ARC RESEARCH HUB
ENERGY EFFICIENT SEPARATION

HUB NEWSLETTER ISSUE 6, November 2021

DIRECTOR'S WELCOME

It would be fair to say that 2021 has not been what we had hoped, with many of the restrictions and limitations of last year impacting us again this year.

Nevertheless, I am proud to say that we have continued to strive for the best outcomes, collaborate where possible, and communicate our research via our regular webinar series. All webinars are recorded and can be watched online. Look out for the summaries and link on page 5.

Other highlights this year include members of our Hub being among the finalists in the Australia Museum Eureka Prize for Innovative Use of Technology. We also extend our congratulations to Hub CI Matthew Hill who was promoted to full professor this year. Matthew is an outstanding researcher and an recognised and respected expert in his field.

In research developments, our congratulations to Hub CI Professor Hokyong Shon for his successful bid to establish a new ARC Hub for Nutrients in a Circular Economy (NiCE). Read more about this wonderful initiative on page 2. Further, as our centre matures, we are proud to report on some of our PhD Alumni who have taken positions around the world, continuing their important work in their research field.

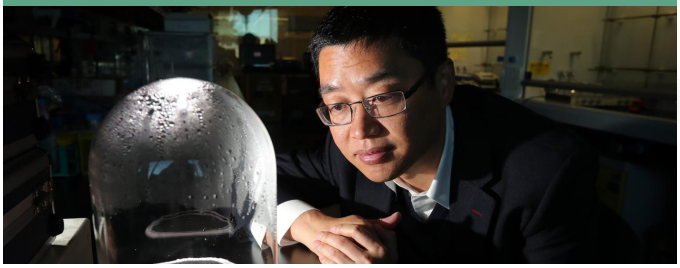
With another extraordinary year drawing to a close I would like to take the opportunity to thank all our Hub members and collaborators for their hard work this year and to extend my best wishes to our broader community. Looking forward to working with you all in 2022!

Professor Xiwang Zhang *(Hub Director)*

ARC Future Fellowship and Linkage Project for Prof Xiwang Zhang

Hub Director Professor Xiwang Zhang has been awarded a 2021 ARC Future Fellowship for his project *Epitaxial Stacking of Nanoporous Nanosheets for Next-generation Membranes*. This project aims to develop high-precision selective membranes, which are urgently needed in key Australian industries. The membranes facilitate solute-solute separation by constructing vertically-aligned and chemically-tailorable nanochannels using two-dimensional porous nanosheets as building blocks.

Adding to Professor Zhang's impressive research profile is a new ARC Linkage Project with industry collaborators Water Research Australia and GrapheneX Pty Ltd. The project, *Sustainable Hydrogen Production from Used Water*, aims to address the pressing challenge of water scarcity in hydrogen production by developing an innovative approach to apply used water as the feed for water electrolysis.



Public Service Award Received by Professor Matthew Hill

Congratulations to Hub CI Professor Matthew Hill, who received a Public Service Medal for outstanding public service to materials development for industry and the Australian Defence Force. Professor Hill is an internationally recognised expert in the design, synthesis and characterisation of nanomaterials. His service to the scientific community, both nationally and internationally, and the to the improvement of Australian's Defence capability, is recognised with this award.

In profile, Dr Lizhong He

Hub CI Dr Lizhong He is a Senior Lecturer at the Department of Chemical Engineering, Monash University with an interest in the interface between biomolecules and nanomaterials and how this can help build new functional products.

His multidisciplinary group carries out research in bioengineering and nanotechnology with the aim to develop products that are simple, cost-efficient and environmentally friendly. Their primary objective is to develop new and simple approaches to control assembly of biomolecules at interfaces with desirable attributes such as controlled orientations for the application of biocatalysis, drug-delivery and stimuli-responsive foams.

Specifically their research is centred on protein engineering, particularly for bio-interfaces involving biomolecular interactions at various interfaces like solid-liquid, liquid-air and nanoparticle surfaces. These materials are of great importance in the area of medical, pharmaceutical, biotechnological and food industries.

The team integrate bioengineering and nanotechnology to engineer advanced products ranging from stimuli-responsive peptide-controlled foams and functional foods, to nanoparticle-based enzyme biocatalysts and antibody-based biosensors.

