

Welcome to Ecolab

Nederlands Membraan Genootschap

June 2023

ECOLAB[®]

NALCO Water

Agenda

- Introduction Ecolab /Nalco
- Analytical capabilities
- Visit the laboratories in Leiden
 - i. Ecolab Intelligence Center Europe
 - ii. Membrane Autopsies
 - iii. Micro / analytics
- Break
- Digital – The future of membrane processing and cleaning
- Closing of the lectures
- Network and a drink

Safety First!

Safety instructions for Leiden office and labs

IN CASE OF AN EMERGENCY

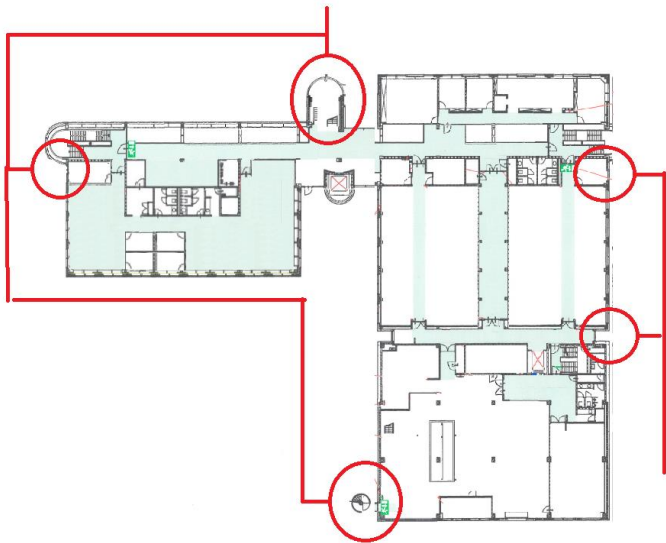
CALL ext. #1222

When visiting the laboratories: always wear safety glasses when you step behind the yellow lines!

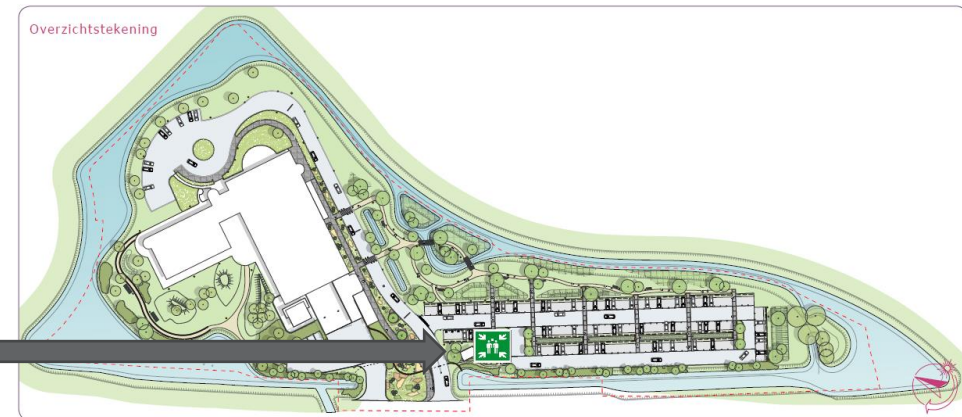
EVACUATION PROCEDURE

Things to be prepare for

- Which exit should you use??
 - Take shortest route to Assembly Point
- Do not use elevators!!
- People who are unable to use stairs should remain on ground floor level!
- No Check Out needed
- In case doors are locked



To Assembly Point



Our history

M.J. Osborn founds Economics Laboratory (EL)	1923
EL goes public	1957
Pioneers CIP technology	1961
Introduces Solid Power [®]	1981
Ecolab Inc. on the NYSE	1986
Launches 3D TRASAR [™] Technology	1988
Acquires Kay Chemical	1994
Acquires Nalco Water	2011
Acquires Laboratoires Anios	2017
Launches ECOLAB3D [™] platform	2019



Ecolab | Global and Growing

Cleaner, safer, healthier

Founded in
1923

Headquartered in
St. Paul, MN

+47,000
Global employees

25,000
sales and service
associates

1,200
Scientists

Serving customers in
170+ countries

3 million+
Customer locations

\$13 billion
In 2021 sales

293
ranked on Fortune 500 (2022)



A snapshot of Ecolab in Europe

- HQ in Wallisellen ZH

- +10,000 Associates

- 4,500 Sales Associates

- 2022 Sales \$2.8 billion

- 48 LOCATIONS across Europe

- 15 major offices

- 29 manufacturing plants

- 7 R&D Centers

- Balanced Revenue streams

- 50% Industrial

- 26% Institutional & Specialty

- 23% Healthcare & Life Sciences

Organized around our customer segments

INSTITUTIONAL



- Restaurants
- Hotels
- Quick-service restaurants
- Retail

INDUSTRIAL



- Heavy industries
Steel, chemical, paper, mining, refining
- Light industries
Food, beverage, animal health, textile
transportation, high tech, manufacturing

HEALTHCARE



- Hospitals
- Long term care
- Pharmaceutical
- Life sciences

We partner to protect the world's most famous brands



What have all these companies in common?

They use water and energy in their production



WATER



ENERGY

To be fit for business operations, water must be:



