ZwitterCo

Evolution Case Study

Optimizing Cleaning in a Dairy Wastewater Concentrator

Proving ZwitterCo Evolution RO Simplifies Cleaning Programs

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Fast Facts

Industry:	Dairy
Application:	Eflluent concentration
Location:	Midwestern USA
Membrane:	RO protected by ZwitterShield™ technology
Element type & model:	ZwitterCo Evolution RO 3838-30
No. of elements supplied:	200
Average feed flow rate:	268 GPM (60 m3/h)
Year of installation:	2024

Key Highlights

- **Cleaning Cost Reduction**
  Over 52% reduction in membrane cleaning costs.
- **Water Savings**
  Nearly 42% less water used for cleaning.
- **Simplified Cleaning**
  Shorter and faster cleaning program by eliminating the enzyme step - the most expensive step in a cleaning program.
- **Reliable Performance**
  Over 10.5 months of operations with like-new performance.
- **Sustainability Gains**
  Lower chemical use, water consumption, and wastewater generation, supporting the whey processor's sustainability goals.

The Opportunity

A leading whey processor in the Midwest United States with a strong commitment to sustainability and operational excellence is continuously exploring ways to optimize its processes. As a significant user of membranes, one of their major focus areas for optimization and cost savings is their membrane operations. Within their membrane operations, they were interested in finding ways to achieve simpler cleaning programs, which created an opportunity for ZwitterCo membranes to help.

This whey processor is demonstrating the performance of Evolution RO membranes in a full, industrial-scale system to validate their performance and identify opportunities to improve their cleaning program, with a particular focus on reducing chemical and water consumption.

The Solution

In 2024, the whey processor installed Evolution RO membranes, replacing conventional RO membranes. Evolution RO membranes are protected by ZwitterShield™ technology, a permanently bonded zwitterionic barrier that forms an extremely hydrophilic surface to repel organic foulants. This hydration barrier prevents irreversible adhesion of proteins, fats, and other organic compounds, which allows the membrane to be more easily cleaned than conventional membranes.

The Results

As a seamless direct replacement, Evolution RO membranes required no system modifications while demonstrating a simplified cleaning program. The whey processor was able to eliminate the enzyme step, the most expensive and longest cleaning step, from their cleaning program. The cleaning temperatures were also reduced from 122°F to 100°F

(50°C to 38°C). The simplified cleaning program for Evolution RO membranes, compared to the cleaning program of the replaced conventional RO membranes, is illustrated in Table 1 below.

Step	Cleaning Program for Conventional RO Membranes	**Cleaning Program for Evolution RO Membranes**
1	Caustic + Detergent, 122˚F (50˚C), 15 min.	**Caustic + Detergent, 100˚F (38˚C), 25 min.**
2	Enzyme + Caustic, 122˚F (50˚C), 40 min.	**Acid, 100˚F(38˚C), 25 min. (as needed)**
3	Acid, 122˚F (50˚C), 10 min.	**Caustic, 100˚F (38˚C), 25 min.**
4	Soak + MBS, Ambient Temp., 30 min.	**Sanitize, Ambient Temp.,10 min.**

Table 1: *Cleaning Program Comparison of Conventional RO vs. Evolution RO*

The data collected from the whey processor's initial 10.5-month operational period with an average runtime of 20 hours/day confirm the reliable stability of Evolution RO membranes. This normalized data is visualized in Figure 1 below. Analysis of the normalized polisher flux values shows minimal variation from the flux starting point, indicating consistent operational efficiency and reinforcing the membrane's stable performance. The average permeate conductivity consistently remained around 25 µS/cm, demonstrating stable permeate quality throughout the 10.5-month operational period, as shown in Figure 2. In both Figures 1 and 2, the numbered CIP (clean-in-place) lines indicate different experiments run to optimize the cleaning program to balance chemical and water costs versus time. The observed dip in normalized flux, accompanied by an increase in conductivity at the end of CIP 3, is attributed to the experiments to optimize the membrane cleaning program.

