MA Business

membrane TECHNOLOGY

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Swiss firm distributes Evonik's PuraMem organic solvent NF membranes in Europe

Modular Process Solutions AG (m-PS), a Swiss company that specialises in thermal separation and membrane filtration technologies, is now distributing, in Europe, PuraMem® organic solvent nanofiltration (NF) membranes developed by speciality chemicals company Evonik Industries.

The companies signed the distribution agreement to jointly grow the market for Evonik's PuraMem organic solvent NF (OSN) membranes earlier this year. Evonik says that m-PS will be the only distributor in the region of trial products of its PuraMem OSN membranes.

The agreement includes all A4 membrane flat-sheets and modules of sizes 1.8 × 12 inches and 2.5 × 12 inches (about 4.6 × 30 cm and 6.4 × 30 cm). Larger modules will be supplied by m-PS on a non-exclusive basis.

The PuraMem brand of silicone-coated composite membranes are used in processes such as the efficient recovery of valuable homogeneous catalysts, solvent recycling or gentle processing of natural oils.

In addition to high selectivity, the company's membrane technology offers the benefit of lower energy consumption, compared with conventional separation technologies.

m-PS started serving Evonik's customers at the beginning of July.

For further information, visit:
www.membrane-separation.com/en/organic-solvent-nanofiltration-with-puramem
www.evonik.com &
www.m-ps.ch

Israel's largest desalination plant Sorek B employs DuPont's FilmTec membranes

DuPont Water Solutions' (DWS) FilmTec™ membranes have been selected by IDE Water Technologies for sea-water reverse osmosis (SWRO) filtration at the Sorek B desalination plant in Israel.

The durability, rejection, energy efficiency and extremely long service life of the these membranes are expected to contribute to the lower long-term costs of the plant, says DuPont.

IDE Water Technologies, which specialises in the development, engineering, construction and operation of thermal and membrane desalination facilities and industrial water treatment plants, designed the plant to drive efficiency, environmental sustainability and achieve an exceptionally low water price.

The facility, which will have a capacity of 200 million m^3 (about 52 834 million gallons) per year will operate for 25 years. As the largest plant of its kind in Israel and one of the largest in the world, it is predicted to set a new benchmark for sea-water desalination water prices on a global scale.

DWS is providing SWRO membrane elements to the project site, including dry SWRO elements. It says that the dry SWRO membranes will give IDE and its project managers more flexibility and ease of installation.

As dry membranes do not require preservation solution, they can be stored for longer periods. They are also more sustainable, using less water and chemicals in production, and significantly reducing the carbon footprint of shipping.

HP Nanda, Global Vice President and General Manager, DWS, commented: 'As our industry works to solve global water chal-

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

NX Filtration's NF membranes treat wastewater in India

Dutch firm NX Filtration BV has received an order to supply nanofiltration membranes for use in a wastewater treatment plant in India.

Indian original equipment manufacturer Aquarius H_2O Dynamics Pvt Ltd, which focuses on wastewater treatment, has selected NX Filtration to supply its hollow-fibre direct nanofiltration (dNF) membranes for wastewater treatment at the common effluent treatment plant (CETP) in Jetpur, in the state of Gujarat.

NX Filtration, which develops membrane products for treating water, says that this is its second project with Aquarius H_2O Dynamics this year.

The system, based on 102 dNF40 membrane modules, will be used for the recovery of caustic from the water-intensive textile industries in Jetpur. Caustic is used for the purification of cellulosic fibres – removing hemicellulose and other impurities from the fibres – and for dyeing and printing operations.

The new membrane filtration system will enable CETP Jetpur to recover caustic from its wastewater streams for reuse in the textile manufacturing. This not only saves money, but it also reduces the treatment cost of caustic wastewater and ensures compliance with increasingly stringent discharge regulations.

Sandip Patel, MD, Aquarius H_2O Dynamics, commented: 'Earlier this year we piloted NX filtration's unique hollow-fibre nanofiltration membranes for various applications.'

The firm has already integrated its membranes into a facility for the industrial reuse of wastewater at the KKCL denim jeans company.

Patel continued: 'This new application, for the municipal recovery of caustic, marks an important step for the future of wastewater treatment in India.'

Manish Ghogle, Sales Manager, NX Filtration, India, added: 'We are proud of this further development of our relationship with Aquarius H_2O Dynamics.'

'Our innovative hollow-fibre direct nanofiltration membranes enable this simple and sustainable process of reusing wastewater. Compared with traditional wastewater treatment methods, it reduces the number of filtration steps, avoids the use of chemicals in the pretreatment of the wastewater and significantly reduces energy use.'

As reported earlier this year, dNF40 hollow-fibre NF modules are being used in a water treatment system at the Forsmark power plant in Sweden by multinational water treatment systems supplier ProMinent (*Membrane Technology*, April 2021, page 1).

Feed water is taken from a local, highly coloured lake – with temperatures close to 0°C in the winter – and goes through a simple one-step process that employs NF modules.

For further information, visit:
www.nxfiltration.com &
www.aquariush2odynamics.in

Asahi Kasei expands production capacity

Asahi Kasei Medical Co Ltd is expanding production capacity of hydrophilic, polyvinylidene fluoride (PVDF) hollow-fibre membranes for its Planova™ BioEX filters at its spinning plant in Oita, Japan.

The company is planning to double spinning production capacity at the site, with the expansion expected to start during the fourth quarter of 2022.

According to the company, the global COVID-19 pandemic has increased the urgent demand for these filters, which are indispensable in the development and mass-production of anti-coronavirus agents.

Six existing plants – including the spinning plant completed in 2019 in Miyazaki, Japan (*Membrane Technology*, November 2019, page 5) – that produce cellulose hollow-fibre membranes for the company's Planova N series filters have been operating efficiently and without any disruption to meet increasing demand worldwide, says the company.

For further information, visit:
www.asahi-kasei.co.jp/medical/en

Oxis acquisition helps JM scale up CCM production

In the UK, Johnson Matthey (JM) recently acquired the assets and intellectual property of Oxis Energy Ltd, based near Oxford, after the firm entered administration earlier this year.

JM, which focuses on speciality chemicals and sustainable technologies, says that with moderate additional investment in upgrades this transaction will significantly accelerate

the scale-up of its growing green hydrogen business.

Oxis Energy was a lithium–sulphur battery developer, with assets that can be adapted for the manufacture of components for green hydrogen production.

The acquisition will further expand JM's ability to develop, test and manufacture catalyst coated membranes (CCMs) and advanced materials for electrolysers, as this market continues to develop rapidly and in response to positive progress with customers.

The site will enable the production of tens of thousands of CCM parts per year – enough to equip hundreds of megawatts of electrolyser capacity, says JM.

In addition to accelerating green hydrogen scale-up, the acquisition of an IP portfolio of next-generation lithium–sulphur and adjacent battery technologies presents opportunities for JM's Battery Materials business in the development of future battery material technologies.

Eugene McKenna, who heads up JM's green hydrogen business, says that the acquisition of Oxis Energy's assets enables JM to support its customers as they meet the strong demand for proton exchange membrane electrolysers used to produce green hydrogen.

Improving electrolyser efficiency and reducing the cost of hydrogen are key to further development of the green hydrogen market, and scaling up CCM manufacturing will help bring JM and its customers closer to achieving this goal.

For further information, visit:
https://matthey.com

PWT and Genesys now operate as a single group

Canada's H_2O Innovation Inc's two speciality chemical businesses Professional Water Technologies (PWT) and Genesys now operate as a single group.

The combined structure – H_2O Innovation Specialty Chemicals Group – was formed in July and brings together the wealth of membrane knowledge that exists within both the PWT and Genesys sales, research and manufacturing teams.

H_2O Innovation says that it is increasing its sales force with the addition of new territory managers and its manufacturing capacity at its facility in Cheshire, UK. In addition, whilst both entities will continue to exist in this new group, and there will be no changes to the current product portfolio, the combined management structure will take advantage of the strengths of the leadership of Genesys and PWT.

H_2O Innovation, which designs and provides custom-built and integrated water treatment systems based on membrane filtration technology, for municipal, industrial, energy and natural resources end-users, had taken a 24% ownership stake in Genesys Membrane Products SL (GMP) through the acquisition of Genesys in the UK in November 2019 (*Membrane Technology*, November 2019, pages 1 & 14).

