# MEMBRANE SOCIETY OF AUSTRALASIA

**December 2024 Newsletter**

***What is covered in this issue:***

- Interview with Gary Crisp
- ARC, CRC-P funding successes
- $119M XPrize Water Scarcity Competition
- Latest membrane science and industry news

… and many more!

# TABLE OF CONTENTS

# In Memoriam: Prof. Enrico Drioli

The Membrane Society of Australasia (MSA) joins the global scientific community in mourning the passing of Professor Enrico Drioli, a towering figure in membrane science and engineering. Born in April 1941 in Naples, Italy, Professor Drioli's extraordinary career spanned over five decades, during which he profoundly influenced the development and application of membrane technologies worldwide.

Professor Drioli served as Emeritus Professor at the University of Calabria and was the founding director of the Institute on Membrane Technology (ITM) at the National Research Council of Italy (CNR). As a prolific author with over 930 scientific papers, his innovative contributions in membranes spanned an extensive array of topics, including membrane preparation, membranes in artificial organs, catalytic and biocatalytic membranes, membrane reactors, as well as membranes for water purification and gas separation. A passionate advocate for process intensification, he championed the integration of membrane technologies across diverse applications and pioneered unconventional uses of membranes, such as in contactors, crystallisation, distillation, and emulsification. His significant contributions earned him numerous prestigious awards and honours, including the Richard Maling Barrer Prize from the European Membrane Society and the Academician Semenov Medal from the Russian Academy of Engineering Science. These accolades are a testament to his enduring impact on the field of membrane science and technology.

Beyond research, Professor Drioli was a visionary leader and mentor, fostering international collaboration and inspiring a generation of membrane scientists and engineers. His unwavering dedication to advancing knowledge and addressing global challenges through membrane technology will remain a lasting legacy.


## ABOUT XPRIZE WATER SCARCITY

XPRIZE Water Scarcity is a $119 million, 5-year prize designed to increase widespread access to clean water by creating reliable, sustainable, and affordable seawater desalination systems. By 2030, we'll only have enough water to meet less than half of growing demand. Traditional desalination methods are expensive and have harmful impacts on the environment and marine ecosystems, making them an unsustainable solution to mitigating water scarcity.

Competing teams will develop new desalination technologies to unlock access to Earth's ocean water year round, helping drive a world where clean water is equitably and sustainably abundant, and enabling people and the environment to prosper. This multi-track competition centers around a core track to rethink the desalination system; the winning team will reliably and most sustainably generate one million liters of potable water per day (1,000 $m^3$/d) from seawater at the lowest cost, below current industry benchmarks, over the course of 1 year. In the Novel Membrane Materials track, the winning team will demonstrate a novel membrane that can sustainably and cost-effectively treat seawater to potable water quality, using pressure-driven salt-water separation, with an operational lifetime of 10 years or more. The novel membrane should be a direct replacement for or a novel innovation on seawater reverse osmosis (SWRO)membranes.

Learn more at [xprize.org/water](xprize.org/water)

XPRIZE Water Scarcity is part of XPRIZE's Food + Water + Waste domain, which focuses on building toward a future of safe access to clean water, sanitation, and nutritious food for all. This grand challenge accelerates technologies, processes, and policies to create resilient, regenerative, and inclusive food systems, with aims to increase nutritional quality, reduce waste, and build novel water systems to provide equitable access to clean drinking water around the world.

# Advancing Resilient Polyester Membranes Towards Driving Sustainable Desalination

By: Hoseong Han and Mehdi Khiadani

Water is a fundamental resource for sustaining all living organisms and ecosystems, including human life. The vital importance of water in our lives is undeniable, as survival on Earth would be impossible without it. However, freshwater constitutes about 3% of the Earth's total water volume.

Desalination technology plays a critical role in addressing global water scarcity. Approximately 61% of the worldwide desalination capacity comes from seawater desalination, while 30% is from brackish water desalination. Membrane desalination technology accounts for half of the world's desalination capacity, with reverse osmosis (RO) membranes being the most established and widely used process. Wastewater purification has been extensively developed over the past half-century to produce drinkable water, addressing the dual challenges of rapid population growth and the scarcity of freshwater.

Polyamide-based thin film composite (TFC) membranes dominate current RO technology. However, the interfacial polymerisation (IP) process used in their production has inherent limitations, such as high surface roughness, which promotes the adhesion of organic foulants or inorganic scalants. While oxidising agents can mitigate biofouling, the polyamide films are prone to degradation when exposed to active chlorine. Industrial water treatment involves several expensive pretreatment steps, including coagulation, antiscalant addition, disinfection, and dechlorination, to eliminate potential foulants and residual oxidising agents. Y. Yao *et al.* reported the molecular design of a resilient polyester-based TFC RO membrane to tackle these challenges. The developed membrane demonstrated excellent water permeability, high NaCl and boron rejection rates, and complete chlorine resistance. It also showed remarkable resistance to fouling and mineral scaling. When compared to the widely used polyamide-based commercial brackish water RO membrane, DuPont (BW30), it outperformed with a significantly smoother, defect-free surface. Specifically, the