MOVED



HEATED



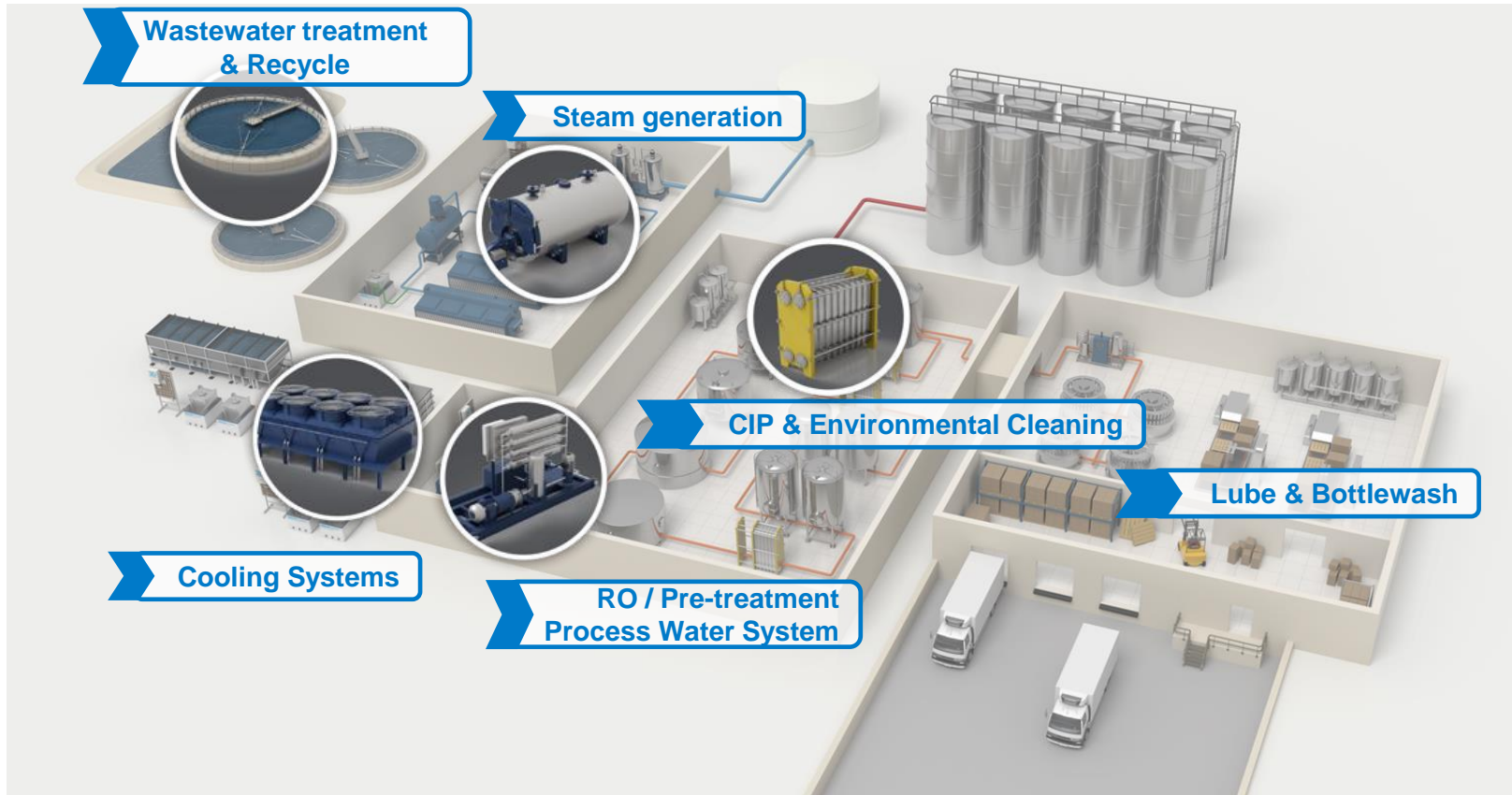
COOLED



TREATED

SCOPE OF ECOLAB SERVICES

Example of what we do in a brewery



WATER & HYGIENE EXPERTISE:

- Water pretreatment program
- Boiler water program
- Cooling water program
- Cleaning in Place program
- Conveyor lubrication and bottle washing
- Wastewater treatment programs
- Wastewater recycle
- Engineering including design / build and Managed Outcomes of water systems

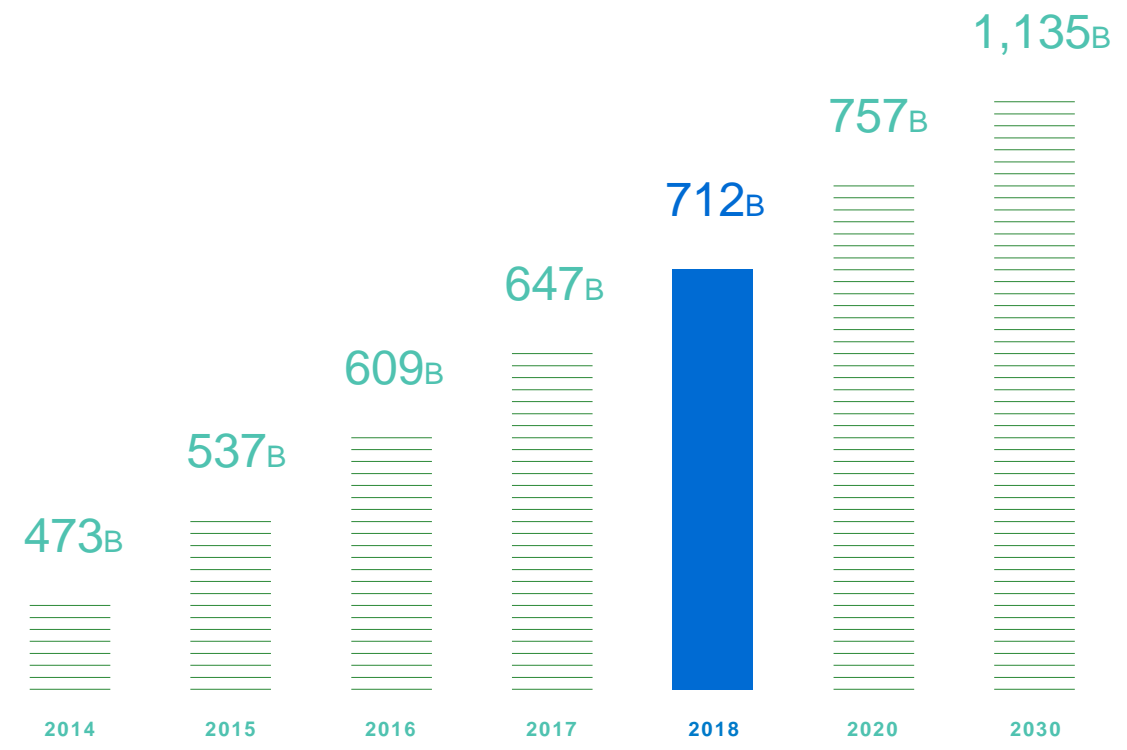


Chemical outcomes Water tech. Digital



EVERYWHERE IT MATTERS

Saving Over One Trillion Liters by 2030





Global Analytical and Microbiological Services (GAM)

Membrane Autopsy Services for Customers



Your Host

- ▲ Priscilla Tulen-Potman
- ▲ Bachelor Analytical Chemistry speciality in Environmental Science
- ▲ Joined Nalco in 2000
- ▲ Principal chemist



Global Analytical & Microbiology Services (GAM) - Leiden

Provides Specialist Analytical Support to Customers throughout Europe, Middle-East & Africa

Solid/Deposit

- Deposit analyses
- Investigative (Infrared, Electron microscope)
- Membrane

Water

- Water analyses (includes special analyses suites for membrane systems)
- Product (TRASAR) analyses
- Support field testing

Microbiology

- DMA, Biocide screening
- Innovation support (BPR, Efficacy testing)

Metallurgy

- Corrosion Coupon analyses
- Failure analyses
- DWD

Administrative Support

- Legionella Services (contracts)
- LIMS database

Membranes

Ecolab customers use Membranes for a variety of industrial and municipal purposes i.e.

