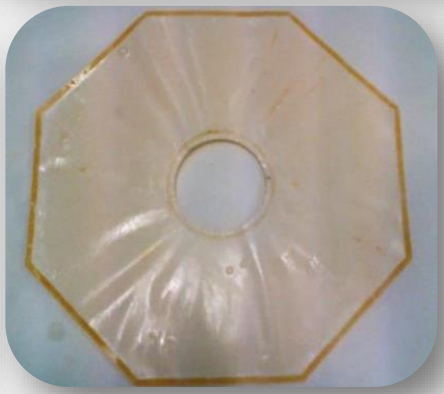


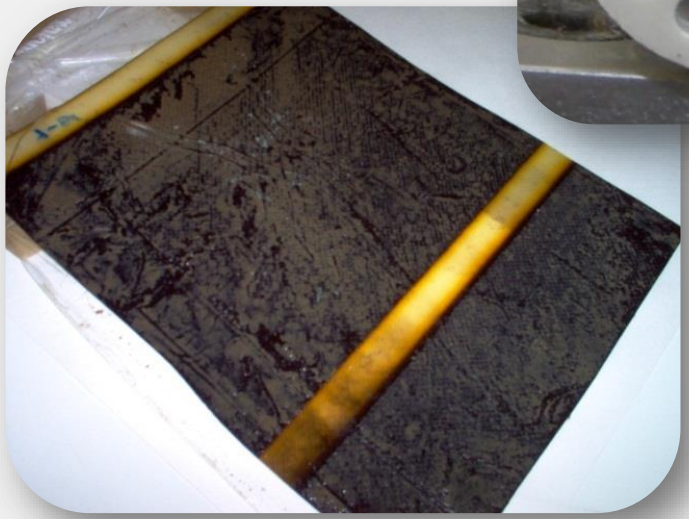


Quiz time

Which is the main analytical technique available in our service to analyze water ions for antiscalant selection?

MEMBRANE AUTOPSY





MEMBRANE AUTOPSY

RO-NF

RO Autopsy level I	• External Inspection • Internal Inspection • Fouling identification	Report delivery: 2 weeks from membrane reception
RO Autopsy level II	• External Inspection • Internal Inspection • Fouling Identification • Performance parameters • Integrity tests	Report delivery: 3 weeks from membrane reception
RO Autopsy level III	• External Inspection • Internal Inspection • Fouling identification • Performance parameters • Cleaning tests	Report delivery: 4 weeks from membrane reception
RO Autopsy level IV	• External Inspection • Internal Inspection • Fouling identification • Performance parameters • Integrity tests • Cleaning tests	Report delivery: 4 weeks from membrane reception

UF

UF Autopsy level I	• External Inspection • Internal Inspection • Fouling identification	Report delivery: 2 weeks from membrane reception
UF Autopsy level II	• External Inspection • Internal Inspection • Fouling Identification • Integrity tests	Report delivery: 3 weeks from membrane reception
UF Autopsy level III	• External Inspection • Internal Inspection • Fouling identification • Cleaning tests	Report delivery: 4 weeks from membrane reception
UF Autopsy level IV	• External Inspection • Internal Inspection • Fouling identification • Integrity tests • Cleaning tests	Report delivery: 4 weeks from membrane reception

MEMBRANE AUTOPSY

Main causes of membrane failure

FOULING

PHYSICAL DAMAGE

CHEMICAL DAMAGE

Reversible

Irreversible

Suitable cleaner applied on time

MEMBRANE AUTOPSY

RO-NF

External inspection

Internal inspection

UF

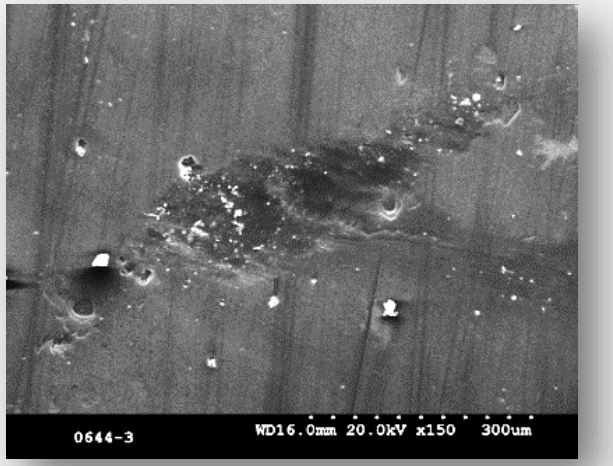
Foulant / membrane analyses:
- SEM-EDX
- ATR/FTIR
- ESCA / XPS
- Others

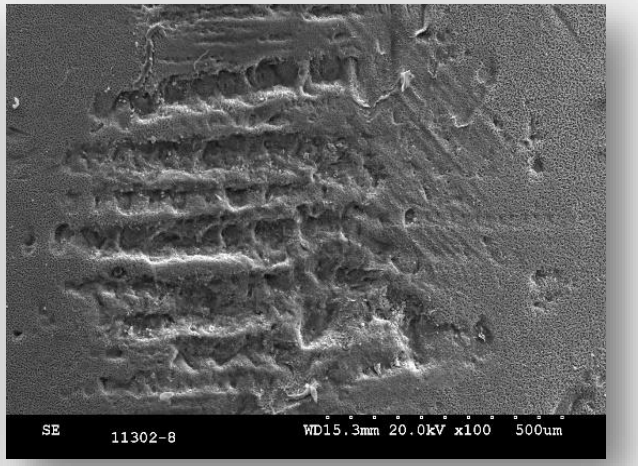
Integrity tests:
- Methylene Blue Test
- Fujiwara Test
- Tensile Test
- TGA

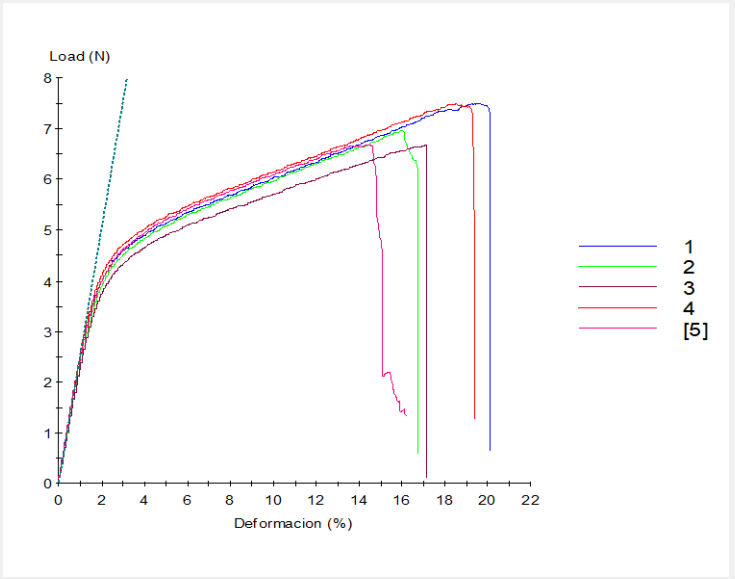
RO performance parameters (flat test rig):
- Permeate flow rate
- Salt rejection

