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Acquisitions expand DuPont's portfolio of water purification and separation technologies

DuPont has finalised the acquisition of four companies that develop and supply membrane-based systems and products, in a move that expands its portfolio of water purification and separation technologies, including ultrafiltration (UF), reverse osmosis (RO) and ion exchange resins.

As reported previously (*Membrane Technology*, November 2019, pages 2–3 and page 1, respectively), towards the end of 2019 the company agreed to buy inge GmbH – a UF membrane business – from BASF SE, and Memcor, Evoqua Water Technologies Corp's UF and membrane bioreactor (MBR) technologies division.

Together with these two firms it has also acquired closed-circuit RO (CCRO) company Desalitech Ltd, and OxyMem Ltd, which develops and produces membrane aerated biofilm reactor (MABR) systems for the treatment and purification of municipal and industrial wastewater.

According to DuPont, these acquisitions support its goal to increase access to the products and technologies needed to meet global customers' current and future challenges, including the increased need to recycle water, whilst reducing the energy requirements to generate clean water.

It says that adding inge GmbH and Memcor portfolios enables it to supply UF systems across multiple market segments, such as the residential, industrial, utility and wastewater sectors.

CCRO from Desalitech will help DuPont provide customers with more options and flexibility to solve water scarcity and purification challenges, whilst emerging technologies from OxyMem, will enable it to better support customers aiming to reduce footprint and energy requirements for secondary wastewater treatment.

'These four acquisitions are absolutely aligned to our strategy to be the leading supplier of water technologies to better serve evolving needs of our global customers,' said Nicole Richards, Director of Growth and Strategy, DuPont Water Solutions.

H.P. Nanda, Global Vice President & General Manager, DuPont Water Solutions, added: 'Water scarcity is a global challenge that needs to be solved with a sense of urgency. As a global leader in innovative water technologies, we are continually expanding our technology portfolio of high-quality solutions to help our customers purify, conserve and reuse this precious resource.'

For further information, visit:
www.dupont.com/water,
www.dupont.com/brands/inge.html,
www.dupont.com/brands/memcor.html,
www.desalitech.com & www.oxymem.com

Versatile membrane-based brine concentrator makes extensive use of RO

Saltworks Technologies Inc has developed a membrane-based brine concentrator that makes extensive use of reverse osmosis (RO).

The Canadian company, which develops technology for industrial desalination, brine treatment and zero liquid discharge (ZLD), says that it has started commissioning the plant – believed to be the first of its kind – that minimises the volume of brine sent to disposal or processed by more costly thermal technologies.

Capable of ultra-high recovery processes and the treatment of fluids containing perfluoroalkyl and polyfluoroakly substances (PFAS), the concentrator relies on what is described as "turbocharged" RO. In the case of PFAS, advanced oxidation or disposal may be employed downstream.

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

Xylem establishes technology hub at its regional headquarters in Singapore

Global water technology company Xylem Inc has established a multidisciplinary centre for water, wastewater and energy technologies at its regional headquarters in Singapore.

Located at ICON@IBP – a leasehold commercial building situated at Singapore's International Business Park – the expanded headquarters brings the company's regional research and development capabilities into a new Xylem Technology Hub Singapore, alongside its regional leadership and personnel.

Research at the centre will focus on developing technologies for water distribution, and water and wastewater treatment, says the firm.

Its new facility will also feature customer experience and training centres – bringing together all of its sales, customer support and technical capabilities for Southeast Asia.

'This new multidisciplinary centre will create ample opportunities to innovate and collaborate with our customers, as we work with them to tackle the region's greatest water challenges, including water scarcity, affordability and infrastructure resilience,' said Patrick Decker, President and CEO, Xylem.

One of the first projects Xylem is pursuing at the centre is a collaboration with the Agency for Science, Technology and Research's (A*STAR) Institute of High Performance Computing (IHPC).

Xylem says that it will combine its knowledge of water technologies with IHPC's expertise in computer modelling and simulation. Together, they will evaluate fluid-structure interaction in pipe flow to develop a new computational fluid dynamics model tailored to the company's applications, such as SmartBall and PipeDiver.

Work at the centre also will be supported by Xylem's ongoing partnership with PUB, Singapore's National Water Agency, to address challenges brought about by climate change and increasing water demand.

Xylem continues to work with PUB on the development and implementation of technologies in common areas of interest, such as high-precision leak detection and condition assessment technologies, and using data analytics to pinpoint water loss.

The model will then be applied to the design and testing of other advanced products and solutions to be deployed in treatment plants and water distribution networks.

Decker continued: 'We are excited about the energy and innovation that is possible when we focus our resources, talent and technologies in one centre like this.'

'This new integrated facility will offer our customers and partners an immersive technology experience, as well as a state-of-the-art training centre. Singapore's water sector continues to grow and innovate, so this is a great location to work together on solving the region's water challenges.'

Xylem first entered the Singapore market in 1982 and has since grown and expanded its facilities.

For further information, visit: www.xylem.com, www.pub.gov.sg & www.a-star.edu.sg/ihpc

Porvair launches filters for process gases and the nuclear power sector

Porvair Filtration Group has further expanded its portfolio of microfiltration products by introducing seven new metallic Compfil™ filters for applications involving process air and gas. The specialist filtration and environmental technologies group has also launched Sinterflo® MC Septa filter elements for aggressive applications encountered in the nuclear power industry.

The Compfil filters exhibit a number of different properties and are used in many industries, including sterile applications within water, chemical, pharmaceutical, and food and beverage manufacturing.

Compfil PD, WD, WV, ST and PC sterile filters consist of three-dimensional borosilicate depth media, achieving a void volume of 95%, which ensures a high containment capacity at high flow-rates and low differential pressure.

A range of sterile filters, Compfil SF is designed to remove particles from gases, liquids and steam. Each filter consists of a regenerable, isostatically pressed filter cylinder made from sintered stainless steel. The retention rate ranges from 1 µm to 25 µm.

The Compfil AR range comprises pre-filters and final filters with absolute retention rate for particle removal from aqueous solutions, water and other liquids, as well as gases. The products consist of a regenerable stainless steel mesh, with an outer-guard made from the same material, and end caps. The retention rate ranges from 5 µm up to 250 µm.

The company's Sinterflo MC Septa filter elements are made from Sinterflo mesh composite

(MC) filter media. This material is made from wire mesh and perforated metal, sintered together into a durable porous filtration medium.

Benefits include high strength and corrosion resistance, with the ability to withstand harsh operating conditions at temperatures of from -50°C to 550°C (-65°F to 1000°F).

The company says that these elements are suitable for a wide range of uses in the nuclear power generating industry, including reactor water clean-up, processing radioactive waste, fuel pool clean-up and condensate polishing.

For further information, visit: www.porvair.com & www.porvairfiltration.com

H_2O Innovation's Piedmont secures substantial orders for FRP and couplings

Canada's H_2O Innovation Inc has announced that its independent subsidiary Piedmont – which focuses on corrosion-resistant equipment for desalination plants in the industrial and municipal markets – has secured several orders totalling $3.5 million for fibre-reinforced polyester (FRP) cartridge filter housings and couplings.

It received a purchase order for FRP filter housings that will be used in a sea-water reverse osmosis (SWRO) desalination plant in the Middle East. As one of the largest facilities in the world, it will treat up to 900 000 m^3 (about 238 million gallons) of water a day.

In the same business line, the firm has also been awarded other major projects. In Tunisia – for the second time in a row – it will be providing FRP filter housings for two medium-sized SWRO desalination plants, rated at 50 000 m^3 (13.2 million gallons) per day. It is also delivering four FRP units to Saudi Arabia for a project with a capacity of 24 480 m^3 (around 6.5 million gallons) per day.

Piedmont reports that it was recently added to the approved vendor list by the Egyptian army. It says that this will enable it to bid on upcoming large-scale desalination plants, and will provide good growth opportunities in this booming region.

The company has won several other projects, for both coupling and FRP business lines, in North America, Latin America, Europe, the Middle East, North Africa, India and Singapore during the last five months.

It secured a record number of orders in its fourth quarter of fiscal 2019 as reported previously (*Membrane Technology*, September 2019, pages 3–4).

For further information, visit: www.h2oinnovation.com & www.piedmontpacific.com

Green hydrogen plant in The Netherlands uses De Nora electrode technology

Industrie De Nora SpA reports that the latest generation of its advanced electrode package for water electrolysis is to be employed in a green hydrogen project in The Netherlands.