- De-salinisation
- Potable water
- Pre-treatment
- Recycling



Membrane Autopsy

Purpose of Membrane Autopsy:

Troubleshooting poor performance and failure in membrane systems i.e.

- Feed Pressure
- Differential Pressure
- Permeate Quality/Salt Passage
- Permeate Flow

Membrane Types submitted:

- Reverse Osmosis, Ultrafiltration, Nanofiltration.
(Hollow fibre and Spiral wound)

Membrane Autopsy

Destructive procedure consisting of observations and analytical tests on systems' membranes:

- Visual Inspection & Photographs
- Chemical Analysis
- Microbial Analysis
- Damage identification
- Performance and cleaning testing

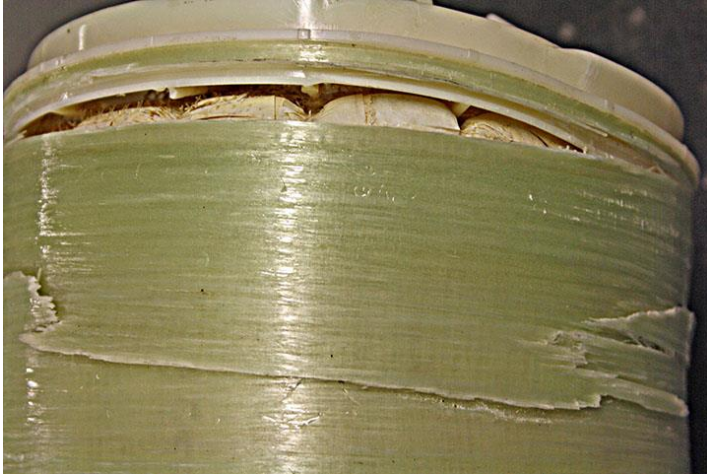
Membrane Autopsy

Exterior Examination

- Integrity of exterior casing
- Brine seal condition
- Inlet and outlet ATD condition
- Gaps of membrane sheets
- Note amount and type of debris impacted on faces
- Photographic documentation of observations
- Removal of external casing and unrolling of membrane



Membrane Autopsy Exterior Observations



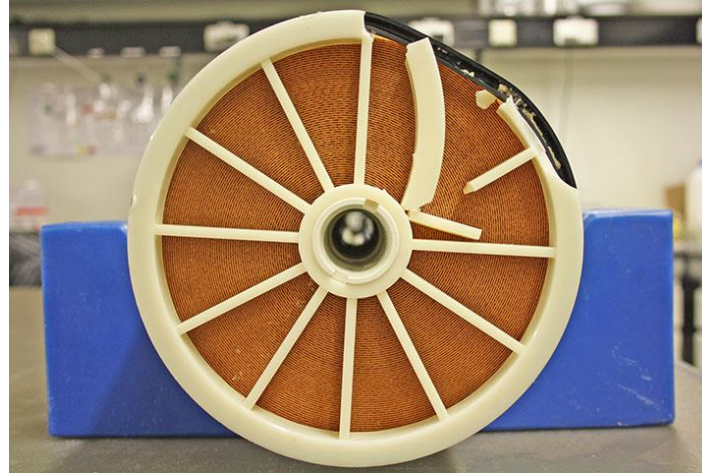
Exterior Damage



Foulant on inlet fins/face

Membrane Autopsy Exterior Observations

Exterior Damage to
ATD (Anti – Telescoping
Device) and Gaps



Telescoping & Spacer
Protrusion



Membrane Autopsy

Internal Examination

- Inspection of glue lines
- Examination for creasing of membrane surface
- Examination for delamination
- Examination of the spacer for foulant adhering or plugging
- Notation of any odour emanating from foulant
- Foulant amount, colour, location
- Photographic documentation observations



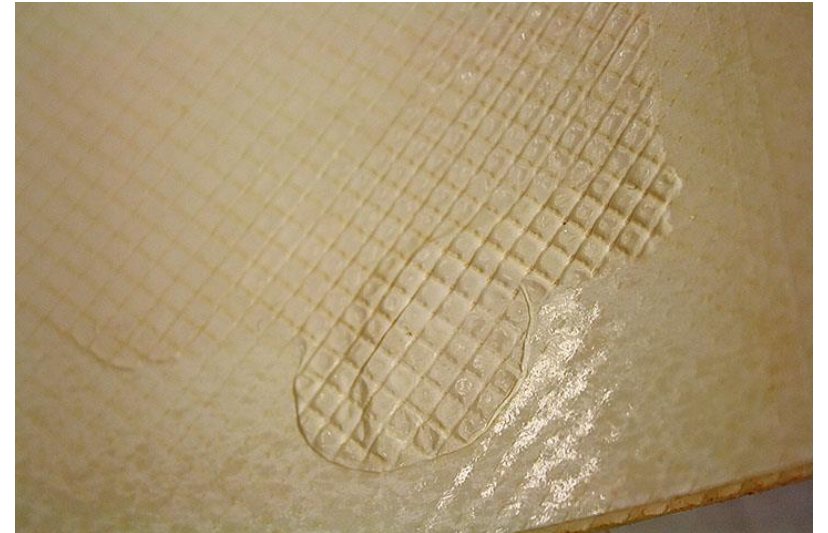
Samples collected for Microbiological Analysis, Analysis of Foulant, Deposit Density Determination, and Coupons of the Membrane taken for Cleaning Studies (if required)