Biophysical methods including neutron and x-ray scattering and surface plasmon resonance (SPR) are used to reveal interfacial structure of proteins and peptides, guiding design and production of advanced products at interfaces.

Prior to joining Monash University, Dr He was an AINSE Research Fellow and Deputy Director at the Centre for Biomolecular Engineering, Australian Institute for Bioengineering and Nanotechnology at The University of Queensland and spent two years as a postdoctoral researcher at the Max-Planck-Institute for Polymer Research in Germany.

READ MORE

Hub CI Prof Hokyong Shon leads new ARC Research Hub into a nutrient circular economy.

Hub CI Professor Ho Kyong Shon (UTS) has been successful in his bid for new ARC Research Hub for Nutrients in a Circular Economy (NiCE). NiCE aims to transform the wastewater industry with an unprecedented, city-scale circular economy of nutrients based on urine separation and processing at building level, to produce safe and effective liquid fertilisers.

The NiCE Hub will bring together the water and agriculture industries, along with manufactures, regulators, councils and communities to demonstrate a value chain for a circular economy of nutrients based on urine.

The ARC NiCE Hub aims to:

» Make removal, transport, and treatment of sewage adaptable to fast-changing cities by creating and demonstrating decentralised, precinct-scale nutrient recovery opportunities;

» Secure a new sustainable source of fertiliser for agriculture and horticulture through urine separation and processing at the source;

» Better protect waterways from the harms of excess nutrients (e.g. nitrogen and phosphorous), pharmaceuticals and hormones; and,

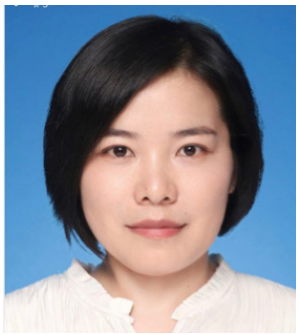
» Investigate the scalability, durability and resilience to variable field conditions of urine processing technologies for harvesting safe fertiliser with varying environmental and social challenges.

ALUMNI SNAPSHOT

Hub Alumna Dr Nawshad Akther received her PhD in 2021 and is now a Research Engineer at UTS.

Supervised by Prof Hokyong Shon from UTS during her PhD, her research focuses on the development of materials and advanced membranes for various applications.

Dr Nawshad Akther is known for her work on the synthesis of nanocomposite membranes modified with graphene oxide and derivatives for forward osmosis and has already published more than 20 journal articles in highly ranked international peer-reviewed journals. She also won more than 10 awards over the past two years for her research, including the Membrane Society of Australasia (MSA) Best Student Award (2021), MSA Best Short Talk Award (2020), UTS 3MT (2020), UTS Research Excellence Commendation Award (2019) and UTS Collaboration Experience Award (2019).



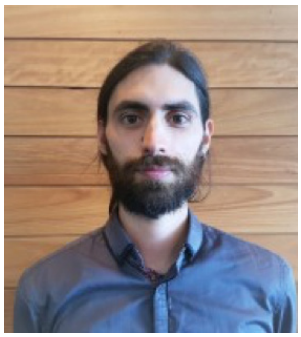
Hub Alumna Dr Xiaofang Chen collaborated with Baosteel while at the Hub and is now a Zijiang Research Fellow at East China Normal University.

Dr Chen completed her PhD and a postdoctoral research fellowship in Chemical Engineering at Monash University supervised by Professor Huanting Wang. She was awarded an “Excellent Research Award” by the Hub in 2019. Her current research focuses on nanocatalysts, two-dimensional materials, and nanoporous membranes for separations. She has published over 20 publications and four patents.

Alumnus Dr Baiqian Dai worked as a Research Fellow on a Hub project collaborating with Shanghai Boiler Works and is now a senior lecturer at Monash University Suzhou.

Dr Dai completed his PhD in 2017. His research interests focus on clean solid fuel utilisation technologies, solid waste utilisation, catalyst, and low emission technologies. He has been the Chief Investigator for several research projects, including Australia-China JCG exchange project, Brown Coal Innovation Project.

He has published more than 40 research papers in international journals and international conferences and is a board member for the journal of Minerals (SJR Q2) .



Dr Andrea Merenda was working as a researcher in a Hub project collaborating with CSL Behring (Australia). He is now an Associate Research Fellow at RMIT University.

