

# membrane TECHNOLOGY

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www.markallengroup.com/brands/membrane-technology

## De.mem introduces proprietary membrane technology enhanced by graphene oxide

### De.mem Ltd has developed and launched proprietary graphene-oxide-enhanced membrane technology.

According to the Australian–Singaporean water and wastewater treatment company, this technology provides significant customer benefits, including increased throughput – and therefore, a reduced operating cost – and superior filtration performance.

De.mem also says that the new intellectual property complements its existing portfolio and further strengthens its position as a developer of hollow-fibre membrane technology.

It is based on the firm's existing polymer membranes, which are infused with graphene oxide nanoparticles as an additive, using a manufacturing process that is highly scalable and consistent with existing production processes.

De.mem's new membrane technology has the potential to disrupt the existing global market for hollow-fibre membranes, which is expected to grow substantially over the next five years.

As reported in the article entitled 'De.mem advances its hollow-fibre ultrafiltration (UF) and nanofiltration membrane technology', the introduction of different products supports the company's strategy of developing a portfolio of membranes, and helps to strengthen its customer-base and broaden revenue streams (*Membrane Technology*, August 2019, pages 5–7).

In 2019, the newsletter covered the release – for commercial sale – of the company's first hollow-fibre UF membrane to be developed in-house (*Membrane Technology*, January 2019, page 1).

For further information, visit:  
[www.demembranes.com](http://www.demembranes.com)

*(A focus article, which will be published in a forthcoming issue of Membrane Technology, will provide further details of this technology and what its development means for the company.)*

## Asahi Kasei and Recherche 2000 services target membrane-based chlor-alkali electrolysis

### Asahi Kasei Corp reports that it is initiating a proof-of-concept demonstration of data-driven services for membrane-based chlor-alkali electrolysis with Recherche 2000 Inc (R2), which it acquired in February 2020.

The companies jointly completed a preliminary study and co-development of such services following the acquisition.

A blueprint of data-driven services, such as predictive maintenance and process optimisation was prepared by integrating Asahi Kasei's technical service expertise and R2's technologies and know-how of intelligent systems.

According to Asahi Kasei, such services focus on key attributes "smart (digital transforma-

tion)," "safe/stable" and "sustainable" that contribute to the further success of customers operating membrane-based chlor-alkali electrolysis plants. Trials of the new services are being launched for the proof-of-concept demonstration at some customers' plants.

Asahi Kasei says that since it was commercialised over 45 years ago its membrane process for chlor-alkali electrolysis has gained a strong reputation amongst customers for its superior operating performance and reliability. As of August 2021, it has been adopted at more than 150 plants in 30 countries, with a total capacity of over 30 million tons per year converted to 100% caustic soda.

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For a press release on the purchase, please visit <https://markallengroup.com/our-news/>

(The content of this newsletter is compiled from a variety of sources, including press releases.)

## Seccua purchase grows Mann+Hummel's water filtration portfolio

**A**fter investing in a strategic partnership with Seccua Holding AG in 2019, German filtration company Mann+Hummel has now acquired all shares in the company.

Mann+Hummel says that the acquisition of the firm, which specialises in the manufacture of ultrafiltration membranes, strengthens its activities in the field of water filtration.

Fua Nipah, President and General Manager, Life Sciences & Environment Business Unit, Mann+Hummel, said: 'For years Mann+Hummel has been continuously expanding its portfolio in the areas of water and air filtration. We are convinced of the growing importance of the drinking-water market. By fully acquiring Seccua we will continue to grow in this area.'

Mann+Hummel and Michael Hank, Former Chairman of the Executive Board of Seccua – and the company's founder – have jointly agreed that he will continue to support Seccua as an independent advisor. The two remaining board members Martin Kunze and Daniel Haußmann will jointly lead the business on an interim basis.

Mann+Hummel also recently invested in ZwitterCo, an early-stage company based in Cambridge, Massachusetts, USA, that focuses on membrane technology developed to treat organic-heavy waste streams (*Membrane Technology*, January 2021, page 1)

**For further information, visit:**

[www.mann-hummel.com/en/products/water-reuse/water-treatment.html](http://www.mann-hummel.com/en/products/water-reuse/water-treatment.html) &  
[www.seccua.com](http://www.seccua.com)

## NX Filtration helps to reduce paper mills' water footprint

**I**n The Netherlands, NX Filtration BV, which develops membrane products for treating water, has started a pilot project with Industriewater Eerbeek (IWE), a subsidiary of three Dutch paper mills focusing on wastewater treatment.

Since 1960, IWE has been purifying surplus process water from three paper mills (Folding Boxboard Eerbeek BV, DS Smith Paper De Hoop Mill and Neenah Coldenhove BV) in

Eerbeek. With a strong focus on achieving a circular process, it is seeking to use NX Filtration's direct nanofiltration (NF) membranes to upgrade the wastewater stream to enable it to be reused as process water at the paper mills.

William Suijkerbuijk, director at IWE, commented: 'With a true sense of conviction, IWE is therefore happy to play a role in maintaining natural resources. This pilot with NX Filtration's direct nanofiltration technology supports us in further reducing the water footprint of our operations.'

Gerard Ruiter, sales manager at NX Filtration, added: 'Our tight direct nanofiltration membranes remove micro-pollutants (including pharmaceuticals, medicines, polyfluorinated substances and insecticides), colour and selective salts, but also bacteria, viruses and nano-plastics, from water in one step.'

'We are proud to support the sustainability initiatives of IWE and deploy our technology to further reduce the water footprint of the paper industry in Eerbeek.'

**For further information, visit:**

[www.nxfiltration.com](http://www.nxfiltration.com) &  
<https://iweerbeek.nl>

## Veolia invests in its mobile water services in the Middle East

**V**eolia Water Technologies is continuing its investment in its mobile water services through the development and construction of a new regeneration and recycling service centre in Dammam, Saudi Arabia.

The facility will regenerate and recycle the resins used in the mobile water treatment process.

The subsidiary of the Veolia group and specialist in water treatment says that following the recent opening of a similar facility in Heinsberg, Germany, the Dammam service centre is another key expansion of its mobile water services, and demonstrates its commitment to invest to support its Impact 2023 strategy (*Membrane Technology*, March 2021, pages 2–3)

The location will grant access to regional industrial manufacturing, supporting customer operations throughout the country as well as Qatar, Oman, Kuwait, Bahrain and Egypt – providing them with local access to this flexible service.

Mark Dyson, Vice President, Mobile Water Business, Veolia, commented: 'This service centre enables us to bring our unique innovative service to support our customers in the region with mobile water treatment technologies and

expertise anytime and anywhere. It will enable our customers to have greater resilience around business continuity and ensure a reliable and compliant supply of treated water in the event of an unforeseen circumstance, providing peace of mind and stable operations.'

Thierry Froment, CEO, Veolia Water Technologies Middle East, added: 'Mobile water services are a key part of Veolia's Impact 2023 strategy and contribute to businesses being more resilient in the face of planned or unforeseen events.'

'This offering strengthens our portfolio of services in the region and enables us to help and support our customers to solve many of their treated water needs in a safe and responsible way. Damman is the perfect base to do it from and this investment will ensure we maintain our market leadership.'

In addition to the unique regeneration capability, the centre will be equipped to maintain, service and store all of Veolia's mobile water services assets, spare parts and consumables.

The company is also investing in its Malaysian regeneration station to expand its capability from a service ion-exchange recycling business to being able to offer Veolia's full range of ion-exchange mobile water services.

Located in Penang, it will be able to support and help its customers within the Asia-Pacific region, starting with Malaysia, Singapore and Thailand. This facility is set to start operating at the end of 2021.

**For further information, visit:**  
[www.veoliawatertechnologies.com](http://www.veoliawatertechnologies.com) &  
[www.veolia.com](http://www.veolia.com)

## Toray and Siemens aim to produce green hydrogen

**T**oray Industries Inc and Siemens Energy KK, the Japanese subsidiary of Siemens Energy AG, are jointly working on a project that aims to produce green hydrogen – contributing to a carbon-neutral society.

To produce the gas, the companies say that they will use technology based on polymer electrolyte membrane (PEM) water electrolysis, using renewable energy sources.

The resulting green hydrogen can be used not only for large-scale power generation and other areas that require electric power, but also in transportation and industrial applications.

Toray will provide Siemens Energy with its proprietary hydrocarbon electrolyte membranes. The two companies will work together to pro-

mote the installation and demonstration of these membranes in Siemens Energy's large industrial-scale PEM water electrolyser.

The companies say that they are being supported by the Green Hydrogen Project, under the Green Innovation Funding Program organised by the Japanese Ministry of Economy, Trade and Industry (METI) and the New Energy and Industrial Technology Development Organization (NEDO).

They will receive funding together with six other companies, including the Yamanashi Prefectural Enterprises Bureau and Tokyo Electric Power Co.

