ZwitterCo

Evolution

Anti-Fouling Membranes for Food & Dairy Processing

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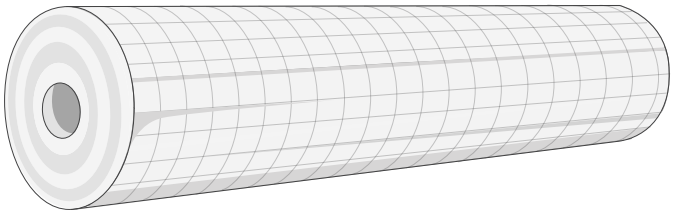

Evolution Membranes

Enabling Lower-Cost, Sustainable Operations for Food & Dairy Processing

Leveraging the remarkable hydrophilic (water-loving) power of zwitterions, ZwitterCo now offers a suite of sanitary membrane products to help food and dairy processors lower their operating costs while advancing their sustainability goals by enabling simpler cleaning programs that save time and money.

- ✓ Cut cleaning costs by over 50%
- ✓ Save at least 30% in cleaning-related water usage
- ✓ Reduce cleaning time by 1 hour or more per day

What Would You Do with More Time?

Every step of a daily cleaning program takes about an hour, with each step using chemicals and make-up water, creating wastewater to treat, and requiring energy and operator time to complete.

Imagine if you could eliminate one or more steps. Anti-fouling sanitary Evolution membranes allow food and dairy processors to have fewer and less expensive steps in their membrane cleaning process, resulting in unmatched improvements in operating efficiency.

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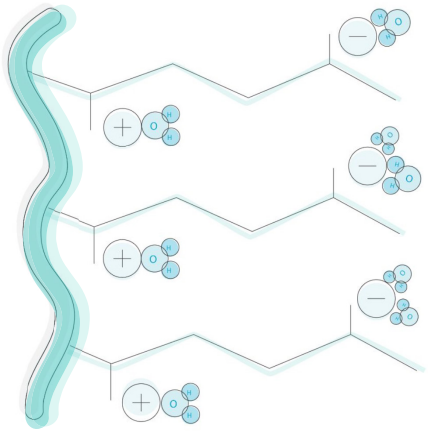
A New Material Chemistry