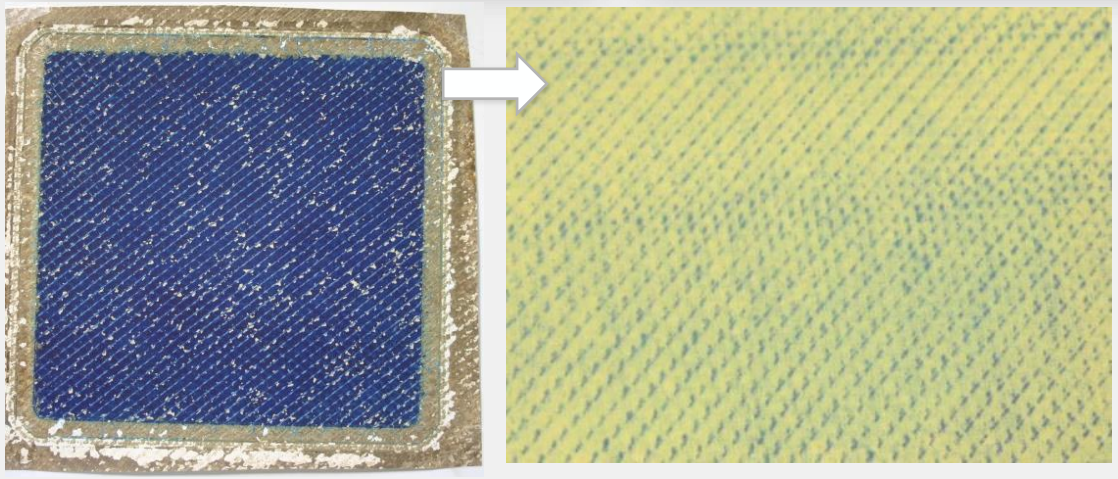
Cleaning tests

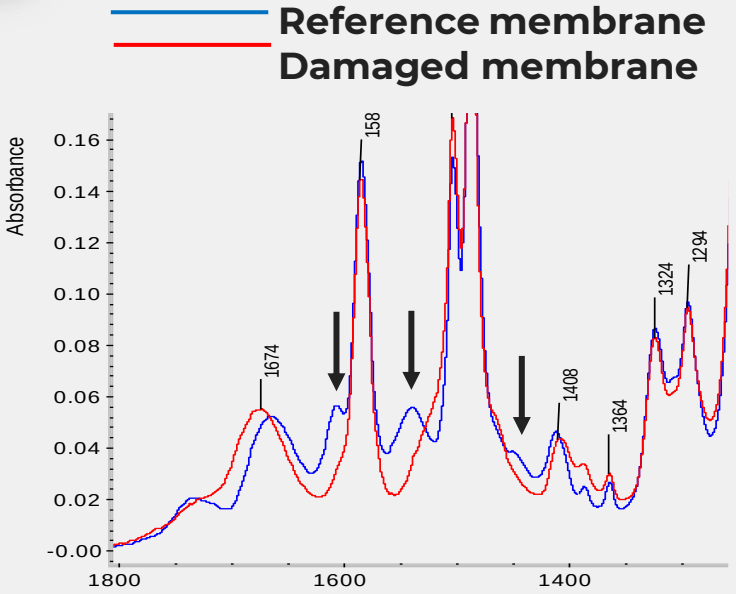
Membranes damage



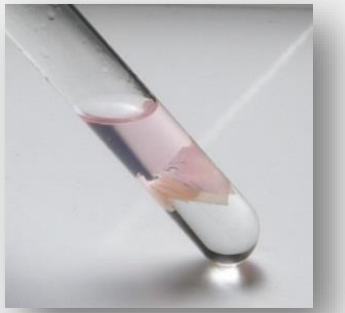








Decrease in Poliamide bands



Summary of analytical techniques and tests used for detection of membrane damage

DAMAGE	Flow rate	Salt rejection	SEM-EDX	ATR-FTIR	XPS / ESCA	Confocal microscopy	AFM	Z potential	TGA	Tensile tests
Physical damage	☑ Increase	☑ Decrease	☑ Abrasion marks	☒ Unless it is massive	☒	☑ Visual	☑ Visual	☑ Shifts on Z pot	☒	☑ Changes on elongation properties
Chemical damage	☑ Increase	☑ Decrease	☒	☑	☑	☑ Emission spectrum	☑ Visual	☑ Shifts on Z pot	☑ Shifts on degradation temperatura (UF)	☑ Changes on elongation properties
Extent of the damage	☑	☑	☒	☒	☒	☒	☒	☒	☒	☑

FOULANT IDENTIFICATION

Foulant

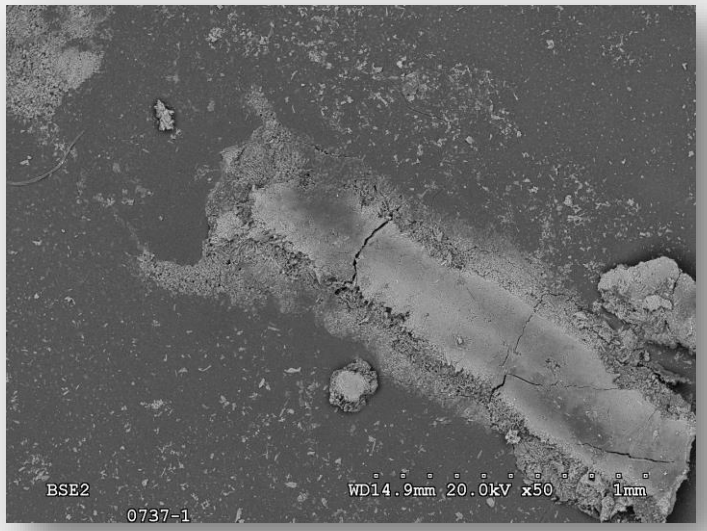
Scaling

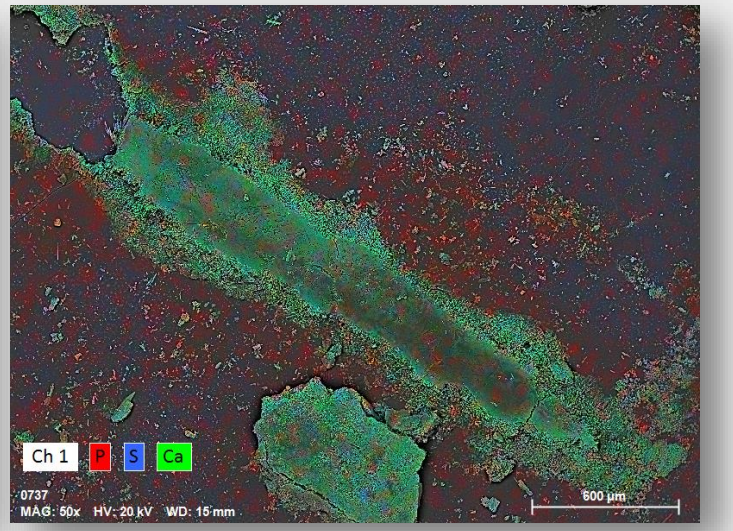
Summary of analytical techniques and tests used for foulant identification