The provider of electrodes and coatings for electrochemical processes, says that the project – initiated by speciality chemicals company Nouryon and Dutch natural gas infrastructure and transportation firm Gasunie – will create, in Delfzijl, what is believed will be the largest zero-carbon hydrogen plant in Europe, with a production capacity of 3000 ton/year (20 MW).

Green hydrogen will be deployed for the decarbonisation of the industry sector, reducing CO_2 emission by 27 000 ton per year.

The production of hydrogen is based on McPhy Energy Sa's alkaline water electrolysis technology "Augmented McLyzer", specifically designed for large-scale installations and equipped with De Nora special electrodes.

According to De Nora, its "electrodic package", installed in the McPhy electrolyser, enables hydrogen to be generated with the lowest total cost of ownership. This is achieved through a substantial reduction in the overall plant footprint (maximising operating current density) and the optimisation of the total power consumption (increasing efficiency and operating pressure), whilst, at the same time, making use of the low cost of the electrolyser.

Luca Buonerba, Chief Marketing & Business Development Officer, De Nora, said: 'This is the first installation of our latest generation of advanced electrode package for water electrolysis. We are happy that our continuous efforts to achieve better performances are shortening the roadmap towards a sustainable solution for decarbonisation and energy transitions.'

Towards the end of 2019, De Nora and hydrogen power generating technologies company AFC Energy Plc strengthened their commercial relationship. As reported in *Membrane Technology*, October 2019, pages 4–5, the companies signed the next phase of a joint development agreement covering electrode technology for fuel-cell systems – setting updated targets for mass manufacture prior to commercial deployment.

For further information, visit: www.denora.com & www.mcphy.com

Aquaporin joins the United Nations Global Compact

Denmark's Aquaporin A/S has joined the United Nations Global Compact.

The aim of the pact is to encourage companies to align strategies and operations with universal principles on human rights, labour, environment and anti-corruption, and take action that advances societal goals.

Aquaporin, a developer of biomimetic membranes for industrial and consumer water applications, says that with its pledge of support it is committing to adhere to these principles. And it is pleased to formally sign the pledge as a natural next step on its journey towards sustainability.

Furthermore, it is looking forward to further engaging in collaborative projects, which will advance the broader development goals of the United Nations, particularly the sustainable development goals (SDGs).

Peter Holme Jensen, CEO, Aquaporin, elaborated: 'We perceive this important step as being a natural extension of our daily work with the SDGs.'

'We believe that companies carry a huge responsibility when it comes to human rights and working towards a more sustainable world, so we need to set the stage and demonstrate a good example. After all, clean water is a human right.'

For further information, visit: www.aquaporin.dk & www.unglobalcompact.org

New furnaces at LiqTech expand manufacturing capacity of filters

In Denmark, LiqTech International Inc, has installed a new furnace to expand manufacturing capacity of its proprietary silicon carbide (SiC) ceramic membrane filters.

LiqTech, which develops and provides technologies for gas and liquid purification, based

on the SiC filters, says that because of its size and efficiency the new furnace has a throughput that is more than three times that of its existing furnaces.

According to the company, the installation of this initial new furnace is the first step of a multi-phase process to increase overall capacity with modernised equipment that should also benefit its gross margins.

It is planning to install a second new furnace at the time of writing, and two additional ones by June 2020. Upon successful installation of all four, brand new, efficient furnaces in June 2020, the firm expects to completely retire its current older, less efficient ones.

Overall, LiqTech's manufacturing initiatives are expected to result in a total capacity of between $150 million and $200 million on an annualised basis by mid-2020.

For further information, visit: www.liqtech.com

W12 Congress: public sessions delayed until May

The team behind the W12 Congress announced recently that the public sessions of the event are now taking place in Cape Town, South Africa on 18–19 May 2020, according to the International Desalination Association (IDA).

The IDA, a strategic partner of Cape Town's 2020 W12 Congress, says the sessions – initially set to take place in January – have been delayed because the W12 Congress received many requests from organisers to delay them in order to further strengthen the opportunities and new developments that have emerged from the COP25 (Climate Change Summit) that was held in Madrid, Spain.

As a strategic partner, the IDA says that it is in full support of this change and encourages its members to take these new dates into account.

The W12 Water Congress organisers regret this delay, but they believe that holding the public sessions later in the year considerably outweigh the inconveniences of the change in plan. In a statement it said: 'In order to have the greatest impact, the decision to move parts of the event until later in the year is the right one.'

Further speaker and celebrity involvement are being announced on a biweekly basis.

For further information, visit: www.idadesal.org & www.w12-congress.com

Ecolab's Water Risk Monetizer is updated to reflect current water trends

Ecolab Inc, which specialises in water treatment, hygiene, and energy technologies and services, has updated key data within its Water Risk Monetizer tool to reflect current water trends.

The tool, which enables businesses to factor current and future water risks into business strategy, is increasingly being used by companies as they plan action steps to support sustainable growth.

The latest version of the Water Risk Monetizer – developed by Ecolab in partnership with Microsoft and Trucost, part of S&P Global – reflects the changing landscape in water risk analysis, ensuring the tool continues to take advantage of best-in-class information and scientific methodologies.

Paul Reig, Director of Aqueduct and Corporate Water Stewardship at the World Resources Institute, commented: 'The Water Risk Monetizer provides companies with a comprehensive tool to deepen their understanding of the financial implications associated with water risks. Tools like this can empower organisations to prioritise and invest in water conservation.'

With research from the United Nations predicting that global demand for water will exceed supply by 40% by 2030, the Water Risk Monetizer's latest update supports the advancement of corporate water management in an increasingly water-scarce world.

The tool uses water-basin data sets, economic techniques and scientific methodologies developed by Trucost, to give companies the insights needed to make more informed decisions about their operations.

The latest update includes the newly released water stress data set from the World Resources Institute's Aqueduct Water Risk Atlas, updated global water pricing data and an updated global GDP population model.

Planned expansions for the tool in 2020 include:

- facility-level action planning for smart water management practices;
- additional context-based approaches to local water challenges; and
- industry benchmarking

'Additional advancements to the Water Risk Monetizer later this year will amplify the tool's ability to geographically differentiate watersheds and provide applicable, actionable insights suited to a facility's location,' explained Emilio Tenuta, Senior Vice President of Corporate Sustainability, Ecolab.

'It enables users to view water as a shared resource and consider the way they use water in their operations – as well as their supply chain and within their community.'

Ecolab is also using digital technology to help businesses reduce the amount of water they use.

As reported previously (Membrane Technology, September 2019, page 3), the company says that it is taking advantage of its global 3D TRASAR™ footprint and digital technology through its ECOLAB3D™ cloud platform to help businesses improve asset performance and reduce water use.

For further information, visit: www.ecolab.com/ecolab3d & www.WaterRiskMonetizer.com

Adrien Fremau appointed CFO, SUEZ North America

Adrien Fremau, former Head of Financial Planning and Controlling at the SUEZ Group, has been appointed Chief Financial Officer (CFO), SUEZ North America.

In his new role, Fremau will be responsible for SUEZ North America's strategic planning programme and all financial functions, including accounting, treasury, corporate finance, financial planning, regulatory business and procurement.

According to SUEZ, which operates largely in the water treatment and waste management sectors, Fremau has been working for the company for the past nine years at different positions within the group's international divisions, following six years of statutory audit experience at Ernst & Young. He reports to Nadine Leslie, CEO, SUEZ North America.

'Adrien brings exceptional global experience to the role. His success in calculating risk/return ratios for projects and in analysing the financial structure of different activities in a global setting will help SUEZ North America as we expand our operations and improve profitability,' commented Leslie.

'In addition to his financial acumen, Adrien is also a civil engineer and has extensive knowledge of construction. These are great assets in a capital-intensive industry such as ours.'

For further information, visit: www.suez.com & www.suez-na.com

Veolia helps pharmaceutical manufacturer in South Africa meet strict standards of purity for process water

Edited by Simon Atkinson

In South Africa, a global speciality and branded multinational pharmaceutical company – with a presence in both emerging and developed markets – is installing a water purification system from Veolia Water Technologies as part of an expansion project at its plant based in Korsten, Port Elizabeth. This brief focus article takes a look at what is involved and how it will help the company meet strict standards of purity for process water.

Facilities that manufacture pharmaceuticals require process water that meets strict standards of purity.

Veolia Water Technologies has developed a range of packaged water purification systems that are designed to help manufacturers meet compliance with all regulations with a cost-effective, efficient and reliable supply of water.