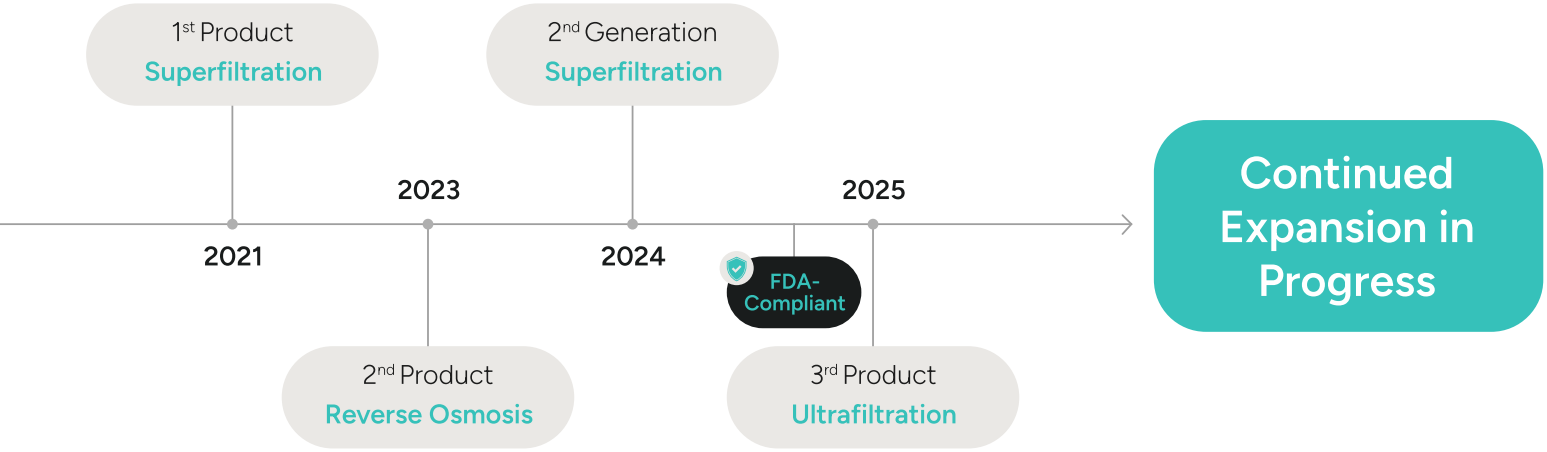


ZwitterCo developed a breakthrough membrane technology leveraging the extreme hydrophilicity of zwitterions to attract water and repel organics.

This membrane chemistry prevents irreversible adhesion of proteins, fats, and other organic compounds, which allows the membrane to be more easily cleaned than conventional membranes.

The Evolution of ZwitterCo Membranes

ZwitterCo introduced superfiltration (SF) membranes in 2021 for a variety of industrial applications, from bioprocessing to dairy wastewater, and demonstrated the anti-fouling nature of the membranes. Industrial reverse osmosis (RO) membrane elements were then introduced in 2023 and have been installed in dozens of water treatment systems and applications, including boiler make-up and landfill leachate treatment. These industrial installations showed that the membranes experience full performance recovery, enable shorter cleanings, and saved significant operating expenses, which led to the company exploring food and dairy processing applications next. The first FDA-compliant spiral membranes were introduced in 2024, bringing this target to realization.



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Evolution RO Membranes

Evolution RO sanitary full-fit elements were introduced in 2024 as a direct replacement for non-food grade applications:

- ✓ Effluent or wastewater concentration
- ✓ Industrial product concentration

Evolution RO is growing – with food-grade options coming soon for regulated applications.

Multiple installations of Evolution RO in these applications demonstrated their ability to significantly reduce operating expenses:

- ✓ Remove the enzyme cleaning step
- ✓ Reduce cleaning costs by over 50%
- ✓ Save up to 40% in cleaning-related water usage
- ✓ Reduce cleaning time by 1 hour or more per day

A leading whey processor in the Midwest United States installed Evolution RO elements in 2024 and reduced chemical costs by **56%** and cut water use by **41%** through months of like-new operation in their effluent concentration system. In the figure below, normalized polisher flux values show minimal variation from the flux starting point, indicating consistent operational efficiency and reinforcing the membrane's stable performance.