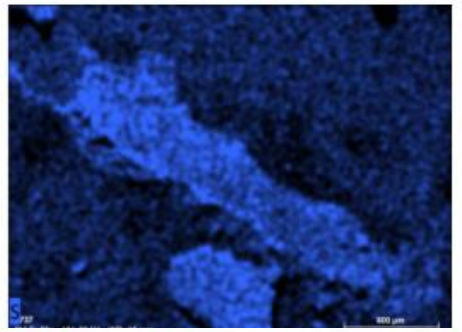
FOULANT IDENTIFICATION	SEM-EDX	ATR-FTIR	XPS / ESCA	DRX	Confocal microscopy	LC-OCD	GC/MS	Flow rate	Salt rejection
Inorganic	☑ Elementary composition and foulant distribution	☑ Compounds identification	☑ Elementary composition Oxidation state	☑ Compounds identification	☒	☑ Only some group of compounds identification	☑ Known compounds identification	☑ Decrease	☑ Significant Decrease
Organic	☒ Only presence and foulant distribution	☑ Compounds identification	☑		☑ Dead/alive microorg.	☑ NOM group of compounds identification	☑ Known compounds identification	☑ Decrease	☑ Decrease
Impact of foulant on membrane	☑ Abrasion marks	☑ Detection of membrane composition bands	☒	☒	☒	☒	☒	☑	☑