**For further information, visit:**  
[www.toray.com](http://www.toray.com) &  
[www.siemens-energy.com](http://www.siemens-energy.com)

## Power plant in Chile uses IDE's MAXH<sub>2</sub>O Desalter technology

**I**ndustrial effluent treatment and brine minimisation technology from IDE Technologies has been selected for use at a power station in Chile.

The desalination and water treatment systems company has signed a contract with ENEL Generación Chile SA to demonstrate its MAXH<sub>2</sub>O Desalter technology at the electricity utility's San Isidro power plant in Quillota.

The scope of this project includes the fabrication, installation and operation of a fully advanced demonstration treatment unit – the first of its kind to be implemented for a facility of this size.

According to IDE, from the outset the technology impressed ENEL, which was interested in further exploring its use for complex cooling-tower blowdown minimisation at its power plants – a process that often poses challenges for many industries in general, but in particular for power plants.

By introducing this technology for this industrial application, it is possible to minimise and reuse much of the cooling-tower blowdown and offer a more economic and sustainable approach for ENEL, says IDE.

The MAXH<sub>2</sub>O Desalter operates by rapidly recirculating treated water through a reverse osmosis (RO) system and a fluidised bed pellet reactor, continuously precipitating supersaturated salts from the recirculated brine.

It offers high recovery rates and flexibility without putting at risk membrane service life – translating into a reduced investment and low operational costs for the facility.

A recently published technology focus article

## In Brief

### Pentair acquires Pleatco

Global water treatment company Pentair Plc has acquired US company Pleatco Llc – which manufactures water filtration and clean air technologies for pool, spa and industrial air customers – for approximately US\$255 million in cash, subject to customary adjustments. According to Pentair, the acquisition provides it with additional replacement filter products to be sold through its existing pool and spa distribution channels, as well as through those established by Pleatco. 'We are excited about the addition of Pleatco as it provides additional aftermarket product offerings for both our pool filtration and industrial air filtration portfolios,' said John Stauch, President and CEO, Pentair.

### G<sub>2</sub>O appoints chief marketing officer

UK-based G<sub>2</sub>O Water Technologies, which develops and provides graphene oxide membrane coatings designed to significantly reduce the cost and environmental impact of water filtration, has expanded its executive management team with the appointment of Andrew Walker as Chief Marketing Officer – to join Craig Clement, Chief Operating Officer and Chris Wyres, CEO. Commenting on the appointment Wyres said: 'As we shift gear, launching an exciting range of industrially proven products, Andrew will help us to reach out with our brand, expand the range of markets we address and accelerate growth. He has a strong reputation with key partners including, clients, investors and associations and a good knowledge of many of the industrial sectors we are targeting, so his role will include developing the business with our team and our strategic partners.'

### Brochure describes production of membrane material

Alsys, which develops ceramic and polymeric membranes, has produced a brochure describing its service capabilities. The publication, which describes the development and production of membrane material, can be accessed at the link below.

### More information:

<https://s3.alsys-group.com/uploads/2021/08/alsys-en0002-membrane-services--development-production-membranematerial-data-sheet-v08.21.pdf>

### Sartorius joins DAX blue chip index

Life science group Sartorius Ag has been admitted to the German DAX blue chip index. 'Sartorius has been performing very dynamically. We are now pleased that the performance of our shares has resulted in their inclusion in the DAX,' said Joachim Kreuzburg, Executive Board Chairman and CEO, Sartorius.



provides details of an environment-friendly seawater RO technology, developed by IDE, that is at the heart of a facility on Bonaire, an island in the Leeward Antilles in the Caribbean Sea (*Membrane Technology*, April 2020, page 6). The plant has been installed to produce drinking water, without the use of chemicals, for the island's inhabitants.

For further information, visit:  
[www.ide-tech.com](http://www.ide-tech.com)

## KMU supplies MBR system for US water reclamation facility

**K**ubota Membrane USA Corp (KMU) is supplying a membrane bioreactor (MBR) system for the Big Creek Water Reclamation Facility, owned by Fulton County, Georgia.

KMU, a member of the Kubota family of companies that provides MBR systems for municipal and industrial clients, recently signed an agreement to supply the system and related equipment for the facility, which will have a capacity of 121 130 m<sup>3</sup> (32 million gallons) per day. According to KMU, the facility will be one of the largest in North America when it comes on stream.

Commenting on the agreement, David Clark, Director of Public Works, Fulton County, said:

'The Big Creek facility is located in Roswell Georgia, serves approximately 50 000 wastewater customers in North Fulton County and is in one of the fastest growing areas in the Atlanta region.'

'Fulton County has been a strong proponent and user of membrane technology for over 12 years and believes that it is the best option for returning treated effluent back to the river system in a responsible manner for use by our downstream water neighbours. Kubota's recent advancements in flat-plate technology will allow for easier maintenance of the system, whilst enabling it to perform at peak levels.'

KMU says that it was selected to supply the MBR system after a rigorous evaluation process – involving three other manufacturers – which looked at multiple factors, such as life-cycle costs, ease of operation, and maintenance and warranty support.

This project, which marks KMU's second plant in North America of 30 million gallons per day, or larger, is scheduled to be completed in 2024.

For further information, visit:  
<https://kubota-membrane.com>

## UHP RO achieves high water recovery in Southeast Asia

**C**anada's Saltworks Technologies Inc has provided details of another recent application of its ultra-high pressure reverse osmosis (UHP RO) technology, in which it has been used to treat wastewater from a complex manufacturing process in Southeast Asia.

In 2020 we reported on the firm's first commercial order for its next-generation UHP RO industrial system which was being used by a US manufacturer of advanced materials, enabling it to achieve a substantial reduction in disposal volume, whilst recovering clean water for reuse (*Membrane Technology*, July 2020, page 1).

According to Saltworks, which develops technology for industrial desalination, brine treatment and zero liquid discharge, in a more recent application – in Southeast Asia – the plant operated continuously around-the-clock for 90 days, achieving high water recovery from a complex, mixed industrial wastewater with high organics and variable water chemistry.

The pilot plant crossed the Pacific Ocean with a quick turnaround after its cooling tower blowdown trial at an agrichemicals facility – for which Saltworks is now designing and building a full-scale, permanent installation.

The company's pilot team operated the plant both on-site and remotely despite the ongoing international challenges of the COVID-19 pandemic.

High-performance PRO-XP1 spiral-wound membranes from Hydranautics, a membrane technology company that is part of Japan's Nitto Group, were once again employed to great effect, as well as Saltworks' advanced process technologies that enabled the membranes to perform BrineRefine, XtremeUF, ScaleSense and XtremeRO.

The system treated variable water quality originating from multiple streams – consistently achieving 98% recovery and concentrating a sodium sulphate-rich brine to over 200 000 mg/l total dissolved solids. The 2% brine volume is small enough such that direct solidification becomes viable, avoiding the need to use an energy intensive evaporator-crystalliser.

For further information, visit:  
[www.saltworkstech.com](http://www.saltworkstech.com),  
[www.membranes.com](http://www.membranes.com) &  
[www.nitto.com](http://www.nitto.com)

## 3M joins Water Resilience Coalition

**U**S company 3M Co recently announced that it is joining the Water Resilience Coalition (WRC).

By joining the WRC leadership committee and endorsing the United Nations Global Compact's CEO Water Mandate, it will be working to preserve the world's fresh-water resources and achieve a net positive water impact. It also will be better positioned to advance its ongoing work to improve the environment and build a brighter future around the world.

'3M is proactively applying its science and innovation to improve the water supply used in its operations and the communities we serve,' said Mike Roman, CEO, 3M.

'We are committed to sharing our expertise on global water solutions, and our participation in the WRC will expand and amplify our efforts.'

Jason Morrison, President, Pacific Institute and head of the CEO Water Mandate, added: '3M's expertise in science and creative solutions finds a significant space of opportunity in the CEO Water Mandate.'

'Additionally, by being a part of the leadership committee of the WRC, it also joins a leading platform on water for businesses that are elevating their ambition and accelerating results through collective action on water.'

3M is planning to invest \$1 billion over the next 20 years to achieve its environmental goals, including a commitment to install advanced purification technology at its largest water-using facilities by the end of 2023 and be fully operational by the end of 2024.

The WRC brings together some of the biggest companies in the world to help preserve the world's fresh-water resources. Led by the CEO Water Mandate, an initiative of the UN Global Compact, coalition members commit to having a positive impact in water stressed basins, to develop and implement resilient practices across their industry, and to provide leadership and advocacy in the field of water resilience.

As a special initiative of the UN Secretary-General, the United Nations Global Compact is a call to companies everywhere to align their operations and strategies with principles in the areas of human rights, labour, environment and anti-corruption.