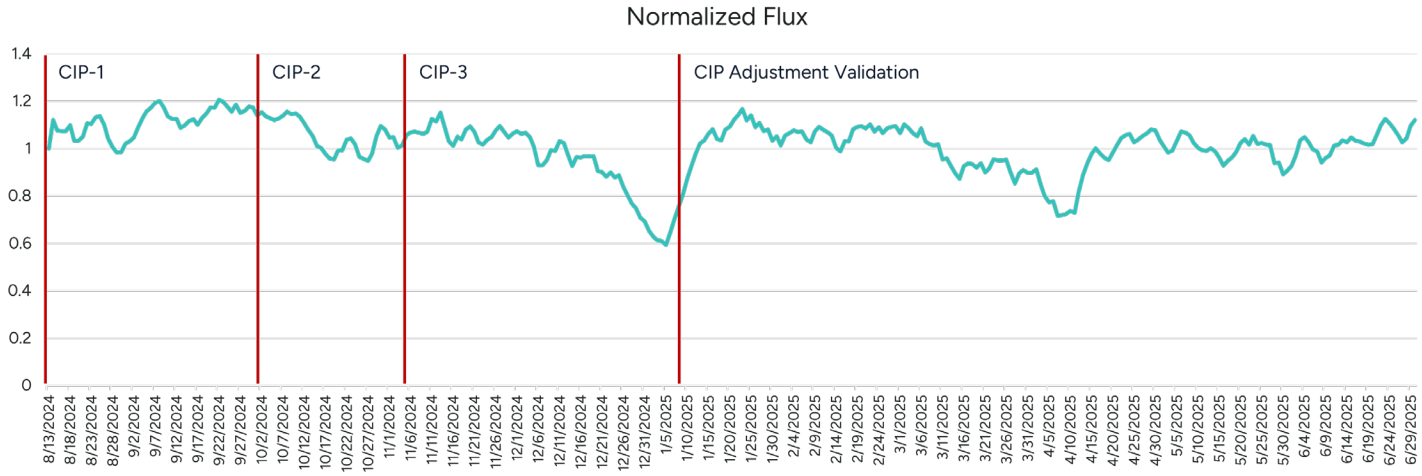

Figure 1: *Evolution RO normalized flux over the first 10.5 months post-installation*

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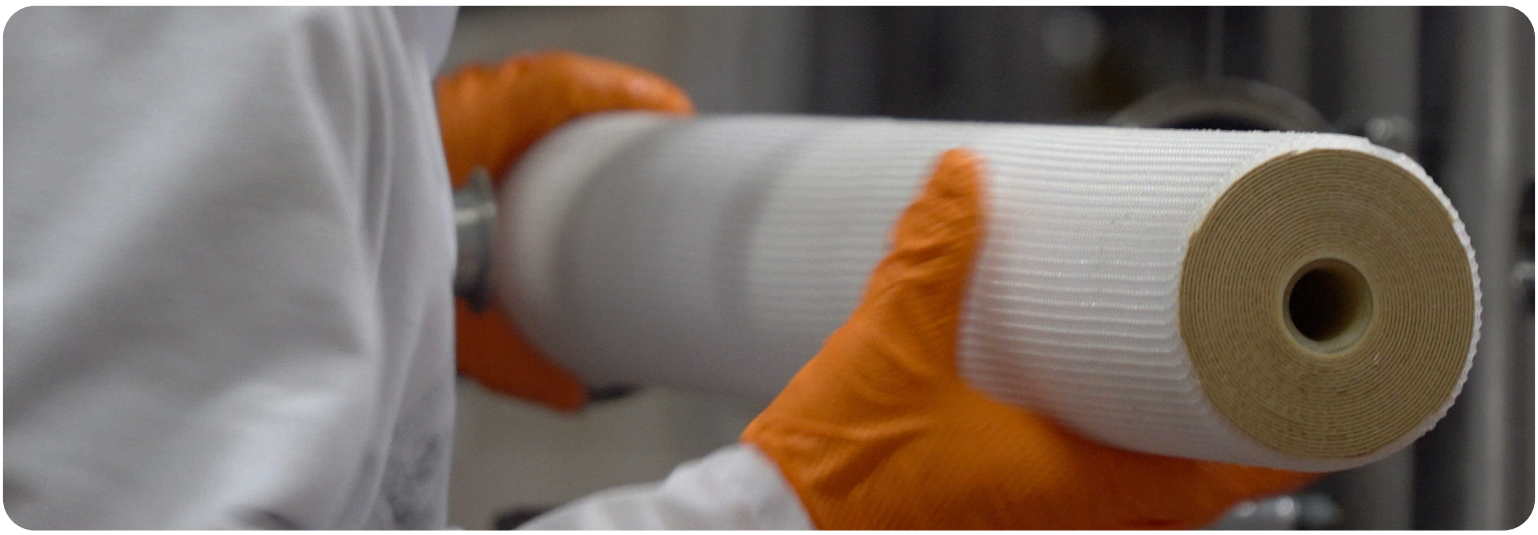
Evolution SF Membranes

ZwitterCo has introduced second-generation zwitterionic SF membranes that have performance benefits over first-generation products. FDA-compliant full-fit spiral Evolution SF membranes are now available for whey and milk processing. Outside of dairy, FDA-compliance will be evaluated on a case-by-case basis.

