CASE STUDY: FROM EFFLUENT TO EXCELLENCE - MICROBIOLOGICAL ASSESSMENT OF A CONTAINERISED MODULAR WATER REUSE PILOT SYSTEM

CONTEXT

Water reuse is becoming a key sustainability strategy for industries with high water demand, especially in biopharmaceutical manufacturing. A leading multinational biopharma company partnered with Ekopak – a solution provider for mobile water reuse systems – to assess the feasibility of treating its effluent water to meet drinking water standards with the following objectives:

Key objectives

1. Assessment of microbial water quality at multiple treatment stages.
2. Analysis of the impact of operational parameters on microbiological processes.
3. Identification of critical control points to optimise system performance.
4. Provision of a data-driven foundation for large-scale implementations.

AT A GLANCE

- Demonstrated the feasibility of water reuse with advanced monitoring technologies.
- Tracked microbial dynamics in filtration units.
- Assessed impact of process changes.
- Enabled timely interventions for quality control.

PILOT SET UP

Ekopak deployed **a containerised, modular pilot system, integrating ultrafiltration (UF), two-stage reverse osmosis (RO), and BactoSense CORE** for automated microbial monitoring at four points. The system was housed in a unit enabled with SCADA-based remote monitoring and multiple sampling points for detailed water quality analysis. BactoSense enabled rapid detection of total cell counts (TCC) in just 20 minutes, providing operators with **real-time microbial insights to optimise treatment performance.**

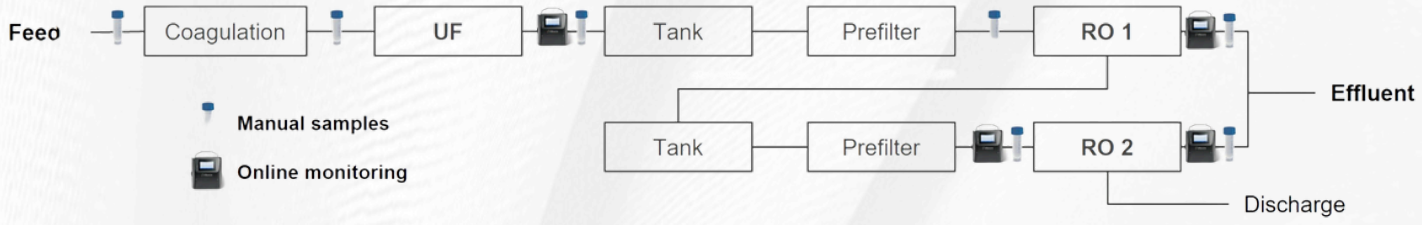

Figure 1 Structural overview of the pilot module for water reuse treatment, integrating BactoSense CORE. RO, reverse osmosis; UF, ultrafiltration

The role of BactoSense CORE in the water reuse pilot system

BactoSense was used to evaluate the effectiveness of UF, prefiltration, and RO by measuring bacterial log reduction at each treatment stage. The pilot also investigated key factors influencing bacterial levels, including feed pressure, flow rate, stagnation and descaling.

KEY FINDINGS

1. Membrane filtration and microbial regrowth influence the overall microbiological profile.
Continuous monitoring with BactoSense enabled early detection of microbial hotspots in RO prefilters and storage tanks and allowed immediate corrective actions, such as prefilter replacements.

2. The duration of stagnation plays a key role in biofouling and affects the final water quality.
Short-term stagnation caused temporary surges in TCC within the RO permeate, while long-term stagnation led to a sustained decline in water quality, necessitating additional flushing steps.

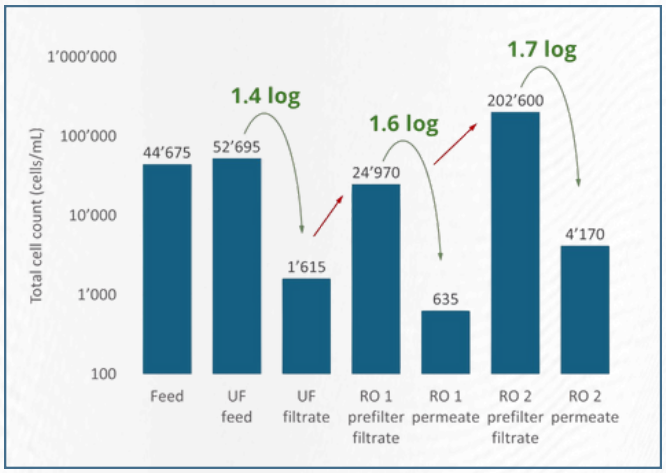

Figure 2 Total cell counts along the water reuse treatment train. RO, reverse osmosis; UF, ultrafiltration.