Such a system was recently supplied to Aspen Pharmacare's SVP 2 (sterile facility) plant in Korsten, Port Elizabeth, South Africa, which is being expanded.

Sixth installation

Aspen Pharmacare has a long-standing relationship with Veolia Water Technologies South Africa, where the company's Orion® purified water systems have been supplied to meet the pharmaceutical manufacturer's requirements for purified water.

'…the company's Orion® purified water systems have been supplied to meet the pharmaceutical manufacturer's requirements for purified water.'

This will be the sixth Orion purified water system to be installed at the firm's site based in Port Elizabeth, as part of its Stockholm Clean Utilities project which involves the reuse and recycling of water and wastewater.

In April 2019, the contract was awarded to Veolia Water Technologies South Africa for the design, supply, manufacture, delivery, installation and commissioning of a new Orion 9000MKIII purified water generation unit, complete with pretreatment skids for Aspen Pharmacare's SVP 2 facility.

RO and CEDI technology

The system was imported by sea freight from SOLYS UK, another Veolia business unit.

'This was freighted on completion of the factory acceptance test in mid-August,' said Vashlin Govender, Business Development Manager, Veolia Water Technologies South Africa. The pretreatment skids are designed and produced locally.

The Orion 9000MKIII E-Series that was supplied is described as a hot-water sanitisable, purified water generator. It is based on reverse osmosis (RO) and continuous electrodeionisation CEDI technology.

Veolia Water Technologies' Orion® packaged systems are pre-validated, skid-mounted units developed specifically for the pharmaceutical market, and they are compliant with all industry requirements *(photograph courtesy of Water Technologies South Africa).*

Incorporating BES Duplex Softeners, it will produce 9000 l/h of purified water – compliant with European and US Pharmacopoeia regulations – for the production of clean utilities for Aspen Pharmacare.

Maintenance support

Veolia also provides continuous operations and maintenance support for all purified water generation and distribution plants installed at Aspen's Port Elizabeth site.

This includes continual technical support and the provision for the supply of spares and annual maintenance servicing when requested.

'We also have a formal service-level agreement (SLA) with Aspen Pharmacare, with an optional renewal on an annual basis,' continued Govender.

According to this SLA, Veolia performs a number of scheduled equipment inspections through the course of the year to assess the performance of the various purified water plants and identify potential operational and technical issues to be addressed via preventative maintenance.

Veolia's water treatment technology, which is targeted at companies operating in the pharmaceutical industry in South Africa, Africa and internationally, includes systems for producing purified water, highly purified water, pyrogen-free water and water for injection.

For further information, visit:
www.veoliawatertechnologies.com,
www.veoliawatertechnologies.co.za &
https://solys.shop.veoliawatertechnologies.com

(This technology focus is based on press material issued by Water Technologies South Africa.)

RO-based system ensures alcohol-free beer retains its genuine flavour and original features

Edited by Simon Atkinson

Finnish brewery Laitilan Wirvoitusjuomatehdas Oy is employing the membrane-based AromaPlus de-alcoholisation system from GEA Group Aktiengesellschaft in part of the process it uses to produce alcohol-free beer. Used for the first time in Scandinavia, this technology ensures that the independent brewery's Laitilan Kukko beer retains its genuine flavour and original features, as this brief article explains.

Laitilan Wirvoitusjuomatehdas started operating in 1995 and is now the fourth largest brewery in Finland. Its Kukko beer was the world's first full-malt beer to receive the international gluten-free product trademark in 2005.

'Laitilan wanted to avoid wort-like flavours and achieve the best results in terms of taste and quality.'

There are several different ways of producing de-alcoholised or non-alcoholic beer. Laitilan wanted to avoid wort-like flavours and achieve the best results in terms of taste and quality. It selected AromaPlus, a membrane-based filtration system developed by GEA – which supplies machinery, plants, and process technology and components to the food-processing industry and a range of other sectors – because it ensures that the genuine flavour and original features of the beer are retained.

Laitilan Oy's brewmaster Ville Vilen makes no compromises when it comes to taste and quality *(photograph courtesy of Laitilan Oy and GEA Group Aktiengesellschaft).*

GEA AromaPlus is in use at breweries throughout Europe. However, Laitilan is the first Scandinavian brewer to purchase this system. The de-alcoholisation plant was installed towards the end of 2019.

Reverse osmosis

During a separator installation at the Laitilan brewery in 2017, plant manager Tommi Suutari asked GEA about possible systems for beer de-alcoholisation. At that time GEA had just developed and launched AromaPlus, a new process unit that uses membrane-based filtration. Laitilan decided to investigate this technology further.

AromaPlus uses reverse osmosis (RO), which allows the passage of alcohol and water, whilst retaining essential ingredients that contribute to aroma, colour and turbidity. The system achieves the required alcohol-free percentage of 0.5% – down to 0.05% – says GEA.

Retaining flavour

According to GEA, cold separation techniques, based on membrane-based filtration technology, have less impact on beer flavour and more of the aroma is maintained, compared with de-alcoholisation methods that rely on thermal processes.

After having visited one of the first producers of de-alcoholised beer using the AromaPlus – the Schönbuch brewery in Stuttgart, Germany – and having tested the technology to de-alcoholise its own beer using GEA's pilot plant, Laitilan was convinced that it should employ the technology.

GEA product manager Ralf Scheibner explained: 'We put a lot of effort into developing the new AromaPlus process and now we are seeing that demand for non-alcoholic beer is increasing. Our solution has been well-received and is very much appreciated by breweries and consumers.'

Unit design and layout

The de-alcoholisation unit is mounted on a frame and comes ready for installation. It includes the filtration modules, fitted with the AromaPlus RO membranes; pumps for media transport or for providing the required system pressure; the entire internal piping; a clean-in-place (CIP) dosing unit (installed next to the unit); and the control technology for semi-automated operation.

In addition to the de-alcoholisation process, the controller also manages the CIP process to ensure proper operation and reliable cleaning of the membranes.

AromaPlus units have a standardised layout and, depending on their size, are designed for batch processing volumes of approximately 50 hl/day to more than 600 hl/day. GEA also offers larger de-alcoholisation units for continuous processing of more than 50 hl/hour.

For further information, visit: www.gea.com & https://laitilan.com/en

(This technology focus is based on press material issued by GEA Group Aktiengesellschaft.)

Submerging polymer in water drastically improves its CO_2 permeability whilst slightly enhancing its CO_2 selectivity

Edited by Simon Atkinson

Work done by a team comprising researchers from North Carolina State University, the Norwegian University of Science and Technology and the Università di Bologna has found that it is possible to significantly enhance a midblock-sulfonated multiblock polymer membrane's ability to selectively remove carbon dioxide from gas mixtures by first submerging the material in liquid water. This article provides a summary of the findings.

Polymer membranes that can filter out carbon dioxide (CO_2) are desirable for use in a variety of applications, such as removing CO_2 from natural gas and sequestering CO_2, in order to limit emissions from industrial facilities.

The polymer at issue in this research is a thermoplastic elastomer that is recyclable, relatively tough, and has been shown to have desirable properties[1] for a wide range of contemporary technologies.

Material permeability and selectivity

For this work, the researchers set out to see how the morphology of the material – how the molecular sequences comprising the polymer molecules are arranged relative to each other – affects its performance as a CO_2-selective membrane.

When dry, the permeability of CO_2 through the polymer examined in this research is less than 30 Barrer. Previous work[2] reported by members of the team had shown that inclusion of water vapour in the feed could improve CO_2 permeability – boosting it to as high as 100–190 Barrer, at relative humidity levels above 85%.

Normally, improving the permeability of a gas through a material impairs the material's selectivity.

To explain this, using CO_2 as an example, the more easily gases can pass through a material, the less able the material usually is to remove CO_2 from a gas mixture.

It lets through the CO_2, but it lets through other gases as well. There is a real tradeoff when engineering polymers for use as gas-separation membranes.