For further information, visit:  
[www.3M.com/sustainability](http://www.3M.com/sustainability),  
<https://ceowatermandate.org/resilience> &  
[www.unglobalcompact.org](http://www.unglobalcompact.org)

# Osmoflo plays major role in mine's rehabilitation programme

Edited by Simon Atkinson

**In Australia, Osmoflo recently commissioned a plant for treating intermediate brine solutions as part of a mine's rehabilitation programme. Installed at Energy Resources of Australia Ltd's Ranger mine site in the Northern Territory, the plant – which helps to maximise the conversion of contaminated wastewater into water suitable for release into the environment – has now moved into the long-term operational phase, following rigorous testing, says the Adelaide-based desalination and water treatment company. Here we look at this facility, but also briefly mention another project in the mining sector in which the firm has been involved recently.**

In 2018, Energy Resources of Australia Ltd (ERA) engaged Osmoflo to deliver its patented Osmoflo Brine Squeezer (OBS) to treat concentrate brine from existing desalination plants operated by ERA at its Ranger mine, as part of the site's closure and rehabilitation programme (*Membrane Technology*, June 2018, pages 6–7).

The Ranger mine – located 8 km (5 miles) east of Jabiru and 260 km (162 miles) south-east of Darwin, in the Northern Territory – was Australia's longest producing uranium mine.

Processing ceased in January 2021. Over the 40 years of production at Ranger, ERA produced in excess of 132 000 tonnes of uranium oxide for the global nuclear energy market.

## Rigorous testing

The OBS treatment plant was required to undergo an intensive and rigorous testing process – including a three-month continuous performance trial – to demonstrate full compliance with all operational and process key performance indicators (KPIs).

Osmoflo announced recently that it has successfully completed commissioning of the plant and in June 2021 it moved into the long-term operational phase.

The company installed the OBS plant, with a capacity of 3000 m<sup>3</sup> (around 792 500 gallons) per day, at the mine to help maximise the conversion of contaminated wastewater into water suitable for environmental release, as part of rehabilitation activities being undertaken by ERA.

## Major installation

Inoue Takayuki, Managing Director & CEO, Osmoflo, says that the company is delighted to continue its work at the Ranger mine site.

He said: 'This project is a significant OBS installation for both Osmoflo and ERA. It is the third major installation undertaken



Aerial photograph of the Ranger mine site (photograph courtesy of Osmoflo).

by Osmoflo at Ranger since 2008, with the continued relationship illustrating ERA's trust in Osmoflo's tailored water treatment technologies.'

## Pilot studies

In partnership with ERA, Osmoflo conducted extensive pilot studies, prior to being awarded the contract, to ensure the right system was delivered to ERA to solve its unique water requirements.

Construction of the OBS plant was completed at the end of 2020, followed by a successful performance trial lasting 90 days.

Neil Palmer, Chief Technology Officer, Osmoflo, commented: 'No two brines are the same in terms of chemical composition and other parameters. The pilot trial undertaken by Osmoflo as part of our project delivery was critical in establishing the final design and effective operating regime of the OBS plant for ERA.'

'Successful commissioning of the OBS plant is a demonstration of Osmoflo's ability to

solve "difficult to treat" water challenges. The Ranger OBS is similar to the Leewood plant that Osmoflo installed for Santos, which is used to reduce brine volumes produced by the coal seam gas (CSG) industry.'

Osmoflo's contract also includes operation and maintenance of the OBS plant, which is expected to run until all processing and major rehabilitation activities cease at the site.

## Patented technology

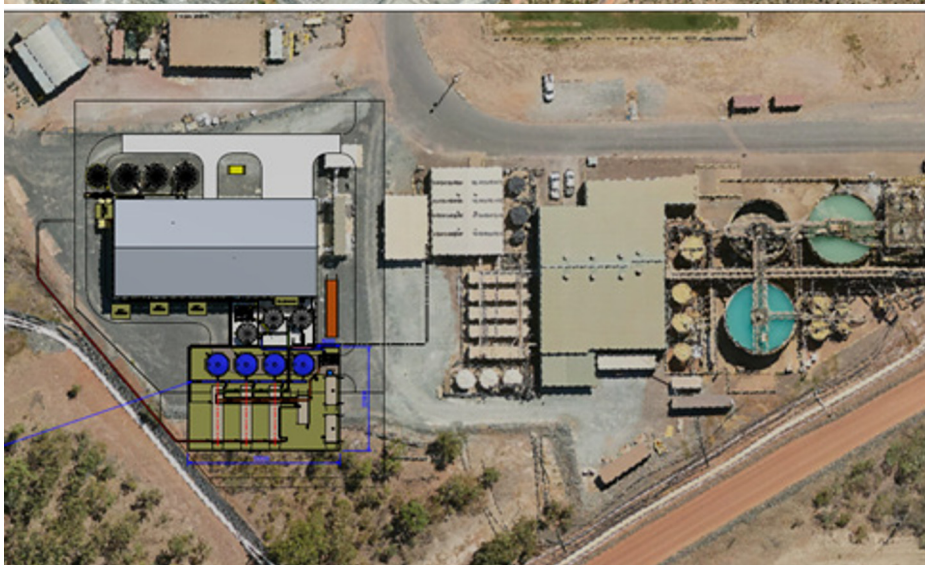
Osmoflo's patented OBS technology further concentrates reject water (also called brine) from conventional reverse osmosis water treatment plants.

The OBS can achieve overall recoveries of up to 95%, depending on feed-water quality, and it is particularly applicable in instances where brine volume must be minimised.

The technology includes the use of proprietary membranes and effective use of anti-scalants and cleaning regimes.

Combined with advanced automation and





Aerial photograph of the Osmoflo Brine Squeezer (OBS) plant at the Ranger mine site (top) – the OBS system is housed in the buildings seen at the lowest point in the image. The layout of the OBS upgrade (bottom) (photograph courtesy of Osmoflo).



Inside the Osmoflo Brine Squeezer (OBS) plant at the Ranger mine site (photograph courtesy of Osmoflo).

machine learning, to continuously adjust operating parameters, the OBS can provide a lower cost way of dealing with brine, compared with alternative technologies, such as thermal processes and evaporation ponds, says Osmoflo.

Bench-scale tests followed by on-site pilot trials are required before implementing a full-scale OBS system and are used to tailor the design and Osmoflo's operational requirements, in order to meet the individual chemical composition of the feed brine.

The OBS is delivered to clients by Osmoflo as a complete water treatment service, including operation and maintenance of the OBS plant.

For further information, visit:

[www.osmoflo.com](http://www.osmoflo.com)

(This technology focus is based on press material issued by Osmoflo.)

## Desalination at an iron ore mine

In addition to the OBS treatment plant discussed in this article, in 2018 Osmoflo was also awarded a contract covering the delivery and long-term operation of a major desalination plant for Roy Hill Holdings Pty Ltd – an integrated iron ore mining, rail and port operation located in the Pilbara region of Western Australia (*Membrane Technology*, June 2018, pages 6–7).

In 2019, Osmoflo received a 'Practical Completion Certificate' for the successful delivery of the desalination plant for Roy Hill Iron Ore Pty Ltd (*Membrane Technology*, September 2019, pages 2–3).

## Bore water

The engineering, procurement and construction contract involved the delivery of a desalination and blended water treatment plant at the mine site, with capacity up to 20 million litres (about 5.3 million gallons) a day.

The plant treats bore water to produce treated water that is suitable for use by Roy Hill's processing plant. Osmoflo also provided the subsequent operational, maintenance and whole-of-life asset management of the facility for the life of the mine.

According to Roy Hill Project Director Paul Laybourne, Osmoflo has delivered an important piece of infrastructure that will support the ongoing sustainability of the mining operation.



# Spacer patterns are printed directly onto membranes

Edited by Simon Atkinson

**A resin-based printing technology is being used to dramatically improve the efficiency of spiral-wound reverse osmosis membrane elements. The companies developing this technology say that the new approach eliminates the need for conventional plastic mesh feed spacers by printing unique spacer patterns directly onto delicate flat-sheet membrane materials – minimising fouling potential, and reducing capital and operational costs. Here, we briefly look at the process and the advantages it offers.**

Henkel Corp and Aqua Membranes are introducing what is described as revolutionary Printed Spacer Technology® for spiral-wound element design and manufacturing, as previously reported (*Membrane Technology*, October 2021 page 14).

The new technology eliminates the need for conventional plastic mesh feed spacers by printing unique spacer patterns directly onto delicate flat sheet membrane materials. These patterns have the potential to reduce fouling and scaling in the element and offer a more open water flow channel, which reduces energy consumption during the filtration process.

## Directly printed

‘Our new resin and process technology, coupled with Aqua Membranes’ print patterns, enables spiral-wound element producers to print directly onto the membrane, as well as print a variety of patterns and print heights over the entire surface area of a membrane leaf,’ explained Dan Oberle, Global Business Development Manager, Henkel.

