



CUT LANDFILL LEACHATE TREATMENT COSTS  
Achieve 50% OPEX Savings with Advanced RO Membranes



**ZWITTERCO**

# OVERVIEW



Reverse osmosis (RO) membranes are a cornerstone in industrial applications, particularly when treating wastewaters like landfill leachate. However, despite their role in treating leachate for reuse or discharge, traditional RO membranes often face significant challenges that can increase operating costs.

High organic content in leachate often fouls the first pass of a multi-pass RO system. This means RO membranes may need to be cleaned as often as every few days and must be fully replaced every 6-12 months.

In the past 40+ years, membrane development has been incremental, but the era of new membrane chemistry has finally arrived. ZwitterCo has developed an advanced RO membrane that uses zwitterionic chemistry to solve these challenges. This innovative membrane technology ensures **reduced cleaning, which means less downtime, longer membrane life, and lower costs.**

**ZwitterCo is not reinventing the wheel – just making it *better*.**

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# CHAPTER 1

## Identifying Problems with RO Membranes

Leachate is a wastewater formed when water filters through landfill waste. When water comes in contact with buried wastes, it leaches, or draws out, chemicals and pollutants from the waste, resulting in a mixture that contains heavy metals, color, and various inorganic and organic components.

Due to its high toxicity, landfill leachate must be treated to meet discharge regulations or hauled to a municipal wastewater treatment plant for treatment. Because landfill leachate often contains high levels of ammonia, many sites use a two-pass RO system to meet discharge limits.



The first-pass system typically uses seawater RO membranes because they can handle the higher pressures needed to overcome the high osmotic pressure caused by the high salt content. The permeate from the first pass then goes to the second-pass RO, using either seawater or brackish water RO membranes.

Because landfill leachate often has high levels of organic material (like TOC, COD, or BOD), the first-pass RO membranes regularly suffer from organic fouling. This means the membranes may be cleaned every few days and fully replaced every 6-12 months. This frequent maintenance is not only costly but also time-consuming, preventing operators from focusing on preventative maintenance or other critical tasks.

One of the biggest challenges with RO systems in landfill leachate operations is **membrane fouling**.

While RO membranes may be chemically cleaned to remove these organic materials and recover performance, **cleaning accelerates the deterioration of RO membranes, requiring regular replacements, causing significant operational burdens, and driving up operational costs.**

## DOWNTIME DUE TO FREQUENT CLEANING

Frequent membrane cleaning, while necessary to maintain system performance, tends to heavily increase overall expenses. With each cleaning cycle requiring a temporary system shutdown, downtime costs from membrane cleaning can detrimentally affect operations.

Each time your system goes offline for a cleaning cycle, you sacrifice operator hours due to excessive maintenance. This lost productivity can quickly add up, especially if your facility operates on tight schedules.

## HIGH OPEX DUE TO FREQUENT REPLACEMENTS

Every cleaning cycle chips away at the lifespan of your membranes, requiring you to replace your membranes more often. Whether planned or unplanned, the cost of new RO membranes can negatively impact budget.

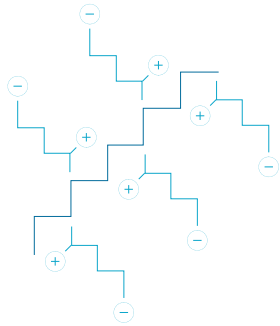
Frequent replacements not only increase overall costs but also contribute to additional downtime associated with installing and commissioning new membranes. Because each replacement cycle requires taking the system offline, frequent replacements often disrupt operations and lead to lost productivity on top of additional expenses.