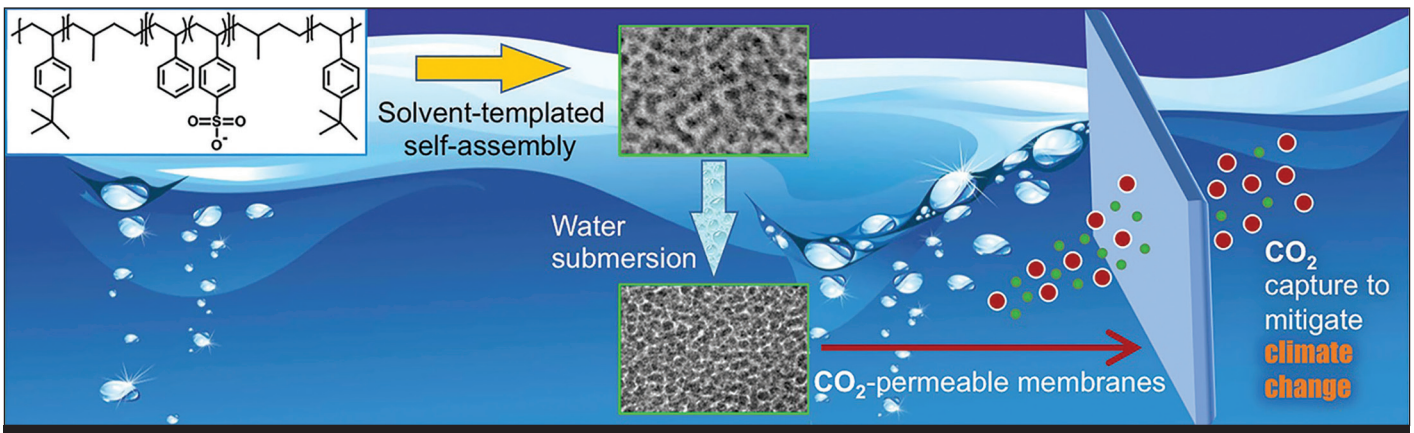
Drastic improvement

Rich Spontak, co-corresponding author of the paper on the work, and Distinguished Professor of Chemical and Biomolecular Engineering and Professor of Materials Science and Engineering at North Carolina State University (NCSU), commented: 'What is remarkable about our finding is that we were able to drastically improve the polymer's CO_2 permeability whilst also slightly enhancing its CO_2 selectivity.'

'…we were able to drastically improve the polymer's CO_2 permeability whilst also slightly enhancing its CO_2 selectivity.'

'And the process that led to this substantial improvement was related to transforming the microstructure of the membrane in low-cost and nontoxic fashion – we submerged the material in water.'

Liyuan Deng, Professor of Chemical Engineering at the Norwegian University of Science and Technology (NTNU) and co-corresponding author of the paper, added: 'With these new results, we have shown we can reach a permeability of almost 500 Barrer at 90% humidity.'



The process that led to the substantial improvement in the polymer membrane's characteristics related to transforming the microstructure of the membrane in a low-cost and nontoxic fashion – by submerging the material in water ***(diagram courtesy of Dr Zhongde Dai, NTNU).***

'At the same time, the selectivity of CO_2 relative to nitrogen (N_2) increases to as high as ~60.'

'For comparison, the best commercial polymer membranes that could be used for CO_2 capture possess a permeability up to ~200 Barrer and a CO_2/N_2 selectivity up to ~50. It is very important that both of these performance metrics are considered simultaneously to achieve competitive membranes.'

Potential

Professor Deng continued: 'This work demonstrates the polymer's potential for use in industrial gas separation and carbon capture technologies, with benefits for both manufacturing efficiency and efforts to mitigate global climate change.'

'It also provides a previously unexplored and facile route by which to transform the morphology of a polymer membrane and achieve tremendous improvement in gas transport properties.'

Support

The work was done with support from the European Commission within the NanoMEMC2 project in the Horizon 2020 research and innovation programme and the North Carolina State University Nonwovens Institute. The research also used resources at the Advanced Photon Source, a US Department of Energy Office of Science User Facility operated by Argonne National Laboratory.

For further information, contact:
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Email: rich_spontak@ncsu.edu, or Professor Liyuan Deng, Department of Chemical Engineering, NTNU, Email: liyuan.deng@ntnu.no

(This technology focus is based on press material issued by North Carolina State University.)

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(Further details of the research discussed in this article are presented in a paper entitled 'Highly CO_2-permeable membranes derived from a midblock-sulfonated multiblock polymer after submersion in water', which appears in *NPG Asia Materials* (https://doi.org/10.1038/s41427-019-0155-5) – an open access, international journal that publishes peer-reviewed review and primary research articles that cover all aspects of the materials sciences.

RESEARCH TRENDS

Phenol separation from saline wastewater using a membrane-based aromatic recovery system

According to the authors of this study, an electro-spun poly(dimethyl siloxane)/poly(methyl methacrylate) (PDMS/PMMA) membrane (EPPM) is an emerging material for use in a membrane aromatic recovery system (MARS) for phenol separation from saline wastewater. However, its application and performance in a MARS are hindered by poor mechanical properties. To solve this issue, thermoplastic polyurethane (TPU) was mixed with PDMS and PMMA to fabricate what is described as a novel electro-spun TPU/PDMS/PMMA membrane (ETPPM). Membrane morphologies showed that intrinsically random-oriented fibres of the EPPM were gradually changed into the self-bundled fibre yarns with a point-bonded structure. This led to the tensile strength and elongation at break for the third (ETPPM-3) morphology studied, increasing 12.6 times and 89.9%, respectively, after the addition of 1.5 g TPU. Furthermore, ETPPM-3 presented a simultaneous organophilic and hydrophobic surface with a phenol static contact angle of 0° and NaCl solution static contact angle of 143.4°, indicating its potential use in phenol separation from saline wastewater. After the MARS system operated for 24 hours, 498.3 mgl^{-1} of phenol was separated from the initial phenol saline wastewater (2.0 gl^{-1} phenol and 10.0 gl^{-1} NaCl), with an increases in conductivity of 21.2 μscm^{-1}. As a result, 24.9% phenol recovery and 99.86% salt rejection were achieved with a mean phenol mass-transfer coefficient of $7.3 \times 10^{-7} ms^{-1}$ and flux of 4.4×10^{-4} $kgm^{-2}s^{-1}$.

L.-F. Ren, E. Al Yousif, F. Xia, Y. Wang, L. Guo, Y. Tu, X. Zhang, J. Shao and Y. He:
Separation and Purification Technology, Volume 212, pages 21–29, (1 April 2019).
https://doi.org/10.1016/j.seppur.2018.11.006

Integration of silver nanoparticles and micro-current for water filtration

Silver nanoparticles (AgNPs) have been incorporated into water filtration membranes as an effective agent for controlling biofouling. However, the antimicrobial efficacy of silver is substantially reduced after sulfidation caused by sulfur species that are naturally present in many types of water. To minimise silver oxidation and flux loss, this paper proposes a novel strategy that integrates AgNP-impregnated membranes with low-intensity electro-filtration technology. Polysulfone membranes, incorporating AgNPs or polyaniline nanofibres, were fabricated using the wet phase-inversion method. The membranes were connected to the cathode of a low-intensity direct current source to form an electric field, which facilitated an electrophoretic force to direct aqueous ions. Without the presence of AgNPs, the low-intensity electric activation alone did not exert a significant effect on membrane filtration efficacy or biofilm resistance. However, the combined effect of AgNP and electric activation resulted in a substantial biofilm reduction against both gram-positive and gram-negative bacterial strains over a period of 24 hours. Mass spectrometry and X-ray photoelectron spectroscopy showed that the cathodisation preserved the metallic state of AgNPs for a long period, which led to superior performance, compared with passive AgNP membranes. The integration of AgNP and electro-filtration extended the duration of biofouling resistance and minimised the silver leaching. It is a low-input, innovative approach that addresses the primary limitations of silver-based membrane technologies, say the authors.