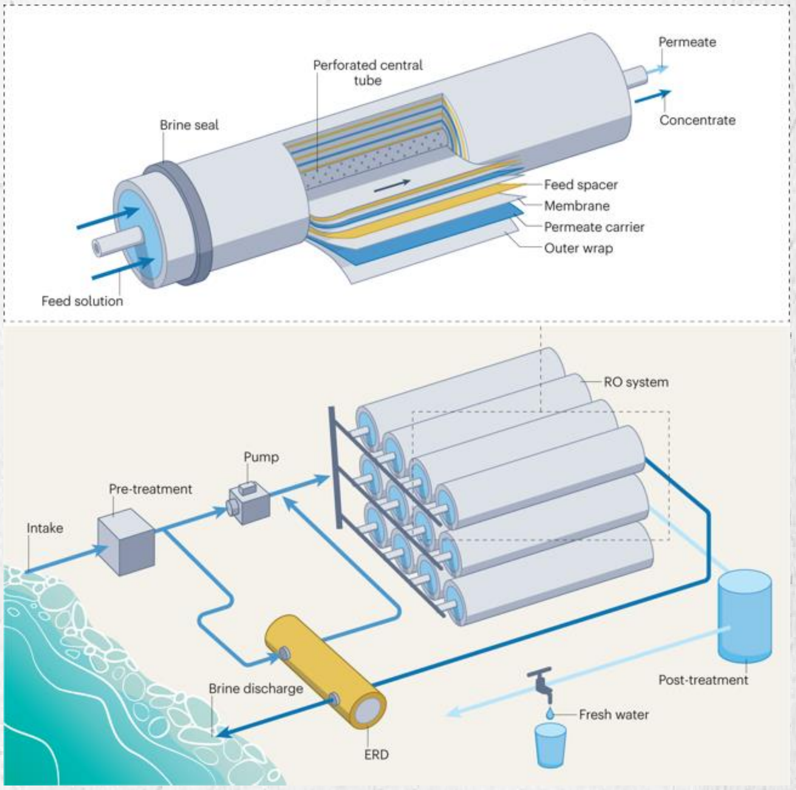



**Fig 1**. Seawater RO desalination system and its membrane module (source).

developed membrane demonstrated a water permeance of 3.36 ± 0.27 L $m^{-1}h^{-1}bar^{-1}$ and a salt rejection rate of 98.2 ± 0.3%, compared to 3.24 ± 0.16 L $m^{-1}h^{-1}bar^{-1}$ and 96.9 ± 0.6% salt rejection for BW30 when tested with a 2000 mg $L^{-1}$ NaCl feed solution.

The newly developed techniques for TFC RO membranes, which involve fewer manufacturing steps, offer the potential to reduce greenhouse gas emissions. However, a notable drawback is the wastewater generation during the membrane preparation process. To advance desalination technology in a sustainable and environmentally friendly manner, greater emphasis is placed on research into green preparation processes. Developing a closed-loop system through innovative and eco-friendly approaches in research and development is important for ensuring a sustainable desalination process in the future.

# ARC Discovery Projects

**The Australian Government has announced 536 new research grants under the Discovery Projects scheme for 2025. A total of $342.2 million has been awarded in this 2025 round.**

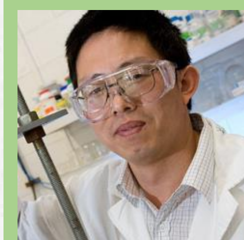

The University of New South Wales

### Professor Chuan Zhao; Dr Quentin Meyer

Fuel cell is a cornerstone technology for the success of Australia's hydrogen economy, but its scalability has been stagnant for decades because of its high cost and reliance on platinum materials. This project aims to unlock the potential of non-precious metal catalysts for hydrogen fuel cells using an interdisciplinary approach. Highly porous, multi-site single atom catalysts will be developed to block the degradation pathways, and integrated into a novel low-water retention membrane electrode assembly. The expected outcomes include new materials development, new cell design and a robust platinum-free hydrogen fuel cell prototype.The project will provide significant benefits to Australia in developing revolutionary hydrogen technologies.

### Professor John Zhu; Dr Rijia Lin

This project aims at new metal-organic framework (MOF) crystal-glass proton exchange membranes (PEMs) for Proton Exchange Membrane Fuel Cells (PEMFCs). The high processability of MOF glasses allows for the fabrication of grain-boundary-free membranes, addressing the key challenge of impeded ion transport. Expected outcomes include new knowledge in ion conductive MOF glasses, techniques for assembling MOFs into practical devices, durable PEMs suitable for various temperature/humidity levels, and PEMFCs with improved efficiency, lifetime, and operational capabilities. This project expects to accelerate the development of a sustainable energy technology viable for diverse applications, including transportation and portable power systems.




The University of Queensland


The University of Melbourne

### Professor Dan Li; Dr Mengran Li

The project aims to develop new materials and experimental tools to probe and exploit the complex ionic microenvironment at electrochemical interfaces – a centrepiece of clean energy and sustainable technologies. The novelty lies in using tuneable porous membranes made from electroconductive materials and charged polymers as a new platform to amplify and detect signals from the interfaces. Harnessing advanced characterisation and modelling, this project will build a key framework of the local ionic landscape and offer a new screening protocol for application-targeted ionic microenvironment design. This tool will help bridge the gap between basic research and real-world utility and accelerate Australia's transition to a net-zero economy.

# ARC Discovery Projects

RMIT University

### Professor Leslie Yeo; Dr Ravichandar Babarao

This project aims to develop a new, simple and fast method for synthesizing films of a new class of highly porous materials onto different surfaces not easily possible with other techniques. Elucidating the mechanisms governing the process will allow us to control the quality and stability of these films, which we will demonstrate for producing highly efficient gas separation membranes for carbon capture and storage, as an example application. Scaling the platform is expected to yield a thousandfold energy efficiency improvement, thus constituting disruptive technology that is an attractive economical and environmental alternative to conventional spray drying, and hence transforming industrial practice in the manufacture of these materials.