Membrane Autopsy Interior Observations

- Feed spacer plugged & Scraped Foulant on Membrane Surface



- Membrane creases & Delamination

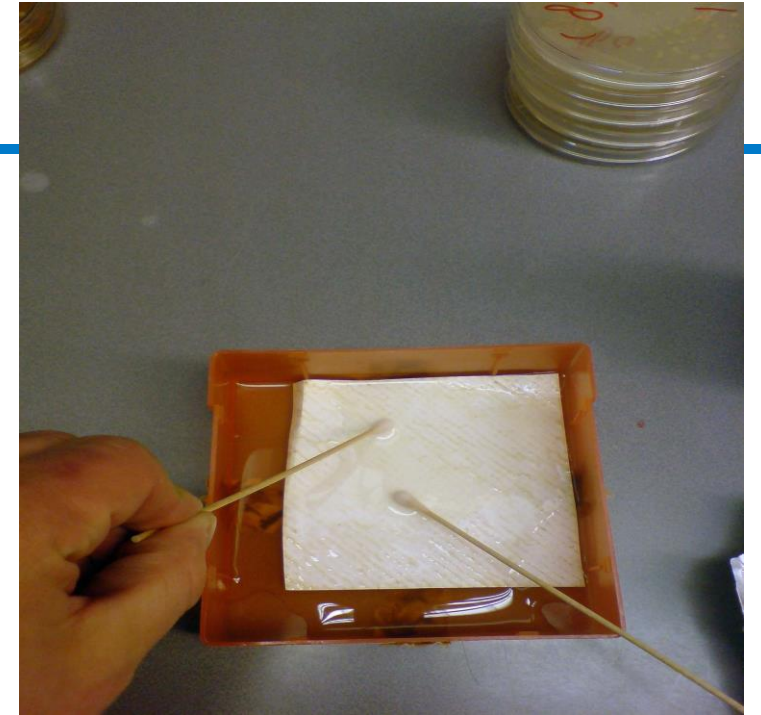


Membrane Autopsy Testing

Foulant Analyses:

- **Microbiological**

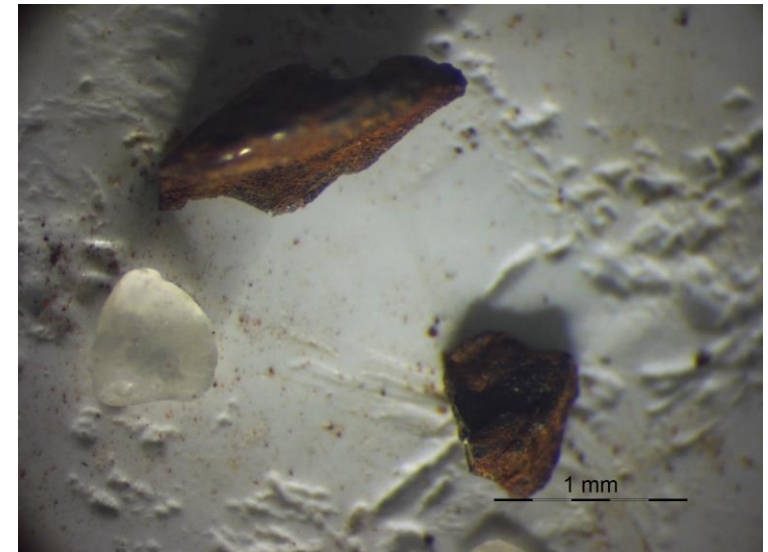
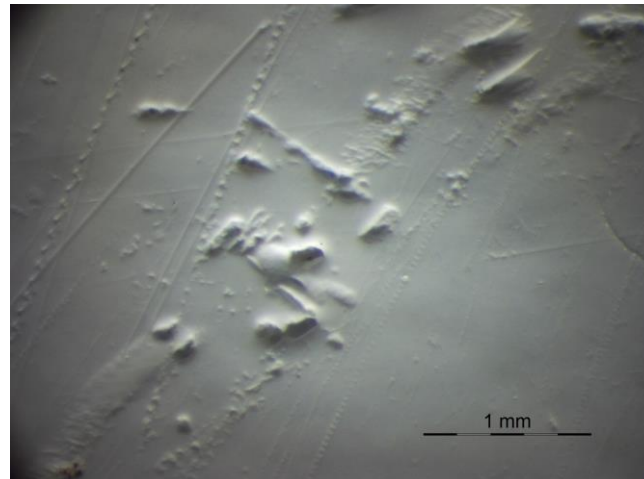
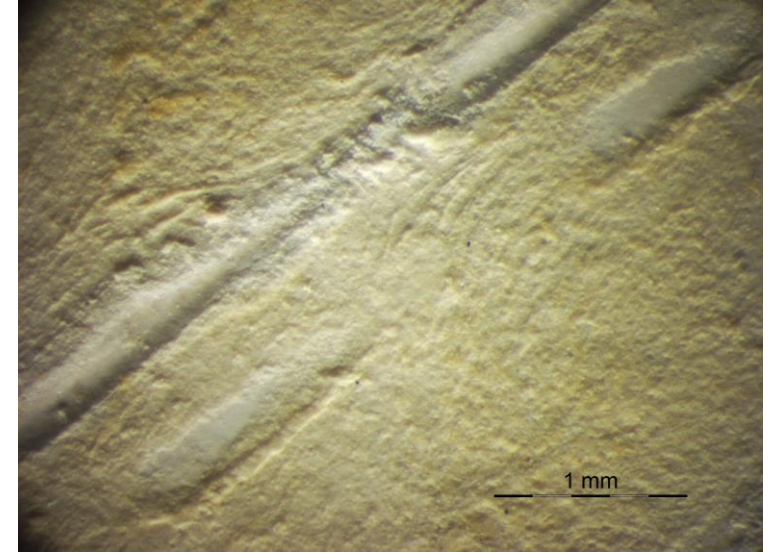
- Aerobic Bacteria
- Anaerobic Bacteria
- Fungi
- Microscopic Examination