S. Maharubin, Y. Zhou and G.Z. Tan:
Separation and Purification Technology, Volume 212, pages 57–64, (1 April 2019).
https://doi.org/10.1016/j.seppur.2018.11.016

Recovery of sulphuric acid and added-value metals from acidic mine waters using NF membranes

Acidic mine water (AMW) contain, in addition to moderate concentrations of sulphuric acid, relatively high concentrations of transition elements (such as Fe, Al, Cu and Zn) and, in some cases, minor amounts of valuable rare earth elements (REEs). The established management routes for AMWs, based on the neutralisation and metal stabilisation as hydroxides, are limited by the associated costs, such as reagent consumption. Treatment processes based on nanofiltration (NF) have the potential to improve these management routes by recovering the sulphuric acid and simultaneously increasing the concentration of valuable elements (for example Zn, Cu and REEs) for further valorisation after the proper removal

of Fe. In this study, three different types of NF membranes were evaluated. These have a poly(piperazinamide) active layer (NF270); a double active layer (poly(piperazinamide)/proprietary polyamide) (Desal DL); and a sulphonated poly(ethersulphone) active layer (HydraCoRe 70pHT). The influence of Fe(III) concentration on the sulphuric acid recovery from solutions at pH 1 was characterised. NF270 showed the higher permeate fluxes and the higher heavy and REE metal rejections (that is, higher concentration factors). As the Fe(III) concentration increased, higher acid permeation was obtained, which helped to decrease the neutralisation costs during its post-treatment. The membrane chemistry of the active layer (nature and acid-base membrane properties) and structure (single/double layer) were found to be strong parameters in the membrane separation performance. Ion transport data were modelled according to a solution–electrodiffusion model coupled with ion reactive transport, and the membrane permeances to ions were determined.
J. López, M. Reig, O. Gibert and J.L. Cortina:
Separation and Purification Technology,
Volume 212, pages 180–190, (1 April 2019).
https://doi.org/10.1016/j.seppur.2018.11.022

UF with intermittent relaxation using colloidal silica and humic acid as model foulants

Crossflow microfiltration (MF) and ultrafiltration (UD) are widely used in membrane bioreactors for wastewater treatment and applications in the food, biotechnology and process industries. Membrane fouling is an endemic problem in these operations that can be mitigated by using backwashing and intermittent relaxation of the pressure or flux. Compared with backwashing, intermittent relaxation offers advantages because it does not alter the membrane morphology or damage susceptible membranes. It is also capable of removing the foulant cake layer uniformly, and is potentially more energy-efficient. This paper describes a study of intermittent relaxation to mitigate fouling under both constant flux and constant pressure operation, using a regenerated cellulose flat-sheet UF membrane (MWCO 30 kDa) and two model foulants: colloidal silica, which is completely rejected and highly compressible and metastable; and humic acid that is partially rejected, can cause internal pore fouling and is relatively incompressible. Intermittent relaxation more effectively mitigated humic acid fouling because of the compressibility and metastability of colloidal silica. An optimum relaxation frequency exists as a result of the counterbalancing effects between increasing the permeation flux and reducing the time for permeation, which is determined for both constant flux and constant pressure operation. Design heuristics are put forward for the operation of intermittent relaxation.
A.H. Taheri, L.N. Sim, W.B. Krantz and A.G. Fane:
Separation and Purification Technology,
Volume 212, pages 262–272 (1 April 2019).
https://doi.org/10.1016/j.seppur.2018.11.037

Fabrication of a membrane with controllable transport properties

Porous polymeric membranes are widely used in potable water purification, wastewater treatment, the food and the pharmaceutical industries and for haemodialysis. However, producing specialised membranes with diverse transport properties is challenging. A method for fabricating membranes with controllable transport properties is described by the authors of this paper. It involves stepwise synthesis of aromatic oligoamide on a porous polymeric support. The use of aromatic oligoamide affords good water permeance because of its hydrophilic character. Alternate couplings of trimesoyl chloride and *meta*-phenylenediamine yielded an oligoamide dendrimer that was covalently bonded to the support. The water permeance and molecular weight cutoff (MWCO) of the synthesised membranes were controlled (with values of 4.6–543 $lm^{-2}h^{-1}bar^{-1}$ and 22.6–332 kDa, respectively) by adjusting the number of oligoamide synthesis cycles in the range of 2.5–20.5. The oligoamide membrane with 5.5 synthetic cycles showed a high rejection of the negatively charged rose bengal dye (95% rejection) with high flux (126.4 ± 4.2 l m^{-2} h^{-1} at 5.2 bar), compared with other membranes reported in the literature. The fabricated membranes are potentially highly useful for the separation of macromolecules with specific ranges of molecular weight, for industrial separation processes that require membranes with tunable MWCO ranges, or for the separation of charged macromolecules.
P. Manna, A. Tiraferri, M. Sangermano, R. Bernstein and R. Kasher:
Separation and Purification Technology,
Volume 213, pages 11–18 (15 April 2019).
https://doi.org/10.1016/j.seppur.2018.12.014

Current trends and future prospects for removing ammonia from wastewater

The excessive amount of ammonia present in water streams is contributing to a serious shortage of potable water worldwide. The application of conventional methods that are used to remove ammonia suffer from many drawbacks. For this reason, the shift towards using adsorptive membrane technology to eliminate ammonia is gaining great attention because of its outstanding performance – attributable to the hybrid process, that is, adsorption and filtration approaches, as a single step. This review critically discusses the current trends in methods used for ammonia removal and ways of fabricating adsorptive membranes. Also discussed is the potential use of natural zeolite as an adsorptive membrane.
M.R. Adam, M.H.D. Othman, R.A. Samah, M.H. Puteh, A.F. Ismail, A. Mustafa, M.A. Rahman and J. Jaafar:
Separation and Purification Technology,
Volume 213, pages 114-132 (15 April 2019).
https://doi.org/10.1016/j.seppur.2018.12.030

Gradual PVP leaching from PVDF/PVP blend membranes and its effects on membrane fouling in MBRs

Membrane bioreactors (MBRs) for wastewater treatment have become a more mature technology and gained an increasing market share. However, membrane fouling is still one of the main challenges and it has long been one of the main focuses of MBR research. Proper control of membrane fouling requires a more complex operation. Eventually, it causes permanent membrane permeance loss which leads to the need for membrane replacement. One recent MBR development is the application of a magnetically induced membrane vibration (MMV) system. This offers a substantial advantage in sustaining the membrane performance by enhancing the liquid flow hydrodynamics on the membrane surface. Improving the hydrodynamics on the membrane surface in a magnetically induced membrane vibration system (MMV) has been proven efficient for membrane fouling control in membrane bioreactors. This advantage can be further extended by using an optimised membrane. This is realised in this study by preparing porous polyvinylidene fluoride (PVDF) membranes via polyvinylpyrrolidone (PVP) blending and later by leaching out the PVP from the membrane matrix via post-treatment using NaOCl. The results show that increasing the PVP content in the casting solution increases membrane fouling resistance. Slowly leaching of PVP after several periodic NaOCl cleanings increased membrane permeance. No advantage of NaOCl post-treatment was observed. The long-term filtration confirmed the superiority of the highly porous membrane that complemented the advantages offered by the MMV system. This suggests that despite the small quantity of the remaining PVP, its leaching offered a substantial gain to improve membrane filterability.
L. Marbelia, M.R. Bilad and I.F.J. Vankelecom:
Separation and Purification Technology,
Volume 213, pages 276–282 (15 April 2019).
https://doi.org/10.1016/j.seppur.2018.12.045

PATENTS

Membrane element and filter cartridge

Applicant: **A.O. Smith Corp, USA**
This patent discloses details of a membrane element and filter cartridge. The membrane element comprises: a water-collecting tube; and first and second membrane units wound onto this tube. The wastewater outlet of the first membrane unit is connected to the raw-water inlet of the second membrane unit. When the first and second membrane units are expanded, the wastewater outlet of the first membrane unit and the raw-water inlet of the second membrane unit are located on the same side. The first and second membrane units may be wound on the water-collecting tube together, in one step. According to various embodiments, in this implementation the surface flow-rate of the membrane element can be improved, the anti-contamination performance of the membrane is enhanced, the service life of the membrane is prolonged and the pure water yield of the element, under constant water inlet pressure, remains unchanged. In addition, the method for preparing the membrane element is relatively simple. The membrane element that is detailed by the various embodiments has a small size.
Patent number: WO/2019/037713
Inventors: K. Shen, Y. Hou and C. Wang
Publication date: 28 February 2019

Apparatus and method for treating hard water

Applicant: **Organo Corp, Japan**
An apparatus and method for treating water with a hardness component forms the subject of this patent. It is used as part of a reverse osmosis (RO) membrane-based treatment process, which is used after the water, containing the hardness component, has been softened. The apparatus and method described are able to reduce the volume of hardness components in the concentrate that is produced in the latter stage. The apparatus includes: a reaction tank, for adding an alkaline agent and/or a carbonic acid compound to the water, in order to make the hardness components insoluble; a system for performing solid–liquid separation of the insoluble product obtained; a RO membrane device for treating the solid–liquid separation liquid to obtain a concentrate and permeate; and a pipe for returning at least a portion of the concentrate obtained, to the earlier stage of the solid–liquid separation system.
Patent number: WO/2019/044197
Inventors: T. Nakano, K. Fukumizu and A. Takada
Publication date: 7 March 2019