Earlier this year, it acquired the remaining 76% of the issued and outstanding shares in GMP, located in Madrid, Spain, from arm's length sellers, in a move, which it says, will help it focus on the growth of the technical, geographic and commercial scale of its speciality chemicals business lines (*Membrane Technology*, March 2021, page 1).

'This new structure will bring the wealth of membrane knowledge that exists within both the PWT and Genesys sales, research and manufacturing teams to all our customers. They will also have access to a wider range of chemical products and services,' commented Frédéric Dugré, President and CEO, H_2O Innovation.

A project is underway to expand H_2O Innovation's operations in Cheshire, which will nearly double the warehouse area, enabling the facility to manufacture PWT's dendrimer-based antiscalant, which will also continue to be manufactured in Vista, California, USA.

The project will also expand the capabilities of blending both Genesys and PWT powder products to better serve European and Asian costumers, reduce shipping delays and freight costs, and improve gross profit by insourcing its manufacturing.

Gregory Madden, Chief Strategy Officer, H_2O Innovation, explained: 'This project to expand our facility in the UK is a strategic move which reduces the risks associated with having a single point of manufacture for our dendrimer scale inhibitor.'

'It will also enable us to be more competitive on the products we sell, to have better quality control, enjoy better margins and to reduce our water footprint.'

'We are working towards being able to manufacture all products from Genesys and PWT in either of our two locations. By manufacturing and blending the right products in the right location we will optimise freight and tariff costs.'

For further information, visit:
www.h2oinnovation.com/specialty-products/genesys-pwt &
www.h2oinnovation.com

In Brief

De Nora completes major produced water recycling project

De Nora Neptune, Industrie De Nora SpA's primary service arm that specialises in recycled produced water systems and fracking water disinfection, has completed the first phase of its Delaware Basin Wastewater Recycling Project – achieving produced water rates exceeding 140 000 barrels per day. The project, which began in May, established four ClorTec Mobile Treatment Units along a network of simultaneous fracturing systems. This approach gives producers the ability to target areas of concern at any point in the upstream or midstream water utilisation cycle, tapping into existing pipelines or feeding directly off salt-water disposal wells. This reduces the reliance on fresh water for planned fracturing activity, whilst also eliminating the emissions traditionally required for the transportation of water. 'De Nora is leading the charge in produced water recycling,' commented Alex Gonzalez, President, De Nora Neptune.

Biwater awarded contract in Morocco

UK-based engineering company Biwater has been awarded a turnkey contract by the Millennium Challenge Account-Morocco Agency (MCA-Morocco) to design and construct a wastewater treatment facility in the Bouznika industrial zone, which is undergoing a significant extension in the Casablanca-Settat region of Morocco. The facility will provide pretreatment, biological treatment and advanced tertiary treatment of the wastewater for reuse applications. The company is continuing to expand its operations in Morocco, and under two new separate turnkey contracts, has commenced construction of new wastewater treatment facilites in the coastal towns of Moulay Bousselham (*Membrane Technology*, September 2021, page 3) and Tarfaya.

Evoqua expands its board of directors

Evoqua Water Technologies, which provides a range of water and wastewater treatment systems and technologies, and mobile and emergency water supply systems, has appointed Sherrese Clarke Soares to its board of directors. Soares will serve as an independent director. Ron Keating, CEO, Evoqua, commented: 'Sherrese is a seasoned financial services executive who brings extensive experience in corporate finance and investment banking.'

Ecolab opens healthcare advanced design centre

Ecolab Inc is opening the Ecolab Healthcare Advanced Design Center in Eagan, Minnesota, USA. The company, which specialises in technology that optimises water and energy use, and infection prevention products, says that the centre aims to drive innovation for the medical device industry.

Rabigh 3 produces its first permeate stream

Spain's Abengoa SA reports that it has obtained the first permeate, or desalinated water, from the Rabigh 3 desalination plant, which it is building in the city of Rabigh, in Saudi Arabia.

The engineering, procurement and construction contract for the facility, which will have a capacity of 600 000 m^3 (158.5 million gallons) per day, was awarded to a consortium of Abengoa, Chinese engineering and construction company SEPCOIII, and SIDEM (Veolia) in 2018.

The plant is scheduled to be commissioned in the first quarter of 2022, complying with the deadline agreed with ACWA Power, a major Saudi developer, investor and operator of power-generating and water desalination plants in 13 countries. It is also the majority owner of the Rabigh 3 plant.

When the project is completed, desalinated water will be supplied to state-owned Saudi Water Partnership Co.

According to Abengoa, which applies and develops technology for sustainability in the infrastructure, energy and water sectors, this is an important milestone during the operational tests that are part of the commissioning phase of the desalination plant, which is currently under construction, and represents a further step towards its commercial operation.

It says that the production of permeate at Rabigh 3 has been made possible through the good performance of the team involved in the facility's construction over the past year, and to their effort and commitment – overcoming adverse circumstances, such as those caused by the COVID-19 pandemic.

The desalination plant will supply drinking water to more than three million people in the cities of Makkah Al-Mokarramah, Jeddah and Mastorah.

Abengoa says that it is seen as an important reference in the desalination sector not only because it is one of the largest reverse osmosis (RO) desalination plants in Saudi Arabia to date, but also because it is an example of innovation and sustainability in its design and construction, which enables it to reduce energy consumption and increase plant availability.

The company recently completed the construction of the Salalah desalination plant in Oman, rated at 113 500 m^3 (about 30 million gallons) per day and continues to work on projects, including what it says is the world's largest RO desalination plant, located in the Taweelah water and power generation complex, north east of the city of Abu Dhabi, United Arab Emirates, with a production capacity of 909 000 m^3 (240.1 million gallons) per day.

It currently has an installed desalination capacity of 1.8 million m^3 (475.5 million gallons) per day, which will be expanded to 4.3 million (1135.9 million gallons) when the portfolio is completed.

For further information, visit:
www.abengoa.com

Petrobras FPSO platforms employ SUEZ membranes

SUEZ – Water Technologies & Solutions has been contracted as the exclusive supplier of membranes for use in sea-water sulphate removal (SWSR) systems on board 15 floating production, storage and offloading (FPSO) platforms.

The platforms, which are owned by Petróleo Brasileiro SA – better known as Petrobras – which operates in the petroleum sector, are located in the Campos, Búzios, Espírito Santo and Santos oil basins, off the coast of Brazil.

'Petrobras is a leader when it comes to deep-water offshore oil recovery,' commented Kevin Cassidy, Executive Vice President, Engineered Systems, SUEZ – Water Technologies & Solutions.

'We are proud that they continue to rely on our membranes to prevent scale in injection wells and to better mitigate well souring by reducing sulphate.'

This contract adds to SUEZ's long history of working closely with Petrobras for both onshore and offshore wastewater treatment applications. In 2019, the company selected SUEZ membrane technology to replace poor performing systems at two main refineries in the region.

SUEZ, which manufactures membranes and supplies them to the offshore oil and gas industry says that its SWSR series is designed to consistently produce high-quality water for injection in undersea oil reserves.

The nanofiltration (NF) membranes are recognised for their low fouling properties, ability to minimise strontium and barium sulphate scale, and better mitigate well souring. They also minimise operating pressure through high transmission of sodium chloride into the permeate, says the company.

Earlier this year, SUEZ supplied ultrafiltration (UF) and NF systems for a FPSO sea-water process plant (*Membrane Technology*, February 2021, page 4). The contract from MODEC Offshore Production Systems included project management services, procurement, construction supervision and delivery to MODEC's integration yard.

It involved designing and supplying the complete sea-water treatment plant, with a capacity of 23 000 m^3 (around 6.1 million gallons) per day, including coarse filtration, UF, NF and vacuum deoxygenation equipment. The site requires the plant to produce water with sulphate levels of less than 40 ppm.

For further information, visit:
www.suezwatertechnologies.com,
www.suez.com &
https://petrobras.com.br

Whitefox helps improve efficiency at Golden Grain Energy

In the USA, Golden Grain Energy Llc is installing membrane-based systems from Whitefox Technologies Ltd for improved energy use and to aid future expansion.

It is using a Whitefox (Integrated Cartridge Efficiency) ICE membrane dehydration unit at its plant in Iowa that produces 454.2 million litres (120 million gallons) of ethanol per year.