**If you are replacing your membrane every two years or more frequently, or cleaning at least once a month, expenses can add up quickly. Along with increased expenses, the downtime from cleaning and maintenance can disrupt production schedules and impact overall productivity.**

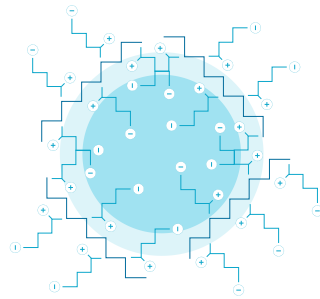
# CHAPTER 2

## Why ZwitterCo Membranes Are Different



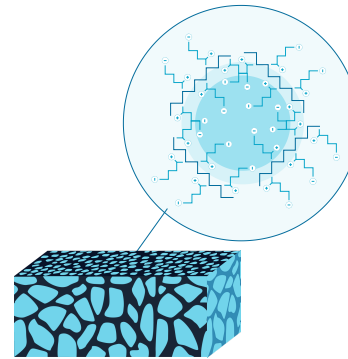
### POSITIVE & NEGATIVE CHARGES

First, zwitterions attract water molecules, displacing or repelling organic compounds.



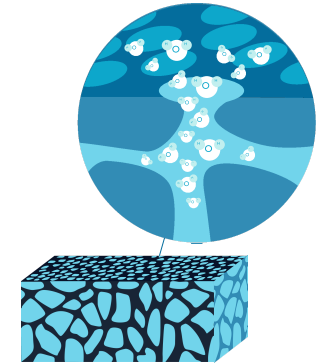
### PROPRIETARY CO-POLYMERS

Co-polymers bind zwitterions with hydrophobic molecules for stability, preventing wearing away over time.



### FOULING IMMUNITY

Zwitterions create water-loving channels, ensuring immunity to fouling internally and externally.



### CLEAN PERMEATE

Zwitterionic channels retain contaminants and produce clean water and can operate for years at full capacity.

## THE SCIENCE

ZwitterCo has set new standards in the membrane industry with its innovative zwitterionic technology. By integrating the technology with **proven commercial brackish water membranes**, ZwitterCo RO addresses the critical and persistent issue of irreversible organic fouling - making it a thing of the past.

A zwitterion is simply a small organic molecule that carries both positive and negative charges, which balance each other out, resulting in a molecule that is net neutral. In 2013, researchers

at Tufts University made a breakthrough, discovering that specialized copolymers combining hydrophilic zwitterionic monomers with hydrophobic monomers could yield stable materials with the astonishing ability to form self-assembled pore structures.

Being extremely hydrophilic, the zwitterions are central to ZwitterCo's membrane technology, as they create water-loving channels that prevent organic compounds from adhering to the membrane surface, significantly enhancing fouling resistance.





## OPERATIONAL BENEFITS

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ZwitterCo membranes offer unparalleled organic fouling resistance, reducing the frequency of high pH chemical cleaning by up to 90%. This means longer operational periods without the need for shutdowns and maintenance, enhancing overall system efficiency.



## ECONOMIC BENEFITS

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The economic advantages of ZwitterCo RO membranes are substantial long-term. By reducing cleaning frequency by up to 90%, ZwitterCo RO elements may also last at least twice as long as conventional RO elements, reducing element replacements and lowering overall operating costs.

Not only can ZwitterCo RO membranes reduce your overall operating expenses (OPEX) **by 50% over two years**, but they are also designed to be drop-in replacements, offering a no-risk opportunity for users to upgrade their system and lower costs without additional capital expenditure (CAPEX).



## SUSTAINABILITY BENEFITS

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Designed to offer stable performance even in high-fouling streams, ZwitterCo membranes can be fully restored with less frequent cleaning. This results in at least twice the membrane life, which keeps OPEX costs low, minimizes waste, and reduces chemical usage.

Additionally, the longer element life helps reduce the number of used elements ending up in landfills, ensuring long-term performance with minimal environmental impact.

# 90%

Reduce cleaning cycles by up to 90% with ZwitterCo

# 2x

Our advanced drop-in replacement RO membranes offer at least 2x membrane life

A leachate treatment system using 30 x 8040 RO elements could **reduce annual cleaning costs by over \$1,500 per element** when switching to ZwitterCo RO.