Membranes for gas separation

Applicant: **Ohio State Innovation Foundation, USA**
Membranes, together with methods for making and using them are described by this patent. The membranes are composed of a support layer and a selective polymer layer that is disposed on the support layer. In some cases, the support layer may comprise a gas-permeable polymer and hydrophilic additive dispersed within the gas permeable polymer. In other cases, the selective polymer layer is composed of a selective polymer matrix and carbon nanotubes dispersed within the matrix. According to the inventors, the membranes exhibit selective permeability to gases. As such, they can be used for the selective separation of carbon dioxide and/or hydrogen sulfide from hydrogen and/or nitrogen.
Patent number: WO/2019/040445
Inventors: W.S.W. Ho, D. Wu and Y. Han
Publication date: 28 February 2019

Highly selective transport membrane

Applicant: **UOP Llc, USA**
This invention concerns a highly selective and stable transport membrane. The method used to make this membrane is also described. It comprises a polyethersulfone (PES)/polyethylene oxide-polysilsesquioxane (PEO-Si) blend support material, and a hydrophilic polymer inside the pores on the skin layer surface of the PES/PEO-Si support. A hydrophilic polymer is coated on the skin layer surface of the PES/PEO-Si blend support membrane, and metal salts are incorporated into the hydrophilic polymer coating layer and the skin layer surface pores of the PES/PEO-Si support membrane. This invention also relates to a method for using this membrane for olefin/paraffin separation, for example, propylene/propane and ethylene/ethane separation processes.
Patent number: WO/2019/040633
Inventors: C. Liu, N.K. Karns, H.Q. Tran and D. Le
Publication date: 28 February 2019

Methods, systems and compositions for delivering nano-bubbles in water treatment systems

Applicant: **The Regents of the University of California, USA**
This patent provides details of methods, systems and devices for water treatment or for preventing the fouling of components used in such systems. The aim is to introduced – upstream – nano-bubbles in-line and/or in close proximity to a reverse osmosis (RO) membrane in the water treatment system. According to the inventors, these nano-bubbles bind to and cluster (flocculate) nanoparticles (and possible larger solid particles) so that they can be removed and not foul water purification components such as the RO membranes. The nano-bubbles also interact with (and change) some characteristics of the nanoparticles and, thereby, reduce fouling of system components, such as the RO membranes, or other components. The systems, methods and devices disclosed can be used to help produce potable water that is safe for human consumption in a more cost-effective manner by, for example, reducing maintenance costs and, in some cases, manufacturing costs.
Patent number: WO/2019/046490
Inventors: J.C. Earthman, M.K. Misra and S.D. Slingsby
Publication date: 7 March 2019

Concentrating aqueous solutions using hybridising electrodialysis and other desalination techniques

Applicant: **Massachusetts Institute of Technology, USA**
This invention relates to a method and apparatus for concentrating an aqueous solution, using a hybridisation of electrodialysis with another desalination technique, such as reverse osmosis (RO). According to the associated patent, an aqueous solution flows through a desalination system that separates it into purified water and concentrated brine. The concentrated brine is directed into an electrodialysis system that includes an anode and cathode and at least two monovalent selective ion-exchange membranes (between the anode and cathode). At least one of these selective ion-exchange membranes separates at least one diluate channel from at least one concentrate channel in the electrodialysis system, and this membrane selectively enables at least one monovalent ion to pass through the membrane whilst blocking or inhibiting the transport of multivalent ions. The concentrated brine flows through at least the concentrate channel whilst a voltage is applied to the anode and cathode. An additional volume of aqueous solution flows through the diluate channel.
Patent number: WO/2019/046628
Inventors: J. Lienhard, K. Nayar, R. McGovern and B. Al-Anzi
Publication date: 7 March 2019

Synthetic membrane composition comprising a polyurethane blend

Applicant: **DSM IP Assets BV, The Netherlands**
This patent provides details of a membrane, a composition for forming it and a method

for producing it. Also described are sensors and other devices that make use of this membrane. The membrane contains a polyurethane component comprising a blend of 5–95 wt% (based on the total weight of the polyurethane component) of an amphiphilic polyurethane, and 5–95 wt% (again based on the total weight of the polyurethane component) of a hydrophobic polyurethane. The compositions, methods, membranes and articles disclosed may exhibit benefits in film formation, reproducibility, mechanical properties, anti-fouling, health and safety, improved compatibility with sensors, and/or solvent removal, say the inventors.
Patent number: WO/2019/046281
Inventors: J. Al-Rashid, C. Sugiyama, J. Zupancich and D.P. Chalasani
Publication date: 7 March 2019

Method for manufacturing a membrane with a co-solvent in the polymer dope solution

Applicant: **BASF SE, Germany**
This invention relates to a process for making a membrane. It involves a series of steps. In the first step described, a dope solution is created that comprises a polymer, selected from polyphenylenesulfone (PPSU) or mixtures of PPSU with non-ionic polyarylene ethers; a first solvent, selected from aprotic polar solvents; and a co-solvent selected from C2–C8 alkanediol, C3–C8 alkanetriol, polyethylene glycol, or a mixture of these. The membrane is prepared by bringing together the dope solution and a coagulating agent. The associated patent also discusses the membrane obtained by using the process described.
Patent number: WO/2019/042749
Inventors: O. Gronwald, M. Weber and M. Heijnen
Publication date: 7 March 2019

Hollow-fibre membrane

Applicant: **Asahi Kasei Kabushiki Kaisha, Japan**
The abstract of this patent describes a process for creating a porous hollow-fibre membrane. One step involves preparing a mixture by combining, and "hot mixing" or "melt-kneading", a thermoplastic resin, a non-solvent and an inorganic compound. The non-solvent does not evenly dissolve a 0.25 mass ratio of the thermoplastic resin at a temperature that is lower than the boiling point of the solution or 250°C.
Patent number: WO/2019/045069
Inventor: D. Okamura
Publication date: 7 March 2019

Separation membrane based on a cellulose compound

Applicant: **Fujifilm Corp, Japan**
A composition for forming a separation membrane is discussed by this patent as is the production method used to make it. According to the patent's abstract, a separation membrane is produced that simultaneously has a higher level of separation selectivity and permissivity even when it is used under high-pressure conditions. Also covered are a separation module and device that is based on the membrane described. The invention also pertains to a cellulose compound that is suitable as a constituent material for the separation membrane. The cellulose compound has a Hansen solubility parameter in which the polar parameter δP and the hydrogen bonding parameter δH satisfy the formulae δP > 9.0 and δH < 13.8. The separation membrane has a separation layer containing the cellulose compound. The composition used to make the separation membrane contains the cellulose compound, and a polymer and solvent. The production method involves applying the composition to a porous support layer and then drying the composition.
Patent number: WO/2019/044196
Inventor: Y. Iizuka
Publication date: 7 March 2019

High-flux RO membrane

Applicant: **UOP Llc, USA**
This patent provides details of a high flux reverse osmosis (RO) membrane. A method for making this membrane is also described. It comprises a nanoporous polyethersulfone (PES)/polyethylene oxide-polysilsesquioxane (PEO-Si) blend support material (PES/PEO-Si); a hydrophilic polymer inside the pores of the skin-layer surface of the PES/PEO-Si blend support membrane; and a thin, nanometre layer of cross-linked polyamide on the skin layer surface of the blend support membrane This invention also provides a method of using this high-flux RO membrane for water purification.
Patent number: WO/2019/046068
Inventors: C. Liu, N.K. Karns, H.Q. Tran and D. Le
Publication date: 7 March 2019

Filtration assembly and method for microbiological testing

Applicant: **Merck Patent GmbH, Germany**
This invention concerns a filtration assembly for microbiological testing and a method for using the filtration assembly for that purpose. The assembly comprises a ring-like membrane support, which holds a filtration membrane; and a cylindrical reservoir of which opposite axial ends have openings, and one axial opening can be removed and attached (but is also fluid-tight) to the membrane support to define a sample volume adjacent to the filtration membrane on one axial side of the membrane support. In addition, a drain member (which again can be removed and attached, but is fluid-tight) defines a drain channel adjacent to the filtration membrane on an opposite axial side of the membrane support.
Patent number: WO/2019/048402
Inventors: P. Rivat, M. Arrault and V. Schaal
Publication date: 14 March 2019