The facility, located in north central Iowa, is dedicated to adding value to the local community by turning locally grown corn into clean-burning ethanol and animal feed.

Gillian Harrison, CEO, Whitefox Technologies CEO, said: 'It is great to be working with the team at Golden Grain, and to help improve the company's already impressive operational efficiency.'

It is a long-time leader of the Iowa ethanol industry, and its chairman Dave Sovereign has been a real champion for the industry as a whole.'

'This installation will take Whitefox to over 150 million gallons per year of installed membrane capacity in the USA, which is an exciting milestone.'

Whitefox specialises in technology development and process integration based on its proprietary membranes. ICE is described as a bolt-on technology developed for the ethanol industry. With a small footprint, it is designed to "de-bottleneck" distillation and dehydration.

With a firm commitment to sustainable and energy-efficient ethanol production, Golden Grain was one of the first Midwest plants certified under California's Low Carbon Fuel Standard programme.

The plant has continued to take significant

steps through innovative technology and operations to increase its efficiency and lower its carbon intensity (CI) score. Installing Whitefox's energy-efficient membrane technology will further improve its efficiency and competitive advantage.

Chad Kuhlers, CEO, Golden Grain Energy, added: 'We have been in discussions with Whitefox and watching the technology continue to advance for a few years now, and we felt the time was right to adopt membrane dehydration as part of our operational future.'

'Whitefox systems have been verified in 24/7 operations at several other plants. With the other yield and operational improvements Golden Grain has implemented, Whitefox is a good solution for our plant to de-bottleneck existing process units, and we expect additional benefits in plant maintenance and overall operational efficiency.'

Ethanol producer BGW Sp.z.o.o. invested in the expansion and modernisation of its ethanol plant in Poland by installing membrane systems from Whitefox Technologies (*Membrane Technology*, April 2021, page 3).

In early 2020, in the USA, Kansas Ethanol Llc installed a Whitefox ICE membrane dehydration system at its plant in Lyons, Kansas that has a capacity of 291.5 million litres (77 million gallons) per year (*Membrane Technology*, April 2020, page 3).

E Energy Adams was the first ethanol plant in the US state of Nebraska to install a Whitefox ICE system (*Membrane Technology*, June 2018, pages 1 & 16).

For further information, visit:
www.whitefox.com &
www.ggecorn.com

Voltea helps secure water supply for manufacturer in South Africa

Edited by Simon Atkinson

Technology developed by US-based Voltea Inc is being used to treat borehole water for a manufacturing facility in South Africa. The aim is to not only alleviate the customer's dependence on the municipal water supply for its daily operations, but also provide other benefits, including high recovery, reduced chemical and energy consumption, and minimal maintenance, compared with traditional reverse osmosis plants, as this brief article explains.

In 2020 Voltea Inc, which specialises in salt-free Membrane Capacitive Deionization (CapDI©) electro-desalination technology, won a contract in South Africa for a project that involves purifying water for a manufacturing facility near Port Elizabeth.

Now in the final stages of commissioning, the water treatment plant has a capacity of 1000 m^3/day (or 183 gallons per minute).

Voltea says that the project resulted in the largest sale to date of one of its Industrial Series (IS) systems. Multiple IS-48 CapDI systems are being employed to treat borehole water to alleviate the customer's dependence on the municipal water supply for its daily operations.

The customer, together with engineering consultant Zutari (Pty) Ltd, conducted a feasibility study on the use of water treatment technology to most effectively and efficiently treat water in the local area.

Water security

The Port Elizabeth area is known for its water scarcity issues, which prompted Zutari to explore opportunities that would ensure a secure supply of water for this manufacturing facility – beyond a potential day zero.

Of the three feed-water supply options – sea water, a nearby lake and an on-site borehole – the borehole water supply was chosen as the most attainable way of providing a steady source of water to the facility, without the risk of affecting the local municipal water supply to the larger community.

Naturally, the on-site borehole at the facility had elevated salinity levels, which meant that the water would need to be purified by a suitable water treatment system.

Water purification

Zutari evaluated membrane capacitive deionisation (MCDI) as an innovative, lower-cost alternative to traditional reverse osmosis (RO) to purify the on-site borehole water supply for the customer.

'Voltea's CapDI© is a salt-free desalination technology that removes total dissolved solids from water sources, with minimal pretreatment requirements.'

The CapDI system from Voltea, which specialises in commercial MCDI technology, was chosen for this application.

According to the study conducted by Zutari, conventional RO is often associated with high capital expenditure, maintenance and energy costs because of the energy-intensive pressure process that it requires to treat water.

RO also typically requires extensive pretreatment. Because of these unfavourable expenditures, Zutari recommended the use of CapDI to purify the on-site borehole water at the facility.

Sustainability

Zutari believes that the best performance – environmentally and socially – needs to be underpinned by strong financial performance. Furthermore, true sustainability requires these three entities to be integrally linked.

It says that the technologies and systems it employs always consider the effect that they may have on the environment and communities. However, it also consciously delivers outcomes that help clients stay and thrive in business.

It is for this reason that its engineered systems employ the use of novel technology to achieve water treatment performance on par with conventional means, whilst reducing expenditure over the full life-cycle of the asset.

Voltea's CapDI

Voltea's CapDI is a salt-free desalination technology that removes total dissolved solids from water sources, with minimal pretreatment requirements. It eliminates dissolved salts and other minerals via direct current (DC), or

electro-deionisation, where oppositely charged salt ions are attracted to electrodes, leaving pure water flowing out of the cells in a two-step process of purification and regeneration *(see box-copy entitled 'Two-step process')*.

A major difference between CapDI and conventional water treatment technologies, such as RO, is its "tunability" feature. This means customers can choose the level of dissolved salts that are removed, as well as take advantage of automatic adjustments to the ion removal rate for any fluctuations in feed-water quality.

Not all applications require the same removal rate, which eliminates any remineralisation or blending needed from using traditional desalination and softening technologies.

Environmentally responsible features

The sustainable and environmentally responsible features of CapDI mean that soft salts or chemicals are never added to the system to replace the hard salts that have been removed.

This prevents non-native, harmful salts and chemicals from being discharged into the local ecosystem, which stops the local water supply from being potentially polluted and protects it for future generations.

Traditional water softeners, where hard salts are replaced by soft salts, have been banned in some municipalities, especially those struck by drought which have made environmental concerns a priority.

Automated treatment plant

Zutari created a water treatment plant for its customer using Voltea's CapDI technology as the purification component of a larger, fully automated treatment facility.

This facility includes gravity sand filters for pretreatment; ultraviolet light sterilisation which targets bacteria that may be present in the borehole water supply; an air oxidation step for iron removal; stripping out CO_2 to raise the pH; and a storage tank.

The entire CapDI IS plant consists of five IS-48 single systems, with a total of 218 modules. **Figure 1** shows a single CapDI IS-48 system.

Five IS-48 Systems provide enough space to house 240 CapDI modules, which gives this customer space to grow if it discovers that it requires a larger volume of water to be purified, without having to invest in additional framing equipment.

Figure 1. Voltea's Industrial Series 48 (IS-48) CapDI© system. Five of these systems provide enough space to house 240 CapDI modules at the manufacturing facility in South Africa *(photograph courtesy of Voltea Inc).*

Strategic partners

Voltea is pleased to be working with Zutari on this innovative water treatment plant that provides many benefits to the customer, including high recovery, reduced chemical and energy consumption, plus minimal maintenance, compared with traditional RO plants.

Voltea says that its growing list of valued customers and strategic partners are adopting CapDI technology and are benefiting from both lower capital expenditure and significantly lower life-cycle costs, compared with conventional, legacy technologies.

For further information, visit:
www.voltea.com &
www.zutari.com

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

Two-step process

Membrane Capacitive Deionization (CapDI©) electro-desalination technology is a simple two-step process.

Water flows between electrodes, the surfaces of which are separated from the water by ion-selective membranes that allow the passage of positive or negative ions.