‘With more open patterns, water flows more freely, reducing wasted energy. Printed feed spacers will produce more clean water, faster and at a lower cost than conventional spacer technology. We are confident this development will have a significant impact on the global water crisis.’

Conventional extruded plastic mesh spacers take up valuable space between membrane leaves. Their closed structure creates a demanding flow path that requires high pressure to move water through an element, which must be frequently cleaned because of fouling.

By printing feed spacer patterns directly onto a flat-sheet membrane, element manufacturers can reduce the thickness of each spacer, fitting more layers into the element. This expands available surface area inside the membrane element by 20–40%, thereby increasing the total permeate flow.



The automated system prints the feed spacer directly onto the flat-sheet web. In this image, three “1812 patterns” are printed side by side (photograph courtesy of Henkel).

## Reduced energy consumption

Alternatively, this new technology can radically reduce energy consumption by keeping larger gaps and more open flow channels, resulting in significantly lower pressure drop.

‘R&D engineers are realising that this design flexibility is a major value contributor,’ continued Oberle.

Craig Beckman, CEO, Aqua Membranes, added: ‘Unlike traditional membrane spacers that trap particles and biofilm within the mesh, and create high pressure drop, our 3D-printed spacers can optimise flow patterns and turbulence through the membrane element.’

‘This optimisation leads to lower energy consumption, a reduced system footprint, improved cleaning and potentially longer element service life. Printed feed spacers are superior to mesh spacers because they

lower the costs to buy, operate and expand these systems.’

Oberle concluded: ‘This technology is the result of many years of research and development work. The question has not been “why” printed spacers – but rather “how”. We now have a working solution that answers that question.’

**For further information, visit:**

[www.henkel-adhesives.com/us/en/industries/manufacturing/filtration.html](http://www.henkel-adhesives.com/us/en/industries/manufacturing/filtration.html) &

[https://aquamembranes.com/technology](http://https://aquamembranes.com/technology)

(This technology focus is based on press material issued by Henkel.)



Automated printing and verification methods ensure high quality, accuracy, repeatability – within automated element production speeds (photograph courtesy of Henkel).

# Comparison of ceramic $\alpha$ -alumina and modified $\gamma$ -alumina membranes for $H_2$ separation

Ifeyinwa Orakwe, Abubakar Alkali, Habiba Shehu and Edward Gobina (*corresponding author*), School of Engineering, Robert Gordon University, Aberdeen, Scotland, UK.

**This article provides details of a study that investigates hydrogen ( $H_2$ ) separation, purification and transport behaviour of a ceramic  $\alpha$ -alumina membrane and compares it with that of a  $\gamma$ -alumina membrane modified with Boehmite sol.**

The use of membrane technology in  $H_2$  separation and production processes is becoming an important and enabling approach to current global decarbonisation efforts that aim to combat climate change and ensure energy security.

Fully adopting  $H_2$  as the global energy carrier, to replace fossil fuels, is still “work in progress”. During the transition period – from fossil fuels to  $H_2$  – research into several  $H_2$  separation and purification processes is gaining increased attention.

Membrane technology offers several advantages in separation processes used to produce hydrogen, including energy efficiency and cost-effectiveness.

In addition, certain materials possess infinite selectivity to hydrogen, when defect free, for example, dense palladium membranes. The use of alumina membranes for  $H_2$  separation – which is discussed in this article – are thermally and chemically stable and can withstand harsh operating conditions.

## Permeation behaviour

The main purpose of the work described in this article is to investigate the hydrogen permeation behaviour of a commercial ceramic alumina membrane and compare this process with that of a  $\gamma$ -alumina ( $Al_2O_3$ ) membrane graded with a Boehmite ( $AlOOH$ ) sol, and fabricated using the dip-coating method.

The permeance of hydrogen and five other single gases ( $He$ ,  $N_2$ ,  $CH_4$ ,  $CO_2$  and  $Ar$ ) were investigated at high temperatures. Mixed gas permeation tests for a  $H_2$  gas mixture were also carried out.

The results show that the permeance of  $H_2$  increased with increasing temperature for the graded  $\gamma$ - $Al_2O_3$  membrane, whilst it decreased for the  $\alpha$ - $Al_2O_3$  support.

For the single-gas tests, the  $\alpha$ - $Al_2O_3$  support showed a higher permeance of up to  $9.45 \times 10^{-3} \text{ mol m}^{-2} \text{ s}^{-1} \text{ Pa}^{-1}$ , compared with  $1.03 \times 10^{-3} \text{ mol m}^{-2} \text{ s}^{-1} \text{ Pa}^{-1}$  for the  $\gamma$ - $Al_2O_3$  support, but the graded substrate was permeable to only  $H_2$  at the fifth coating.

The mixed-gas tests for a gas mixture ( $H_2 = 50\%$ ,  $CO = 28\%$ ,  $CO_2 = 10\%$ ,  $CH_4 = 8\%$  and  $N_2 = 4\%$ ) showed lower  $H_2$  permeance, which was attributed to the inhibition effect of  $CO_2$  in the gas mixture.

The  $H_2/N_2$  permselectivity for both membranes was lower than the theoretical Knudsen value of 3.73, which suggests a viscous flow transport mechanism.

## Experimental work

The experiment was carried out for a macroporous  $\alpha$ -alumina support, with a 30 nm pore size and inside diameter of 7 mm; outside diameter of 10 mm; and an effective length of 0.34 m.

Another 30 nm  $\alpha$ -alumina support was graded with  $AlOOH$  sol and converted to  $\gamma$ -alumina through five sequential dippings using the dip-coating method.

The objective was to investigate hydrogen permeation and selectivity at a high temperature, including the gas transport mechanisms.

The “tubes” were dried in an oven at  $65^\circ\text{C}$  for 2 hours in order to remove any water vapour or moisture, and sealed at both ends.

The modification of the  $\alpha$ - $Al_2O_3$  support was carried out through a multilayer deposition process using a dipping, drying and calcining method. After each dipping, the support was dried for 10 hours at  $65^\circ\text{C}$  and calcined at  $873 \text{ K}$  for 24 hours. Permeation tests were carried out using a membrane reactor module at  $298 \text{ K}$ ,  $323 \text{ K}$ ,  $373 \text{ K}$ ,  $473 \text{ K}$  and  $573 \text{ K}$ .

## Theoretical considerations

The permeance,  $F_0$  of gas through the multi-layered inorganic membrane is equal to the gas flux  $Q$  (that is, the gas flow-rate, divided by the membrane area  $A$ ) divided by the pressure drop  $P_1 - P_2$  across the membrane.

In the simplest approximation, the permeance is the sum of a viscous and Knudsen contribution, and can be described by **Equation 1**:

$$F_0 = F_{\text{Knudsen}} + F_{\text{viscous}} \left( \frac{\text{mol}}{\text{m}^2 \text{ s}} \right) \quad (1)$$

where  $F_{\text{Knudsen}}$  and  $F_{\text{viscous}}$  are the Knudsen and viscous contributions, respectively, and are defined by:

$$F_{\text{Knudsen}} = \frac{8r_p (P_1 - P_2)}{3\delta(2\pi MRT)^{1/2}} \left( \frac{\text{mol}}{\text{m}^2 \text{ s}} \right) \quad (2)$$

$$F_{\text{viscous}} = \frac{r_p^2 (P_1^2 - P_2^2)}{16\delta\mu RT} \left( \frac{\text{mol}}{\text{m}^2 \text{ s}} \right) \quad (3)$$

Substituting **Equations 2 & 3** into Equation 1 gives **Equation 4**:

$$F_0 = \frac{8r_p (P_1 - P_2)}{3\delta(2\pi MRT)^{1/2}} + \frac{r_p^2 (P_1^2 - P_2^2)}{16\delta\mu RT} \quad (4)$$

Equation 4 can be normalised to take into consideration the separating layer thickness. This is achieved by multiplying both the left-hand side and right-hand side of the equation by  $\delta/(P_1 - P_2)$  to give **Equation 5**:

$$\frac{F_0 \delta}{(P_1 - P_2)} = F_T = \frac{8r_p}{3(2\pi MRT)^{1/2}} + \frac{r_p^2 (P_1 + P_2)}{16\mu RT} \left( \frac{\text{mol m}}{\text{m}^2 \text{ s Pa}} \right) \quad (5)$$



where  $F_T$  is the normalised permeance or permeability of the multilayered membrane.