Apparatus for *in situ* product recovery

Applicant: **VITO NV, Belgium**
A method and apparatus for *in situ* product recovery have been developed and are detailed by this patent. The method involves adding a substrate (biomass is mentioned in the decsription) to a medium contained in a reactor, and reacting the substrate to form the compound. A first stream is separated from the reaction liquid through a first membrane. In addition, a second stream is separated from the reaction liquid through a second membrane. The first membrane is for filtration, whilst the second one is configured for liquid–gas or liquid–liquid extraction. The first and second membranes are at least partially immersed in the medium and are moved relative to the reactor during the separation steps.
Patent number: WO/2019/048438
Inventors: W. van Hecke, H. Elslander, K. Vanbroekhoven, H. De Wever and H. Beckers
Publication date: 14 March 2019

Filtration method using a porous membrane

Applicant: **Asahi Kasei Kabushiki Kaisha, Japan**
A filtration method is described by this patent that includes a cleaning step, which uses a chemical agent. The method also involves a filtration step in which the liquid to be filtered is passed through a porous membrane made from a resin. A cleaning step is described in which the interior of the porous membrane is cleaned after the filtration step. According to the patent's abstract, the area ratio of the resin part, which has an area of 1 μm^2, or less, included in each "visual field" is 70% or more with respect to the total area of all the resin parts included in each visual field in all the visual fields in the cross section inside the film. In addition,

the area ratio of the resin part, with an area of 10 μm^2, or more, included in each of the fields of view is 15% or less that the total area of all the resin parts included in each of the fields of view. The cleaning step uses an aqueous solution of at least 1% sodium hydroxide, which is passed through the porous membrane.
Patent number: WO/2019/049858
Inventor: D. Okamura
Publication date: 14 March 2019

Microporous membrane and method for making it

Applicant: **Fresenius Medical Care Holdings Inc, USA**
A method is disclosed for forming a microporous membrane that incorporates an additive, which has low water solubility at the membrane's active surface, from a precipitation fluid. The additive is said to improve one or more of the membrane's characteristics, including its hydrophilic properties, wettability, anti-fouling behaviour, blood compatibility, and stability over long periods of use, or repetitive use. The microporous membrane based on this modified active surface can take the form of a hollow fibre, flat sheet, or other self-supporting shape. It can be used for filtration or a solute and/or solvent exchange process, which involves contacting the aqueous-based fluid, or blood, with the membrane, in processes such as dialysis, blood oxygenation, or blood separation filtration, or other related processes.
Patent number: WO/2019/051345
Inventors: P. Kosaraju, M.P. Hall and J. Teo
Publication date: 14 March 2019

Proton selective membrane

Applicant: **Stichting Wetsus, European Centre of Excellence for Sustainable Water Technology, The Netherlands**
This invention relates to a membrane for pure proton conduction. It incorporates a layer of water which, according to the associated patent, is 'substantially entirely in a solid state' (ice). The invention also relates to a device for storing and/or producing energy. The device described contains a housing which is filled with fluid. An electrode is positioned in a first compartment in the housing, and an electrode is located in a second compartment in the housing. The membrane is positioned so that it forms the first and second compartments. The electrodes are connected to an external power source and/or a load in order to form an electric circuit.
Patent number: WO/2019/050409
Inventors: W.J. van Egmond, M. Saakes and H. van de Kooi
Publication date: 14 March 2019

Systems and methods for electrochemical reduction of carbon dioxide

Applicant: **The University of British Columbia, Canada**
A process and apparatus for reducing carbon dioxide, based on an electrocatalytic process, has been developed. It involves supplying a gas, containing carbon dioxide, to the cathode of an electrolytic cell composed of a membrane electrode assembly that includes a bipolar membrane, which separates the anode from the cathode. A support layer, containing water, is located between the bipolar membrane and the cathode. An electrical potential difference between the cathode and anode of the membrane electrode assembly reduces (electrocatalytically) the carbon dioxide to carbon monoxide or another useful chemical. The support layer ensures that the system operates stably at higher current densities.
Patent number: WO/2019/051609
Inventors: C. Berlinguette and D. Salvatore
Publication date: 21 March 2019

Extracting alkaline metals from metal-rich solutions using an ionic-conductive electrolyte membrane

Applicant: **Ampcera Inc, USA**
This patent provides details of a system and method for selectively extracting alkaline metal from a metal-rich solution – in particular extracting lithium from lithium-rich solutions. Although the system and method is typically described with reference to selectively extracting lithium from lithium-rich solutions using solid-state lithium-selective ionic-conductive electrolytes, the lithium-selective electrolytes may be replaced with solid-state ionic-conductive electrolytes of another chosen alkaline metal, such as sodium and potassium.
Patent number: WO/2019/055730
Inventors: H. Du, S. Zhu and J.E. Brown
Publication date: 21 March 2019

Proton-conducting polymer/synthetic resin composite

Applicant: **National Institute for Materials Science, Japan**
This invention pertains to a proton-conducting polymer/synthetic resin composite. It consists of a polymer electrolyte that exhibits proton conductivity and includes, for example, a fluoropolymer and a hydrocarbon-based polymer, and has enhanced mechanical properties. A proton-conducting electrolyte membrane is produced from the composite described. The fluoropolymer may be a perfluorosulfonic acid polymer. The hydrocarbon-based polymer may be a sulfonated polyphenylsulfone or another sulfonated polymer that has a specific structure. The proton-conducting polymer is the hydrocarbon-based polymer, and the hydrocarbon-based polymer and the synthetic resin may be at least partly cross-linked with each other. The synthetic resin may be a heat-cross-linking type functional synthetic resin, and is selected from the group consisting of Vinylon, polyimides, phenol-formaldehyde resins, melamine-formaldehyde resins, urea resins, nylons and polyurethanes.
Patent number: WO/2019/054098
Inventors: J. Kim and S. Matsushita
Publication date: 21 March 2019

Composite semipermeable membrane and method for manufacturing it

Applicant: **Nitto Denko Corp, Japan**
The purpose of this invention is to produce a composite semipermeable membrane that has superior oxidant resistance (chlorine resistance) and salt rejection, and a method for manufacturing it. This membrane has a skin layer, which includes a polyamide resin obtained by polymerisation of multifunctional amine and acid halide components, and is formed on the surface of a porous support body. The multifunctional amine component includes an alicyclic diamine. The skin layer has an absorption peak intensity of at least 0.03, which is obtained using Fourier transform infrared spectroscopy (FTIR) and originates in the stretching vibration of C=O in the amide groups.
Patent number: WO/2019/054119
Inventors: T. Miyabe, S. Inoue, Y. Okazaki and T. Ogawa
Publication date: 21 March 2019

Systems, devices and methods for extracorporeal removal of carbon dioxide

Applicants: **S.P. Keller, B.Y. Chang and J. Wang – USA**
This patent covers systems, devices and methods for removing carbon dioxide from a target fluid, for example, blood, to treat hypercarbic respiratory failure or another condition. The device described has first and second membrane components for removing dissolved gaseous carbon dioxide and bicarbonate from the fluid. These processes can be done simultaneously. The device can take the form of a cartridge configured for use in a dialysis system. A method of treatment is also discussed. It involves drawing blood from a patient and bringing this blood into contact with

a first membrane component, to which is applied a sweep gas, and a second membrane component to which a dialysate is applied. The dialysate's composition can be selected such that charge neutrality is maintained.
Patent number: WO/2019/055933
Inventors: S.P. Keller, B.Y. Chang and J. Wang
Publication date: 21 March 2019

Device for a tangential-flow filtration system

Applicants: **Sartorius Stedim Biotech GmbH**, and **DWI - Leibniz-Institut für Interaktive Materialien eV – Germany**
A filter device – in particular, one that is designed to be used in a tangential-flow filtration system – is described by this patent. It comprises at least one fluid inlet, at least one retentate outlet and at least one permeate outlet. The device also incorporates a membrane which, within the filter device, separates a retentate portion from a permeate portion. A flow fitting is arranged in the retentate portion and/or in the permeate portion and, rather than being formed from a woven or nonwoven fabric, it is made from a structured plastic/silicone part, or metal or ceramic component.
Patent number: WO/2019/057652
Inventors: S. Weisshaar, M. Leuthold, U. Grummert, M. Wessling, K. Baitalow and J. Loelsberg
Publication date: 28 March 2019