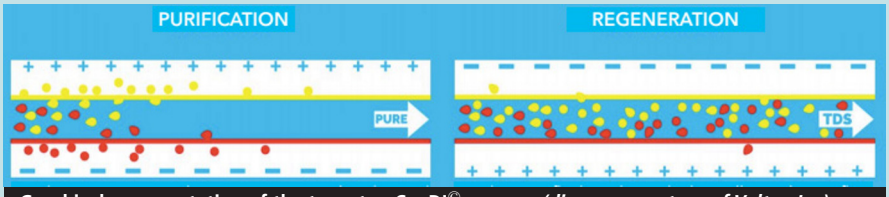
In the purification step, feed-water passes between oppositely charged electrodes, which electrostatically remove dissolved ions, leaving pure water flowing out of the cell.

In the second, regeneration step, feed-water flushes through the cell at a lower flow rate, whilst the electrode polarity is reversed. Ions are rejected from the electrode surface, concentrated in the flow channel and flushed from the cell before the cycle is repeated.

Tunable process

CapDI is described as a tunable process. This enables total dissolved solids (TDS) reduction to be adjusted between 25% and 90% depending on the customer's requirements – eliminating the need for blending to achieve a specific water quality.

The desired reduction rate is set and CapDI maintains this level, continually adjusting itself to account for any fluctuations in feed water characteristics.



Graphical representation of the two-step CapDI© process *(diagram courtesy of Voltea Inc).*

Energy-saving ultrafiltration membrane removes viruses

Edited by Simon Atkinson

Japan's Toray Industries Inc has created a virus-removing ultrafiltration membrane which, it says, is capable of producing water safely and economically – whilst using minimal energy – for a range of applications. This article takes a look at the technology and briefly explains how the company overcame challenges associated with its development.

Toray Industries has developed an energy-saving ultrafiltration (UF) membrane based on polyvinylidene fluoride (PVDF) for water treatment, which possesses an exceptional virus removal rate and high water permeability.

According to the Japanese manufacturer of membranes for applications that also include microfiltration, nanofiltration, reverse osmosis and membrane bioreactors, it is capable of producing water safely and economically – whilst using minimal energy – for a range of applications.

With the potential to be used in the food and beverage industry, and to treat wastewater for reuse, the company is accelerating application testing with a view to commercialising the technology.

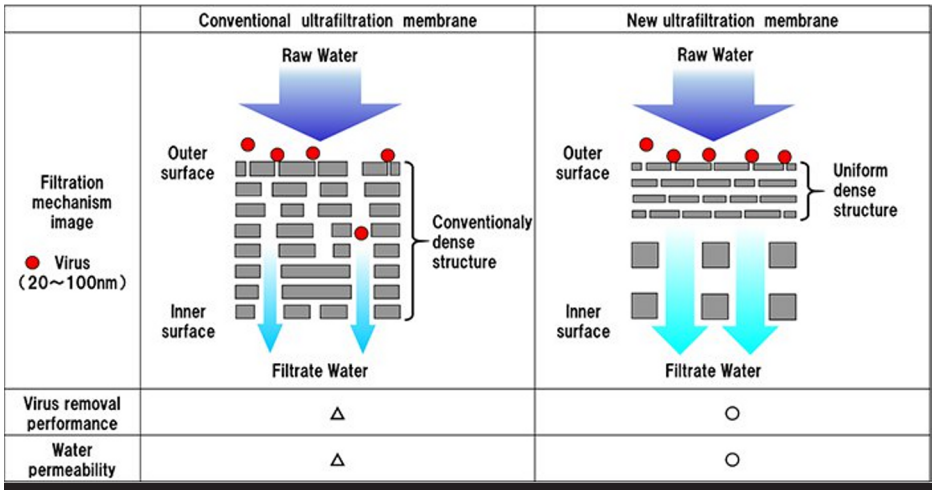


Figure 1. A conventional ultrafiltration membrane compared with the technology recently developed by Toray Industries Inc ***(diagram courtesy of Toray Industries Inc).***

Challenges

For many years Toray has been involved in the development of PVDF-based UF technology, and has pursued the production of membranes for water treatment that have high strength and high water permeability.

It says that in recent years there has been a growing expectation for UF membranes to enhance pathogenic virus removal and water permeability without reducing safety or increasing costs.

However, there has long been a problem associated with the fabrication of these UF membranes because reducing pore diameters to remove viruses increases membrane resistance, which results in a decrease in water permeability.

Toray says that it overcame that challenge by improving its technology in two key areas.

Phase separation control technology

Using phase separation control technology to create a uniformly dense structure, the company focused on minimising coarse voids exceeding 100 nm through which viruses can easily pass. By laminating layers which have a homogeneous pore-size distribution, it created a uniform dense structure without coarse voids.

This uniform density made it possible to create a thinner dense structure than that of a conventional UF membrane and showed 99.99% removal of *Essherichia coli* phage MS2, which has a diameter of around 27 nm.

Hollow-fibre process technology

The development work also involved innovative hollow-fibre membrane manufacturing technology, says Toray.

A dense structure increases resistance and impedes water flow. The company resolved this issue by using a proprietary hollow-fibre membrane process technology – built on experience in water treatment and artificial kidney applications – to create a thin, uniformly dense structure.

Excellent virus removal

It says it achieved excellent virus removal and water permeability (see **Figure 1** and **Figure 2**) by increasing porosity in the whole membrane except for the uniform dense structure, thus securing more water channels and boosting overall membrane permeability.

For further information, visit:
www.toray.com

(This technology focus is based on press material issued by Toray Industries Inc.)

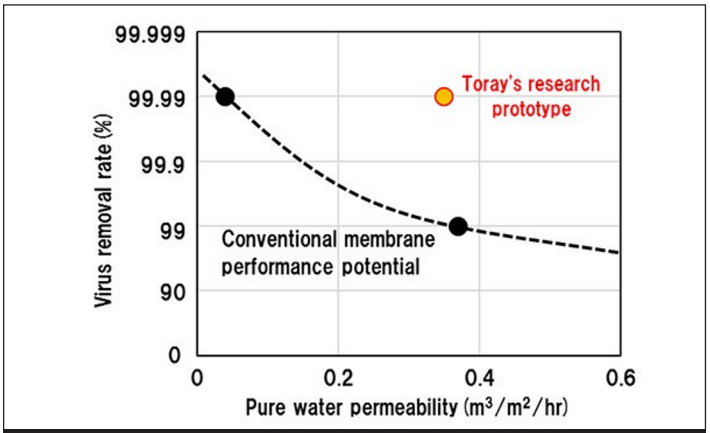


Figure 2. The relationship between water permeability and virus removal – in this case, ***Essherichia coli*** **phage MS2** ***(graph courtesy of Toray Industries Inc).***

Solving water scarcity using artificial intelligence

Edited by Simon Atkinson

As previously reported, water purification technology company Aquatech International, and Pani Energy, which specialises in computational technology for water-treatment infrastructure, are working together to help solve the problem of water scarcity, using artificial intelligence (*Membrane Technology*, August 2021, page 2). The aim is to lower the industry standard energy requirement for desalination. Here we provide further details of the partnership that was formed earlier this year.

Desalination has traditionally been viewed as a reliable, though expensive, means of producing fresh water in water-scarce regions.

To help remedy this problem, Aquatech International has partnered with Pani Energy, an artificial intelligence (AI) analytics technology provider for water treatment applications, to reduce the energy and cost associated with desalination – thereby encouraging further adoption of desalination and addressing water security issues.

Membrane-based desalination process

The partnership aims to augment Aquatech's proprietary LoWatt® membrane desalination process with Pani's AI platform to reduce the energy required for desalination to levels that have not been achievable using existing approaches.

'The partnership aims to augment Aquatech's proprietary LoWatt® membrane desalination process with Pani's AI platform…'

LoWatt is a low-energy desalination process. Aquatech claims that by integrating robust pretreatment, optimised reverse osmosis (RO) design and a proprietary cleaning mechanism, the technology delivers the lowest specific energy consumption of RO-based desalination.

According to the company, LoWatt's performance already betters the current industry standard and offers additional advantages, including higher reliability and better plant uptime, thus reducing the overall cost of desalination.

Water-scarce regions worldwide

It says that the integration of Pani's software will help it further lower the energy consumption and establish a new industry standard of 2.7 kWh/m^3. Enabling this lower energy consumption is expected to increase the adoption of desalination in water-scarce regions.

Desalination plays a critical role in solving water security issues. It is estimated that over 20 000 desalination facilities worldwide treat over 99 million m3 of water per day – a volume that is equal to more than 26 billion US liquid gallons, or equivalent to almost 40 000 Olympic swimming pools – providing water for more than 300 million people globally.