# CHAPTER 3

## Preventing Membrane Fouling

To thwart fouling and clogging, RO membrane operators typically rely on a combination of:

- **Pretreatment** - Treating wastewater with biological and mechanical processes, including NF/UF membranes, leading up to RO
- **Clean-in-Place (CIP)** - Chemical cleaning to remove scaling and deposits

Together, these methods effectively remove fouling. However, the operational costs of running them, mainly due to chemical consumption, severely impact facility budgets. The list of proprietary CIP chemicals, coagulants, and other methods relied on to prevent fouling makes RO a costly endeavor for industries that produce toxic wastewater. This historically unavoidable aspect of RO operations has made the technology and its benefits financially unfeasible for the same sectors that would benefit most from its treatment—until now.



By integrating zwitterionic technology with proven commercial brackish water membranes, ZwitterCo RO makes irreversible organic fouling a *thing of the past*.



## CHAPTER 4

### ZwitterCo RO in Landfill Leachate

#### LESS FREQUENT REPLACEMENTS

In the Southeastern United States, there is a landfill that treats water from their leachate pond with RO membranes to prevent the pond from overflowing.

While conventional RO membranes initially produced a permeate stream that met discharge quality requirements, the high organic levels in the leachate at this site caused the membranes to suffer from rapid fouling and loss of flow.

To manage costs and keep things running smoothly, the site had to purchase used membranes and replaced them as often as *every two days*. This constant maintenance was a burden on onsite operators, adding more work and stress to their daily routine.

Site management realized this was not a sustainable approach, so they decided to put ZwitterCo RO elements to the test to lower operating costs. With ZwitterCo's support and guidance, the site modified their system maintenance and has been **operating for 7 weeks without needing to replace any elements.**



*With ZwitterCo's support and guidance, the site modified their system maintenance and has been **operating for 7 weeks without needing to replace any elements.***

## LOWER CLEANING COSTS

In a European landfill, a two-pass RO system is used to treat their leachate. Due to the high feed TDS, they use seawater RO membranes in the first pass (to allow for high pressure operation) and brackish water RO membranes in the second pass for a final polish before discharging.

Given the high organic levels in the feedwater, the site cleans every other day—about 180 times a year—and replaces the RO elements every two years. This frequent cleaning and element replacement not only requires significant amounts of chemicals and labor, but also creates large volumes of waste and results in high operating costs.

The site decided to replace their first-pass seawater RO membrane elements with ZwitterCo High Pressure RO elements. These elements are designed to operate at up to 1,200 psi (83 bar), just like conventional seawater RO elements. This allows the site to operate at similar conditions, but brings a new advantage: **reduced cleaning frequency and longer element life.**

After installing the ZwitterCo High Pressure RO elements, the site saw immediate benefits. In the first two weeks of operation, they only cleaned one time. Since then, they've implemented weekly preventative chemical cleanings to ensure reliable operation. Even with these weekly chemical cleanings, the site has **dramatically reduced their cleaning frequency and cleaning costs by over 70%.**

*With ZwitterCo RO membranes, the site has **dramatically reduced their cleaning frequency and cleaning costs by over 70%.***

	System Information	Competitive RO	ZWITTERCO RO Elements
	Element Life	1 yr	2 yrs
	Cleaning Frequency (per yr)	180	<b>36 (80% reduction)</b>
	<b>Downtime Cost (per yr)</b>	\$1,170	<b>\$234</b>
	Annual Cleaning Chemical Cost (per element)	\$880	<b>\$176</b>
	<b>Annualized Cost Per Element</b>	<b>\$2,875</b>	<b>\$1,160</b>
		<b>Annual OPEX Savings with ZwitterCo RO</b>	<b>\$1,715 per element (60%)</b>

## REDUCED FOULING ISSUES

In another landfill in Europe, an onsite RO system was implemented to treat their low-strength (light) leachate in an effort to cut down on the costly process of trucking the leachate to an offsite treatment plant. They also reuse the RO permeate for cleaning and dust control at the site.

Given that the leachate was relatively low in total dissolved solids (TDS), the site chose to use low-energy brackish water RO elements. Even though the leachate was considered light, the team had been dealing with the hassle of performing chemical cleans every 24 hours and replacing elements every 4-6 months.