Dr Andrea Merenda received his PhD from Deakin University in 2019. He holds a MSc in Chemical and Sustainable Engineering from the Polytechnic of Turin (Italy) and a MSc in Chemistry and Chemical Engineering from the Ecole Nationale Supérieure de Chimie de Montpellier (France).

He specialises in the design and synthesis of functional nanomaterials and stimuli-responsive surfaces, with a focus on heterogeneous catalysis and membrane catalytic reactors applied to the sustainable production of fuels and chemicals and to water remediation. Dr Merenda has published 34 research papers (since 2016, h-index: 11) and a book chapter. Dr Merenda is also Board Director of the Membrane Society of Australasia and member of the American Chemical Society.

Despite all the challenges that 2021 has thrown at us, we are pleased that we were able to continue to host our webinar series. We have listed some highlights below. The webinars can be watched via the link provided on page 5.

Dr Zongli Xie

Dr Zongli Xie has shared her research outcomes on the mixed matrix membranes in her webinar *Nanomaterials Enhanced Mixed Matrix Membranes for Efficient Separation of Aqueous Mixtures*.

Dr Jing Guan

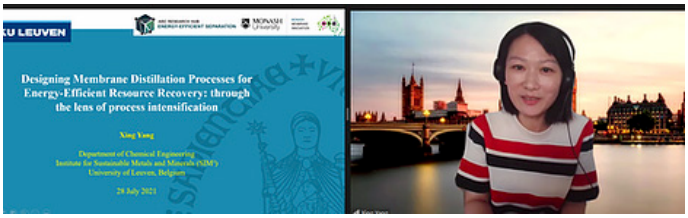
Chief Scientist of OriginWater Technology Co., Ltd., Dr Jing Guan spoke on the application of membrane technology in wastewater treatment and reuse in the industry. Novel technology has brought great success in wastewater treatment especially in China.

Professor Faisal Hai

Professor Faisal Hai from UOW has shared his journey working with a membrane bioreactor in waste water treatment during his talk *Membrane Bioreactor (MBR) and I: The Voyage Continues*.

Professor Xing Yang

Professor Xing Yang from KU Leuven Institute for Sustainable Metals and Minerals (SIM²) in Belgium delivered a talk *Designing membrane distillation processes for energy-efficient resource recovery: through the lens of process intensification*.

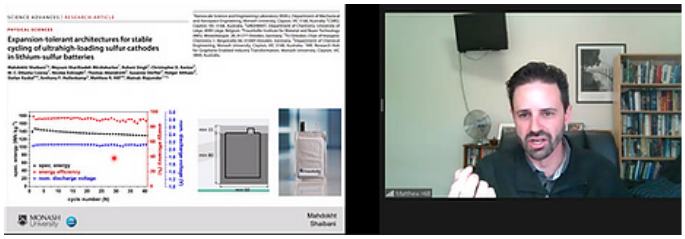


A/Professor Wenjing (Angela) Zhang

A/Professor Wenjing (Angela) Zhang delivered a great presentation from the Technical University of Denmark titled *Functional material and membrane design for water technology*.

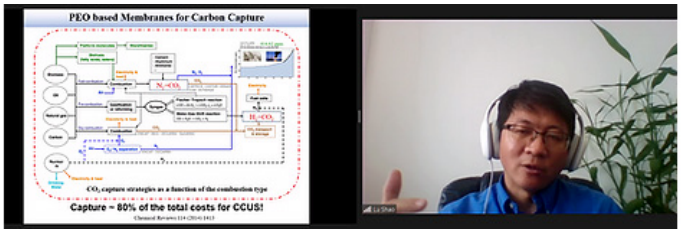
Professor Matthew Hill

Professor Matthew Hill has shared a new method to stop the physical aging of membranes, with discussion also the role and challenges of membranes in batteries



Professor Lu Shao

Professor Lu Shao from Harbin Institute of Technology (HIT) China delivered the talk *Fabricating Advanced Membranes for Molecular Separation*". Professor Shao has reported on a promising membrane in the carbon separation process.

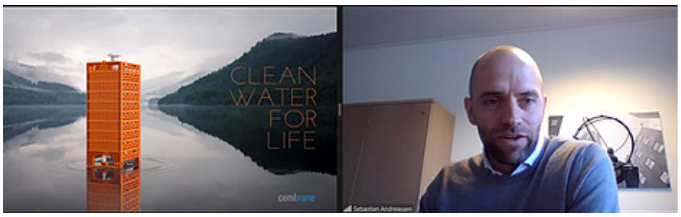


A/Professor Collin Scholes

A/Professor Collin Scholes from The University of Melbourne discussed the application of membranes in gas separation. A/ Scholes and his team have had success with their technology at an industrial scale.