Whilst many more water-scarce regions stand to benefit from desalination technologies, high energy requirements and costs have limited adoption, as energy alone can account for more than 50% of a desalination facility's operating cost.

Greater efficiency

AI technologies, such as Pani's AI Coach™, promise to bring greater efficiencies to current processes, making desalination an affordable and robust option to meet the fresh water needs of many water-scarce regions around the globe.

'By using existing data, systems and people, paired with machine-learning techniques, current desalination technologies can be lifted to new standards of efficiency – making water less expensive to produce and delivering affordable, climate-resilient water to people and communities in water-stressed regions,' commented Devesh Bharadwaj, CEO, Pani.

Meeting treatment goals effectively

Ravi Chidambaran, Chief Operating Officer, Aquatech, added: 'With superior process design, combined with advanced machine learning, Aquatech can provide a system that reliably meets treatment goals whilst minimising energy consumption and operations and maintenance requirements in real time.'

'Aquatech is proud to welcome Pani as its official digital partner for LoWatt. This partnership enables us to better serve our customers and address the biggest "pain points" of desalination – energy consumption and biofouling.'

For further information, contact:
www.aquatech.com,
www.aquatech.com/innovations/lowatt-desalination-process &
www.panienergy.com

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

Clarifier eliminates process steps to simplify purification

Edited by Simon Atkinson

This article briefly describes next-generation harvest and clarification technology that has been developed by US company 3M Co. Using the firm's proprietary fibrous chromatography media, it condenses three process steps into a single-stage chromatographic purification step – essentially embracing the discovery phase all the way to manufacturing.

3M Health Care has recently launched the 3M Harvest RC clarifier.

Using its proprietary fibrous chromatography media, it has been developed to deliver single-stage purification for recombinant protein therapeutic manufacturing.

According to 3M, it is the next generation of harvest and clarification technology and is designed as an efficient option to increase monoclonal antibody (mAb) yields whilst streamlining, into a single stage, a traditionally multi-stage harvest clarification process.

Challenging

'As cell culture processes are intensified to yield higher cell densities and product titres, the ability to effectively harvest the cell culture fluid with the consistency and scalability required becomes challenging,' explained Dr Alexei Voloshin, Global Application Development Manager, 3M Separation and Purification Sciences.

'The 3M Harvest RC clarifier is an innovative technology that combats these challenges whilst eliminating several steps to improve the biopharmaceutical purification process.'

Predictable performance

With the capacity to support single-stage clarification across a wide range of cultures with different cell densities, high packed cell volumes and cell culture characteristics, the 3M Harvest RC clarifier enables manufacturers to achieve predictable performance, without programming every step.

The clarifier is available for the discovery phase through to commercial volumes.

This new technology provides multiple opportunities to support upstream processes:

- *high yield:* the clarifier capsules consistently provide high mAb product recovery (> 95%);
- *optimised upstream harvest and clarification process:* the clarifier condenses three process steps into a single-stage chromatographic purification step;
- *reliable scalability:* precision quaternary ammonium (Q) functionalised polypropylene fibre, combined with a 0.2 µm polyether sulfone membrane, provides scalable and predictable clarification from discovery to commercial manufacturing scale;
- *consistent effluent quality:* the clarifier introduces chromatographic separation earlier in the process to remove soluble impurities, resulting in cleaner effluent; and
- *low total cost of manufacturing:* the manufacturing flexibility, high yield and condensed stages provide economic benefits.

The 3M Harvest RC product family, including laboratory, pilot and production capsules *(photograph courtesy of 3M Co).*

For further information, visit:
www.3M.com/harvest

(This technology focus is based on press material issued by 3M Co.)

PATENTS

Porous membrane

Applicant: **Asahi Kasei Medical Co Ltd, Japan**

This invention addresses the problem of providing a porous membrane in which the phenomenon of membranes fusing to each other (membrane sticking), during the manufacturing process, is reduced. The problem can be solved by a preparing a porous membrane containing a hydrophobic polymer and a hydrophilic polymer, where the average value T of the ratio of the hydrophilic polymer-derived ion count, relative to the hydrophobic polymer-derived ion count – when the surface of the porous membrane is measured by time-of-flight secondary ion mass spectrometry – is $1.0 \leq T$.

Patent number: WO/2020/203716

Inventors: Y. Takazono and M. Komuro

Publication date: 8 October 2020

Desalination brine concentration system and method

Applicant: **Saline Water Conversion Corp, Saudi Arabia**

A system and method has been developed for

producing high concentration brine streams from which commercially (and efficiently obtained) minerals may be obtained. It involves the use of a dual membrane brine concentrator system. The system includes a nanofiltration (NF) unit that removes divalent ions from sea water; a brine concentrator, such as a hollow-fibre forward osmosis (FO) component, which receives and further concentrates the brine rejected from the NF system; a sea-water reverse osmosis (SWRO) unit that receives the NF system permeate and removes monovalent ions; and another brine concentrator that further concentrates the brine rejected by the SWRO system. Various volumes of permeate and reject brine flow may be forwarded through the dual membrane brine concentrator system, and multiple stages of the system components may be used to enhance brine concentration and improve efficiency, say the inventors.
Patent number: WO/2020/204963
Inventors: N. Voutchkov, A.S.M Alamoudi, M.F. Ayumantakath and S. Ihm
Publication date: 8 October 2020

System for CO_2 capture through membrane conduits

Applicant: **Rizona Board of Regents on Behalf of Arizona State University, USA**
A system and method for collecting carbon dioxide (CO_2) is disclosed. It includes a liquid sorbent, which is a CO_2 sorbent, and a plurality of conduits. Each conduit has a hollow interior, enclosed by a conduit wall. This wall includes a membrane material that is both hydrophobic – trapping the liquid sorbent inside the hollow interior – and porous, enabling gaseous CO_2 to transfer from outside the conduit, through the conduit wall, and into the liquid sorbent. The system also includes a first manifold, and a second manifold, which is connected to (or "in fluid communication") with the first manifold through the plurality of conduits and a riser. The liquid sorbent flows in a circuit – from the first manifold to the second manifold – through the plurality of conduits, and from the second manifold to the first manifold through the riser.
Patent number: WO/2020/206148
Inventor: K. Lackner
Publication date: 8 October 2020

Preparing an organic–inorganic piperazine polyamide composite ceramic NF membrane

Applicant: **Suntar Membrane Technology (Xiamen) Co Ltd, China**
This invention relates a method for preparing an organic–inorganic piperazine polyamide composite, ceramic nanofiltration (NF) membrane. A cross-linking agent is loaded onto an alkali-activated ceramic membrane. In the next step – using piperazine as an aqueous phase monomer, trimesoyl chloride as an organic phase monomer and a polyamine as an acid acceptor – an organic functional layer is formed on the surface of the ceramic membrane by means of an interfacial polymerisation reaction, thereby creating the piperazine polyamide composite ceramic NF membrane. The hole diameter of an inorganic functional layer of the ceramic membrane is 10–100 nm. The ceramic membrane is based on aluminium oxide, titanium oxide, or zirconium oxide, and the cross-linking agent is polyethylene glycol (or a cellulosic agent). According to the associated patent's abstract, the width of the polyamide dense functional layer of the ceramic membrane is 300–400 nm, whilst the membrane's surface has a water contact angle of 38°.
Patent number: WO/2020/200289
Inventors: Y. Chen, Y. Hong and W. Lan
Publication date: 8 October 2020

Membranes for detecting, filtering and purifying biomolecules

Applicants: **Fujifilm Manufacturing Europe BV, The Netherlands**; and **Fujifilm Imaging Colorants Ltd, UK**
The membranes detailed by this patent can be used to detect, filter and purify biomolecules. The membrane comprises polymer particles fused together – which pores existing between the fused particles. The polymer particles have an average diameter of 0.1 nm to 5000 nm; the membrane has a mean flow pore size of 5 nm to 5000 nm and has been obtained by a specific process. This involves curing a composition comprising a monomer; an organic polymerisation retardant; and an inert solvent. This membrane is useful for detecting metal ions and for filtering, and/or purifying biomolecules and compositions containing metal ions.
Patent number: WO/2020/201714
Inventors: I. Jimenez-Pardo, B. Bogels and Y. Itami
Publication date: 8 October 2020