Membrane Autopsy Foulant Analysis

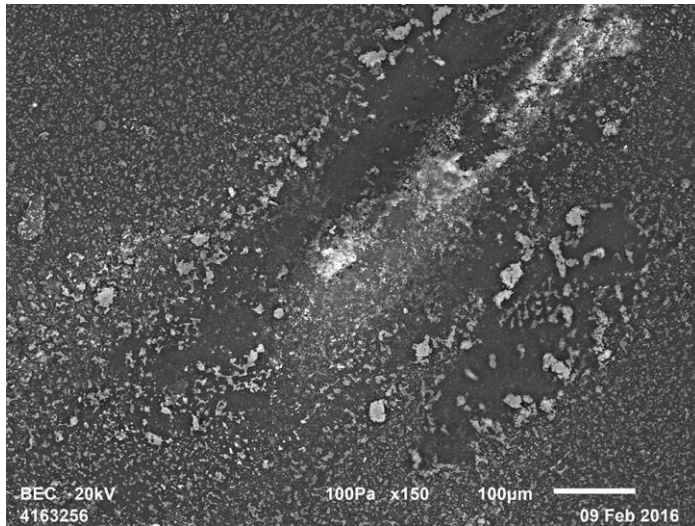
▲ Chemical

- Gravimetric Testing
 - Loss at 500 and 925°C
- X-Ray Fluorescence (XRF)
- X-Ray Diffraction (XRD)
- Infrared (IR)
- Microscopy

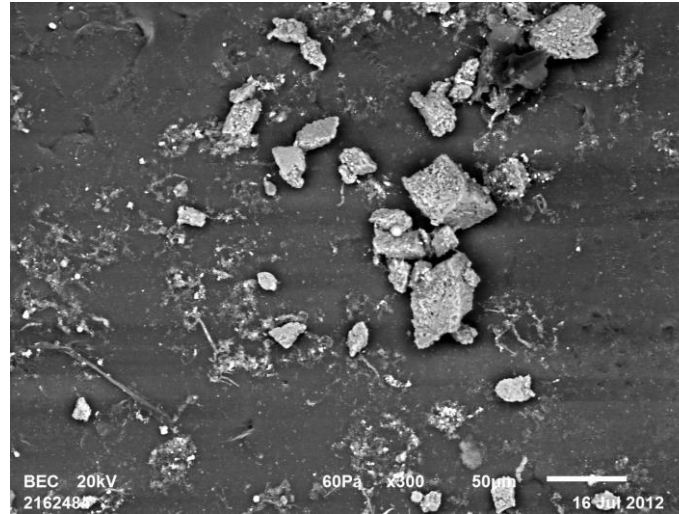


Membrane Autopsy Testing

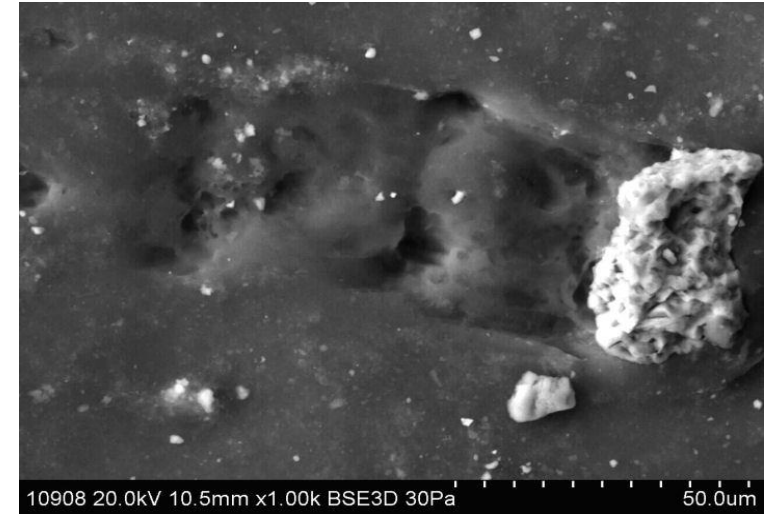
Scanning Electron Microscope (SEM) is utilized to identify the foulant for membranes with very little foulant, not possible to remove foulant from the surface, hollow fibers or tubular membranes



SEM Image of a Deposit at Spacer Contact Area



SEM Image of Deposit



SEM Image of Particle and Damage to Membrane Surface

Membrane Autopsy Testing – Other tests

- ▶ Fujiwara Test to detect chlorine oxidation

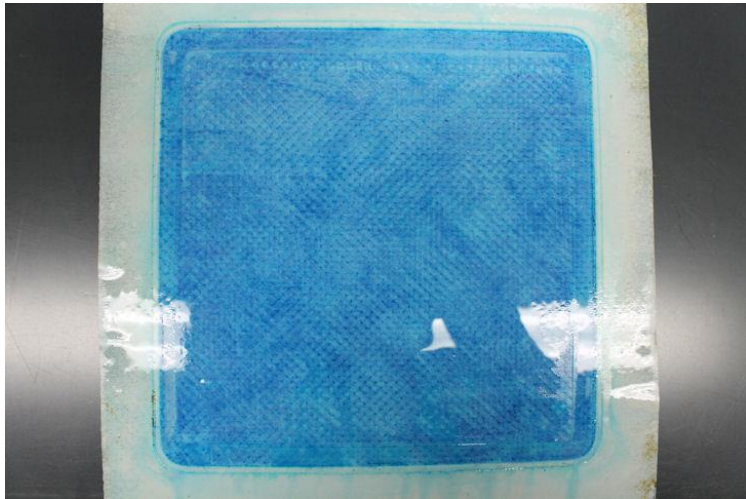


- ▶ Deposit Density – quantification of foulant density (mg/cm²)

Dye Test of Membrane Integrity

Methylene Blue dye test:

- membrane layer punctured by feed spacer mesh or abrasion/punctures by large particles.