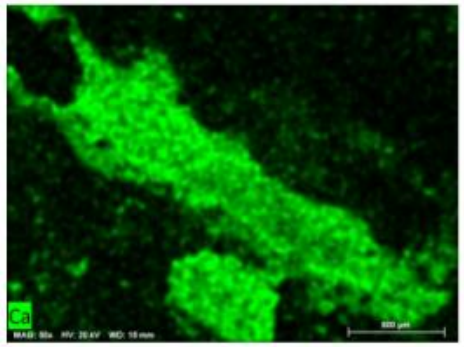
Main analytical tools

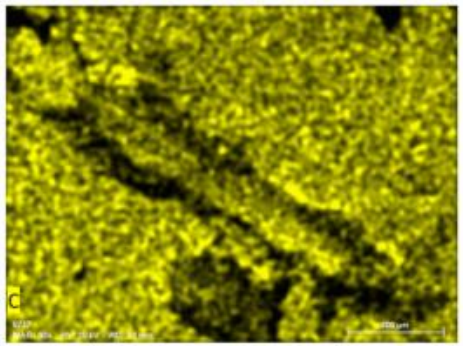
FOULANT IDENTIFICATION

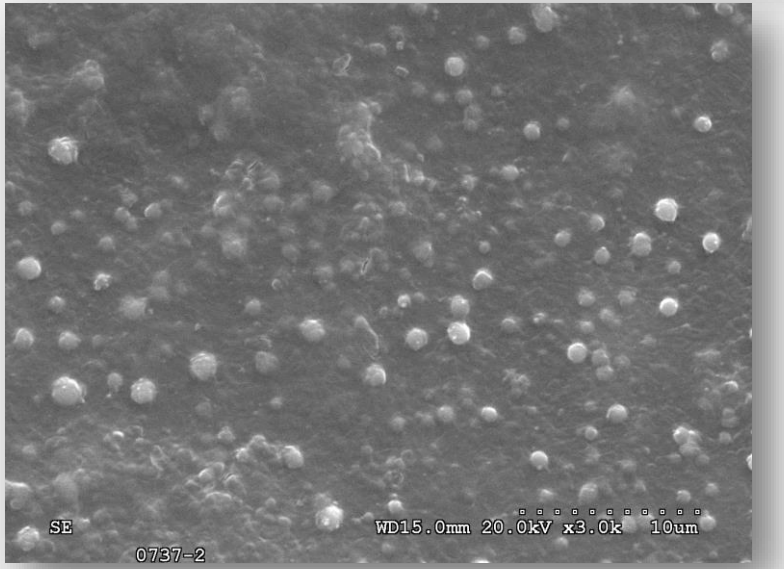


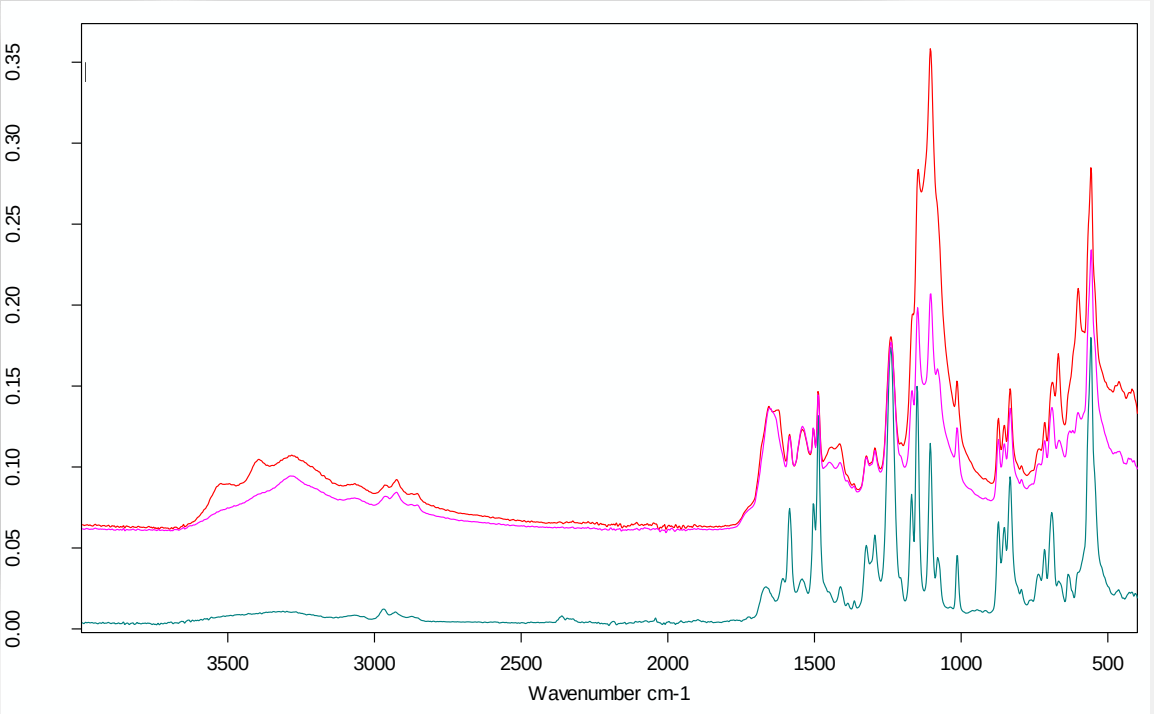






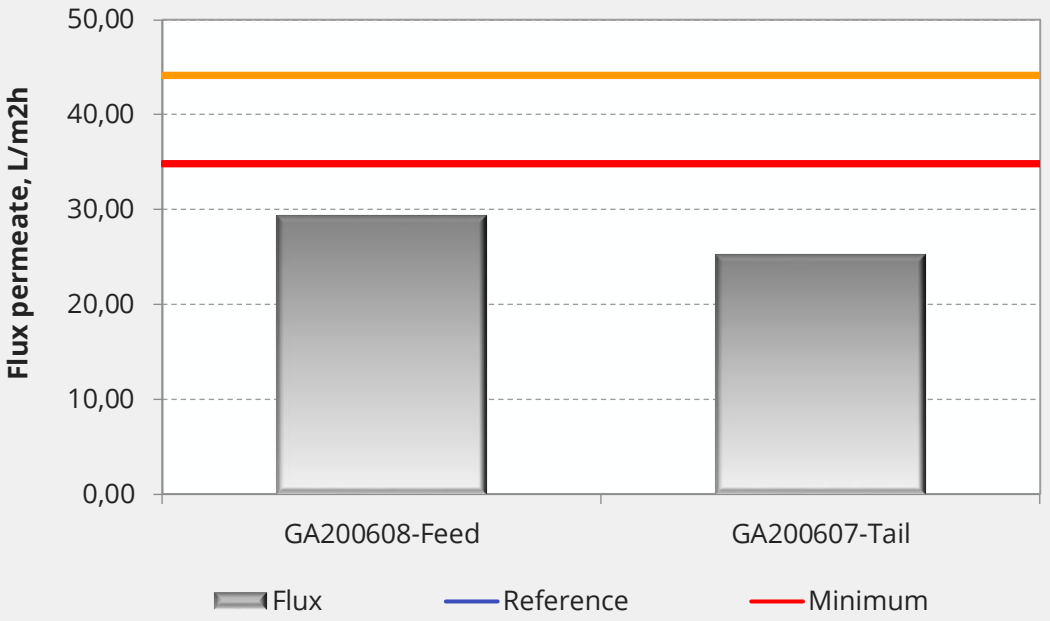


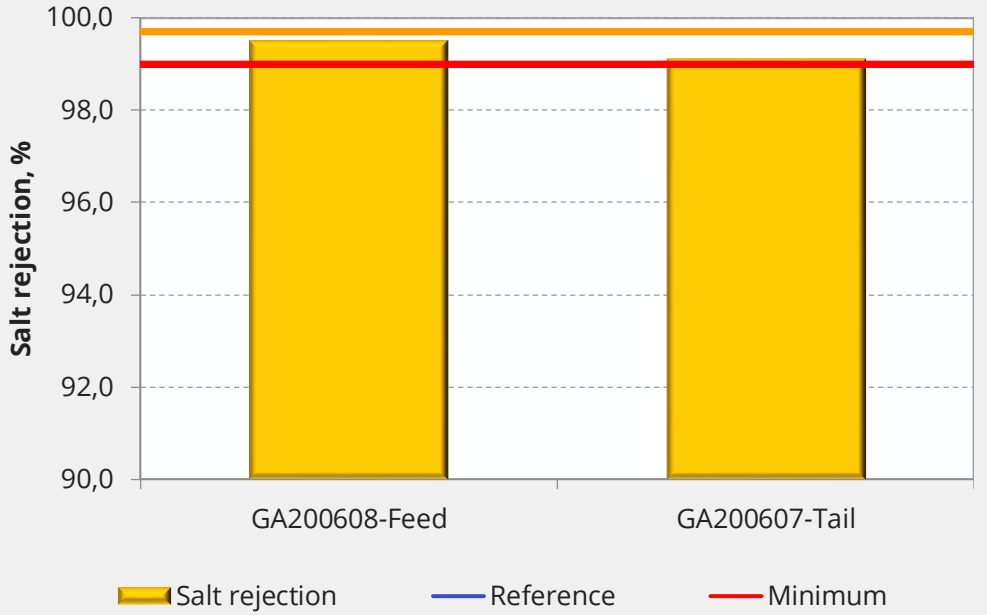




MEMBRANES CHARACTERIZATION

IMPACT OF FOULANT





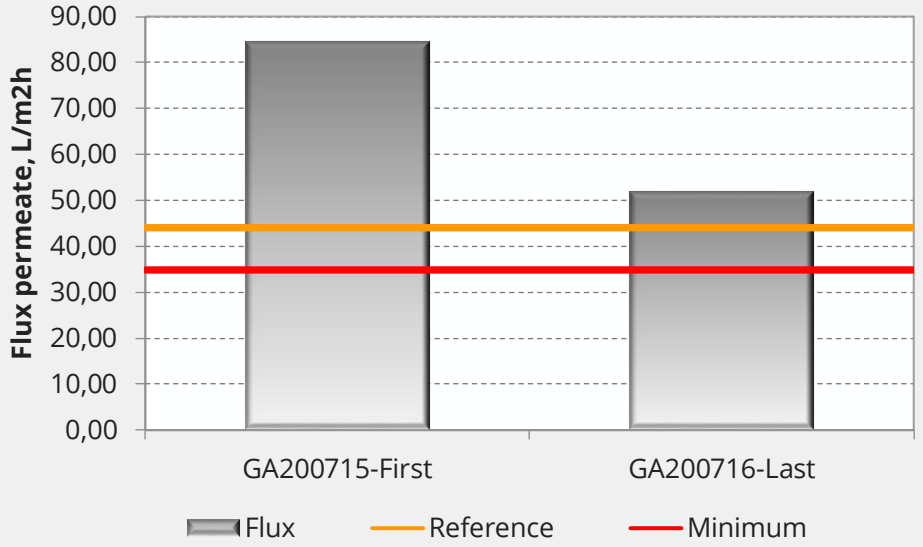
Characteristic behavior:

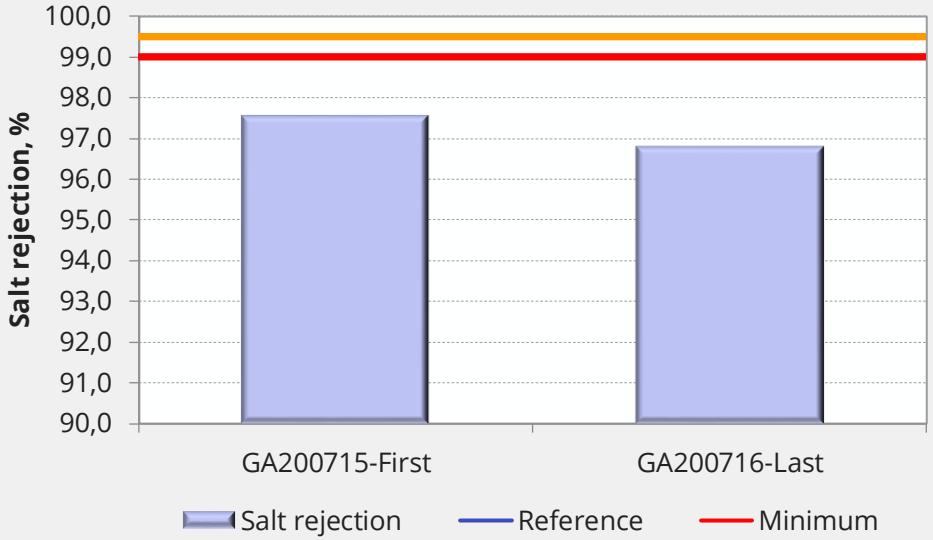
- **Permeate flux lower than reference**
- **Salt rejection lower but close to reference.**

They can be recovered during cleaning tests / foulant removal

MEMBRANES CHARACTERIZATION

IMPACT OF FOULANT





Characteristic behavior:

- **Permeate flux higher than reference**
- **Salt rejection lower than reference.**

They cannot be recovered during cleaning tests / foulant removal

Quiz time

Is it possible that a membrane with foulant gives a permeate flow higher than reference?