Filtration device and method

Applicant: **Fujifilm Corp, Japan**
A filtration device forms the subject of this patent. According to the patent's abstract, it comprises a meandering flow channel; a filtration membrane, which partitions the supply and permeation sides of the flow channel; a first flow-port, on one end of the supply side of the flow channel; a second flow-port on the other end of the supply side of the flow channel; a first exhaust port located on the permeation side of the flow channel; and a second exhaust port placed at a position differing from the first exhaust port, on the permeation side of the flow channel. A first feed, in which liquid that has entered from the first flow port is caused to flow out from the second flow-port, is processed using filtration alternately with a second feed, in which liquid that has entered from the second flow-port and flows out from the first flow-port. Whilst the first liquid feed is being processed, the liquid that has permeated through the filtration membrane is exhausted from the first exhaust port, and whilst the second liquid feed is being processed, the liquid that has permeated through the filtration membrane is exhausted from the second exhaust port.
Patent number: WO/2019/059241
Inventors: H. Takayama, H. Yamashita and M. Miyajima
Publication date: 28 March 2019

Electrolyser

Applicant: **Siemens Aktiengesellschaft, Germany**
This invention relates to an electrolyser that is composed of at least one electrolytic cell, comprising two electrodes – namely an anode and cathode. Each of these electrodes is in contact with an electrode compartment that is filled with a liquid electrolyte. The two electrode compartments are separated by a membrane and a conveying device – one for each of the two electrodes – for moving the electrolyte in each case in a circuit (cathode and anode circuit) through the electrode compartment via at least one collection vessel per circuit and back into the electrode chamber. This invention is characterised in that a device is provided outside the electrolytic cell, for conveying an auxiliary volume flow between the cathode and anode circuits.
Patent number: WO/2019/057593
Inventors: M. Hanebuth, G. Schmid, K. Stark and D. Taroata
Publication date: 28 March 2019

Method for creating a free-standing membrane for biological applications

Applicant: **Applied Materials Inc, USA**
A method is described for manufacturing well-controlled nanopores using directed self-assembly and for producing free-standing membranes using selective etching. In one aspect, one or more nanopores are formed by directed self-assembly with block co-polymers to shrink the critical dimension of a feature which is then transferred to a thin film. Another aspect of this patent involves forming a substrate. There is a thin film over a highly etchable layer of the latter. One or more nanopores are formed through the thin film over the highly etchable layer, and a portion of the layer is selectively removed under the one or more nanopores to form a thin, free-standing membrane.
Patent number: WO/2019/060168
Inventors: A. Vora, K. Ohno, P.A. Kraus, Z. Hesabi and J.R. Johnson
Publication date: 28 March 2019

Apparatus for efficient genetic modification of cells

Applicant: **The Charles Stark Draper Laboratory Inc, USA**
A device for the treatment of cells with particles is disclosed by this patent. The device includes a semi-permeable membrane that is positioned between two plates. The first plate defines a first flow-chamber and comprises a port, flow-channel, transverse port and a transverse flow-channel. The first flow-chamber is constructed and arranged to deliver fluid in a transverse direction along the first side of the semi-permeable membrane. The second plate defines a second flow-chamber and includes a port. A method for transducing cells is discussed. It involves introducing a fluid, with cells and viral particles, into the flow chamber adjacent to the semi-permeable membrane such that they (cells and viral particles) are substantially evenly distributed on the semi-permeable membrane. The method also includes introducing a recovery fluid to suspend the cells and the viral particles, and separating the cells from the viral particles. Also detailed is method for the activating cells.
Patent number: WO/2019/060642
Inventors: K.T. Kotz, B.D. Teece, J.G. Truslow and N.F. Moore
Publication date: 28 March 2019

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

EVENTS CALENDAR

16–20 March 2020
2020 Membrane Technology Conference & Exposition
Phoenix, Arizona, USA
Contact: American Membrane Technology Association (AMTA), 2409 SE Dixie Hwy, Stuart, FL 34996, USA
Tel: +1 772 463 0820
Email: custsrv@amtaorg.com
Email: events@amtaorg.com
www.amtaorg.com/awwa/mtc20reg

17 March 2020
MENA Water Summit
Kuwait City, Kuwait
Contact: Ulrika Varela, White Paper Summits Llc, PO Box 1406, PC 133 Al Khuwair, Sultanate of Oman
Tel: +968 24 788 476
Email: info@wpsummits.com
www.wpsummits.com/menawater

31 March to 1 April 2020
The Water Show Africa 2020
Johannesburg, South Africa
Contact: Terrapinn Holdings Ltd, Wren House, 43 Hatton Garden, London EC1N 8EL, UK
Tel: +44 20 7608 7030; Fax: +44 20 7608 7040
www.terrapinn.com/exhibition/water-africa/Conference.stm

14–17 April 2020
MELPRO 2020
Prague, Czech Republic
Contact: Česká Membránová Platforma z.s. (CZEMP), Mánesova 1580, 470 01 Česká Lípa, Czech Republic
Tel: +420 724 865 177
Email: conference@czemp.cz
www.melpro.cz
www.czemp.cz

20–24 April 2020
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: +1 615 250 7792, Fax: +1 615 530 1037
Email: deahna@afssociety.org
www.wfc13.com
www.afssociety.org

16–20 May 2020
NAMS 2020 – 29th Annual Meeting
Tempe, Arizona, USA
Contact: North American Membrane Society, University of Arkansas, Ralph E. Martin Department of Chemical Engineering, 3202 Bell Engineering Center, Fayetteville, AR 72701-1201, USA
Tel: +1 479 575 3419,
Fax: +1 479 575 7926
Email: Isabel.Escobar@uky.edu
www.membranes.org

17–20 June 2020
XIII Scientific Conference "Membranes and Membrane Processes in Environmental Protection"
Zakopane, Poland
Contact: Irena Korus, Silesian University of Technology, Institute of Water and Wastewater Engineering, Konarskiego 18, 44-100 Gliwice, Poland
Tel: +48 32 237 2020, Fax: +48 32 237 1047
Email:irena.korus@polsl.pl
http://mempep2020.systemcoffee.pl

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Commenting on the system, Malcolm Man, Executive Vice President, Saltworks, said: 'We have seen much customer demand from a wide range of industries for a proving plant that brings ultra-high-pressure RO to the market place.'

'Our clients seek to reduce brine volumes further, whilst using lower-cost and lower energy off-the-shelf reverse osmosis technology. They now have a new option built into a plant that can accept and tolerate their scaling ions, chemistry variability and robustness requirements.'

Saltworks says that the "turbocharging" relies on:

- BrineRefine technology to remove scaling ions, enabling downstream processing at extremely high recoveries;
- a novel real-time calcium sensor (developed by the firm after off-the-shelf sensors failed to meet requirements), which is capable of operating on challenging flows; and
- ultra-high-pressure RO spiral-wound membrane technology, operating at 1800 psi (120 bar or 12 MPa).

Combined, these technologies can concentrate highly scaling brines to 130 000 mg/l total dissolved solids. This means that the system can effectively treat PFAS- laden fluids, cooling tower blowdown, mine wastewater and other industrial saline waters.

The plant – which integrates all technologies into a tidy, intelligent package capable of operating on variable industrial flows – was built with funding and technical input from a leading RO membrane company, says Saltworks Technologies.

For further information, visit:
www.saltworkstech.com

Ionomr financing aids commercialisation of membrane technology

Canada's Ionomr Innovations, which is developing ion-exchange membrane and polymer solutions for use in zero-emission power sources for vehicles and energy storage for renewable power generation, has raised an additional C$3 million (US$2.3 million) in seed financing to advance the development, production and market expansion of its membranes and polymer products.

The Vancouver, British Columbia-based company was founded in 2017 to commercialise a major performance breakthrough from polymer research undertaken at Simon Fraser University. It has subsequently pioneered and advanced the development and production of environment-friendly membranes and polymer products for use in advanced fuel cells, hydrogen production, batteries and renewable energy generation storage systems. Ionomr says that its membranes and polymers will assist product developers to overcome cost, performance and environmental constraints by increasing performance and durability whilst eliminating the use of expensive precious metals and fluorinated compounds, which can adversely affect the environment.

'This new funding, which was led by BC-based seed fund Pallasite Ventures, will help us move rapidly and expand our work with internationally recognised companies and product developers in the emerging clean energy economy,' commented Bill Haberlin, CEO, Ionomr.

In 2018 Ionomr was awarded C$2.3 million (US$1.8 million) by Sustainable Development Technology Canada (SDTC) to support its development of a more efficient, durable and cost-effective membrane system for water treatment and purification, grid-level energy storage and clean-tech energy generation.

For further information, visit:
www.ionomr.com & www.pallasiteventures.com