In an attempt to enhance the system's operational efficiency and cut down on the maintenance costs from frequent cleaning and element replacements, they turned to ZwitterCo Low Energy RO elements. Within the first few months of operation, they noticed a difference. The ZwitterCo RO elements **fouled at a slower rate** compared to the conventional ones, which meant less frequent cleaning and reduced costs. It wasn't long before they saw the potential for a **much longer operating life** with these new elements.



*The ZwitterCo RO elements **fouled at a slower rate** compared to the conventional ones, which meant **less frequent cleaning and reduced costs.***





## CHAPTER 5

### Pricing and Availability

ZwitterCo offers high rejection and low energy brackish water RO elements, as well as high pressure RO elements with either a 34-mil or 50-mil feed spacer for landfill leachate treatment systems. These elements are generally available from stock or with very competitive lead times to meet customer requirements.

While the value delivered from lower cleaning costs, more uptime, and longer membrane life justifies a price 2-3 times that of a conventional RO membrane, ZwitterCo offers special pricing and terms for new users. Our goal is to make it easy for users to **see the performance benefits for themselves**. We not only help new adopters benefit from special pricing, but also offer tier 1 technical/operational support and direct access to our product team.

To learn more about ZwitterCo RO First Install Discounts, click [here](#).

Learn More





## CONCLUSION

The introduction and adoption of new membrane chemistry is critical to make real change in the water industry, and as we often say – *every industry is a water industry*. This new era of membrane technology will enhance efficiency, sustainability, and cost-effectiveness, setting a new standard for water treatment and reuse.

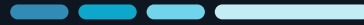
ZwitterCo's innovative membranes are at the forefront of this change, offering solutions that are not only more effective but also more resilient. If you are interested in discovering how much your operation could save by switching to ZwitterCo membranes, we invite you to use our [savings calculator](#) or contact us directly for more information.



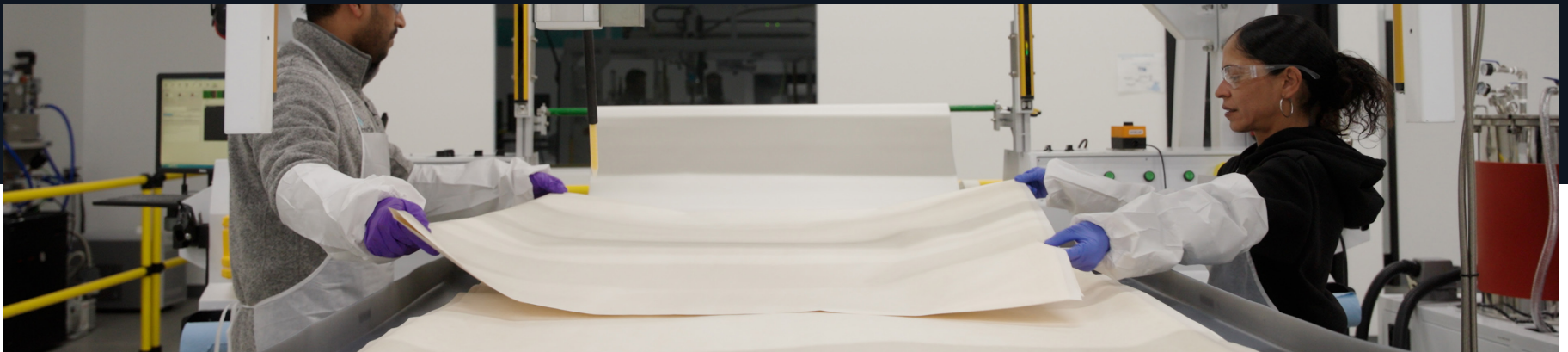
[i](#) [ADDITIONAL RESOURCES](#)



# ABOUT ZWITTERCO



ZwitterCo has developed a breakthrough in materials science, a new class of zwitterionic membranes that are immune to irreversible organic fouling, making it practical and affordable to treat challenging water and wastewater. Our mission is to provide industries with the tools to create clean water from every source, whether it involves accessing novel sources of water, shoring up distressed assets, or enabling onsite wastewater reuse. The company has been recognized as Breakthrough Technology Company of the Year at the Global Water Summit and by the Department of Energy and the National Science Foundation as a leader in clean water technologies.



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