Equation 5 also can be written in the more convenient form of **Equation 6**:

$$F_T = \frac{8r_p}{3(2\pi MRT)^{1/2}} + \dots \quad (6)$$

$$\dots + \frac{r_p^2}{8\mu RT} \left( \frac{(P_1 + P_2)}{2} \right) \left( \frac{\text{molm}}{m^2 sPa} \right)$$

Equation 6 can be written in a more compact form as:

$$F_T = K_0 + B_0 P_{\text{Average}} \quad (7)$$

where:

$$K_0 = \frac{8r_p}{3(2\pi MRT)^{1/2}} \left( \frac{\text{mol}}{m^2 sPa} \right),$$

$$B_0 = \frac{r_p^2}{8\mu RT} \left( \frac{\text{molm}}{m^2 sPa^2} \right)$$

and

$$P_{\text{Average}} = \left( \frac{(P_1 + P_2)}{2} \right) (Pa)$$

**Equation 7** is a straight line of  $F_T$  is plotted against  $P_{\text{Average}}$ , resulting in a slope equal to  $B_0$  and an intercept on the  $F_T$  axis equal to  $K_0$ .

The nature of the straight line indicates the extent of the  $F_T$  relative contributions of viscous and Knudsen flow.

If the graph plotted is of the form  $F_T = B_0 P_{\text{Average}}$ , then the flow is characterised by viscous flow. If, however, the graph plotted is of the form  $F_T = B_0 P_{\text{Average}} + K_0$ , then both the Knudsen flow and viscous flow contribute to the transport characteristics.

Analysis of the intercept and the slope will then yield the values of  $K_0$  and  $B_0$ , which upon substitution into Equation 6 will enable estimation of the pore radius of the multilayered membrane.

Examination of Equations 2 & 3 shows that a number of possibilities exist.

(i) For Knudsen flow:

$$\frac{F_{0,A}}{F_{0,B}} = \sqrt{\frac{M_B}{M_A}} \quad (8)$$

(ii) For viscous flow:

$$\frac{F_{0,A}}{F_{0,B}} = \frac{\mu_B}{\mu_A} \quad (9)$$

The mean free path of a gas molecule is given by **Equation 10**:

$$\lambda = 2r_p \text{Knudsen coefficient (m)} \quad (10)$$

In Equation 7, both  $B_0$  and  $K_0$  depend on the membrane material characteristics, such as thickness of the separating layer, porosity, tortuosity and pore radius.

Temperature and type of gas also influence  $B_0$  and  $K_0$ , as described by **Equation 11**:

$$B_0 \sim 1/\mu T \text{ and } K_0 \sim 1/MT \quad (11)$$

where  $\mu$  is the viscosity,  $T$  the temperature and  $M$  the gas molecular weight.

The viscosities of most gases are relatively close to each other and, therefore, it is obvious that the gas separation will mainly depend on the difference in the molecular weight, and this will be determined by the Knudsen flow contribution of Equation 6, as shown in **Equation 8**, for a gas mixture containing components A and B.

Equation 7 is only a simple approximation, where the pressure difference is the driving force for gas transport through the multilayered membrane and does not consider other transport mechanisms, such as surface flow, multilayer diffusion, capillary condensation and molecular sieving.

However, it gives a good indication of the performance and quality of the membrane,

provided that the necessary precautions are observed before and during gas transport measurements.

## Results and discussion

**Figure 1** shows that  $H_2$  permeance increases with temperature, but decreases with the number of coatings, as more layers of the Boehmite sol were deposited.

This decrease in permeance conforms to the principle that the higher the membrane thickness, the higher the resistance to permeation and, therefore, the lower the permeance.

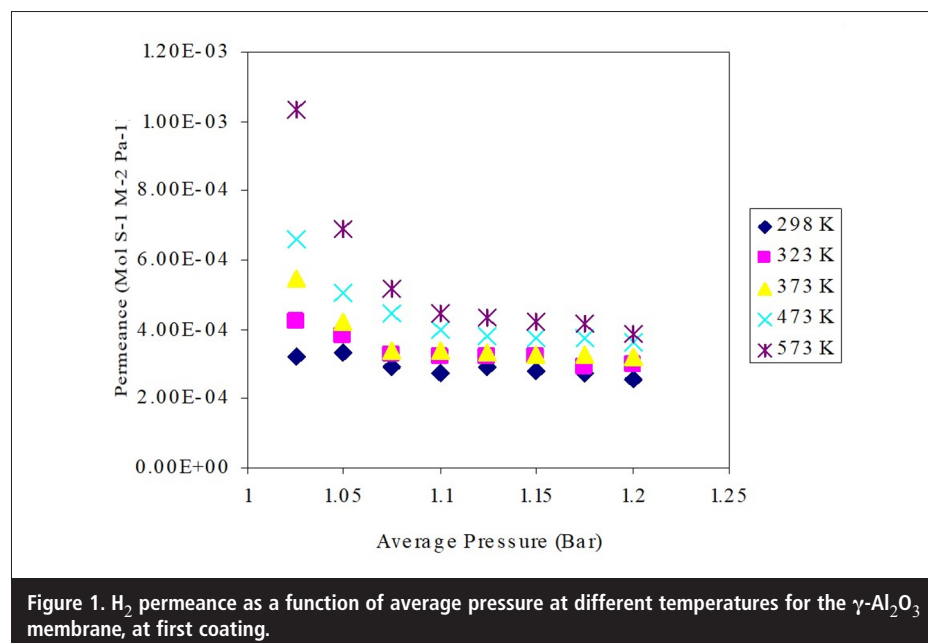
The  $\gamma\text{-Al}_2\text{O}_3$  substrate was only permeable to  $H_2$  at the fifth coating.

In **Figure 2** the decrease in  $H_2$  permeance, with increasing temperature for the  $\alpha\text{-Al}_2\text{O}_3$  support, indicates low mobility of the gas molecules in the pores. This suggests that surface adsorption was inversely proportional to temperature, hence a high temperature negates surface diffusion of hydrogen in the  $\alpha$ -alumina support, whilst a low temperature enhances it.

In **Figure 3**, the maximum  $H_2/N_2$  permselectivity of 3.07 was measured for the  $\gamma$ -alumina support, at 573 K, whilst in **Figure 4**, it was 2.9 for the  $\alpha$ -alumina support at 298 K, and both are lower than the Knudsen value of 3.73, which suggests the existence of the viscous flow mechanism.

The slightly higher  $H_2/N_2$  permselectivity of the  $\gamma$ -alumina substrate, at 3.07, indicates less dominance of viscous flow and more closeness to Knudsen diffusion.

The scanning electron microscope (SEM) image in **Figure 5** shows the  $\alpha\text{-Al}_2\text{O}_3$  structure, which is increasingly open and flowery,



**Figure 1.**  $H_2$  permeance as a function of average pressure at different temperatures for the  $\gamma\text{-Al}_2\text{O}_3$  membrane, at first coating.

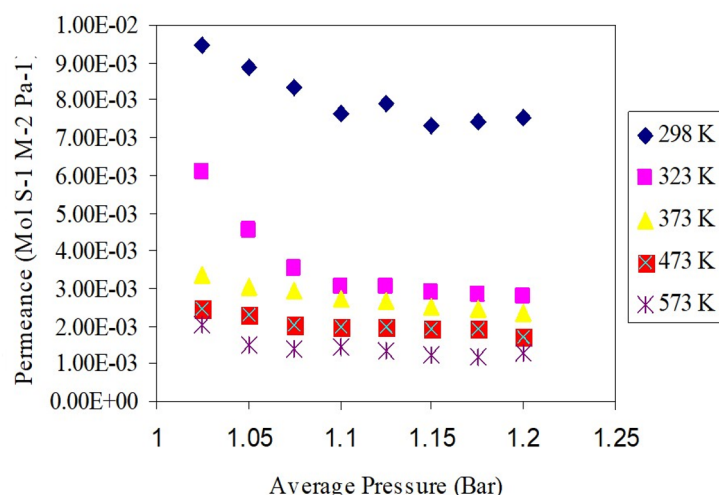


Figure 2.  $H_2$  permeance as a function of average pressure at different temperatures for the  $\alpha$ - $Al_2O_3$  membrane.

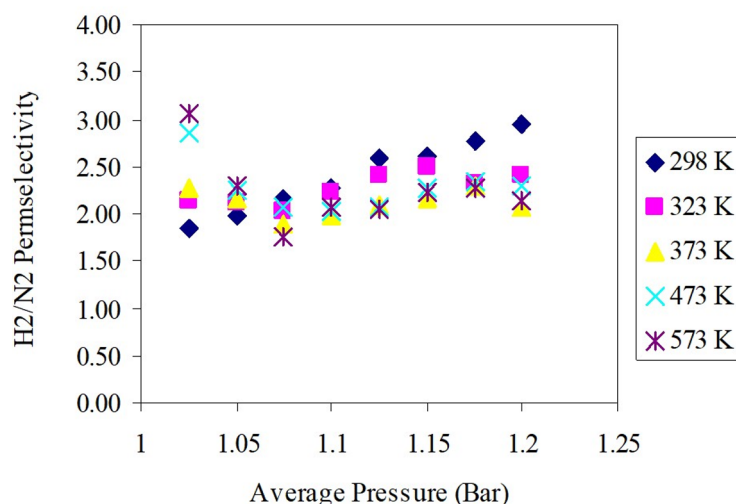


Figure 3.  $H_2/N_2$  permselectivity for the  $\gamma$ -alumina membrane at different temperatures.