Sebastian Andreassen

Mr Sebastian Andreassen, Co-founder and CCO from Cembrane, Denmark, delivered a great talk about the use of SiC ceramic membranes for water- and wastewater treatment. He shared the application of the membrane technology in water and wastewater treatment plants.



Professor Mikel Duke

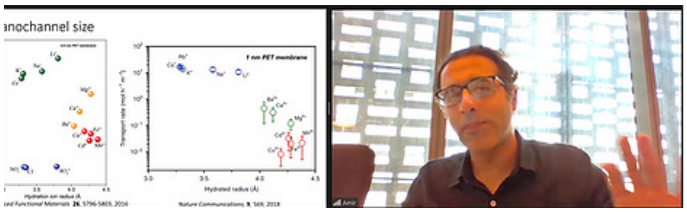
With his talk *Novel separation technology applications for waste reduction and resource recovery in the foods industry* Professor Mikel Duke (Victoria University) discussed new separation methods in reducing waste and recovering the resources.

Professor Tao He

Professor Tao He (the Editor of Desalination and the head of the Lab for Membrane Material and Separation Technology at Shanghai Advanced Research Institute, Chinese Academy of Sciences) delivered a great talk S*ustainable Membrane Extraction for Li Isotope Enrichment and Li Recovery: Development of Robust Solvent/Acid Resistant Membrane Based on Semicrystalline Polymers.*

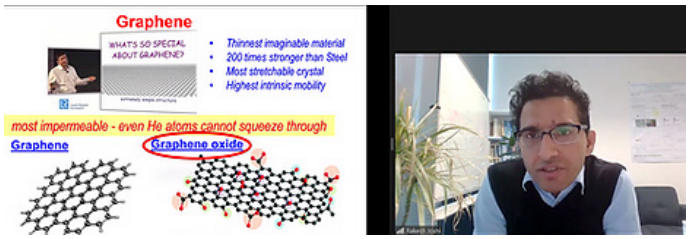
Dr Amir Razmjou

Dr Amir Razmjou from UTS presented a great webinar on the topic of *Emerging Direct Lithium Extraction (DLE) technologies for zero-carbon Li mining* in conjunction with the MSA Award Event.



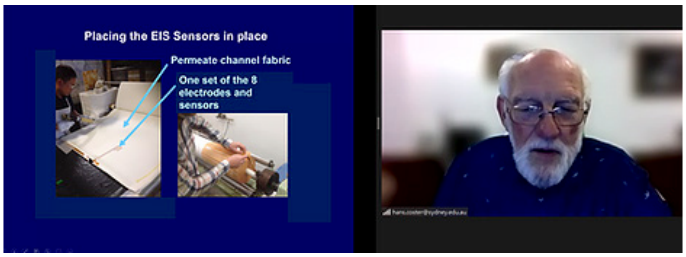
Dr Rakesh Joshi

Dr Joshi has delivered a very informative webinar titles *Applications of Graphene Oxide*. The Q&A session was very dynamic and inspired a lot of audience participation.



Emeritus Professor Hans G. L. Coster

Emeritus Professor Hans G. L. Coster presented a seminar on *Biofouling in RO Membranes: An In-situ Monitoring Technique*, providing insight into a non-destructive method to monitor the bio-fouling on the membrane.



Professor Menachem Elimelech

Over 100 participants joined in to listen to Professor Menachem Elimelech present his talk *Next Generation Desalination Membranes: Where Are We Now?*