Feed Side



Permeate Side
Negative

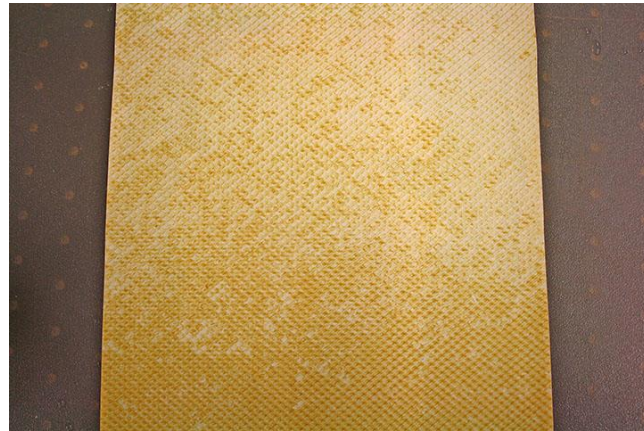


Permeate Side
Positive

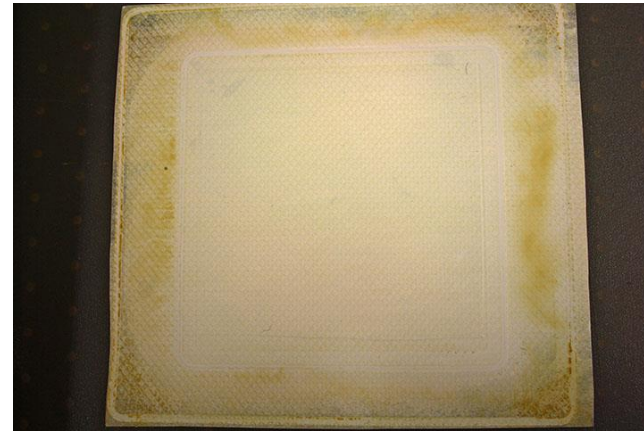
Membrane Autopsy Testing

Coupons from membrane tested in flat sheet rig

- Initial salt rejection (SR) and flux (permeate flow rate) according to manufacturer's specification
- Cleaning solution applied to membrane (standardized Nalco protocol)
- Rinsed with Demin water, salt circulated, and performance measurements (SR & Flux) taken after each cleaning
- Generally, two cleaning programs performed on each coupon (adaptable)



Before



After

Membrane Autopsy

Questions?

=> *Labtour*

ECOLAB[®]
PROTECTING WHAT'S VITAL[™]

Membranes & Digital

5th of June, 2023 – NMG LOL

Lars van Egmond

F&B Technical Excellence Team

“Opening up the
black box”



Today's outline

1. How do you monitor your (customer)membrane systems?
2. Current monitoring in the field
3. Digital insight

What do you(r) (customers) monitor?