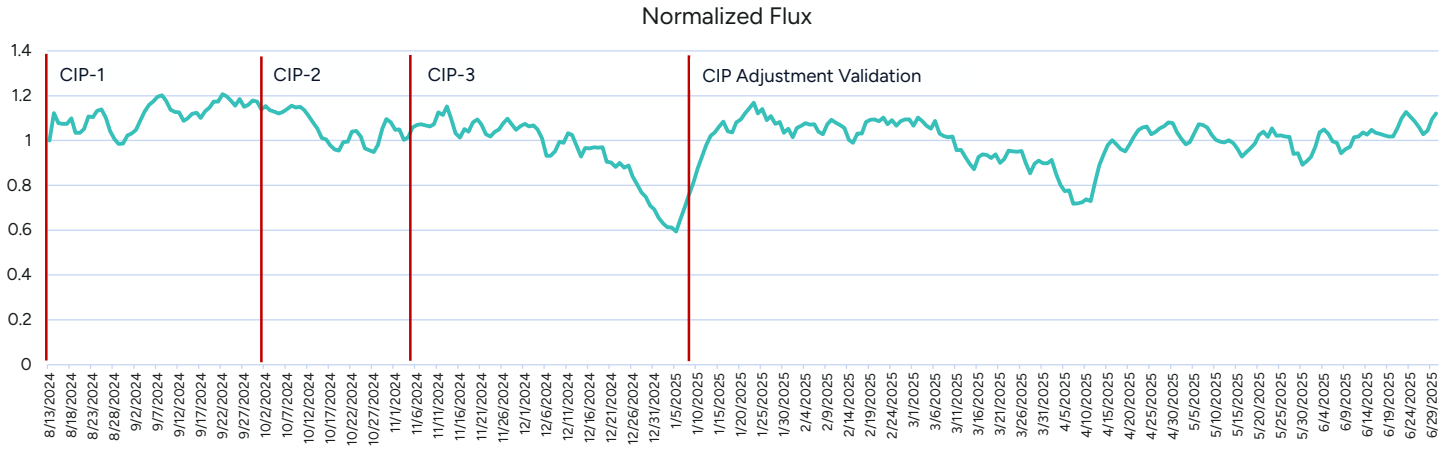

Figure 1: *Evolution RO normalized flux over the first 10.5 months post-installation*

In all variations of the cleaning program, the enzyme step was removed, thus proving that **Evolution RO membranes can eliminate the enzyme step as the most expensive step in a cleaning program.**