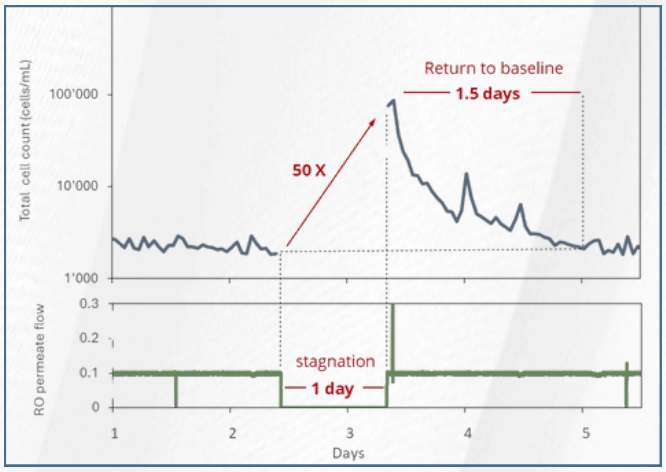

Figure 3 It took up to 1.5 days for RO permeate cell counts to return to normal. RO, reverse osmosis; TCC, total cell count

3. Membrane scaling reduces permeate flow rate and increases bacterial concentrations.
Without antiscalant dosing, permeate flow declined, and BactoSense immediately detected a rise in TCC, underscoring the need for proactive scaling prevention.

4. Optimising operational parameters enhances membrane filtrate quality.
Minor feed pressure adjustments drastically affect microbiological quality in permeate, highlighting the necessity for precise operational controls and real-time monitoring to optimise membrane performance.

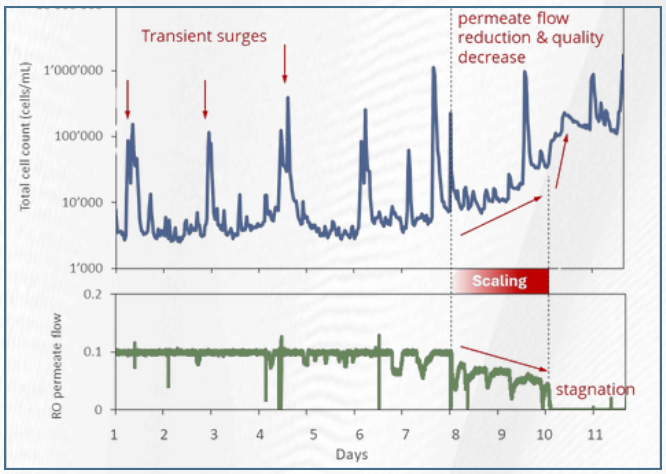

Figure 4 Graph showing RO flow rate and TCC variations over time. RO, reverse osmosis; TCC, total cell counts.

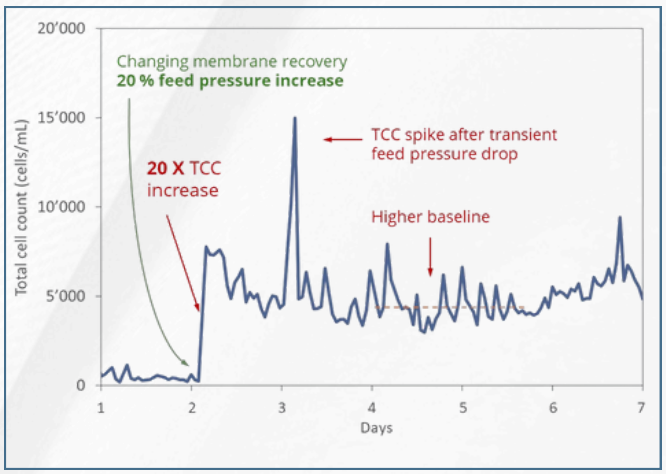

Figure 5 Graph illustrating the impact of feed pressure on TCC. TCC, total cell counts.

KEY BENEFITS

1. **Immediate microbiological insights**: BactoSense enabled operators to quickly understand the microbiological performance of the proposed solution in real time.
2. **Comprehensive microbiological overview**: initial grab sampling provided a full microbiological profile of the treatment train, including membrane performance and microbial regrowth in prefilters and pipes.
3. **Real-time monitoring**: online monitoring installations allowed for continuous tracking of microbial dynamics, providing ongoing insights into membrane filtration unit performance.
4. **Filtration performance management**: data from BactoSense helped assess the impact of prefilter maintenance, stagnation, scaling and operational parameter adjustments on water quality.
5. **Proactive membrane management**: enabled precise monitoring of microbial trends, facilitating timely interventions to maintain optimal system performance and water quality.

> We are very happy to have contributed to this pilot's success with comprehensive and actionable microbiological data.

Silvan Kaufmann
Solutions Programme Manager, bNovate

> Pilot testing is of utmost importance to us. By integrating BactoSense as a monitoring system, we gain rapid insights into microbiological performance, enabling us to make informed, data-driven decisions with confidence.

Benjamin Buysschaert
Manager R&D, Ekopak

ABOUT THE PROJECT PARTNERS

Ekopak is a Belgian company specialised in sustainable water management solutions utilising innovative and environmentally friendly technologies. Ekopak supports businesses in reducing water consumption and dependence on traditional water sources, contributing to a more sustainable future.

bNovate Technologies SA is a leader in the microbiological analysis and monitoring of water. The Swiss company propels industrial microbiology into the digital age with rapid, automated solutions for the global water, food & beverage, pharmaceutical and cosmetics industries.

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