### Associate Professor Huacheng Zhang; Dr Jue Hou; Professor Benny Freeman; Dr Aaron Thornton; Professor Rong Wang

This project aims to explore innovative subnanofluidic devices that can efficiently separate divalent metal ions. The project expects to generate new knowledge in designing membranes with biomimetic pore structures and functionalities for rapid and selective transportation of targeted divalent metal ions. The expected outcomes of this project include a sustainable separation method for reclaiming metal ions from wastewater streams and an effective way to advance mineral refining processes. These advancements should significantly benefit the chemical and energy sectors, reduce waste generated during mining and energy industries, and shift towards a circular economy paradigm by yielding valuable products from recovered metal ions.

RMIT University

Curtin University

### Professor Dr Zongping Shao; Professor WooChul Jung

This project aims to develop anion exchange membrane water electrolysers using all inorganic perovskite oxides as both the electrode and membrane components for the generation of green hydrogen. This project expects to generate new knowledge in understanding the structure-property relationships of perovskite oxide electrocatalysts and the hydroxide ionic conduction behaviours of perovskite oxide membranes under practical operating conditions, which are key to the water electrolysis technologies. This project is expected to improve the utilisation of renewable energy and promote the development of hydrogen research in Australia. This should provide significant benefits to achieve energy sustainability and carbon neutrality for Australia.

# ARC Linkage

**The Australian Government has announced 56 new research grants under the Linkage Projects scheme for 2024. A total of $30.0 million has been awarded in this 2024 round.**





The University of Queensland

**Professor Xiwang Zhang; Dr Zhuyuan Wang; Dr Mike Tebyetekerwa; Professor Darren Martin; Dr Matthew David**

This project aims to expand a sustainable mechanical exfoliation method for producing high-quality two-dimensional (2D) nanosheets to a ton-scale annual output. It integrates membrane separation processes to recover raw materials, thereby minimising waste and achieving zero effluents. Expected outcomes include the scalable production of various high-quality 2D nanosheets and the development of assessment guidelines for their suitability in advanced applications. This initiative is designed to significantly enhance Australia's capabilities in advanced manufacturing and materials technologies, delivering substantial economic benefits and promoting environmental sustainability through waste elimination.

# ARC DECRA

**The Australian Government has announced 200 new research grants under the Discovery Early Career Researcher Award scheme for 2025. A total of $93.0 million has been awarded in this 2025 round.**

The University of Queensland

### Dr Min Liu

It has become evident that maintain global warming at 1.5 °C cannot be achieved simply by reducing carbon dioxide emissions through traditional precombustion and postcombustion carbon dioxide capture. A more progressive approach, known as direct air capture of carbon dioxide, is necessary to directly reduce the atmospheric concentration of carbon dioxide. This project aims to advance the understanding of membrane technologies for direct air capture of carbon dioxide, establish the groundwork for fabricating efficient and scalable nanomembranes for this critical application.

### Dr Qiucheng Xu

This project aims to revolutionize ethanol production to achieve high-current density $CO_2$ electrolysis to ethanol in bipolar-membrane-driven $CO_2$ electrolysers powered by renewable electricity. The project's ground-breaking advancements will encompass rational design and engineering of thiol ligands, elucidation of reaction mechanisms, potential breakthroughs in $CO_2$ electrolysis. Outcomes include in-depth reaction mechanism understandings, demonstration of robust $CO_2$ electrolysers and innovative materials engineering methods. The approach holds immense potential to transform the ethanol industry, foster economic growth, and contribute to a sustainable energy future.

Curtin University

# CRC Projects Round 16

### CPC Engineering Pty Ltd Impact Minerals Limited; Edith Cowan University

Impact Minerals has developed a High Purity Alumina (HPA) production process which addresses both the environmental and operational cost challenges of standard methods. Leveraging expertise from Edith Cowan University, the project integrates Membrane Selective Technologies to the process to increase the purity of HPA to <50ppm contaminants and recycle wastewater and acid by removing impurities, enabling a ‘zero liquid discharge’ closed loop process. cpc engineering will design and construct a pilot plant for process demonstration and optimisation. by demonstrating the use of membrane technologies for separating iron, aluminium and other metals, the project is potentially transformational across australia’s critical minerals industry.

### Enviropacific Services Pty Limited; University of NSW; Flexiroc Australia Pty Ltd; Membrane Systems Australia Pty Ltd

To move towards a circular economy in Australia, the National Waste Policy Action Plan is targeting an 80% average recovery rate from all waste streams by 2030, as well as to significantly increase the use of recycled content across governments and industry. In 2020-21, 59% of treated hazardous waste was disposed of to landfill. Enviropacific, UNSW, Flexiroc Australia and Membrane Systems Australia will commercialise technologies to convert wastes from thermal treatment facilities and soil washing residues into value-added products for construction. It will create new reuse pathways, increase waste recovery rates, replace existing raw building materials, upskill project partners and industry, and contribute to a circular economy.

### The Trustee for E M & H Peihopa Family Trust; Arrow Energy Pty Ltd; The University of Queensland

Raw coal seam gas is saturated with water which can plug or even freeze some of the gas lines during the winter months, leading to a well site shutdown and manual intervention. Productivity declines and more personnel travel to visit well heads – both of which increase costs and safety risks. This project aims to improve the productivity of coal seam gas wells by partially dehydrating the gas as it is produced at the well site using specially developed carbon membranes.