Catch up or re-watch all of our webinars **HERE**

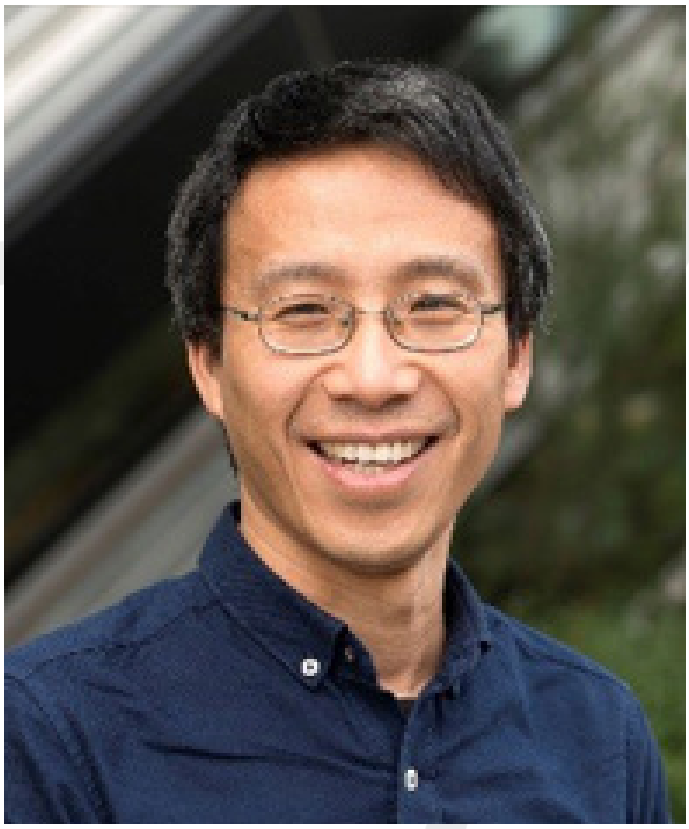
In profile, Associate Professor Lian Zhang

Hub CI Dr Lian Zhang, one of the 200 Inaugural Future Fellowship Awardees across Australia in 2009, specialises in the Research, Development and Deployment related to a broad range of high-efficiency and low-emission clean energy technologies, particularly for the advanced utilisation of low-rank coal, biomass and industry waste.

Dr Zhang leads an interdisciplinary research team investigating diverse topics including hydrometallurgical leaching of low-rank coal and biochar for the selective removal of troublesome elements; extraction of specific metals to make construction materials such as MgO-Board from low-rank coal fly ash and steelmaking slag; as well as the use of synchrotron – based facilities for both ex-situ and in-situ characterisation of a variety of solid products collected from the clean energy processes.

Additional to his research, Dr Zhang is also keen to commercialise a number of patented technologies that were developed by his group, including the manufacturing of high-pyrity $MgO/MgSO_4/CaO$ from low-rank coal fly ash, selective removal of troublesome elements from low-rank coal and biochar, and advanced catalysts for in-situ production of aromatic – rich hydrocarbons from the pyrolysis of low – rank coal and biomass.

Dr Zhang obtained his MEng in 1999 from the Chinese Academy of Sciences, and his PhD in 2003 from the Department of Applied Chemistry, Chubu University Japan. Dr Zhang undertakes extensive collaborative research with a variety of industry partners and research organisations across Australia and from overseas. He is a member of the Japan Society of Chemical Engineers, the Japan Institute of Energy and the Engineer Australia. He is currently leading the Clean Solid Fuel Laboratory (CSFL) in the Department of Chemical Engineering, Monash University, supervising one postdoctoral research fellow and eight PhD students.



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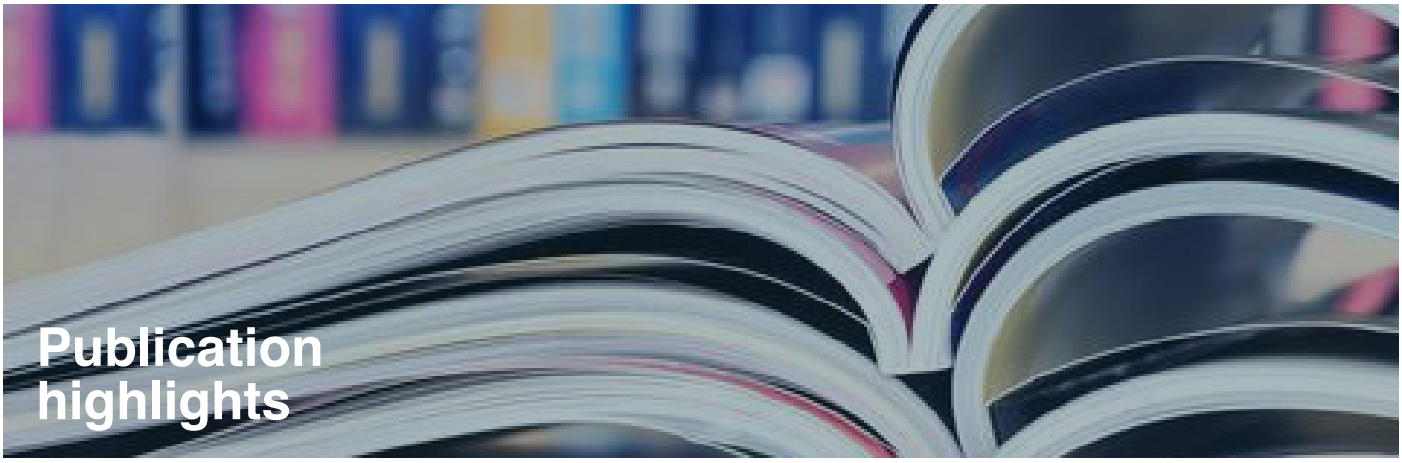
Shortlisted finalist for 2021 ANSTO Eureka Prize for Innovative Use of Technology

