Water Recovery from Chemical Industrial Effluent using an Improved Membrane Distillation System

Recovered water volume (18m^3 / day)
Reduction of carbon footprint (247 tCO2e / year)



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Which SPP thematic track does your case study align with? *Planet*

Where does your case study sit within the procurement lifecycle?

Manage – Measure & Improve Performance

What was the core challenge you were facing, and what was the context?

Penta-Chem is a Singapore-based chemical distributor and waste treatment company serving diverse industrial sectors. The company generates chemical industrial effluent that requires treatment before discharge, resulting in high freshwater demand and increasing wastewater management requirements. As water scarcity, environmental regulations, and sustainability expectations continue to grow, the company recognised the need to improve water resource efficiency. The core challenge was identifying a reliable solution that could recover water from chemical effluent for reuse while maintaining operational performance, supporting regulatory compliance, and reducing the environmental impact of its operations.

What approach did you take to tackle the challenge? The company evaluated available water recovery technologies and selected an improved membrane distillation system based on its suitability for treating chemical industrial effluent and recovering water for reuse. A feasibility assessment was conducted to evaluate wastewater characteristics, water recovery potential, operational requirements, and regulatory compliance. The system was then integrated into the existing treatment process, followed by commissioning, performance testing, and operational monitoring. Internal teams worked closely with the solution provider to optimise operating conditions, validate water quality, and establish routine maintenance and monitoring procedures to support reliable long-term performance.

What was the outcome, and how did you measure the impact? *T*he membrane distillation system achieved a 95% water recovery rate, significantly reducing the volume of wastewater requiring discharge while enabling recovered water to be reused within operations. The system also reduced the treatment footprint by 60% and achieved 80% operating cost savings compared with the previous process. These outcomes improved water resource efficiency, supported circular water management, and reduced wastewater handling requirements. Performance was measured through routine operational monitoring, including recovered water volume, wastewater discharge, system performance, footprint reduction, and operating cost comparisons before and after implementation.

Who was involved and how did you build buy-in (or not)? The initiative involved management, engineering, operations, environmental, and maintenance teams working with a global pharmaceutical company and a local research institute. The global pharmaceutical companyinitiated the collaboration to reduce its carbon footprint by decreasing the need to incinerate high-organic-content wastewater with high chemical oxygen demand (COD). The implementing company collaborated with the research institute under a government-supported grant to validate and implement the membrane distillation technology. As one of the early implementations of its kind, internal buy-in was built through pilot validation, technical assessments, and demonstrated environmental and operational benefits.

This is a community-sourced case study
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What was the cost or investment required, and what have been the expected (or unexpected) business trade-offs or benefits? The initiative required capital investment in the membrane distillation system, installation, integration with existing treatment infrastructure, and staff training. Additional resources were needed during commissioning, testing, and process optimisation. While the upfront investment and implementation effort were higher than conventional treatment options, the system delivered long-term business benefits through 80% lower operating costs, reduced freshwater demand, lower wastewater handling requirements, and a 60% smaller treatment footprint, improving operational efficiency and long-term resource resilience.

What was the "ugly truth" you encountered & what would you do differently next time? One of the biggest challenges was that membrane distillation performance depended heavily on the characteristics of the chemical industrial effluent. Variations in wastewater composition required operating conditions to be adjusted and increased the need for close monitoring during the initial stages. Integrating the system with existing treatment infrastructure also required more time and coordination than anticipated. In hindsight, the company would invest more effort in pilot testing, wastewater characterisation, and operator training before full-scale implementation. These steps would reduce commissioning time, improve process stability, and support smoother adoption by other organisations.

What were the key success factors? Key success factors included strong management commitment, cross-functional collaboration, and a structured implementation process. Early assessment of wastewater characteristics ensured the membrane distillation system was suitable for the application, while close collaboration with the solution provider supported effective system integration and optimisation. Continuous performance monitoring and operator training enabled stable operation and early identification of improvement opportunities. Clear sustainability objectives, combined with measurable performance indicators, helped demonstrate business and environmental value, building confidence in the long-term viability of the initiative. both environmental and operational perspectives.

For whom would you recommend this initiative? This initiative is recommended for organisations in the chemical, petrochemical, pharmaceutical, semiconductor, electronics, food and beverage, and other water-intensive manufacturing sectors that generate industrial wastewater with water reuse potential. It is particularly relevant for companies operating in regions facing water scarcity, rising water costs, or stricter environmental regulations. The approach is suitable for organisations seeking to improve resource efficiency, support circular water management, and reduce the environmental impact of wastewater treatment while maintaining operational performance.

How would you recommend those with fewer resources approach this? Organisations with limited resources can begin with a pilot-scale implementation to validate technical feasibility and quantify potential water recovery before committing to a full-scale system. Priority should be given to streams with the highest water reuse potential and greatest wastewater reduction opportunities. Existing treatment infrastructure should be utilised where possible to minimise capital investment. Collaboration with experienced solution providers, phased implementation, and routine performance monitoring can help manage costs, reduce implementation risks, and support future expansion.

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