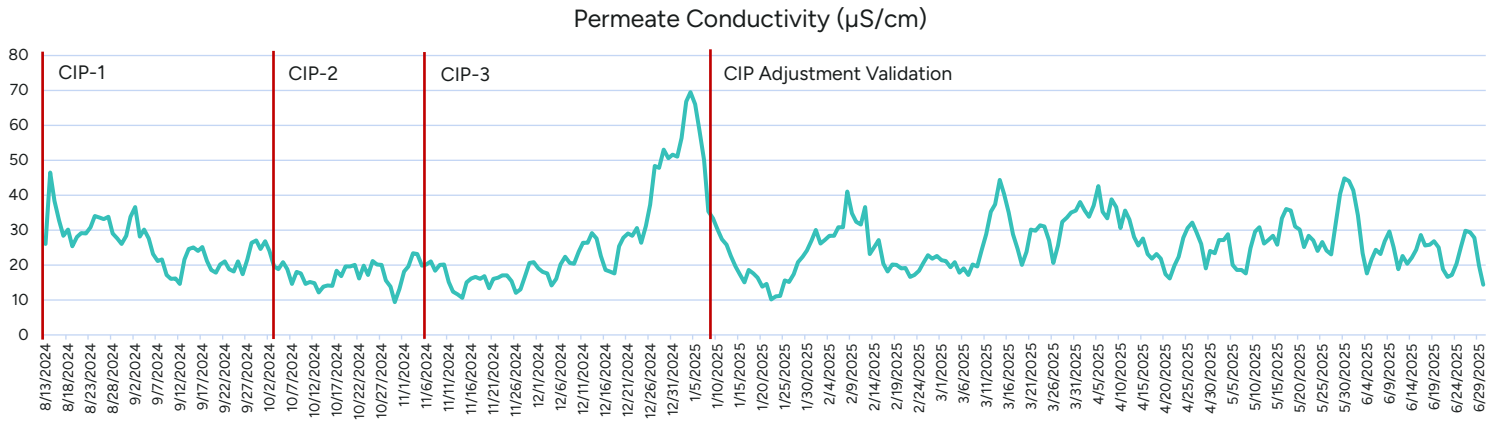

Figure 2: *Evolution RO permeate conductivity over the first 10.5 months post-installation*

The Benefits

The whey processor achieved an immediate reduction in chemical costs by eliminating the enzyme step, the costliest cleaning step at $48.82 per wash (or $15,720 for 10.5 months operation), from their cleaning process. This step is typically also the longest in a membrane cleaning program, and by eliminating the time required to heat the solution and flush it from the system, the processor was able to reduce the overall cleaning time. With the reduction of cleaning temperatures from the typical 122°F to 100°F (50°C to 38°C), heating time and energy costs were also reduced. The cost-saving calculation in Table 2 below demonstrates a significant cleaning cost reduction of over 52%, based on the first 10.5 months of operation, when compared to the conventional RO membranes previously used. The time saved in the cleaning program allowed operators to focus on other critical plant tasks. In addition to economic benefits and process efficiency, this whey processor prioritizes sustainability gains. Through membrane cleaning optimization, the company reduced chemical and energy requirements. Water consumption for cleaning was also reduced by nearly 42%, resulting in net savings of 1,016,960 gallons over the first 10.5-month period post installation, as shown in Table 3 below.

Cost Breakdown	Conventional RO Membrane	**ZwitterCo Evolution RO Membrane**
Chemical Cost	$40,591.32	**$17,715.17**
Water Cost	$19,835.20	**$11,699.52**
Utilities Cost	$15,881.04	**$6,733.02**
Total Wash Cost	$76,307.56	**$36,147.54**
Net Cost Savings	**$40,160.02** (over 10+ month operation period)	

Table 2: *Membrane cleaning costs based on the data from the first 10.5 months post-installation*

	Conventional RO Membrane	**ZwitterCo Evolution RO Membrane**
Membrane cleaning water consumption over 10.5 months of operation	2,479,400 gallons	**1,462,440 gallons**
Net Water Savings	**1,016,960 gallons** (over 10.5 month operation period)	

Table 3: *Cleaning-related water consumption for the first 10.5 months post-installation*