### Clean Teq Ltd; Iconic Industries Pty Ltd; Monash University

This project will provide the scientific basis for modified graphene oxide adsorbents and membranes that will be used to clean wastewater and recover valuable organics.

# Polymers of Intrinsic Microporosity in Aqueous Environment for Ion Separation

By: Amin Sarmadi and Mehdi Khiadani

Polymers of Intrinsic Microporosity (PIMs), with their interconnected nanopores of 1–3 nm, have long been valued for their potential in gas separations (Read more). The concept of intrinsic microporosity in polymers, introduced by Budd et al. in the early 2000s. Thereafter, PIMs present exciting opportunities for interfacial design in electrodes and sensor surfaces, as they can be easily fabricated into membranes, films, and coatings from polymer solutions. Despite limited exploration and minimal molecular structure optimisation, PIMs show promise in diverse applications, particularly in electrochemistry and electroanalysis. In lithium batteries, PIM membranes provide alternatives to traditional separators, preventing metal dendrite formation, while in redox flow batteries, they offer high cation permeability and reduce crossover of redox-active molecules. Additionally, for electroanalytical purposes, PIMs enable size selectivity and analyte accumulation through partitioning effects (Read more). However, their utility has been hindered by a persistent trade-off in ion separation: efforts to enhance conductivity by introducing charged moieties often result in excessive pore swelling, which degrades ion selectivity.

A groundbreaking study conducted by Qilei Song et al. confronts the challenge head-on by confining sulfonate groups within a rigid, amorphous framework, an approach that led to swelling decrease and enabling near-frictionless ion transport. The study focused on adjusting the local hydrophobic environment around ion-conducting moieties as a thermodynamic strategy to prevent hydration swelling. This design employs pendant groups with differing hydrophobic

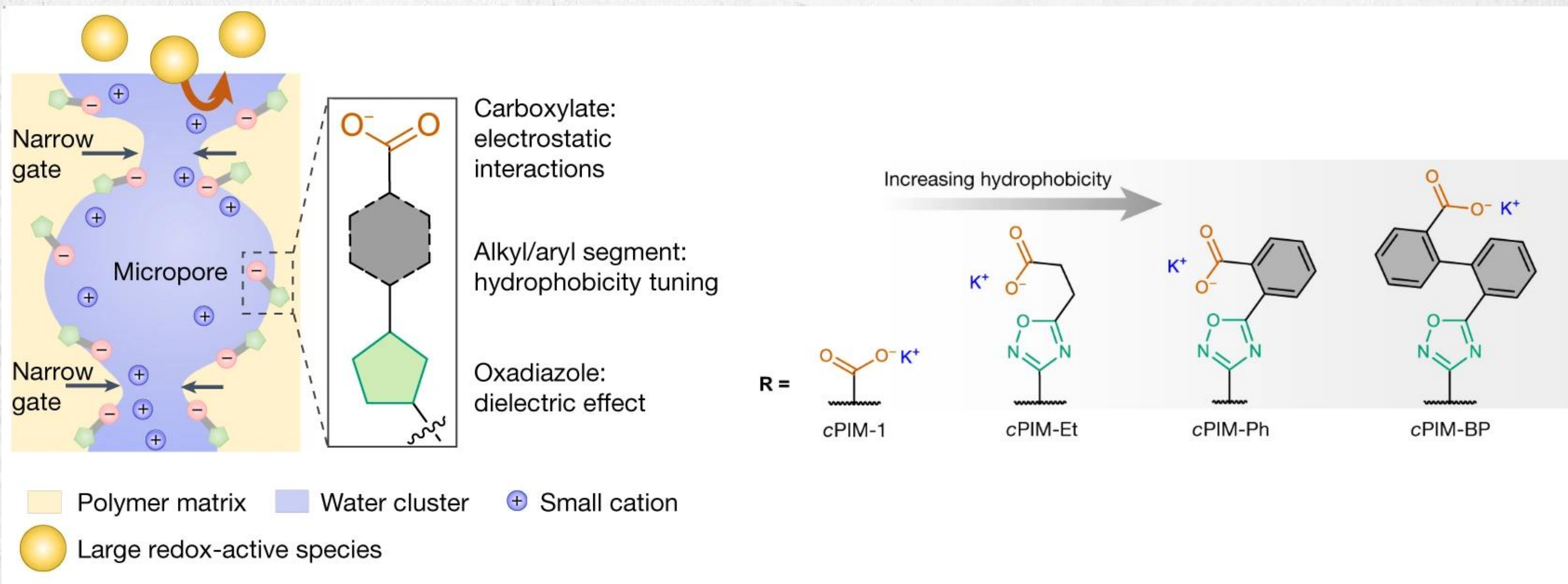



*Figure 1. Schematic of hydrated micropores structure and introducing ethyl-, phenyl-, biphenyl pendant groups between polymer backbones and carboxylate functionalities to achieve hydrophobicity and ion selectivity for PIMs (source).*

properties to manage pore size and hydration, establishing a structural foundation for controlling ion transport. The results highlight significant variations in the behaviour of the polymers analysed. Through advanced characterisation techniques, including small-angle and wide-angle X-ray scattering, they examined membrane pore swelling caused by hydration. Their findings indicate that membranes lacking phenyl groups exhibit more rigid nanopores. In contrast, the hydrated pore gates of PIMs with biphenyl-containing pendant groups showed minimal change, demonstrating their resistance to swelling.