Evolution SF membranes have been field proven since October 2024 and are designed to replace conventional "tight UF" and "open NF" membranes. They are ideal for the following applications:

- ✓ High-solids applications
- ✓ Applications with high fat content
- ✓ Replacing NF for protein concentration



Evolution Protein Concentration Membrane (PCM)

ZwitterCo's third membrane product, an ultrafiltration (UF) chemistry called Protein Concentration Membrane (PCM) is now available. PCM is designed to replace conventional 5-30 kDa UF membranes in a variety of food and dairy protein concentration applications:

- ✓ Whey and milk protein concentration
- ✓ Plant protein concentration
- ✓ Gelatin concentration

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Save Money with Evolution SF and PCM

These revolutionary membrane products can enable the simplest membrane cleaning program ever for food and dairy processors. Evolution anti-fouling membranes can remove one or more steps from the cleaning program, including enzymes. The ultimate goal is to achieve a single alkaline step followed by sanitization.

For every step removed from a cleaning program, an hour of valuable time can be saved, which could lead to increased production and thus revenue and profit growth. In addition, hard dollar savings come from less chemicals and water use with a simplified cleaning program.

Below is an economic model analysis run with customer input demonstrating this.

Cleaning with Conventional Membranes	Optimized Cleaning with Evolution Membranes
Water Flush	Water Flush
Alkaline Wash	Alkaline Wash
Water Flush	Water Flush
Enzyme Wash	
Water Flush	
Acid Wash	
Water Flush	
Alkaline Wash	
Water Flush	
Sanitization	Sanitization
Water Flush	Water Flush

Cleaning Program	Conventional UF Elements	ZwitterCo Evolution Elements
Alkaline wash	✓	✓
Enzyme wash	✓	
Acid wash	✓	
Alkaline wash	✓	
Sanitization	✓	✓
CIP Operational Costs		
Total chemical cost ($/day)	$498.79	$146.48
Total water cost ($/day)	$187.35	$93.69
Total wastewater treatment cost ($/day)	$998.48	$437.11
Total CIP cost ($/day)	**$1,684.62**	**$677.28**
Total CIP cost ($/year)	**$613,203**	**$246,529**
Net savings in CIP costs ($/year)		**$366,674 total** ($1,309 per 8" spiral)

From Economic Model Analysis run with customer input

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Direct Replacements, No System Modifications Required

Evolution membrane elements are available in standard sanitary full-fit element designs to act as direct replacements for conventional membranes. They are compatible with new and existing membrane systems and designs so that modifications are not required.

A variety of feed spacers (e.g. 30 mil, 46 mil, 65 mil, 80 mil) and element dimensions (e.g. 8038, 7838, 6438, 6338, 3838, 1812) are available for Evolution membranes. Please contact ZwitterCo if your opportunity requires a configuration not listed.

Reduced Operating Costs

- ✓ Lower chemical costs
- ✓ Decreased water usage
- ✓ Less wastewater to treat
- ✓ Lower energy requirements

Sustainability

- ✓ Decreased chemical use
- ✓ Less water and energy usage
- ✓ Less wastewater generation
- ✓ Achieve corporate sustainability targets

More Uptime

- ✓ Shorter cleaning program
- ✓ Increased production
- ✓ Frees operators to work on other priorities

ZwitterCo Evolution membranes fully recover their performance with a **shorter, faster, lower-cost cleaning program** allowing food and dairy processors to **reduce chemical usage, lower freshwater demand** during cleaning, and **save an hour or more** every day.

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ZwitterCo is the global leader in membrane solutions for challenging separations, helping industries treat complex wastewater, purify water for reuse, and maximize efficiency in food processing applications.

The company leverages its breakthrough zwitterionic chemistry to build membranes with unprecedented fouling resistance, overcoming the longest-standing limitation with conventional filtration. Manufacturers in more than 20 countries across food and beverage, agricultural, and industrial sectors rely on ZwitterCo's membrane solutions to achieve their most ambitious sustainability and growth targets.

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