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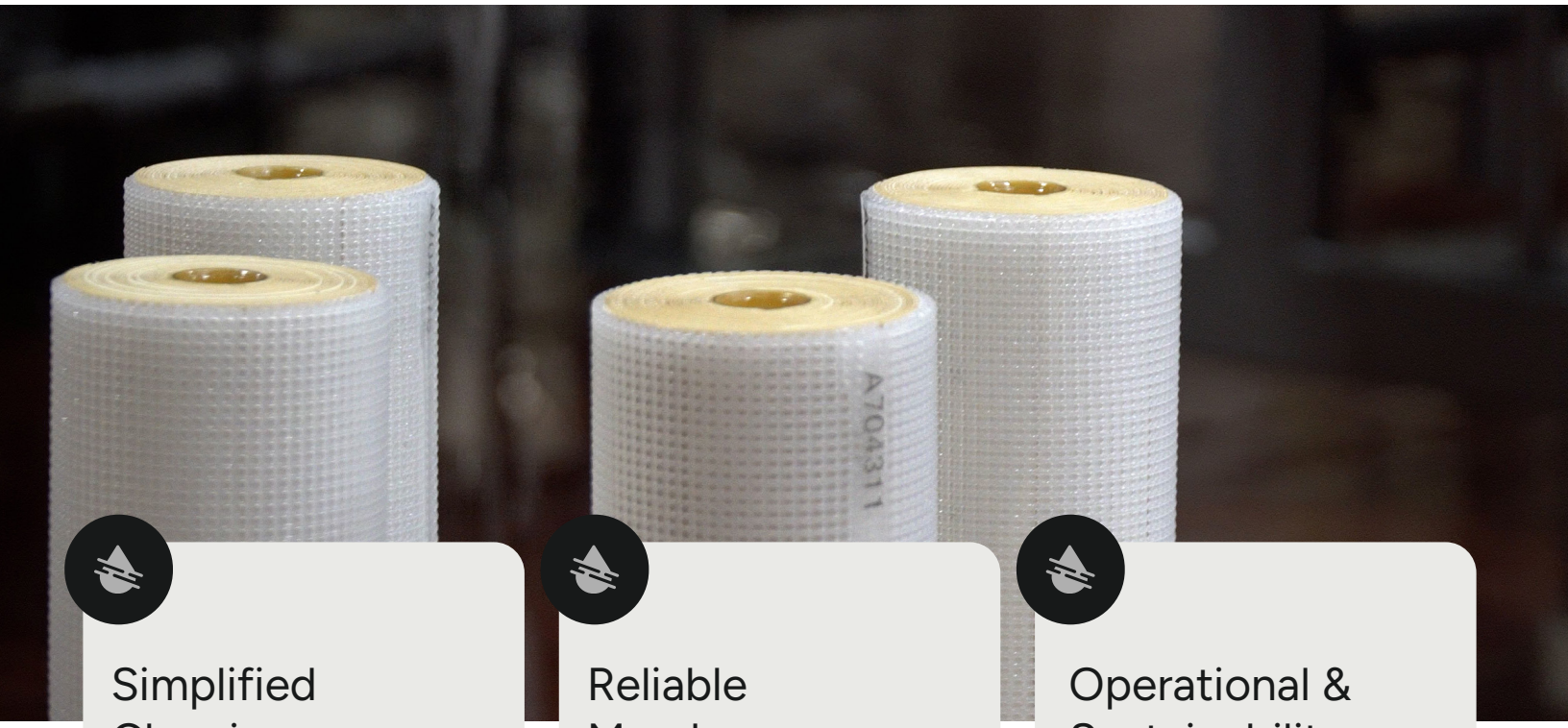
Summary

In collaboration with this whey processor, Evolution RO has been proven at scale to achieve cost reductions and sustainability gains through a simplified cleaning program that eliminates the enzyme cleaning step, reduces overall chemical usage, and lowers cleaning temperatures. Membranes maintained consistent flux and permeate conductivity over time, ensuring reliable performance. These advancements enabled the whey processor to enhance operational flexibility, reduce operational expenses, and align more closely with their long-term sustainability initiatives.



Simplified Cleaning Program

Eliminated the enzyme cleaning step, reduced overall chemical usage, and lowered cleaning temperatures.

Reliable Membrane Performance

Maintained consistent flux and permeate conductivity over time, ensuring reliable performance.

Operational & Sustainability Gains

Created more time for critical tasks, reduced operational expenses, and aligned with long-term sustainability initiatives.

This project, achieved through a direct membrane replacement requiring no capital investment, highlights the **immense potential for cost savings and enhanced sustainability for the dairy industry.**

ZwitterCo

ZwitterCo has developed a breakthrough in materials science - a new class of zwitterionic membranes with unprecedented fouling resistance. Our membrane solutions perform beyond the limits of conventional filtration, making it practical to treat complex wastewater, purify water for reuse, and maximize efficiency in food processing applications. ZwitterCo serves customers in more than 20 countries across food and beverage, agricultural, and industrial sectors. We are rapidly investing in our technology, equipment, and global services platform to help our industrial customers achieve their most ambitious sustainability and growth targets.

We are grateful to have been named as Global Water Intelligence's 2023 Breakthrough Water Technology Company of the year and Fast Company's Top Innovators of 2024.

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