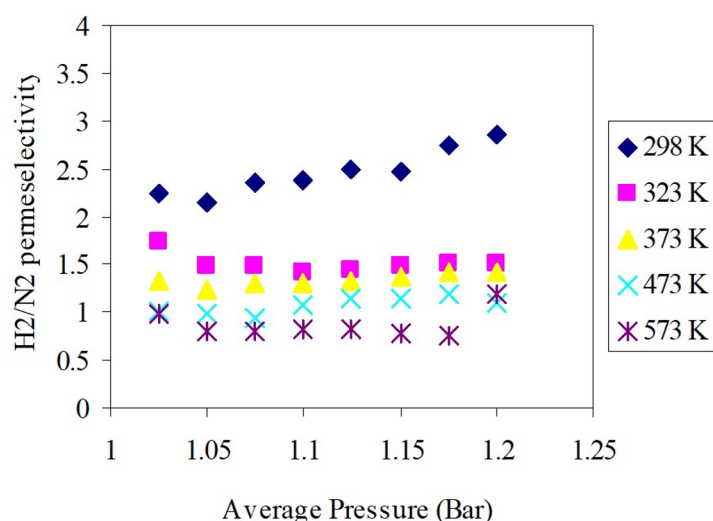


Figure 4.  $H_2/N_2$  permselectivity for the  $\alpha$ -alumina membrane at different temperatures.

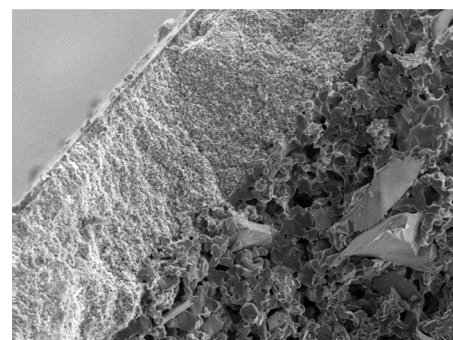


Figure 5. Scanning electron microscope image of a cross-sectional area of the macroporous  $\alpha$ -alumina support (1000 times resolution)

with more open pores layer-wise going from the top to the intermediate and inner areas.

## Conclusion

In this study, a commercial  $Al_2O_3$  support was graded with Boehmite sol using the dip-coating method and its hydrogen permeation behaviour and  $H_2/N_2$  permselectivity was investigated.

The results for the graded  $\gamma$ - $Al_2O_3$  substrate were compared with those of a macroporous  $\alpha$ - $Al_2O_3$  support. They show that  $H_2$  permeance increases with temperature for the  $\gamma$ - $Al_2O_3$  membrane, whilst it decreases for the  $\alpha$ - $Al_2O_3$  substrate.

The measured  $H_2/N_2$  separation ratios indicate a viscous flow mechanism.

## Acknowledgement

The authors sincerely thank Climate Change and Emissions Management Corp (CCEMC), Canada – now operating as Emissions Reduction Alberta (ERA) – and Petroleum Technology Development Fund (PTDF), Nigeria, for sponsorship of this research.

## Further reading

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*(This article is based on a paper entitled 'An investigation into the hydrogen separation, purification and transport behavior of a ceramic  $\alpha$ -alumina membrane and its comparison with a  $\gamma$ -alumina membrane modified with  $\text{AlOOH}$  sol', which was submitted to Membrane Technology newsletter by the corresponding author.)*

## membrane TECHNOLOGY

## PATENTS

### Explosion-proof membrane for power-battery

**Applicant: Panasian Microvent Tech (Jiangsu) Corp, China**

A breathable explosion-proof membrane for a power-battery explosion-proof valve, and a method of manufacturing it, are described by this patent. The explosion-proof membrane is formed from a porous, waterproof, breathable polytetrafluoroethylene (PTFE) material. The surface of each micron-sized PTFE suspension resin microsphere is melted, and they are connected to one another so as to be stacked into a microporous membrane having multiple air-permeable ducts. The air permeability is adjusted by controlling the pore size and the porosity of the explosion-proof membrane, so that balancing the internal and external pressure of a battery pack is achieved. The method for manufacturing the membrane involves evenly mixing a modified PTFE suspension resin or/and a pore-forming agent and moulding this mixture to into a blank. This is followed by a sintering process, cooling and then subjecting the material to a winding or turning process. The membrane is capable of controlling an explosion, should the battery pack be punctured, because the internal pressure and the external pressure of the battery pack can be balanced.

**Patent number:** WO/2020/215637

**Inventors:** Y. Zhang, B. Li, Y. Chen and R. Ding

**Publication date:** 29 October 2020

### Systems for inserting a nanopore in a membrane using osmotic imbalance

**Applicants: F. Hoffmann-La Roche Ag, Switzerland; Roche Diagnostics GmbH, Germany; and Roche Sequencing Solutions Inc, USA**

Systems and methods for inserting a nanopore into a membrane covering a well are described by this patent. By establishing an osmotic

gradient across the membrane it can be bowed outwards in order to drive fluid into the well, which will increase the amount of fluid in the well. Nanopore insertion then can be initiated on the bowed membrane. The aim is to improve the ability to insert pores into membranes and enhance the yield of cells.

**Patent number:** WO/2020/216885

**Inventors:** G. Barrall, A. Bhat, M. Dorwart, J. Komadina, G. Carman, H. Kallewaard-Lum, K. Umeda, W. Jung and Y. Wang

**Publication date:** 29 October 2020

### Electrohydraulic devices and batteries

**Applicant: Cornell University, USA**

This disclosure provides details of an electrohydraulic device. It includes a battery with a vessel containing an electrolyte. The battery may be a flow cell battery – for example, a redox flow cell battery. In such a battery electrolyte that is capable of flowing may be a catholyte and/or an anolyte. An actuator, in contact (or as the patent describes “fluidic communication”) with the vessel, is configured to operate using the electrolyte. A cation exchange membrane separates the vessel into an anolyte side and a catholyte side. The actuator may be in contact with either side (anolyte or catholyte) of the vessel.

**Patent number:** WO/2020/219780

**Inventors:** R.F. Shepherd and J. Pikul

**Publication date:** 29 October 2020

### Composite nanofibre membrane

**Applicant: Southwest Petroleum University, China**

The abstract of this patent discusses a composite nanofibre membrane comprising  $\beta$ -phase Fe(III) oxyhydroxides ( $\beta$ -FeOOH) and polyacrylonitrile, and a method for preparing and using it. The method for producing the membrane involves a series of steps. A polyacrylonitrile nanofibre membrane is initially prepared by means of electrostatic spinning, and is stabilised by subjecting it to gradient heat treatment. A subsequent step requires the use of a biomineralisation treatment process. The stabilised polyacrylonitrile nanofibre membrane is placed into a mixed solution of ferric chloride and hydrochloric acid (at a volume

ratio of 2 : 1). This is stirred for 1–3 min and then allowed to react at 55–65°C for 10–14 h. The resulting  $\beta$ -FeOOH/polyacrylonitrile composite nanofibre membrane is then cleaned and dried. According to the inventors, the membrane has enhanced stability and mechanical properties, and also has super-hydrophilic and super-oleophobic properties, and high adsorption efficiency. In addition, the membrane can be recycled.

**Patent number:** WO/2020/221286

**Inventors:** Y. He, L. Zhang, Y. Fan, L. Ma, H. Shi, S. Li, F. Zhong and Z. Li

**Publication date:** 5 November 2020

### Membrane filter for whole blood treatment

**Applicant: Lansion Biotechnology Co Ltd, China**

A whole-blood filtration method and a membrane-based filter for carrying out this process are described by this patent. According to the abstract, the method specifically involves a series of steps. In the first, a filter structure is selected. It is formed by stacking at least two layers of filter membranes from top to bottom in sequence, and performing red blood cell agglutinin treatment on the structure to make it ready for future use. In the second and third steps, respectively, a whole-blood sample is added to the filter membrane structure for filtration; and the filtered serum or plasma is collected. In forming the structure, the pore diameters of the stacked membranes gradually decrease from top to bottom and their areas gradually increase or are equal. Red blood cells, in the whole-blood sample, are combined with the red blood cell agglutinin in the filter membranes and are trapped in the structure, thereby ensuring that the red blood cells are completely filtered and adsorbed on the filter membrane structure. In this way, plasma/serum can be effectively and stably separated from a small volume of blood.