MEMBRANES CLEANING

Cleaner selection

MEMBRANE AUTOPSY

Client point of view

- ✓ Cost
- ✓ Membrane compatibility
- ✓ Stock
- ✓ Easy to handle
- ✓ Environmentaly friendly

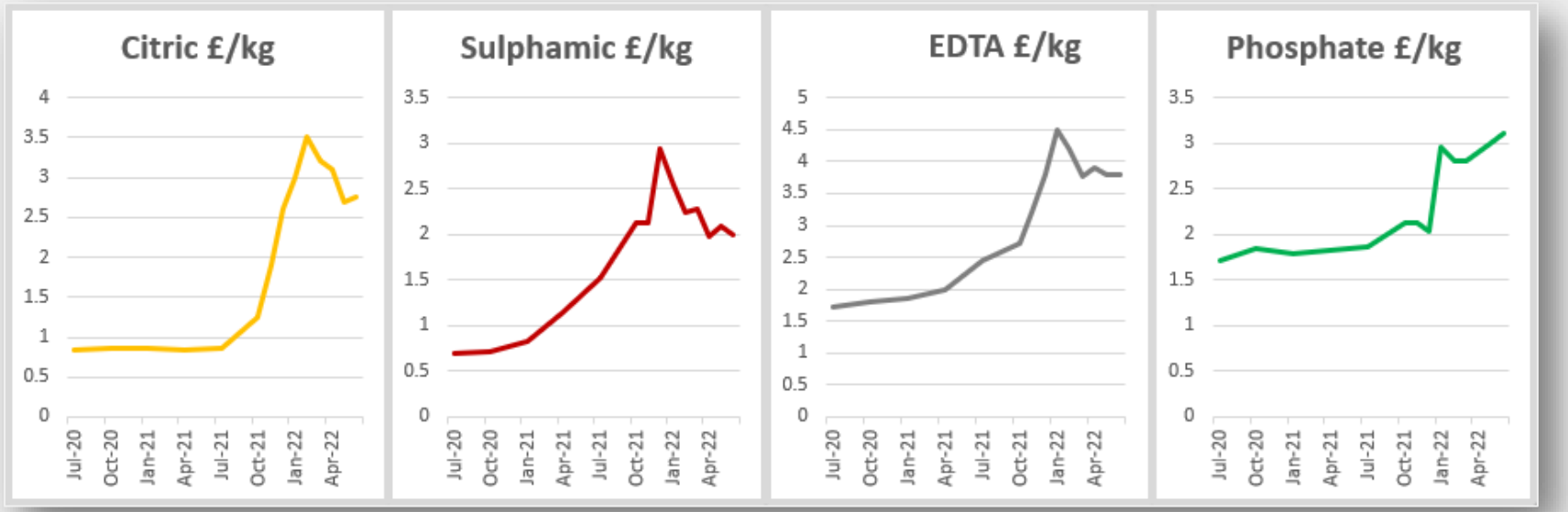
- ✓ Accurate identification of foulant
- ✓ Cleaning tests

MEMBRANES CLEANING

Cleaner selection

COST

Some commodity chemical raw material prices have more than tripled in price since different factors have affected global supply chains.

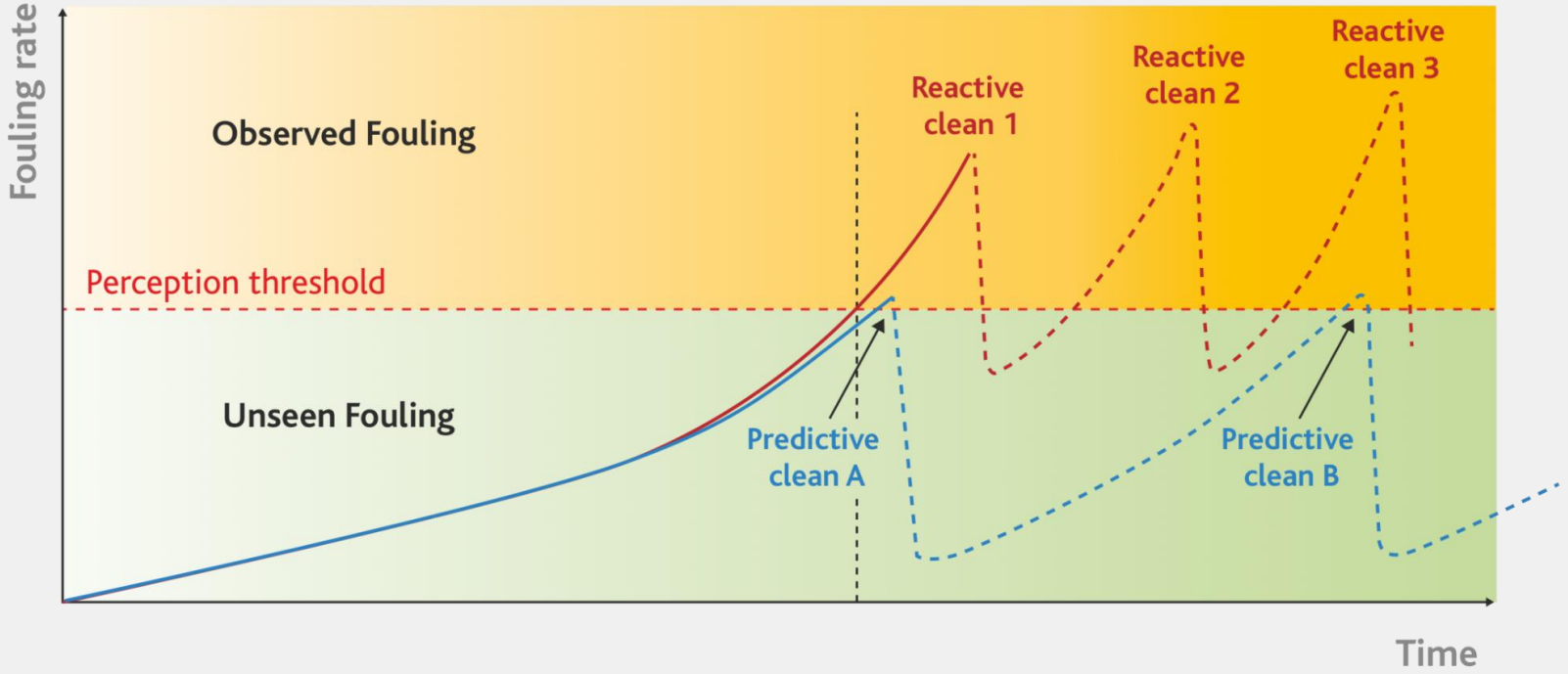


Price increases in Pounds/kg for very basic commodity chemicals that have had stable prices for years.