Current monitoring in the field

From black box to full insight



Manual logbook

Handwritten, stored in boxes



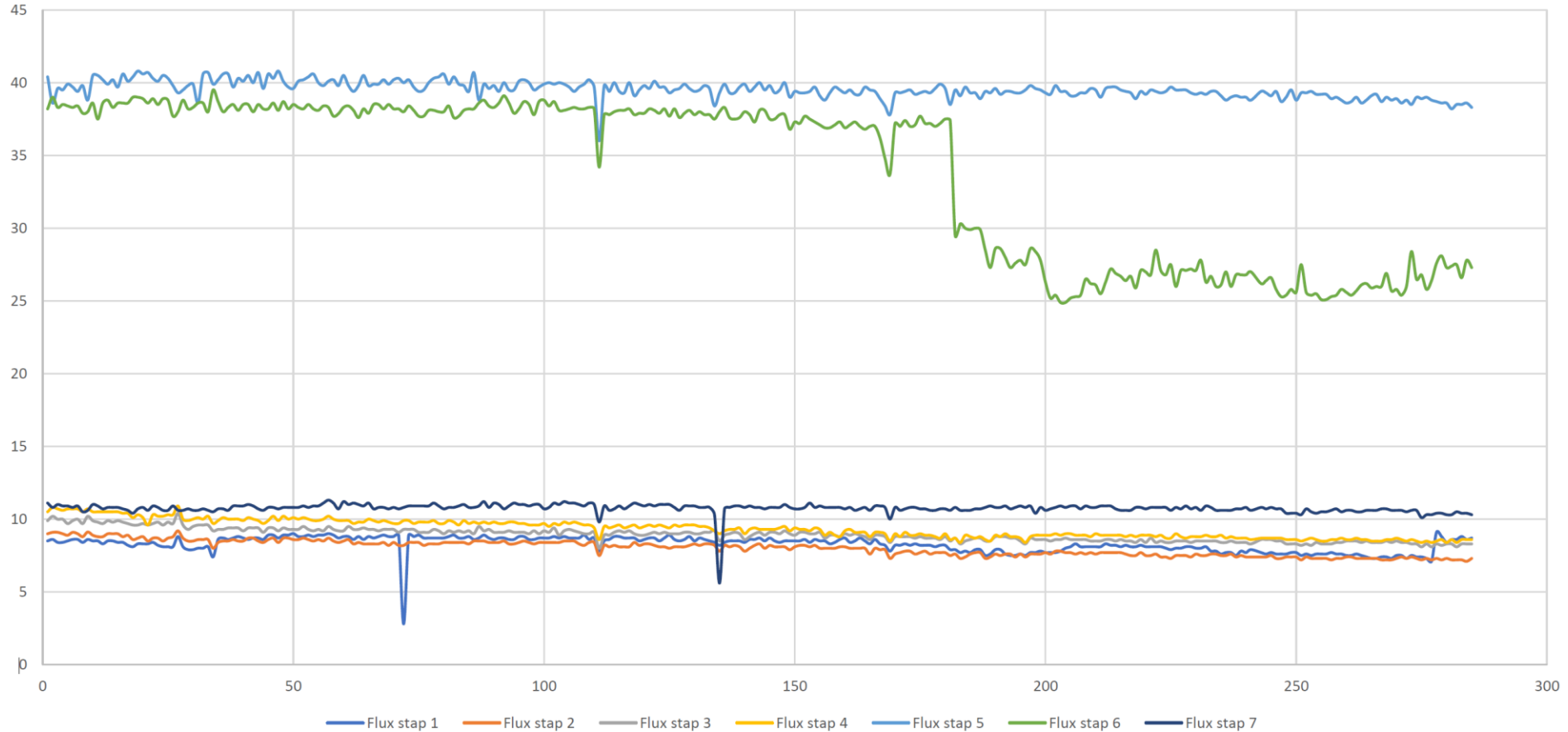
Manual logbook

Manual filled, digital

T (°C) (Feed)	Level BTD	Flow (Feed)	Flow (Retentaat)	Druk (Feed)	Druk(Permeaat)	pH	mS	conc.%	BTD	Flow Feed	Flow perm.	Flow Ret.	Druk Inlet	Druk loop	T (°C)	CT (µS/cm)	Druk (bar)	µS	Temp	Druk (bar)	Flow m3/h	µS	T (°C)	Druk (bar)	Flow m3/h	µS	Temp	Druk (bar)	Flow m3/h	µS	T (°C)
50,3	78	96,354	37,66	3,08	0,23	9,45	0,951	0,04	81	32,795	18,019	14,776	3	6,05	49,4	74	6,11	80	50	6,31	14,219	69	50	6,78	15,701	65	49,9	6,66	14,614	67	50
50,4	83	100,495	38,233	3	0,35	9,95	0,872	0,04	79	35,660	20,861	14,789	3	5,76	49,3	73,8	5,97	76	49,8	6,17	15,391	63	49,9	6,66	16,783	58	50	6,53	15,805	61	49,6
50,4	74	92,057	37,994	3,04	0,2	9,42	0,788	0,04	75	32,604	17,651	14,945	3	6,06	49,4	63	6,13	60	49,9	6,36	14,091	53	49,9	6,85	15,24	55	50	6,78	14,595	60	50
50,6	75	122,891	38,729	3,03	0,27	9,81	821	0,04	71	34,931	18,831	16,112	3,06	5,8	49,5	66	5,9	60	49,8	6,13	14,972	59	49,9	6,64	16,418	55	50	6,57	15,823	60	49,7
50,2	70	92,740	38,29	3	0,21	11	2,62	0,28	64	32,066	16,869	15,188	3,02	6,08	49,2	217	6,11	332	50	6,31	13,417	221	49,9	6,79	14,620	189	49,8	6,72	14,091	173	49,9
50,6	73	120,156	39,302	2,98	0,25	11,1	2,74	0,27	68	35,069	18,983	16,102	3	5,73	49,4	207	5,8	314	50	6,04	14,328	195	49,9	6,53	15,598	151	50	6,47	14,997	144	49,7
50,3	78	89	38,051	3,02	0,19	11	2,72	0,29	74	31,962	16,339	15,63	3	6,05	49,5	225	6,1	306	49,8	6,34	13,903	186	49,9	6,83	14,808	171	50	6,75	14,049	172	50
50,7	66	124,479	41,747	3,02	0,22	11,1	2,96	0,29	64	37,274	19,714	17,544	3,17	5,85	49,5	228	5,71	274	50	5,99	14,632	189	50	6,51	15,774	151	50	6,45	15,1	143	49,8
50,3	80	91,172	36,848	3	0,18	1,95	5,96	0,4	79	31,701	16,897	14,807	3	6,09	49,1	1435	6,15	1704	50	6,35	13,471	1428	50	6,81	14,942	1342	49,9	6,7	14,055	1412	50,1
50,3	79	97,396	37,01	3,01	0,29	2,1	6,22	0,44	78	33,623	19,519	14,822	3	5,8	49,2	1577	5,92	1875	49,9	6,13	14,845	1541	50	6,63	16,437	1415	50	6,48	15,276	1393	49,5
50,3	84	90,938	37,526	3	0,18	1,96	5,89	0,4	82	31,51	16,75	14,75	3	6,08	49,4	1422	6,15	1541	49,9	6,35	13,66	1288	49,9	6,82	14,984	1214	49,8	6,7	14,103	1316	49,9
50,5	82	97,552	38,003	3,04	0,27	2,1	6,05	0,43	81	33,872	19,109	14,76	3	5,82	49,4	1553	5,9	1654	50,1	6,11	15,452	1369	49,9	6,61	17,038	1275	50	6,48	15,762	1258	49,6

Trending CWF

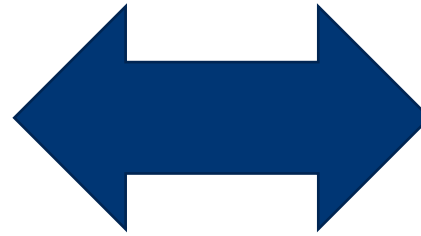
Basic insight from data, but is CWF telling you the whole story?



Symbiosis of features

Optimized Clean

Optimize on site depending on customer prioritisation: capacity, CIP time reduction, residues, water, sustainability performance