The study highlights how carboxylate and oxadiazole groups facilitate potassium ion transport through electrostatic and dielectric interactions, creating an environment optimised for cation mobility. Notably, in PIMs with phenyl pendant groups (not observed in other variants), potassium ions demonstrated reduced mobility due to the strong interactions of potassium ions' first hydration shell with the carboxylates. The precise adjustment of ionic interactions highlights the critical role of pore gate dynamics. The combined effects of rigidity and hydrophobicity in pendant groups serve as the foundational mechanism driving pore hydration control. While pore size distribution provides insights into the overall porous architecture of polymers, the primary determinants of ion transport rate and selectivity are the bottlenecks or pore gates that connect the interconnected micropores. By resolving the conductivity–selectivity trade-off and introducing a scalable design process, pore structure engineering paves the way for impactful applications across water treatment and resource recovery.

For a deeper dive into this research, access the full study at Nature.

# Industry Interview

Prepared by: Shayan Abrishami, Yasamin Hamidian, Milton Chai

**We had the pleasure to interview Gary Crisp, who is undoubtably one of the leading voices in the water industry. He has over four decades of experience in water engineering and desalination and is currently the Chief Engineer at Sequana.**

## Interview between A/Prof Amir Razmjou and Gary Crisp

**Left:** A/Prof Amir Razmjou **Right:** Gary Crisp

**Amir:** Hi Gary, I really appreciate your time for this interview and I'm sure the MSA audience will enjoy this conversation. Tell us a bit about yourself. How did you get into desalination and water-related projects?

**Gary:** I began my career over 45 years ago, but my fascination with water started even earlier - when I was just 5 years old. My father was a plumber who operated from home, and he had pipes lying around in our backyard. He built us a sandpit where I started building dams, pipelines, and tunnels - everything to do with water. I even have an old photograph of that sandpit taken many years ago.

I graduated from the University of Pretoria, South Africa, in 1974 with a Bachelor of Science in Civil Engineering. The education was rigorous - we attended classes from 7:20 AM to 5:00 PM every day, including practical sessions in hydraulics, concrete, and materials laboratories. We were fortunate to have

**Gary (cont.):** Professor Albert Rooseboom from Delft University teaching hydraulics, which really shaped my understanding of water systems.

My early career included 15 years at the Department of Water Affairs in South Africa, and I even spent two years in military service where I designed and built an airfield. When I immigrated to Australia in 1993, I joined the Water Corporation in Perth, though I had to start almost from scratch despite my experience.

**Amir:** What led you to focus on desalination and membrane technologies?

**Gary:** My journey into desalination really crystallised around 1999-2000. During a flight across Perth for a job interview, I looked down at the city's small dams and thought, 'How does this city rely on such small water supplies?' I did not realise then that Perth was getting about 60% of its water from groundwater.

The millennial drought really pushed us to look at alternatives. I discovered an old book about thermal desalination plants in our office, and that sparked my interest. In 1999, Keith Barrett, the head of planning, asked me to prepare the desalination strategy for WA.

My real turning point came when I met Alan Linstrum, who became my mentor. He

**Gary (cont.):** was about 74 years old and came from Glasgow, Scotland. He had recently been involved with building a desalination plant for the island of Jersey, where they had replaced a thermal plant with reverse osmosis. I initially struggled to understand how spiral wound membranes worked - I had never encountered membranes before. Through Alan's guidance, I learned about both thermal and membrane-based desalination systems.

We wrote several papers together for the International Desalination Association, comparing different processes. That is when I developed my saying which has become quite global: It is not about water, it is about energy.

**Amir:** What is your perspective on the maturity of membrane technology for desalination?

**Gary:** I tell the world in all my presentations that nothing on Earth is ever going to replace reverse osmosis - unless you can find an insect that eats salt and produces water! The future of desalination lies in polymeric RO membranes, particularly for seawater applications.

For ultrafiltration, I believe ceramic membranes will become more prominent. However, when it comes to nanofiltration and RO, polymeric membranes will remain the backbone of the technology. There is fascinating research being done on 3D printing of membrane spacers, which I think will lead to significant improvements in performance.

The recovery rates in conventional systems will likely hover between 40-45% for optimum operation. Going beyond 50% recovery puts too much stress on the system due to the high pressures required. However, I see potential in high-recovery RO systems for treating hypersaline waters, particularly as add-on systems to existing plants.

We can handle feed waters up to about 160,000 mg/L TDS, operating at pressures around 120 bar. But the energy consumption jumps significantly - from about 2.2 kilowatt-hours per cubic meter to around 7 kilowatt-hours per cubic meter for these high-salinity applications. Here we should apply Osmotic Enhanced Reverse Osmosis (OERO) such as Counter Flow Reverse Osmosis (CFRO).

**Amir:** Where do you see potential for future research in membrane technology?

**Gary:** I see several critical areas where we need to focus our research efforts. First and foremost is the development of chlorine-tolerant membranes. This would be a game-changer for the industry because it would help us better manage biofouling, which remains one of our biggest operational challenges.

We also need to work on membrane surface modifications. The smoother we can make these surfaces, the less likely they are to foul. I am particularly excited about the possibilities that 3D printing brings to membrane fabrication. We could potentially print entire membrane elements with optimised channel designs and spacing - something that's hard to achieve with current manufacturing methods.

Another crucial area is the development of better pressure vessels. While stainless steel is too expensive, our current fiber-reinforced plastic (FRP) vessels are not lasting as long as we would like them to. There is also a safety component we need to consider.