Controlled nanoscale perforated two-dimensional materials

Applicant: **Khalifa University of Science and Technology, United Arab Emirates**
In this patent, methods are disclosed for producing a nanoporous membrane by coating a planar substrate with a solution that contains a reactive metal adatom. The coated planar substrate is then perforated by initiating a redox reaction (between the reactive metal adatom and the planar substrate) that causes the reactive metal adatom to remove material, forming nanoscale pores in the planar substrate that result in a nanoporous planar material. This material can be formed into a nanoporous membrane, say the inventors.
Patent number: WO/2020/201914
Inventors: S.P. Patole and I. Qattan
Publication date: 8 October 2020

Pure water electrolysis device

Applicant: **Qingdao Lawsci Intellectual Property Co Ltd, China**
This patent's abstract briefly describes an integrated pure water electrolysis device, comprising a water tank and a hydrogen–water separation electrolyser. The electrolyser comprises a top cover; an electrolysis unit; a hydrogen–water separation unit; and a hydrogen gas output passage. The electrolysis unit is composed of positive and negative plates, and a solid electrolyte membrane that is placed between them. Mesh holes are formed in the electrolyser top cover, and the positive and negative plates. The hydrogen–water separation unit consists of a separation chamber; a hydrophilic filter membrane that is positioned at the bottom of the separation chamber; and a water collection filter screen, as a lower support layer of the hydrophilic filter membrane. The top of the separation chamber is a negative plate. The hydrophilic filter membrane only allows the passage of water (and no gas), thereby realising hydrogen–water separation. The device successfully integrates the water tank, the electrolyser and the gas–liquid separation device into a single unit. According to the inventors, this not only greatly reduces the layout space, but also improves electrolytic efficiency.
Patent number: WO/2020/199184
Inventors: W. Zhang, Z. Zhang and D. Wang
Publication date: 8 October 2020

Apparatus for reducing concentration polarisation and membrane fouling

Applicant: **S.N. Das, India**
An apparatus for reducing concentration polarisation and/or membrane fouling, on a membrane surface, in a filtration unit, during a membrane separation process and/or a filter-cleaning process, is discussed by this patent. The apparatus described includes a system that generates electrical signals when there is a fluid flow in the filter unit, and an ultrasonic transducer assembly which receives the electrical signal

(from the signal generator) to produce waves using one or more ultrasonic transducers. These ultrasonic waves pass through the filter unit, whilst the membrane separation process and/or the filter-cleaning process are running, and generate turbulence in the flow of fluid or vibrations on the surface of the membrane. The aim is to dislodge particles clogging the membrane surface, thereby reducing the concentration polarisation and/or the membrane fouling on the membrane surface of the filter unit which, in turn, enhances membrane permeability and efficiency.
Patent number: WO/2020/202200
Inventor: S.N. Das
Publication date: 8 October 2020

Monitoring membrane fouling

Applicant: **Kemira Oyj, Finland**
A method is disclosed for monitoring deposit formation in an aqueous process. The method involves providing a feed flow of aqueous liquid and conveying it to a receiving surface of a monitoring cell. At least part of the receiving surface is illuminated with a light source. Visual data are collected at a multitude of positions across the receiving surface, and these are analysed. Based on that, a quantitative scaling and/or fouling indication is computed for the receiving surface. The monitoring cell has an inlet for the aqueous feed flow and an outlet for reject flow. The receiving surface comprises a selective barrier membrane. The feed flow is directed to the receiving surface at an elevated pressure to produce a permeate part that passes through the selective barrier membrane, and a concentrate part which forms the reject flow.
Patent number: WO/2020/201630
Inventors: M. Hesampour and A. Mäki
Publication date: 8 October 2020

Membrane-based nano-electromechanical systems

Applicant: **Clean Energy Labs Llc, USA**
Nano-electromechanical system (NEMS) sensor devices that use thin electrically conductive membranes which, for example, can be graphene membranes, form the subject of this patent. The electrically conductive membrane has a trough configuration, in the form of a "serpentine shape" arrangement. The thin, electrically conductive membrane can be selected from a group consisting of graphene, graphene oxide, graphene/graphene oxide composites, and electrically conductive polymers. It has structures disposed upon it, in an array of cavities. These structures are located between the thin, electrically conductive membrane and the main membrane trace. Such an arrangement increases the sensitivity of the NEMS sensor device, say the inventors. The membrane can be controllably wicked down on the edge of the oxide cavity to increase the sensitivity of the NEMS sensor device.
Patent number: WO/2020/210756
Inventors: J.F. Pinkerton and A.J. Pinkerton
Publication date: 15 October 2020

Nanostructured membrane filter system for rapid purification of water

Applicant: **Versitech Ltd, China**
This patent provides details of a nanostructured composite membrane filter for rapid water purification. It also describes methods for preparing this composite membrane filter. The nanostructured composite membrane includes a silver layer that has a plurality of silver functionalised nanofibres for disinfecting water that contains microorganisms. It also includes a modified layer that contains a plurality of chemical modified nanofibres, which remove impurities from the water. The silver functionalised nanofibres include ones made from polyvinyl alcohol (PVA), coated with polydopamine (PDA) and silver. Each of the plurality of chemical modified nanofibres includes a polymer matrix such as PVA and anionic polyelectrolytes such as poly(sodium styrenesulfonate) (PSSNa), which capture metal ions present in the water.
Patent number: WO/2020/207361
Inventors: H. Guo, X. Li and C. Tang
Publication date: 15 October 2020

Ocean floor RO desalination plant

Applicant: **M. Torres Diseños Industriales SA, Spain**
This invention relates to a plant for desalinating sea water by means of reverse osmosis (RO) and to method for arranging the plant on the ocean floor. The desalination plant comprises membranes arranged on the seabed. To produce desalinated water they make use of the difference between external and internal pressure. The membranes are disposed in parallel and each one has a flat, elongate shape. A gap is defined between the membranes through which sea water circulates. Also part of the design described is a means of pumping the desalinated water; at least one pipe for removing the desalinated water, which is placed such that it passes transversely through the membranes (establishing a passage for desalinated water to pass between the membranes and the pipe); and a way of holding the membranes and the pipe. This structure is connected to ("in fluid communication with") the pipe by means of at least one column through which the desalinated water is conveyed.
Patent number: WO/2020/208279
Inventor: M. Torres Martinez
Publication date: 15 October 2020

Ion-exchange membrane

Applicants: **Nano-Science Laboratory Corp, Japan**; and **University of Hyogo, Japan**
The objective of this patent is to produce an ion-exchange membrane that can be produced easily, and at a relatively low cost. According to the patent's abstract, two solutions are mixed to form a gel composition. The first of which is 10 ml of a 50 mass% aqueous sodium silicate solution – obtained by adding sodium silicate into ion-exchange water and heating and stirring the resulting material – and 10 ml of a 8 mass% aqueous polyvinyl alcohol solution – obtained by adding polyvinyl alcohol to ion-exchange water and, again, heating and stirring the resulting material. The sodium silicate and the polyvinyl alcohol are cross-linked through hydrogen bonding. The resulting gel composition is introduced into a square container that is 6 cm long, 6 cm wide and 1 mm deep, and is subsequently subjected to vacuum drying, which creates a film. This film is then subjected to what is referred to as "insolubilisation treatment" by being immersed in a solution of hydrochloric acid and methanol that is obtained by mixing hydrochloric acid and methanol at a weight ratio (hydrochloric acid):(methanol) of 2:3, for 1 hour. It is subsequently immersed in 5 ml of ion-exchange water for 30 minutes. The film is cleaned by repeating this process twice.
Patent number: WO/2020/208760
Inventors: K. Iimura, Y. Fujita and M. Kobayashi
Publication date: 15 October 2020

Tubular membrane comprising longitudinal ridges

Applicant: **Berghof Membrane Technology GmbH, Nicaragua**
This invention concerns a tubular membrane, module, a device comprising a number of these membranes and a method for manufacturing them. The tubular membrane described, consists of a tubular base, providing a support and having an inner and outer surface, with the tubular base defining a lumen for the feed flow. A membrane layer is provided on the inner surface of the tubular base. The inner surface comprises a number of inwardly projecting ridges that extend in a substantially longitudinal

direction of the tubular membrane. Providing longitudinal ridges increases the overall effective membrane surface area, say the inventors. This increases the overall capacity of the tubular membrane, resulting in higher module fluxes.
Patent number: WO/2020/209720
Inventors: K.S. Roelofs, G. Bisle and P.E. Dlugolecki
Publication date: 15 October 2020

