Nitto
Innovation for Customers

HYDRANAUTICS

ULTRAPURE WATER FOR SEMICONDUCTORS

Case study

Reducing Biofouling and Optimizing Performance with PRO-XR1 Membranes at a Semiconductor Manufacturing Plant in Singapore

The PROBLEM

Singapore receives an average annual rainfall of 2,340 mm (92 inches), but it has limited fresh groundwater. To ensure a sustainable water supply, the country uses strategies like water recycling. The semiconductor industry requires large amounts of ultrapure water, which is produced from recycled water and local untreated water resources.

In mid-2019, four pre-treatment RO units with conventional membranes were installed at a semiconductor plant. These units began experiencing biofouling, which was partially controlled by automated doses of NaOCl and Na2SO3. However, a chemical cleaning trial using HCl and Special cleaning agent did not improve performance.

Over 3.5 years, permeate productivity dropped from 60 m³/h to 50 m³/h, and permeate conductivity increased from 6 µS/cm to 8 µS/cm. Despite cleaning efforts, the RO performance could not recover, leading to concerns about microbial contamination, declining water production, and worsened water quality.

Table 1. System information

Feed water source	Mixed NEWater (50% ratio) and City water (50% ratio)
Plant capacity (m³/h)	60 m³/h x 4-unit
Pre-treatment	MMF → ACF → RO
Feed conductivity	57 - 60 µS/cm
Recovery	87 %
Array	6:3 (6), 4-unit
No. of membranes	216 pcs PRO-XR1

The SOLUTION

In 2000, the engineering company installed a Reclaim RO system at this semiconductor plant using Nitto Hydranautics membranes, which performed well despite significant biofouling. Based on the demonstrated performance advantages, the existing conventional membranes were replaced with Hydranautics LFC3-LD membranes.

After reviewing the plant's objectives, we recommended the PRO-XR1 as a better alternative to the LFC3-LD. We met with the project manager and highlighted the following benefits of PRO-XR1:

- Better fouling resistance than LFC3-LD.
- Superior permeate quality with 99.8% rejection and less than half of conductivity than LFC3-LD.
- Longer membrane life.
- After internal discussions, they agreed to proceed with 216 PRO-XR1 membranes for improved performance.

Table 2. PRO-XR1 Operating Parameters

Parameter	Unit	After 1 year performance				Remarks
		RO1	RO2	RO3	RO4	
Feed pressure	bar	9.7	9.7	9.7	9.6	
Reject pressure	bar	8.5	8.3	8.4	8.3	
System delta-P	bar	1.2	1.4	1.3	1.3	2-stage(12 membrane in series)
Permeate flow	m^3/hr	60	60	59	60	
Feed water conductivity	µS/cm	73	→	→	→	
Permeate						
water conductivity	µS/cm	5	5	5	5	

Figure 1. Ultrapure water process diagram

3+1 (3 running, 1 standby), 6 x 6 arrangement

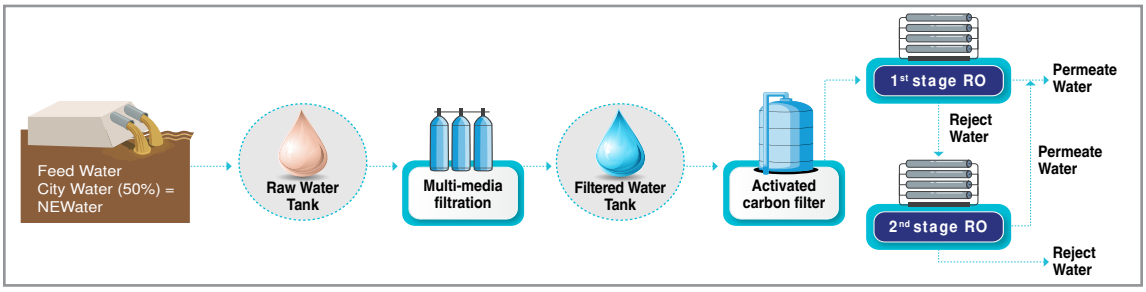


Figure 3: Neutral Surface

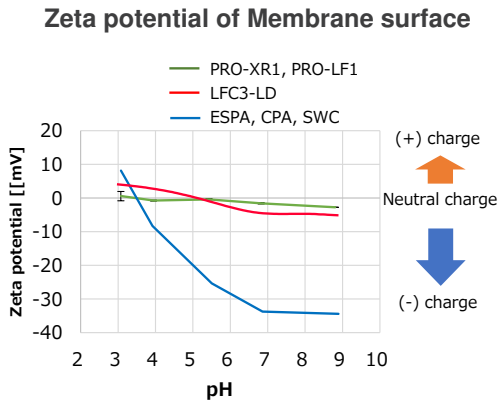
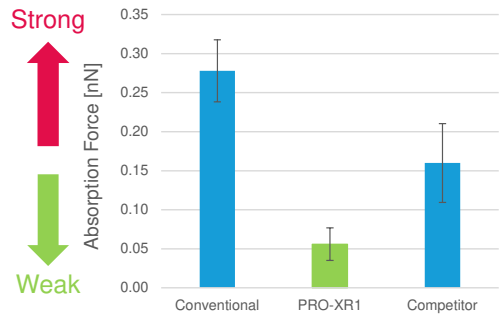


Figure 4: Protein(BSA) Absorption Test



(*) 1 [nN]=1.0197x10-10 [kgf];
The value is the average of 5 samples

The IMPACT

After 2 years of operation, the PRO-XR1 showed 20% higher production with no CIP performed so far. Each RO unit performs similarly, and the permeate quality is significantly better compared to the previously installed conventional membranes.

Table 3. Performance Comparison Between PRO-XR1 and Conventional Membranes

Items / Parameters	Production Flow m^3/hr	Permeate Quality µS/cm	CIP Frequency
Hydranautics Membranes	58 to 60 for 2 years	4 to 5 for 2 years	0 (all 4-units)
Conventional Membranes (Competitor)	60 → 50 after 1 year of operation	Drops 6 to 7 after 2 years of operation	2 (all 4-units)
Design	60	< 10	Target: without any CIP

A few months after the PRO-XR1 installation, we arranged a performance review meeting with the customer to discuss operating data, cleaning methods, and other opportunities. The meeting was very productive, and they decided to replace the conventional membranes in the wastewater reclamation system with PRO-XR1 due to its excellent performance.

The customer has expressed complete satisfaction with the PRO-XR1 membranes, which have been in operation for more than two years without requiring cleaning. Each RO unit performs almost identically, and the initial permeate quality is much better than with the previous conventional membranes.

For more information about Hydranautics case studies, contact us at **hy-marketing@nitto.com** or visit our website at **membranes.com**

About Hydranautics

Since our founding in 1963, Hydranautics has been committed to the highest standards of technology research, product excellence and customer fulfillment. Hydranautics entered the Reverse Osmosis (RO) water treatment field in 1970 and is now one of the global leaders in Integrated Membrane Solutions. Hydranautics became a part of the Nitto Group in 1987. Nitto is Japan's leading diversified materials manufacturer. The group offers over 13,000 high value specialty products worldwide including optical films for liquid crystal displays, automotive materials, reverse osmosis membranes for desalination and transversal drug delivery patches.

As leaders of high quality membrane solutions, we believe our commitments extend beyond manufacturing and selling our products. Our skilled staff of technicians, engineers and service professionals assist in designing, operating and maintaining a robust, reliable and efficient membrane system to meet your requirements and exceed your expectations.

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