**Patent number:** WO/2020/220157

**Inventors:** X. Xu, J. Chen and P. Yu

**Publication date:** 5 November 2020

[www.markallengroup.com/brands/membrane-technology](http://www.markallengroup.com/brands/membrane-technology)

## Zero discharge water treatment apparatus

**Applicant:** Zero Discharge LLC, USA

A wastewater management system is described by this patent. It includes a series of holding tanks, in combination with a membrane bio-reactor treatment subsystem connected to one or more autoclaves and/or sonolysis units and thermal evaporators to treat liquid discharge from the system. A condenser, connected to the thermal evaporators “converts” water vapour (created by the evaporators) into its liquid state for delivery to, and assimilation by, plants in a dedicated greenhouse, hydroponic system or for reuse in a building. Carbon dioxide (CO<sub>2</sub>) and water vapour produced by combustion of a thermal evaporator fuel source is sent through the condenser to add to the liquid water recovery. The CO<sub>2</sub> is conveyed to the greenhouses for carbon fixation by plants. A CO<sub>2</sub> monitoring system ensures that the concentration of CO<sub>2</sub> in the greenhouse is maintained at an acceptable level for humans. Ozonation, ultra-violet and/or chloride also may be used for optional water purification treatment within the system.

**Patent number:** WO/2020/223366

**Inventors:** D.D. Calhoun, M.D. Lorusso and E.R. Rose

**Publication date:** 5 November 2020

## Zeolite membrane composite and method for producing it

**Applicant:** Hitachi Zosen Corp, Japan

This invention relates to a zeolite membrane composite. Used for separating a mixture, it has a high separation coefficient whilst maintaining a practical permeation flow rate. It also can be produced easily. The composite comprises a porous support and a zeolite membrane of an alumino-silicate. The membrane is formed on the surface of the porous support, and possess a framework density of 10–17. The Si/Al molar ratio of the zeolite membrane surface is at least 5, and the ratio ( $A_e/A_0$ ) of a developed membrane area  $A_e$  (considering the surface irregularities of the zeolite membrane) to an apparent membrane area  $A_0$  (not considering the surface irregularities of the zeolite membrane) is 2–20.

**Patent number:** WO/2020/226097

**Inventors:** K. Kida and S. Masaka

**Publication date:** 12 November 2020

## Conversion of carbonate into syngas

**Applicant:** The Governing Council of the University of Toronto, Canada

Various techniques are described by this patent for converting carbonate in a carbonate-loaded

solution into syngas or C2+ products. The process involves an electrolysis cell that includes cathodic and anodic compartments, and preferably a bipolar membrane separating the compartments. Carbonate ions are converted *in situ* by reaction with protons generated by the bipolar membrane to produce CO<sub>2</sub> which, in turn, is electro-catalytically converted into the product. The electrolysis cell can be coupled to an air- or flue-gas capture system that produces the carbonate-loaded solution, and the depleted solution released by the electrolysis cell can be recycled and channelled to the capture system and the feed of the electrolysis cell. The cathode includes a porous substrate that is hydrophilic, and a catalyst metal deposited on the substrate may be copper, silver or an alloy, depending on the target product.

**Patent number:** WO/2020/223804

**Inventors:** C. Li, G. Lee and E. Sargent

**Publication date:** 12 November 2020

## Hydrophilic non-woven nanofibre membrane

**Applicants:** Nanomateriales y Polímeros SL, Spain; and Universidad De Granada, Spain

This invention relates to a hydrophilic non-woven nanofibre membrane based on acrylate and methacrylate copolymers, and to the process of preparing it. Furthermore, the invention refers to its hydrolysed form, further functionalised with a divalent cation selected from Zn<sup>+2</sup>, Ca<sup>+2</sup>, Mg<sup>+2</sup> and Sr<sup>+2</sup>, an antibacterial agent and to any combination of these.

**Patent number:** WO/2020/224960

**Inventors:** M. Toledano Pérez, R. Osorio Ruiz and A.L. Medina Castillo

**Publication date:** 12 November 2020

## Method for preparing a T-type zeolite molecular sieve membrane

**Applicant:** Dalian University of Technology, China

A method for preparing a T-type zeolite molecular sieve membrane forms the subject of this patent. The patent's abstract describes a gel method for preparing the membrane. A carrier structure is coated with crystals and is then wetted and air-dried. A certain proportion of gel synthetic liquid is coated on the surface of the carrier and crystallised at a high temperature to produce the T-type zeolite molecular sieve membrane. It has excellent performance for isopropanol–water and ethanol–water separation, and has good time dependency, say the inventors. In addition, the experimental equipment described is simple to use and easy to operate, repeatability is high, and fewer raw materials are consumed – which reflects the concept of green chemistry.

**Patent number:** WO/2020/224275

**Inventors:** J. Yang, Y. Lu, G. He, J. Lu and Y. Zhang

**Publication date:** 12 November 2020

## Membrane reformer

**Applicant:** Karlsruher Institut für Technologie, Germany

This invention concerns a membrane reformer for generating hydrogen. This design includes a first cavity (or pre-reforming zone, that is, a prereaction area without a membrane) with a catalyst and an inlet for a gaseous starting material capable of being dehydrogenated (preferably together with steam), and in which the generation of hydrogen and at least one further reaction product is carried out. This is followed by a second cavity – downstream of the first (preferably with a catalyst corresponding to that of the first cavity) – in which the generation of hydrogen and at least one further reaction product, with simultaneous separation of the generated hydrogen, is continued using a membrane, and is introduced into a third cavity, with an outlet for hydrogen. The membrane reformer is made from a plate stack with multiple individual plates on both sides of the one membrane, and the cavities are produced by means of depressions, or perforations, in at least one respective plate.

**Patent number:** WO/2020/228982

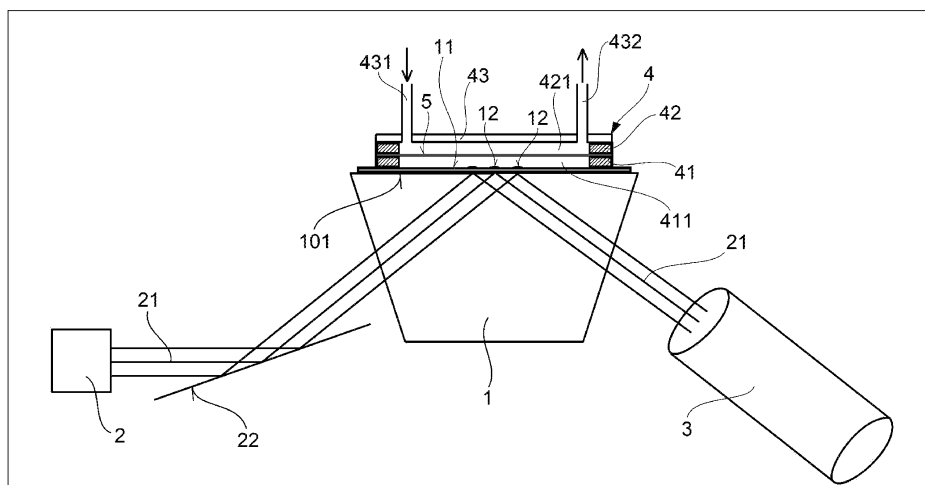
**Inventors:** P. Pfeifer, T. Böltken, R. Dürrschnabel, R. Dittmeyer, E. Hansjosten, T. Gietzelt, T. Wunsch and F. Dallmann

**Publication date:** 19 November 2020

## Apparatus for measuring the permeability of membranes

**Applicant:** Technical University of Ostrava, Czech Republic

An apparatus for measuring the permeability of membranes (5) has been developed and is discussed by this patent. It incorporates an optical prism (1), on the face (101) of which a metal coating (11) is applied that is provided with at least one “detection spot” (12). Outside of the body of the optical prism, a source (2) of electromagnetic beams (21), a mirror (22) and a sensor (3) are arranged, with respect to one another, in such a manner that after reflection from the mirror (22), the beams emitted by the source (2) pass through the body of the optical prism (1) towards its face (101) and, after reflection from the metal coating (11), fall on the receiving area of the sensor (3). On the metal coating (11), a measuring cell (4) is arranged that consists of a detection member (41), which abuts the surface of the metal coating (11); a flow-through member (42); and a pressure module (43). The detection member



An overall schematic cross-section of the apparatus for measuring the permeability of membranes that is detailed by patent WO/2020/228871.

and flow-through member are formed in the shape of frames, between which at least one membrane (5) is placed, and where the detection member (41) is provided with at least one cut, the geometry of which determines the perpendicular projection of the effective area of the membrane (5) on the area of the face (101) of the prism. The flow-through member (42) is provided with a window, thereby forming in the measuring cell (4) – after assembling the apparatus – at least one measuring chamber (411) and one gas-tight flow-through chamber (421), separated from one another by the measured membrane (5). Each measuring chamber (411) is arranged above at least one detection spot (12), and the pressure module (43), which closes the flow-through chamber, is provided with an inlet channel (431) and an outlet channel (432), which are situated above the peripheral regions of the flow-through chamber (421).