Transferable sample platform containing an exfoliated graphene membrane

Applicant: **King Abdullah University of Science and Technology, Saudi Arabia**
A multipurpose and transferable sample platform for supporting, analysing and/or processing a target material has been developed and is described by this patent. The platform includes a substrate; dielectric layer, formed over a face of the substrate; electrodes, formed over the dielectric layer; a slot, formed through the substrate and the dielectric layer; and a membrane, based on exfoliated graphene placed over the slot and in electrical contact with the electrodes. The membrane is configured to support, or act upon, a study material or chemical precursors.
Patent number: WO/2020/208433
Inventors: N.M. Batra, P.M. Costa, D. Mahalingam and S.P. Nunes
Publication date: 15 October 2020

Membrane separation unit

Applicant: **Linde GmbH, Germany**
This invention pertains to a membrane-based unit for a process for separating a gas mixture. The separation unit includes a pressure vessel that contains the membrane. In addition, the pressure vessel has an inlet nozzle, for a feed-gas mixture; an outlet nozzle, for permeate; and an outlet nozzle for retentate. The membrane separation unit has, in this case, a system for carrying out measurements, that is arranged at least partially inside the pressure vessel and/or inside the inlet nozzle, and/or inside the outlet nozzle, and is set up to record one or more parameters relevant to the operation. An arrangement of a plurality of corresponding membrane separation units and a process for separating a gas mixture by means of a membrane separation process using one or more corresponding membrane separation units, or using a corresponding arrangement, are likewise the subject matter of this invention.
Patent number: WO/2020/207625
Inventors: C. Voss, R. Hoffmann, P. Schiffmann and M. Johannink
Publication date: 15 October 2020

Method for manufacturing zeolite membrane

Applicant: **Georgia Tech Research Corp, USA**
Disclosed are methods for manufacturing a zeolite membrane. This involves providing at least one porous substrate, and coating this porous substrate with a membrane. In some embodiments, the method also involves hydrothermally treating the membrane. This is done with a first hydrothermal treatment step, using tetrapropylammonium fluoride (TPAF) and a second hydrothermal treatment step with tetraethylammonium hydroxide (TEAOH). In some embodiments, coating the substrate with a membrane involves surrounding at least a portion of the porous substrate with a precursor gel – the gel comprising a gel phase and a plurality of chabazite (CHA) or MFI (Mobil-type five) crystals; heating the porous substrate and the precursor gel; and washing, drying and calcining the substrate.
Patent number: WO/2020/210460
Inventors: S. Nair, S. Yang, C.W. Jones and B. Min
Publication date: 15 October 2020

Recovering the performance of a water electrolysis device

Applicant: **Hitachi Zosen Corp, Japan**
A method for recovering the performance of a water electrolysis device is detailed by this patent. The water electrolyser described has a solid polymer membrane, and an anode and cathode. The performance-recovery method involves a series of steps. In the first step, the water electrolysis device is set to a low-temperature operating state, in which the temperature of water reaches a level that is lower than that during normal operation whilst the electrolyser is performing water electrolysis. In the second step, current flows between the anode and the cathode, when in the low-temperature operating state. A voltage higher than that seen during normal operation can be generated between the anode and cathode during low-temperature operation.
Patent number: WO/2020/208991
Inventor: T. Yoshida
Publication date: 15 October 2020

Electrically conductive cross-linked polymer membrane

Applicant: **Superdielectrics Ltd, UK**
Disclosed is a process for integrating electrically conductive nano-particulate material into a surface layer of an electrically conductive cross-linked polymer. This is achieved by immersing an electrically conductive cross-linked polymer in a first medium, and subsequently immersing it in a second medium. The first medium is composed of an electrically conductive nano-particulate material dispersed in a non-aqueous polar liquid, whilst the second medium consists of an aqueous liquid. According to the associated patent, it is thought that immersion in the first medium results in the expansion of the polymer lattice, enabling the electrically conductive nano-particulate material to penetrate a surface layer of the polymer structure. Then, the subsequent immersion step, in the second medium, contracts the polymer lattice, thereby trapping the nano-particulate material in the surface layer of the polymer. The polymer used in the process disclosed is capable of functioning as the electrolyte component in a supercapacitor.
Patent number: WO/2020/208348
Inventor: D.J. Highgate
Publication date: 15 October 2020

Gas diffusion electrode substrate for solid-polymer fuel-cell applications

Applicant: **Toray Industries Inc, Japan**
The aim of this invention is to create a gas diffusion electrode substrate that has a high thermal conductivity, even with a low density, and excellent power-generating performance. The patent's abstract describes a gas diffusion electrode substrate that includes a felt composed of carbon fibres with an average diameter of 5–20 µm. At least a portion of the carbon fibres, constituting the carbon-fibre felt, possesses a flat portion, where the maximum fibre diameter is observed to 10–50% thicker than the average fibre diameter when viewing the felt surface from the top, and the number of the flat portions on the surface of the carbon-fibre felt is 50–200/mm^2.
Patent number: WO/2020/213324
Inventors: M. Utsunomiya, S. Shimoyama and F. Watanabe
Publication date: 22 October 2020

System for treating water

Applicant: **Hutchison Water Israel EPC Ltd, Israel**
This disclosure provides details of a system and method for treating water. The aim is to produce water that is suitable for distribution and human consumption. The system and method described incorporates a supply unit, which provides lime water to the water to be treated in at least an initial treatment process. The supply unit includes a mixing chamber, configured to receive and admix calcium oxide (CaO) and/or calcium hydroxide ($Ca(OH)_2$) powder with treated water to form "lime milk". Also included is a lime water preparation unit that consists of

at least one water membrane filtration module. The lime milk and treated water pass through the membrane filtration module and discharge "lime water". The system and method disclosed is use in particular to convert water permeate, received by desalination processes, into finished water.
Patent number: WO/2020/212980
Inventors: M. Faigon and E. Dinar
Publication date: 22 October 2020

Method for making an ion-exchange membrane

Applicant: **Rogers Corp, USA**
This application relates to ion-exchange membranes for redox flow batteries, to methods for manufacture them and to the batteries that make use of them. The ion-exchange membrane consists of a matrix, including a fluorinated polymer and a filler with cellulose nanocrystals. The method for making the ion-exchange battery involves coating a solution – including the fluorinated polymer and the cellulose nanocrystals – onto a substrate; removing solvent from the coated substrate to provide the membrane; and removing the membrane from the substrate. The ion-exchange membrane can be used in a variety of applications, including fuel cells, sensors, electrolytic cells, redox flow batteries, gas separators, humidifiers, and metal ion batteries.
Patent number: WO/2020/214315
Inventors: W. Wang and H. Zhu
Publication date: 22 October 2020

Dialysis solution regeneration

Applicant: **Toray Industries Inc, Japan**
This patent covers a dialysis solution regeneration method which, according to the inventors, exhibits high urea elimination performance, even under low-pressure operation and can be simply used, even at home. This method has been developed to reduce urea concentration in an aqueous solution (containing urea), and involves a step of using a reverse osmosis (RO) membrane element to obtain from the aqueous solution – at an operating pressure of between 0.5 MPa and 2.0 MPa inclusive – a concentrated solution with a higher urea concentration and a permeate solution that has a lower urea concentration. The aqueous solution containing the urea has a urea concentration of 0.5 g/l or higher, and the RO membrane has a pore diameter of 7.0 Å or less, as measured using positron annihilation lifetime spectroscopy.
Patent number: WO/2020/218571
Inventors: K. Ogawa, H. Shimura and S. Hanada
Publication date: 29 October 2020