MEMBRANES CLEANING

Cleaner selection

COST



	Before CIP	After CIP	%
Normalized permeate Flow, m^3/h	794	893	+12,5
dp, bar	1,51	0,96	-36,4
Feed pressure, bar	67,0	63,0	

- ⇨ **Preventive cleanings** will preserve membrane integrity and reduce membrane replacement frequency.
- ⇨ **Effective cleanings** will decrease cleaning frequency and save energy.

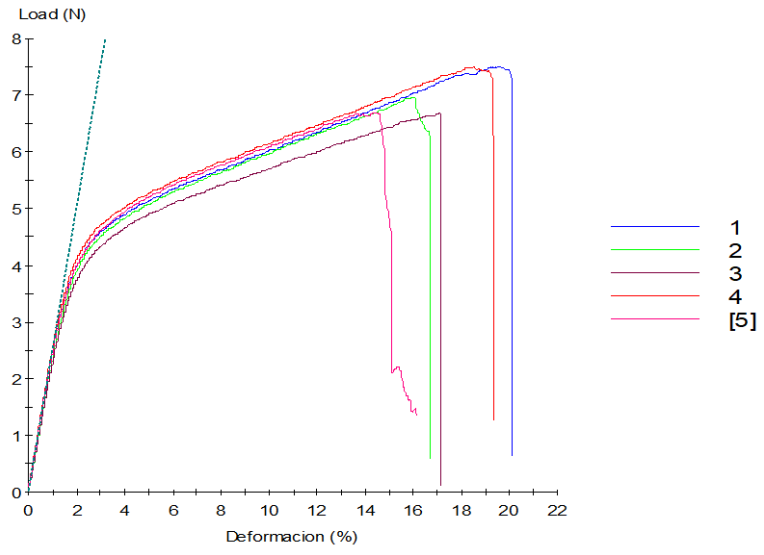
MEMBRANES CLEANING

Compatibility

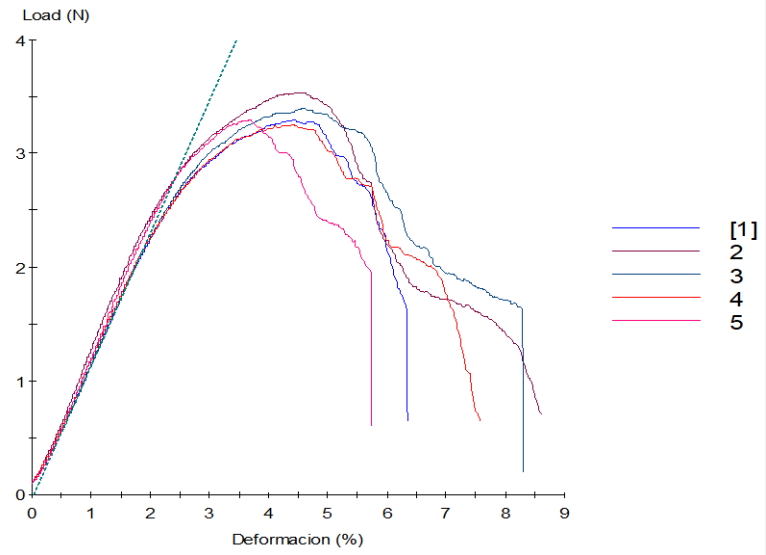
⇨ **Always use membrane compatible chemicals**

⇨ **Follow manufacturer's cleaning guidelines (pH, Temp.,...)**

Tensile test curves of RO membrane reference



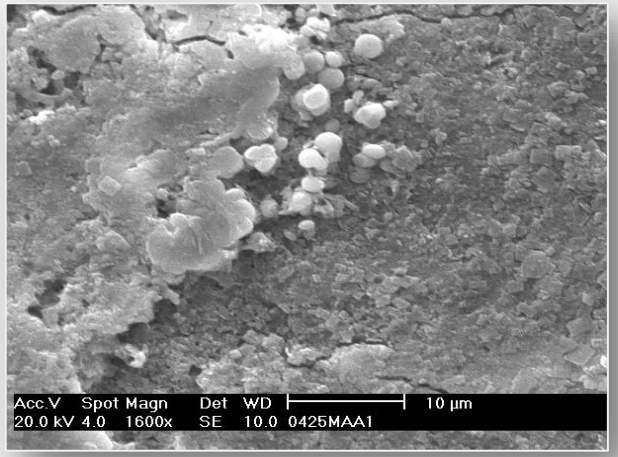
Tensile test curves of RO membrane after NaOH cleaning (aggressive conditions)

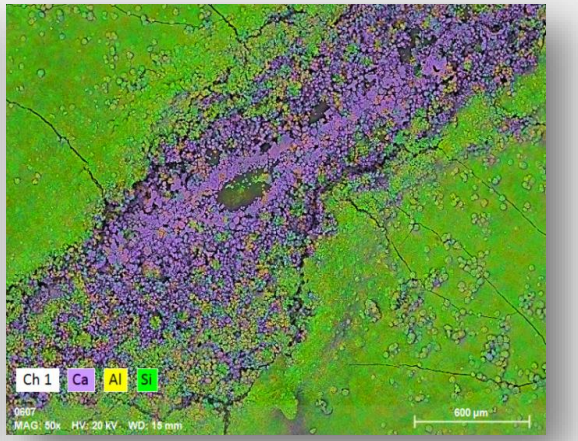


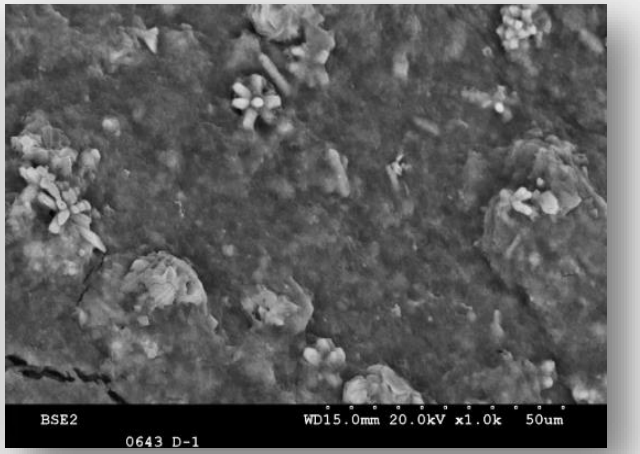
MEMBRANES CLEANING

Cleaner selection

Foulants composition is commonly composite.