*Patent number:* WO/2020/228871

*Inventors:* M. Vrablova and I. Koutnik

*Publication date:* 19 November 2020

### Efficient impurity removal using a diafiltration process

*Applicant:* Janssen Biotech Inc, USA

This patent provides details of a method for purifying a viral vector from a solution including the viral vector and host cell proteins (HCPs). The method involves circulating the solution across an ultrafiltration or diafiltration membrane, in tangential-flow filtration mode, at a loading of between and 100 litres of bioreactor harvest per square metre of surface area of the membrane used, and under a pulsatile flow with a frequency of 1.66–50 Hz and an amplitude of 2–25%, whilst continuously adding diafiltration buffer. The method further involves filtering the solution across the membrane to provide permeate and retentate,

and collecting the latter, such that a purified viral vector solution is obtained. A volume of the retentate is kept constant by the continuous addition of diafiltration buffer. The viral vector is retained in the retentate. The HCP is filtered out via the permeate, and the reduction of HCP from the solution is between 1.5 log and 4.3 log.

*Patent number:* WO/2020/229906

*Inventors:* H.-F. Ko, R. Bhatia, S.M.

Krishnathu, V. Yannone, J.E. Landau, B. Diepenbroek, G.B. Erkens, E. Meulenbroek and F.N. Alazi

*Publication date:* 19 November 2020

### Producing hydrogen and oxygen from contaminated water

*Applicant:* Paragon Space

*Development Corp, USA*

This disclosure describes an integrated system and method for producing purified water, hydrogen and oxygen from contaminated water. The contaminated water may be derived from regolith-based resources on the Moon, Mars, near-Earth asteroids, or other destinations in outer space. The system and method use a cold trap to receive the contaminated water in a vapour phase and selectively freeze out water from one or more volatiles. A heat source increases the temperature in the cold trap to vaporise the frozen contaminated water to produce a gas stream of water vapour and volatiles. A chemical scrubber may be used to remove one or more volatiles. The integrated system uses ionomer membrane technology to separate the remaining volatiles from water vapour, which is delivered for crew use or delivered to an electrolyser to produce hydrogen and oxygen.

*Patent number:* WO/2020/231694

*Inventors:* B.W. Finger, L.K. Kelsey and C.E. Bower

*Publication date:* 19 November 2020

### Durable graphene oxide membranes

*Applicant:* VIA Separations Inc, USA

Embodiments of this invention relate generally to durable graphene oxide membranes for fluid filtration. For example, these membranes can be durable under high temperatures, non-neutral pH, and/or high pressure. One aspect of this disclosure relates to a filtration apparatus comprising a support substrate, on which is disposed a graphene oxide membrane. The membrane has a first lactose rejection rate of at least 50%, with a first 1 wt% lactose solution at room temperature. The graphene oxide membrane has a second lactose rejection rate of at least 50%, with a second 1 wt% lactose solution at room temperature after the graphene oxide membrane is contacted with a solution that is at a temperature of at least 80°C for a specific period.

*Patent number:* WO/2020/232398

*Inventors:* S. Frayne, M. Macleod, B.I.

MacDonald, L. Ortiz Rivera and B. Keller

*Publication date:* 19 November 2020

### Electrochemical system for low-energy and high-efficiency water desalination

*Applicant:* Nanyang Technological

*University, Singapore*

An electrode module for electrodialysis forms the subject of this patent. It comprises a substrate, and an array of electrodes arranged on the substrate. Each electrode is shaped as a planar sheet, with one forming a segment of the array of electrodes. The segments are arranged apart from one another, and each one has a different planar surface area. An electrodialysis system is also discussed. It is composed of one or more electrodialysis cells that comprise an anode electrically coupled to a cathode (with the anode and the cathode comprising the electrode module) and a cation-selective membrane arranged between the anode and the cathode to define concentrate and diluate channels. One pair of segments comprises a segment from the anode and another segment – of identical planar surface area – from the cathode. A method for controlling desalination efficiency in electrodialysis, involving the electrode module, is also discussed.

*Patent number:* WO/2020/231342

*Inventors:* W.J. Ng and E. Grygolowicz-Pawlak

*Publication date:* 19 November 2020

*These patent summaries are based on materials from the World Intellectual Property Organization's Patentscope database <https://patentscope.wipo.int>.*



## EVENTS CALENDAR

4–8 April 2022

**ACHEMA**

Frankfurt am Main

**Contact:** DECHEMA Ausstellungs-GmbH,  
Theodor-Heuss-Allee 25  
60486 Frankfurt am Main, Germany  
Tel: +49 69 7564 100,  
Email: [exhibition@dechema.de](mailto:exhibition@dechema.de),  
[www.achema.de/en](http://www.achema.de/en)

16–18 May 2022

**Global Water Summit 2022**

Madrid, Spain

**Contact:** Roxy Ali, Global Water Intelligence,  
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Email: [roxy.ali@globalwaterintel.com](mailto:roxy.ali@globalwaterintel.com),  
[www.watermeetsmoney.com](http://www.watermeetsmoney.com)

30 May to 3 June 2022

**IFAT 2022**

Munich, Germany

**Contact:** Messe München GmbH,  
Messegelände, 81823 München, Germany  
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Email: [info@ifat.de](mailto:info@ifat.de),  
Email: [exhibiting@ifat.de](mailto:exhibiting@ifat.de),  
[www.ifat.de/en](http://www.ifat.de/en)

2–3 June 2022

**SNMS 2021**

Tangier, Morocco

**Contact:** Professor Dr Saad Alami Younssi,

Moroccan Membrane and Desalination  
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University, Casablanca,  
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27–30 June 2022

**Nanofiltration 2022**

Reutlingen, Baden-Württemberg, Germany

**Contact:** Prof Dr Ing Andrea Iris Schäfer,  
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<https://nanofiltration2022.iamt.kit.edu/index.php>

12–14 July 2022

**American Membrane Technology  
Association (AMTA)/Southeast  
Desalting Association  
(SEDA) Joint Technology  
Transfer Workshop**

Durham, North Carolina, USA

**Contact:** Nicole Zimmerman, American  
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[www.amtaorg.com](http://www.amtaorg.com)

5–9 October 2022

**13th World Filtration  
Congress**

San Diego, California, USA

**Contact:** Deahna Cring, Conference  
Manager, American Filtrations and  
Separations Society (AFS), 529 Myatt Drive,  
Nashville, TN 37511, USA  
Tel: +1 615 345-9586,  
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[www.afssociety.org](http://www.afssociety.org)

15–19 January 2023

**13th IWA International  
Conference on Water  
Reclamation and Reuse**

Chennai, India

**Contact:** International Water  
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House, 12 Caxton Street,  
London SW1H 0QS, UK  
Tel: +44 207 654 5500,  
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<http://iwareuse2021.com>

...Continued from front page

The process produces chlorine, hydrogen and caustic soda by electrolysis of brine using ion-exchange membranes. It eliminates the need to use environmentally hazardous mercury or

asbestos as process materials and enables greater energy efficiency. The combination of low-voltage membranes and electrolysis alleviates the environmental burden by reducing power that is consumed by the electrolysis process.

For further information, visit:

[www.asahi-kasei.co.jp](http://www.asahi-kasei.co.jp) &  
[www.r2.ca](http://www.r2.ca)

[www.markallengroup.com/brands/membrane-technology](http://www.markallengroup.com/brands/membrane-technology)

## Evonik constructs new hollow-fibre spinning plant at its site in Schörfling, Austria

**German speciality chemicals company Evonik Industries Ag is building a new hollow-fibre spinning plant for the production of gas separation membranes at its site in Schörfling am Attersee, Austria.**

The company says that with the new capacity it aims to meet the strong demand for SEPURAN® membranes used in biogas, nitrogen, hydrogen and natural gas applications.

The new facility, which is scheduled to come on stream in the first quarter of 2023, is described as a “construction twin” of the production line that the company started up in late 2017 (*Membrane Technology*, November 2016,

pages 2–3 and January 2018, page 3). Around 30 new jobs will be created in Schörfling.

Dr Goetz Baumgarten, Vice President Membranes, Evonik, commented: ‘The gas separation market is convinced of our innovative membrane technology. Having developed and established the biogas industry in close cooperation with our partners, we are establishing our SEPURAN membranes as the new standard for efficient gas separation in demanding nitrogen, hydrogen and natural gas applications. The additional production capacities will secure our growth targets in these important markets for us.’

Dr Iordanis Savvopoulos, head of the

Fibres, Foams and Membranes Product Line, Evonik, added: ‘By expanding our capacities in Schörfling we are sending an important signal to our customers that Evonik believes in the markets in the future and will continue to support customers’ growth.’

‘The construction of the new hollow-fibre spinning plant also testifies to our clear ambition to become the market leader in membrane-based separation technologies in the coming years.’

For further information, visit:

[www.evonik.com](http://www.evonik.com) &  
[www.sepuran.com](http://www.sepuran.com)