When it comes to pretreatment, I strongly believe ceramic membranes are the future. While polymeric membranes definitely have their place, there have been issues with PFAS in the manufacture of some membranes. This is pushing us to look at alternatives.

**Gary (cont.):** One area that really needs attention is the issue of boron and bromide removal. Most countries are concerned about boron removal – there is a plant in Cyprus that uses resin to remove boron so they do not need a second pass RO system. In Australia, we are particularly concerned about bromide. If we could develop membranes with better rejection of these specific compounds, we might be able to eliminate the need for second pass systems entirely, which would significantly reduce energy consumption and costs.

**Amir:** For early-career researchers and PhD students, what membrane-related topics would you recommend focusing on?

**Gary:** If I were starting my research career today, I would focus on several key areas. The first would be chlorine-tolerant membranes - this is probably the holy grail of membrane development right now. We need membranes that can withstand chlorine exposure while maintaining their salt rejection capabilities.

Second would be developing better high-salinity membranes. As we push towards zero liquid discharge systems and higher recovery rates, we need membranes that can handle TDS levels of 150,000-160,000 mg/L efficiently. This ties into the whole concept of brine management, which is becoming increasingly important.

The third area I would recommend is membrane recycling and sustainability. This is crucial for the future of our industry. I believe membrane manufacturers should have a deposit system, similar to beverage containers, where they are responsible for the cost of disposing of or recycling their products. We need to develop membranes that can either be dismantled or ground up and used as aggregate - something that fits into a circular economy model.

**Gary (cont.):** For those interested in process engineering, I see great potential in improving energy recovery systems. The isobaric pressure exchangers we use today are already highly efficient, but there's always room for improvement, especially for high-pressure applications.

Looking at the bigger picture, I think we need to focus on reducing the environmental impact of desalination plants. This includes not just energy consumption, but also intake and outfall designs, chemical usage, and brine management. For instance, at the Perth plant, we've seen how important proper intake design is - what used to cost $40 million now costs $500 million because we need tunnels deep into the ocean.

Finally, I would encourage young researchers to think about membrane manufacturing processes. Can we make them more environmentally friendly? Can we reduce the use of harmful chemicals? Can we develop new materials that are both high-performing and sustainable? These are the questions that need answering.

Remember, in this field, it is not just about technical performance - it's about finding solutions that are economically viable and environmentally sustainable. The challenges are significant, but so are the opportunities for innovation.

This comprehensive look at the field reflects my experience of over four decades in water engineering and desalination. I have seen the technology evolve from thermal processes to today's highly efficient membrane systems, and I am excited about what the future holds for the next generation of researchers and engineers.

**Amir:** We only have a few minutes left so I

**Amir (cont.):** want to ask some rapid fire questions. If you can pick just one of the membranes, microfiltration, ultrafiltration, nanofiltration, reverse osmosis, which one do you like the most?

**Gary:** Reverse osmosis.

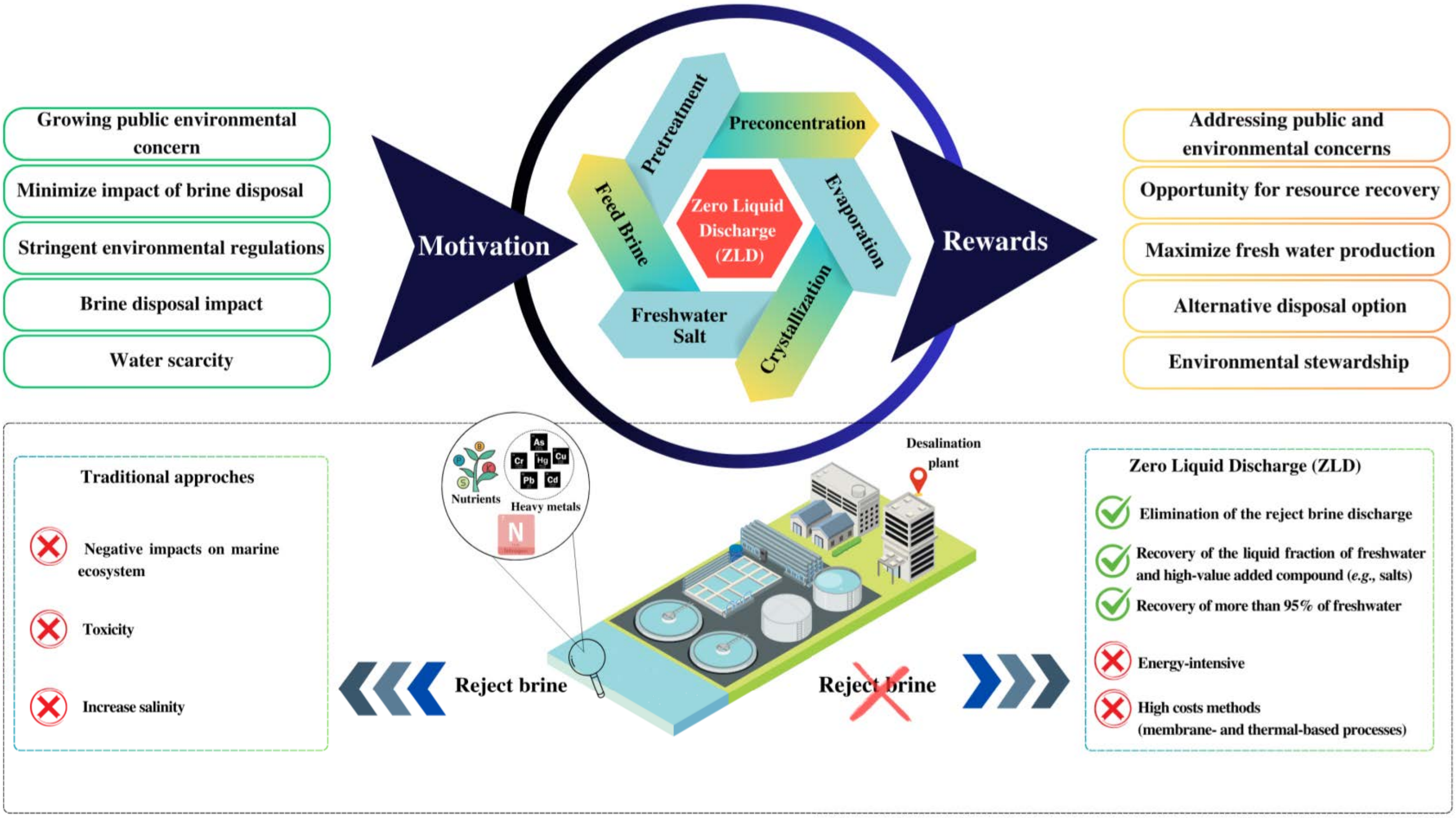
**Amir:** If you had a chance to go back, let's say 30 years ago, to pick another profession other than water, hydrodynamics, dams or river, what would be your first option?