Most common mixture is

biofilm/organic matter + clays-colloidal matter

This kind of foulant is particularly difficult to clean, specially when it is not removed in time, since it ages and get compressed by the effect of pressure

Cleaning recommendations of some of the leading membrane manufacturers

Membrane manufacturer		Biofilm / Organic matter	Colloidal matter / Aluminosilicates
Dow Filmtec-Dupont	OI	0.1% (W) NaOH and 0.025% (W) Na-DSS, pH 12, 35°C max. (Preferred) 0.1% (W) NaOH and 1.0% (W) Na_4EDTA, pH 12, 35°C max. (Alternative)	0.1% (W) NaOH and 0.025% (W) Na-DSS, pH 12, 35°C max.
	UF -CIP	0.2% HCl, 2% citric acid or oxalic	0.1% NaOH + 0.2% NaOCl
Hydranautics	OI	pH = 11.5 of 0.1% (w) de NaOH and 0.03% (w) SDS (sodium dodecylsulfate).	pH of 10.0 2.0% (w) STPP (sodium tripoliphosphate) ($Na_5P_3O_{10}$) and 0.8% (w) Na-EDTA 2.0% (w) citric acid ($C_6H_8O_7$)
	UF – CIP	NaOH, HCl, H_2SO_4, or citric acid	
Toray	OI	Sodium dodecyl sulfate (DSS, sodium lauryl sulfate), 0.03 - 0.2% with alkaline solution or Na polyoxyethylene lauryl sulfate (PSLS), 0.1 – 0.5% with alkaline solution	1 – 2 % citric acid adjusted with ammonia
LG – NanoH_2O	OI	NaOH, EDTA / permeate RO NaOH: until 0.1% weight EDTA: until 1.0% weight Citric acid / RO permeate until 2.0% weight	
Pentair	UF - CIP	NaOCl (active chlorine) 500 ppm max. H2O 1000 ppm max. NaOH pH ≤ 11 Nitric acid pH ≥ 1 Phosphoric acid pH ≥ 1 EDTA pH ≤ 11 Citric acid Enzyme compounds	
Inge / BASF	UF - CIP	NaClO H_2O_2 NaOH Acid pH	

MEMBRANES CLEANING

Cleaner selection

Formulated-multifunctional cleaners :

- ✓ Multifunctional product in a single container:
  - Detergents
  - Surfactants
  - Chelating agents
  - Buffer pH
  - Increase in osmotic pressure
- ✓ 100% active. Lower concentrations of use.
- ✓ Effective in cleaning composite foulants.
- ✓ Shipping savings
- ✓ Savings in the stock area

CLEANING TESTS

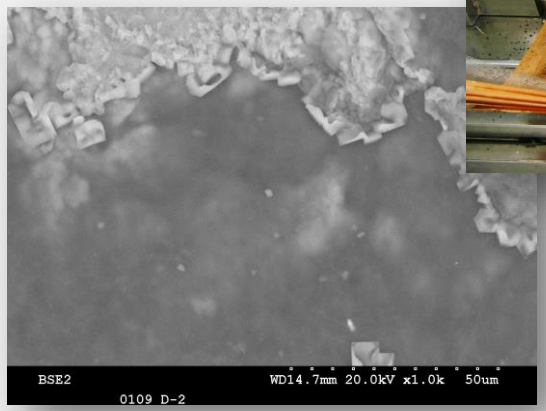
TABLE 1.- CLEANING TESTS SUMMARY RESULTS – MEMBRANE SAMPLE GA210109-1st PASS SW

Flow rate	29,67 L/m²h (minimum 23,88 L/m²h)
Salt Rejection	99,8% (Minimum 99,5%)
	(Reference values established according to membrane manufacturer technical sheet/guidelines. These specifications are based on a 32.000 mg/l NaCl characterization solution at 800 psi pressure and 25ºC)

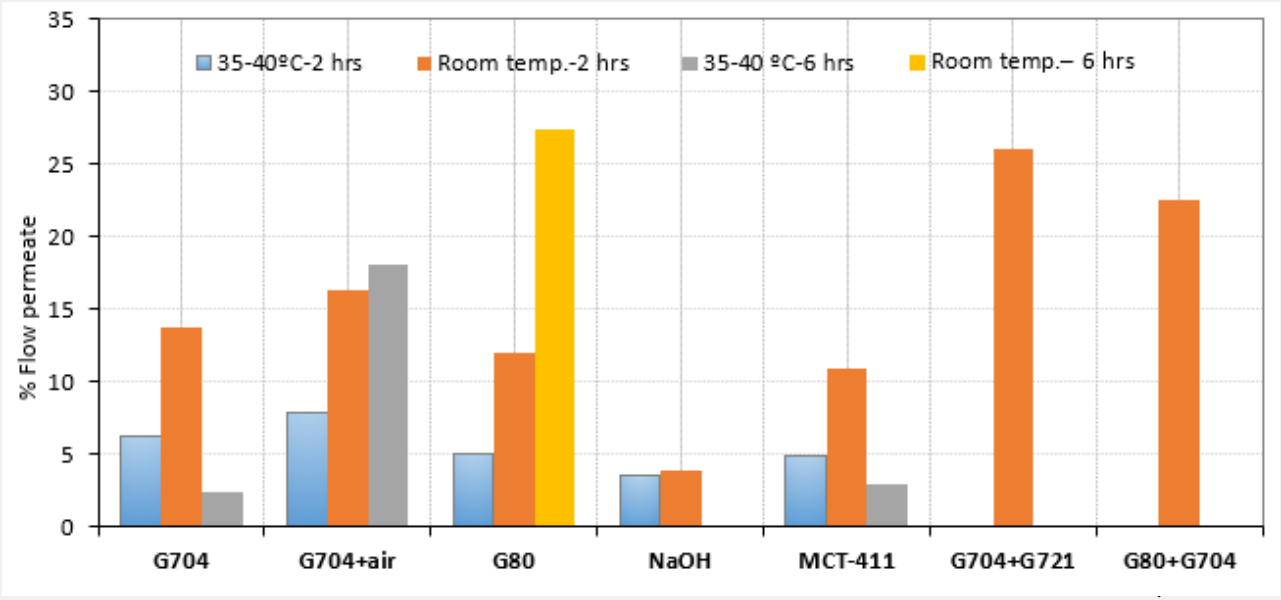
MEMBRANE GA210109-1st pass SW Characterization conditions: 800 psi, 32.000 mg/l NaCl,* 1000 ml/min. Cleaning solutions recirculated at 40 psi.		**Flow rate (l/m²h 25 ºC)**			**% Salt Rejection (CE)**		
		Before	After	%	Before	After	
Clean 1	1% G704 at 35-40° (2 hours)	29,12	30,20	+3,7	99,54	99,44	↓
Clean 2	2% G704 at 35-40° (2 hours)	29,58	31,44	+6,3	99,67	99,69	≈
Clean 3	2% G704+ Air at 35-40° (2 hours)	30,40	32,82	+7,9	99,50	99,69	↑
Clean 4	2% G704+ Air at room temperature (2 hours)	27,77	32,31	+16,3	99,60	99,36	↓
Clean 5	2% G704 at room temperature (2 hours)	26,97	30,68	+13,7	99,66	99,62	≈
Clean 6	2% G704 at 35-40° (6 hours)**	29,62	30,35	+2,4	99,51	99,47	≈
Clean 7	2% G704+ Air at 35-40° (6 hours)	29,01	34,93	+18,0	99,74	99,57	↓
Clean 8	2% G80 at room temperature (2 hours)	26,25	29,41	+12,0	99,57	99,60	≈
Clean 9	2% G80 at room temperature (6 hours)**	26,80	34,15	+27,4	99,69	99,47	↓
Clean 10	2% G80 at 35-40° (2 hours)	25,77	27,05	+5,0	99,66	99,64	≈
Clean 11	Step 1: 2% G80 at room temperature (2 hours) Step 2: 2% G704+ Air at room temperature (2 hours)	27,08 28,09	28,09 33,17	+3,7 +18,1	99,54 99,50	99,50 99,29	≈ ↓
Clean 12	Step 1: 2% G704+ Air at room temperature (2 hours) Step 2: 2% G721 at room temperature (1 hours)	27,77 32,31	32,31 34,99	+16,3 +8,3	99,60 99,36	99,36 99,32	↓ ≈
Clean 13	2% NaOH at 35-40° (2 hours),pH:11,5	27,18	28,18	+3,6	99,52	99,50	≈
Clean 14	2% NaOH at room temperature (2 hours),pH:11,5	27,30	28,38	+3,9	99,65	99,62	≈
Clean 15	2% MCT-411 at 35-40° (2 hours)	29,94	31,40	+4,9	99,70	99,66	≈
Clean 16	2% MCT-411 at room temperature (2 hours)	27,92	30,97	+10,9	99,60	99,61	≈
Clean 17	2% MCT-411 at 35-40° (6 hours)**	29,34	30,21	+2,9	99,73	99,70	≈
Clean 18	Step 1: 2% NaOH at 35-40° (2 hours) Step 2: 2% MCT-411 at 35-40° (2 hours) Step 3: 1% citric acid at room temperature	27,18 28,18 29,21	28,18 29,21 27,79	+3,6 +3,6 -4,8	99,52 99,50 99,53	99,50 99,53 99,25	≈ ≈ ↓
Clean 19	Step 1: 2% MCT-411 at 35-40° (2 hours) Step 2: 1% citric acid at room temperature	29,94 31,40	31,40 32,22	+4,9 +2,6	99,70 99,66	99,66 99,35	≈ ↓