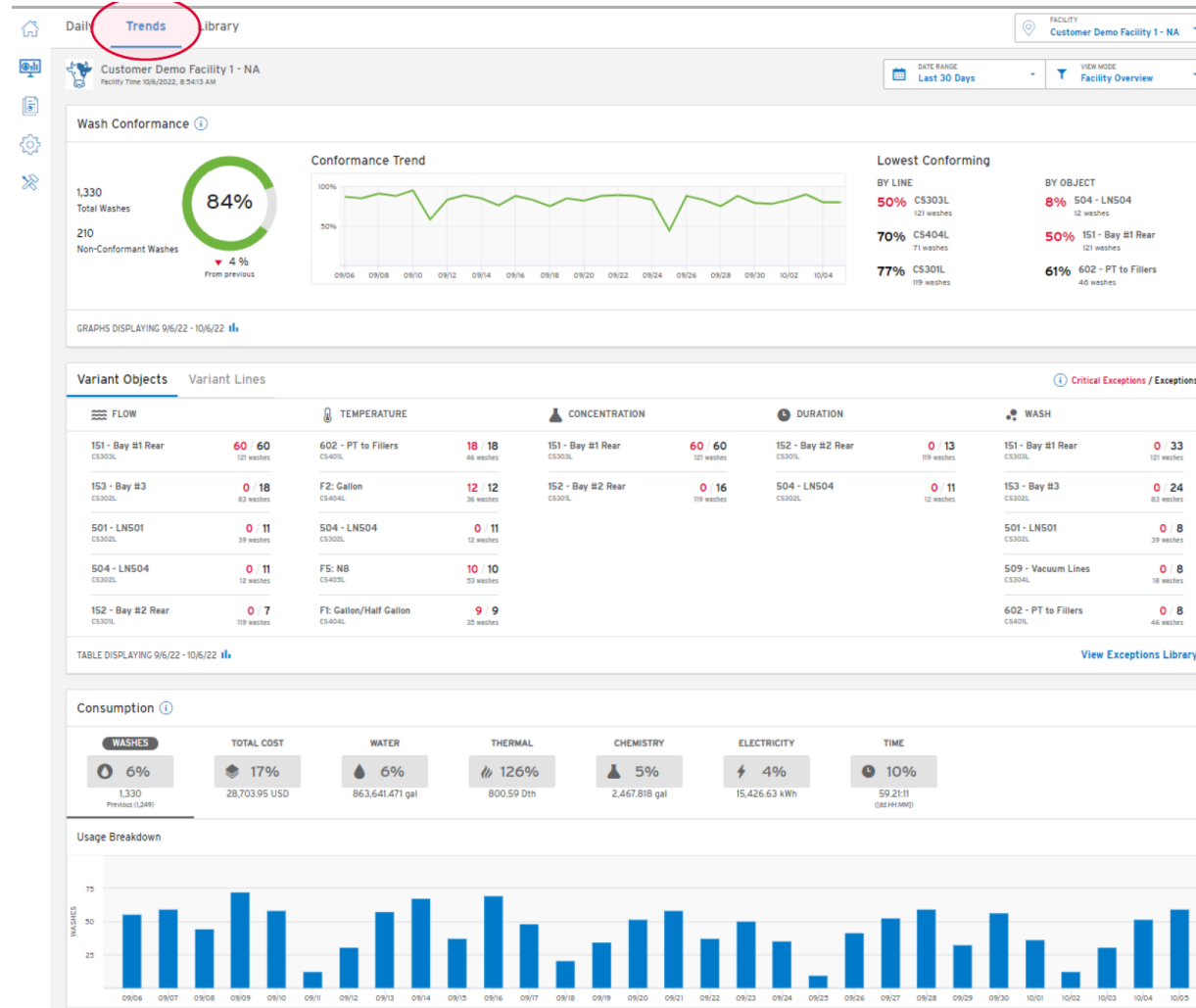
Membrane Monitoring

- Plant visibility
- Membrane performance status
- Tool to optimize overall process



Full digital insight & trending

Cleaning & production data



Membrane productivity Monitoring

Status quo

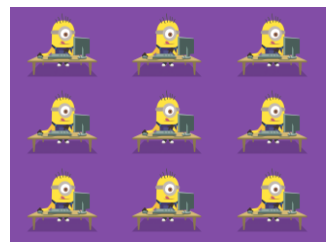
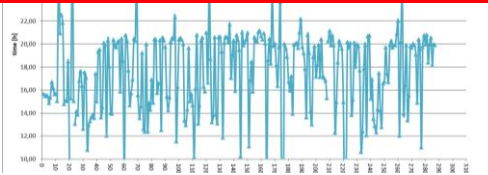
- **Poor Data:** manually log sheets not digitalized (analysed for troubleshooting)
- **Medium Data:** Log sheets tracking Water Fluxes
- **Good Data:** tracking of single KPI's
 - Feed pressure
 - Batch sizes
 - Water Fluxes

Membrane Insights

- **24/7 tracking** of production, CIP and rinse phase

Different level of data management, but not bringing together CIP, production, data and combining parameters.

TS	Hardware	Production		Rinse		CIP		CIP		CIP		CIP		CIP		CIP		CIP		CIP	
		Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop
02-01-17 20:08:41	Batch # 1000000000	08:00	08:15																		
02-01-17 20:10:01	Batch # 1000000000	08:15	08:30																		
02-01-17 20:11:01	Batch # 1000000000	08:30	08:45																		
02-01-17 20:12:01	Batch # 1000000000	08:45	09:00																		
02-01-17 20:13:01	Batch # 1000000000	09:00	09:15																		
02-01-17 20:14:01	Batch # 1000000000	09:15	09:30																		
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02-01-17 20:16:01	Batch # 1000000000	09:45	10:00																		
02-01-17 20:17:01	Batch # 1000000000	10:00	10:15																		
02-01-17 20:18:01	Batch # 1000000000	10:15	10:30																		
02-01-17 20:19:01	Batch # 1000000000	10:30	10:45																		
02-01-17 20:20:01	Batch # 1000000000	10:45	11:00																		
02-01-17 20:21:01	Batch # 1000000000	11:00	11:15																		
02-01-17 20:22:01	Batch # 1000000000	11:15	11:30																		
02-01-17 20:23:01	Batch # 1000000000	11:30	11:45																		
02-01-17 20:24:01	Batch # 1000000000	11:45	12:00																		
02-01-17 20:25:01	Batch # 1000000000	12:00	12:15																		
02-01-17 20:26:01	Batch # 1000000000	12:15	12:30																		
02-01-17 20:27:01	Batch # 1000000000	12:30	12:45																		
02-01-17 20:28:01	Batch # 1000000000	12:45	13:00																		
02-01-17 20:29:01	Batch # 1000000000	13:00	13:15																		
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02-01-17 20:36:01	Batch # 1000000000	14:45	15:00																		
02-01-17 20:37:01	Batch # 1000000000	15:00	15:15																		
02-01-17 20:38:01	Batch # 1000000000	15:15	15:30																		
02-01-17 20:39:01	Batch # 1000000000	15:30	15:45																		
02-01-17 20:40:01	Batch # 1000000000	15:45	16:00																		
02-01-17 20:41:01	Batch # 1000000000	16:00	16:15																		
02-01-17 20:42:01	Batch # 1000000000	16:15	16:30																		
02-01-17 20:43:01	Batch # 1000000000	16:30	16:45																		
02-01-17 20:44:01	Batch # 1000000000	16:45	17:00																		
02-01-17 20:45:01	Batch # 1000000000	17:00	17:15																		
02-01-17 20:46:01	Batch # 1000000000	17:15	17:30																		
02-01-17 20:47:01	Batch # 1000000000	17:30	17:45																		
02-01-17 20:48:01	Batch # 1000000000	17:45	18:00																		
02-01-17 20:49:01	Batch # 1000000000	18:00	18:15																		
02-01-17 20:50:01	Batch # 1000000000	18:15	18:30																		
02-01-17 20:51:01	Batch # 1000000000	18:30	18:45																		
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02-01-17 20:56:01	Batch # 1000000000	19:45	20:00																		
02-01-17 20:57:01	Batch # 1000000000	20:00	20:15																		
02-01-17 20:58:01	Batch # 1000000000	20:15	20:30																		
02-01-17 20:59:01	Batch # 1000000000	20:30	20:45																		
02-01-17 21:00:01	Batch # 1000000000	20:45	21:00																		



Key Takeaways

- Digital monitoring **opens up the black box**, giving you insight the performance of the system.
- Digital insight can **increase** performance, membrane life time and **savings** on water, energy and time.



ECOLAB[®]
PROTECTING WHAT'S VITAL[™]