Congratulations to Prof Xiwang ZHANG (Director of ARC- EESEP), Prof Huanting Wang (Deputy Director of ARC- EESEP), Prof Matthew Hill (CI of ARC- EESEP), Dr Anita Hill (SAC of ARC-EESEP, CSIRO), Prof Benny Freeman (SAC of ARC- EESEP, The University of Texas at Austin), Dr Huacheng Zhang (RMIT University), Dr Jun Lu (Chemical Engineering), and Dr Xingya Li (Chemical Engineering for shortlisted finalist for 2021 ANSTO Eureka Prize for Innovative Use of Technology.

The Team has developed a controlled filtration technology that can separate lithium from other unwanted impurities with remarkable precision, heralding a new era in sustainable battery production.



Publication highlights

We have enjoyed a successful publication year, here are 20 highlights from Hub researchers in 2021.

Liu, S., **Low, Z.-X.**, Xie, Z., **Wang, H.**, *TEMPO-Oxidized Cellulose Nanofibers: A Renewable Nanomaterial for Environmental and Energy Applications*, (2021) Advanced Materials Technologies, 6 (7).

Chen, X., **Wang, H**., *Graphene oxide patchwork membranes*, (2021) Nature Nanotechnology, 16 (3), pp. 226-227.

Liu, S., **Low, Z.-X**., Hegab, H.M., Xie, Z., Ou, R., Mohammed, S., Simon, G.P., **Zhang, X., Zhang, L., Wang, H.**, *Robust Hilly Polyamide Membrane for Fast Desalination*, (2021) ACS Applied Polymer Materials, 3 (2), pp. 1070-1077.

Nyamutswa, L.T., Collins, S.F., Navaratna, D., **Duke, M.C**., *Light Transmitting Substrates for Convenient Solar Illumination of Nanophotocatalyst Coatings on Membranes for Low Pressure Water Filtration*, (2021) Materials and Energy, 17, pp. 459-489.

Zhang, J., Wang, G., Zhang, J., Xu, Z., Zhao, Y., Wang, Y., She, F., **Gray, S., Kong, L**., *Substrate-independent, regenerable anti-biofouling coating for polymeric membranes*, (2021) Membranes, 11 (3).

Pourabed, A., Younas, T., Liu, C., Shanbhag, B.K., **He, L**., Alan, T. *High throughput acoustic microfluidic mixer controls self-assembly of protein nanoparticles with tuneable sizes*, (2021) Journal of Colloid and Interface Science, 585, pp. 229-236.

Shanbhag, B.K., Liu, C., Pradeep, G.C., Younas, T., Hu, K.K.Y., Fulcher, A.J., Struwe, W.B., Steer, D., Dumsday, G., Harper, I.S., Kukura, P., Haritos, V.S., **He, L**., *Custom Design of Protein Particles as Multifunctional Biomaterials*, (2021) Advanced Functional Materials.

Quader, M.A., Rufford, T.E., **Smart, S**., *Integration of hybrid membrane-distillation processes to recover helium from pre-treated natural gas in liquefied natural gas plants*, (2021) Separation and Purification Technology, 263.

Vu, M.T., Nguyen, L.N., Hasan Johir, M.A.**, Zhang, X., Nghiem, L.D., Elimelech, M**., *Biogas sparging to control fouling and enhance resource recovery from anaerobically digested sludge centrate by forward osmosis*, (2021) Journal of Membrane Science, 625.