G= Genesol (Genesys cleaning products denomination)

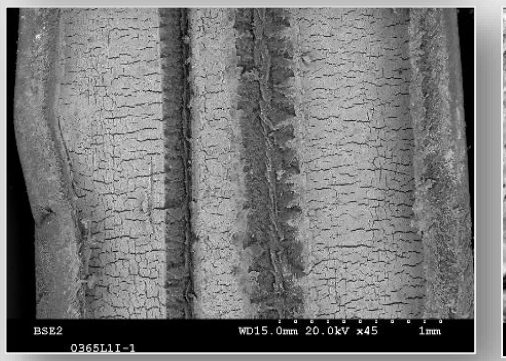
** 6 Hours CIP cleaning procedure: 1 hour cleaning solution circulation +2 hours soaking + 30 Minutes recirculation cleaning solution + 2 Hours soaking + 1 hour recirculation cleaning solution

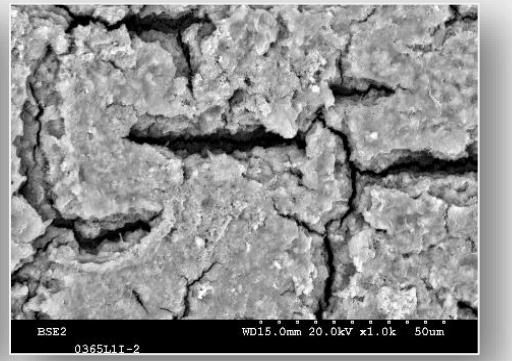


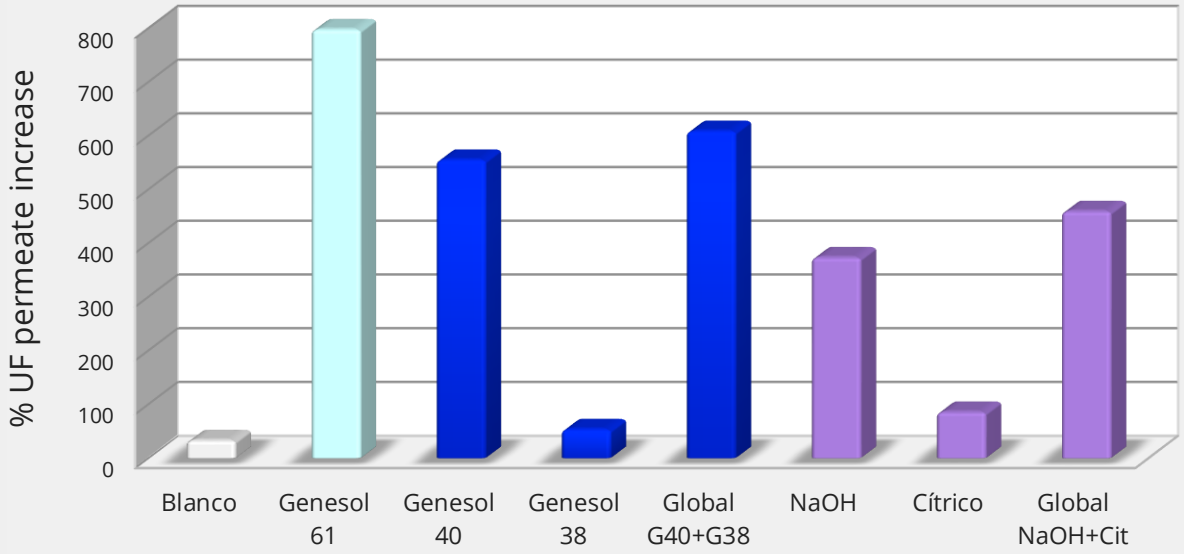
Organic:
Protein derivatives
Inorganic:
NaCl and sea water components



CLEANING TESTS







Organic:
Protein derivatives
Inorganic:
NaCl, Fe, P, Zn, Ca-Mg

Summary

Global Research and Scientific Service

- ✓ Service based on **research** and **scientific basics**
- ✓ Service is a powerful tool to get **faithful clients**
- ✓ **Membrane autopsies** are essential to identify foulant components and to optimize best cleaning procedure.
- ✓ There are different tests available to improve plants **pre-Treatment**
- ✓ **Clients feedbadk is essential to keep improving Service.**

THANK YOU FOR YOUR ATENTION

Global Research and Scientific Service

Amit Sankhe: Amit.Sankhe@h2oinnovation.com

Scientific service: nuria.pena@h2oinnovation.com
lab@genesysro.es

h2o innovation®

Piedmont GENESYS PWT™

WATER COMPANY
OF THE YEAR 2020

GLOBAL WATER AWARDS