**Gary:** I would have become a mechanical engineer working in a Formula One team.

SEQUANA

# Zero Liquid Discharge (ZLD) in Desalination

By: Mahsa Golmohammadi, Milton Chai




This infographic provides an overview of Zero Liquid Discharge (ZLD) in desalination, focusing on its purpose, benefits, and challenges. ZLD is a sustainable approach designed to eliminate liquid waste by transforming brine into usable water and solid byproducts through a combination of processes such as pretreatment, concentration, evaporation, and crystallization. The main drivers for ZLD adoption include increasing environmental awareness, stricter disposal regulations, water scarcity, and the desire to reduce the negative impacts of waste discharge. The benefits of ZLD include conserving freshwater resources, recovering valuable materials like salts and minerals, and offering environmentally friendly waste management alternatives. However, implementing ZLD comes with challenges, including high energy demands, significant operational costs, and technical complexities in handling the final solid waste. This infographic effectively captures the balance between the motivations for ZLD and its potential rewards, while also highlighting the need to address its limitations for broader implementation.

# Memsift Innovations Secures Breakthrough Graphene Membrane Technology

By: **Shokat Akbarnezhad, Milton Chai**

## MEMSIFT - TECHNOLOGY OVERVIEW

Industries such as electroplating, semiconductor, and chemical sectors produce high-salinity wastewater, with recycling rates under 20%. Conventional treatment methods, including reverse osmosis, are limited by salt concentration and environmental disposal issues. Memsift Innovations has developed an innovative zero liquid discharge (ZLD) system using a thermal membrane process that reduces energy consumption by five times compared to traditional methods. This unique system utilises a highly hydrophobic hollow fibre membrane, effectively treating brine and recovering valuable resources while achieving ZLD.

Singapore-based Memsift Innovations has signed a technology transfer agreement with Ngee Ann Polytechnic in Singapore to acquire the innovative graphene membrane technology. This technology, incorporating graphene oxide-based hollow fibre ultrafiltration and nanofiltration membranes, is the result of over a decade of dedicated research and development. The ultrafiltration membranes utilise a graphene oxide-block copolymer composite celebrated for its outstanding chemical and thermal stability, making it particularly well-suited for demanding industrial environments. This technology's distinctive surface chemistry creates a protective water layer, effectively minimising fouling.