Membrane electrode assembly for a battery

Applicant: **University of Yamanashi, Japan**
The membrane electrode assembly, which forms the subject of this patent, comprises a polymer electrolyte membrane, an anode and a cathode. The anode includes an anode catalyst layer, whilst the cathode includes a cathode catalyst layer. The anode catalyst layer is disposed on a first main surface of the polymer electrolyte membrane, whilst the cathode catalyst layer is disposed on a second main surface of the membrane. The anode catalyst layer includes a catalyst material, an electro-conductive material and a hydrocarbon polymer catalyst. The hydrocarbon polymer catalyst includes a hydrophilic segment and a hydrophobic segment. The hydrophilic segment has a sulfonic acid group, where the main chain consists of an aromatic ring, whilst the hydrophobic segment includes an aromatic ring.
Patent number: WO/2020/217845
Inventors: K. Miyatake, M. Uchida and H. Uchida
Publication date: 29 October 2020

Membrane-based processes for sea-water purification

Applicants: **Schlumberger Technology Corp, USA; Schlumberger Canada Ltd, Canada; Services Petroliers Schlumberger, France**; and **Schlumberger Technology BV, The Netherlands**
Methods for operating membrane processes, such as sea-water purification processes, are described by this patent. The methods generally include flowing sea water into a membrane purification process; recovering purified sea water and concentrated sea water from the purification process; sensing operating parameters of the membrane purification process; and determining the state of the membrane purification process from the operating parameters, through a physical model. A statistical model is used to resolve time dependence of the state of the membrane purification process and a recursive statistical process updates the statistical model. The updated statistical model can be applied in order to predict a future state of the membrane purification process. This enables the predicted future state to be compared with a threshold state. It is also possible to predict the remaining time before the membrane purification process reaches the threshold state.
Patent number: WO/2020/219626
Inventors: S. Pan, O.O. Medvedev, R.C.W. Weston and M.S.U. Rossi
Publication date: 29 October 2020

Composite membrane

Applicants: **Shinshu University, Japan**; and **Shin-Etsu Chemical Co, Japan**
This patent provides details of a semipermeable composite membrane with a reduced environmental load, and a method for manufacturing it. The structure described has, on a porous support body, a semipermeable membrane, including a cross-linked polyamide and cellulose nanofibres. A silane coupling agent is bonded to the cellulose nanofibres. The method for manufacturing the semipermeable composite membrane involves a step for obtaining a liquid mixture containing water, an amine component and cellulose nanofibres (to which the silane coupling agent is bonded). It also involves a step during with the liquid mixture is brought into contact with the porous support body. In this way the amine component, in the liquid mixture adhering to the porous support body is allowed to undergo a cross-linking reaction, thereby creating the semipermeable composite membrane.
Patent number: WO/2020/218302
Inventors: T. Noguchi, M. Endo, M. Hotta and M. Tanaka
Publication date: 29 October 2020

Ultra-thin membranes

Applicants: **Acib GmbH, Austria**; and **Universität für Bodenkultur Wien, Austria**
One of the main objectives of this invention is to produce ultra-thin membranes with a thickness of less than about 100 nm that exhibit different textured surfaces. The ultra-thin membranes are fabricated using micro-phase separation during casting. An attempt to overcome some of the hurdles for translation to a large-scale industrial process is made by migrating the procedure to the dip-coating technique. According to the associated patent, one side of the membrane exhibits an uneven textured surface compared with the other side, which is smooth. The ultra-thin membrane comprises pores with an average diameter of 50 nm or less. One embodiment of this invention relates to ultra-thin membranes made from two components. Specifically, the components are selected from an epoxy resin and a curing agent – preferably polyethyleneimine.
Patent number: WO/2020/216957
Inventors: C. Schuster, A. Jungbauer and J. Matzinger
Publication date: 29 October 2020

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

EVENTS CALENDAR

16–18 May 2022
Global Water Summit 2022
Madrid, Spain
Contact: Roxy Ali, Global Water Intelligence, Media Analytics Ltd, Suite C, Kingsmead House, Oxpens Road, Oxford OX1 1XX, UK
Tel: +44 1865 204208
Email: roxy.ali@globalwaterintel.com
www.watermeetsmoney.com

2–3 June 2022
SNMS 2021 – The Second International Symposium on Nanomaterials and Membrane Science for Water, Energy and Environment (Desalination and Reuse in the Face of Water Scarcity)
Tangier, Morocco
Contact: Professor Dr Saad Alami Younssi, Moroccan Membrane and Desalination Society, Materials Membranes and Environment Laboratory FSTM Hassan II University, Casablanca, Director BP 146 FSTM, Mohammedia, Morocco
Tel: +212 661 51 7196 (mobile) Fax: +212 2331 5353
Email: smmdalami@gmail.com
http://smmd.ma

27–30 June 2022
Nanofiltration 2022
Reutlingen, Baden-Württemberg, Germany
Contact: Prof Dr Ing Andrea Iris Schäfer, Karlsruhe Institute of Technology (KIT), Institute for Advanced Membrane Technologies (IAMT), KIT Campus North, Building 352, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany
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Email: andrea.iris.schaefer@kit.edu
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 Membrane Technology Association
PO Box 14918, Tallahassee, FL 32317, USA
Tel: +1 772 469 6797
Email: custsrv@amtaorg.com
www.amtaorg.com

5–9 October 2022
13th World Filtration Congress
San Diego, California, USA
Contact: Deahna Cring, Conference Manager, American Filtration and Separations Society (AFS), 529 Myatt Drive, Nashville, TN 37511, USA
Tel: +1 615 345-9586,
Fax: +1 615 530 1037
Email: deahna@afssociety.org
www.wfc13.com
www.afssociety.org

9–13 October 2022
IDA 2022 World Congress – Charting Resilient Water Solutions
Sydney, Australia
Contact: International Desalination Association (IDA), PO Box 387, Topsfield, MA 01983, USA
Tel: +1 978 774 0959
https://wc.idadesal.org

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lenges, solutions that address sustainability and affordability will have the biggest impact.'

'We are proud to continue our work with IDE Water Technologies to bring affordable sea-water desalination to Israel and tackle water shortages in one of the driest parts of the world.'

Avshalom Felber, Executive Chairman, IDE Technologies, added: 'We are convinced that the new standard we have set will help propel the water treatment world forwards, and encourage the construction of additional high efficiency, environmentally sustainable and low-cost desalination facilities worldwide.'

The largest of its kind RO plant will be built in Sorek central Israel, and will increase the country's desalination capacity by 35%. The Sorek B plant is expected to come on stream in 2023. It will be the sixth desalination plant Israel has built along its Mediterranean coast as the country braces for the risk of climate change and regional conflicts, aggravating water shortages.

DWS introduced dry-tested SWRO elements in 2020 (*Membrane Technology*, April 2020, page 7.)

According to the company, these elements offer customers significant advantages over wet ones, given the requirement to monitor and eventually replace preservation solutions for wet membranes.

Since dry-tested membranes do not need to be stored with the solution, they help extend storage times, reduce labour costs and result in easier, long-term warehouse planning.

Pretreatment technology that eliminates the effects of biofouling in RO systems, to reduce operational costs and boost plant uptime and reliability, has also been developed by DuPont (*Membrane Technology*, July 2021, pages 2–3)

The result of a multi-year research and development effort, B-Free is described as a vessel-based media technology that is reliable, easy to use and sustainable.

It is based on B-Free pretreatment technology's ability to create an instant and sustained biostatic environment for the downstream RO operations without the need for chemicals, and is resilient to upsets upstream.

For further information, visit:
www.dupontwatersolutions.com
https://www.dupont.com/brands/filmtec.html &
www.ide-tech.com

3D printing is set to improve the efficiency of spiral-wound RO membranes

Additive manufacturing, or 3D printing technology, is being used to dramatically improve the efficiency of spiral-wound RO membrane elements – minimising fouling potential and reducing capital and operational costs.

Henkel Corp and Aqua Membranes are introducing what is described as revolutionary Printed Spacer Technology® for spiral-wound element design and manufacturing.

The companies say that this new technology eliminates the need for conventional plastic mesh feed spacers by printing unique spacer patterns directly onto delicate flat-sheet membrane materials.

At the Membrane Technology Conference & Exposition, which was held recently in West Palm Beach, Florida, USA, Henkel representatives helped to introduce the technology at Aqua Membranes' booth. The event also provided them with the opportunity to hand out samples of materials incorporating the 3D printed structure.

For further information, visit:
www.henkel-adhesives.com/us/en/industries/manufacturing/filtration.html &
https://aquamembranes.com/technology

(A focus article, which will be published in a forthcoming issue of Membrane Technology, will provide further details of this technology.)