Tran, V.H., Phuntsho, S., Han, D.S., Dorji, U., **Zhang, X., Shon, H.K**., *Submerged module of outer selective hollow fiber membrane for effective fouling mitigation in osmotic membrane bioreactor for desalination*, (2020) Desalination, 496.

Ansari,A., Kavousi, S., Helfer, F., **Millar, G**., Thiel, D.V., *An improved modelling approach for the comprehensive study of direct contact membrane distillation*, (2021) Membranes, 11 (5).

AlZainati, N., Saleem, H., Altaee, A., Zaidi, S.J., Mohsen, M., Hawari, A., **Millar, G.J**., *Pressure retarded osmosis: Advancement, challenges and potential*, (2021) Journal of Water Process Engineering, 40.

Wang, M., Tan, X., Motuzas, J., Li, J., and **Liu. S**. *Hydrogen production by methane steam reforming using metallic nickel hollow fiber membranes*. (2021) Journal of Membrane Science 620.

Abid, H. R., Rada, Z. H., Liu, L., Wang, S. and **Liu, S**. *Striking CO_2 capture and CO2/N2 separation by Mn/Al bimetallic MIL-53*. (2021) Polyhedron 193.

Ni, T., Lin, J., **Kong, L**., Zhao, S. *Omniphobic membranes for distillation: Opportunities and challenges*. (2021), Chinese Chemical Letters.

Ali, S. M., Im, S., Jang, A., Phuntsho, S., **Shon H. K**. *Forward Osmosis System Design and Optimization Using a Commercial Hollow Fibre Membrane Module for Energy Efficient Desalination*. (2021) Desalination Volume 510, 115075.

Akther, N., Lin, Y., Wang, S., Phuntsho, S., Fu, Q., Ghaffour, N., Matsuyama, H., and **Shon, H. K**. *In situ ultrathin silica layer formation on polyamide thin-film composite membrane surface for enhanced forward osmosis performances*. (2021) Journal of Membrane Science, Volume 620, 118876.

Akther, N., Sanahuja-Embuena, V., Górecki, R., Phuntsho, S., Helix-Nielsen, C., **Shon, H. K**. *Employing the synergistic effect between aquaporin nanostructures and graphene oxide for enhanced separation performance of thin-film nanocomposite forward osmosis membranes.* (2021) Desalination, Volume 498, 114795.

Khan, J. A., Vu, M. T., **Nghiem, L. D**. *A preliminary assessment of forward osmosis to extract water from rumen fluid for artificial saliva*. (2021) Case Studies in Chemical and Environmental Engineering, Volume 3, 100095.

Vu, M. T., Nguyen, L. N., Johir, M. A. H., Ngo, H. H., Skidmore, C., Fontana, A., Galway, B., Bustamante, H, **Nghiem, L. D**. *Phosphorus removal from aqueous solution by steel making slag – Mechanisms and performance optimisation*. (2021) Journal of Cleaner Production, Volume 284, 124753.

Project Meeting with Water Utilities

Our project with the Victorian water authorities water authority Victoria has delivered significant and promising outcomes. Making the most of some COVID-19 freedoms earlier in the year, the team met face to face where our Hub researcher Dr Zhuyuan Zhang has presented the research outcomes to Dr Dharma Dharmabalan (previously TasWater), Dr Li Gao (South East Water) and Mr Joel Segal (South East Water). Plans for the future of the project were also discussed in the meeting.

Steering Committee Meeting

After a year of COVID-19 lockdowns, the steering committee could finally meet up to review the Hub's activities in 2020 and plan for the future direction of the Hub.

SCIENTIFIC & INDUSTRY WEBINAR SERIES

Wed, 17 Nov
Scientific & Industry Webinar Series
Prof Rong Wang - Revisit forward osmosis (FO) and pressure retarded osmosis (PRO) membrane technologies – where we are?

REGISTER HERE

UPCOMING EVENTS

The 11th International Membrane Science & Technology Conference (IMSTEC)
4 -8 December, 2022
Australia

THE 11TH INTERNATIONAL MEMBRANE SCIENCE & TECHNOLOGY CONFERENCE
4-8 DECEMBER 2022
MELBOURNE, AUSTRALIA

IMSTEC is co-organised by the Hub and MSA

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