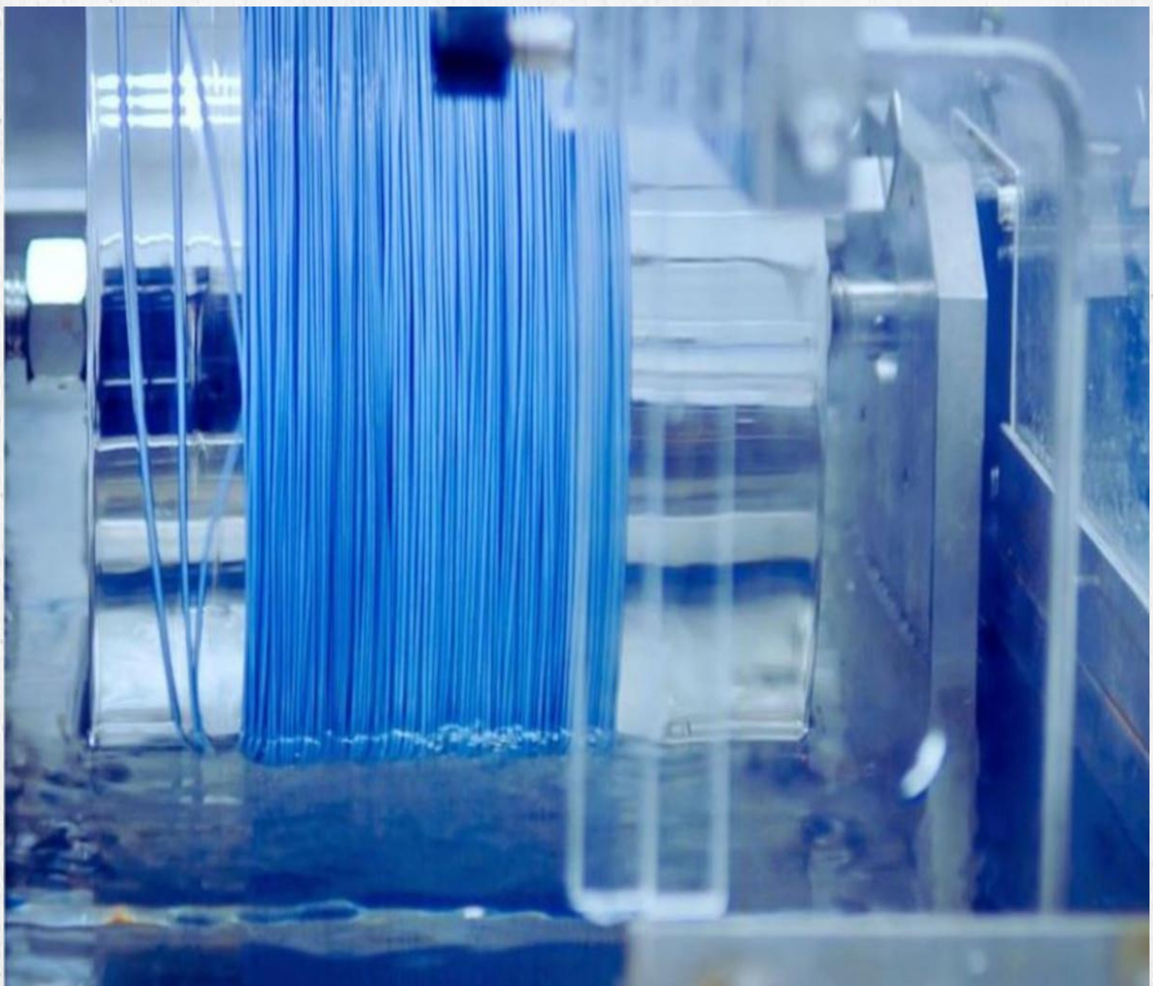
Meanwhile, the nanofiltration membranes feature a durable single-layer modified graphene oxide structure with synthetic water channels. This design significantly improves both selectivity and permeability, enabling precise molecular-level separation and distinguishing effectively between monovalent and multivalent ions.

Memsift Innovations offers membrane-based solutions that utilise advanced technology to tackle complex industrial liquid waste treatment challenges. Its TS-30 system is designed around a distinctive thermodynamic principle for efficient thermal separation. Additionally, the innovative GOSEP Ultra and nanofiltration membranes excel at separating diverse pollutants and monovalent ions from multivalent ions, even in harsh operating environments. To further expand its product offerings, the company is now incorporating next-generation graphene oxide membrane technology developed by Ngee Ann Polytechnic.

"This is a highly anticipated milestone in our journey," said Dr. J Antony Prince, founder & CEO of Memsift Innovations. "The new graphene membrane technology offers several advantages over current state-of-the-art nanofiltration technologies. This chemical-resistant hollow fibre nanofiltration technology will integrate seamlessly as a separation and purification unit before our membrane distillation concentration technology, aiding in chemical recovery and closing the industrial liquid-waste loop."

"This advancement solidifies our market position in industrial liquid waste treatment and resource recovery, enabling us to provide our customers worldwide with the most advanced and valuable technologies."

Dr. Jason Tang, Director of the Centre for Environmental Sustainability and Chief Sustainability Officer at Ngee Ann Polytechnic, commented: "The graphene oxide membrane technology we developed is groundbreaking, as it can reduce energy consumption by up to 50% and has a lifespan twice as long as conventional membranes. My team is excited about the potential of this technology to enhance the sustainability of industrial water treatment".



**Source:**
https://www.memsift.com
https://www.graphene-info.com/memsift-innovations-acquires-graphene-membrane-technology-singapore-s-ngee-ann

# Upcoming Membrane Events

| CURRENT EVENTS | DATE OF EVENT | ABSTRACT SUBMISSION |
|---|---|---|
| IDRA World Congress – Addressing Water Scarcity<br>Abu Dhabi, UAE<br>wc.idadesal.org | 8 – 12 December 2024 | **Closed** |
| 19th Aachener Membran Kolloquium (AMK) 2024<br>Aachen, Germany<br>conferences.avt.rwth-aachen.de/AMK/ | 3 – 5 December 2024 | **Closed** |
| MSA Annual Meeting and Conference 2024<br>Sydney, Australia<br>membrane-australasia.org/msa-amc2024 | 9 – 11 December 2024 | **31 August 2024** |
| 2025 Membrane Technology Conference and Exposition (MTC25)<br>California, USA<br>awwa.org/Events-Education/Membrane-Technology | 24 – 27 February 2025 | **Closed** |
| NAMS 2025<br>Tennessee, USA<br>membranes.org/nams2025/ | 17 – 21 May 2025 | **Opens: November 25, 2024**<br><br>**Closes: January 31, 2025** |

# MSA Newsletter Taskforce

## Meet our newsletter team for this December edition!

**A/Prof. Amir Razmjou**
**(Newsletter Coordinator and Editor)**

**Dr. Milton Chai**
**(Associate Editor)**

**A/Prof. Mehdi Khiadani**
**(Associate Editor)**

**Dr. Shiyang Huang**

**Dr. Hoseong Han**

**Dr. Shokat Akbarnezhad**

**Javad Farahbakhsh**

**Mahsa Golmohammadi**

**Shayan Abrishami**

**Yasamin Hamidian**

**Amin Sarmadi**