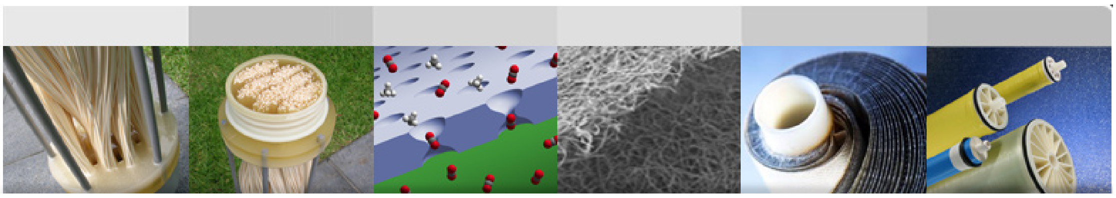
Membrane Society of Australasia



http://www.membrane-australasia.org

MSA Newsletter

October 2013

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Members who wish to contribute to future editions of the MSA Newsletter should contact the editor directly.

Inside this issue:

Upcoming events:

- International conference on membrane and electromembrane processes, MELPRO Prague - Czech Republic, 18-21 May 2014
- 12th International Conference on Inorganic Membranes, ICIM Brisbane—Australia, 6–9 July 2014
- International Conference on Membranes, ICOM Suzhou—China, 20—25 July 2014
- European conferences on Fluid-Particle Separation, Lyon—France, 15-17 October 2014
- 9th Conference of Aseanian Membrane Society, AMS9 Taipei—Taiwan, September 2015

Message from the President

This year will be a very important year for the MSA as we have brought to you the first IMSTEC conference. As you will read in this newsletter, it is already looking to become yet another successful conference with more than the expected number of delegates already registering. I would like to thank the UNESCO Centre for Membrane Science and Technology at the University of New South Wales, who have over decades, built up its excellent international reputation. We look forward to presenting you IMSTEC 2013 in Melbourne! Thank you to Profs Stephen Gray and Sandra Kentish, IMSTEC Co-Chairs, and the committees. But most of all, thank you to all the speakers and delegates.

However it doesn't stop there, as the MSA will also present ICIM in Brisbane next year in July together with Elsevier. ICIM is the world's premier conference on inorganic membranes. More details are found in this newsletter. If you are involved in research or industry on inorganic membranes, please consider submitting an abstract. If you are already an MSA member, you will find out more about ICIM via MSA email postings or the newsletters. If you are not already a member, please go to our website to join now and receive emails, newsletters and other benefits!

So I hope to see you at IMSTEC this year. If you are member, please make sure to join us at the members meeting to be held immediately after the conference close. More details of the meeting are found in this newsletter. This is a great time to get an update on the MSA's operation and activities and participate in discussions that shape the activities of the MSA.

I hope you enjoy our IMSTEC 2013 newsletter, and see you at the conference.

Associate Professor Mikel Duke — President of MSA

Update on the IMSTEC13 Conference

With only a bit more than two months before the next IMSTEC conference, the organising committee is delighted to update MSA members about the latest figures.

More than 300 abstracts have been submitted and accepted in the program as oral or poster presentations. To date, more than 160 delegates have already registered under the early-bird option, which has been extended until the 15th of September. So far, Siemens, MEP Instruments and NCEDA have confirmed their sponsorship.

Everything now indicates that the first IMSTEC organised by the MSA will be a great success. The Co-Chairs of the conference Stephen Gray and Sandra Kentish have been intensively working to welcome you all in Melbourne in November.

For more information, please visit

IMSTEC 2013

25th-29th November, 2013

Melbourne, Australia

Web: http://imstec2013.com/

Next MSA meeting

Time: after the IMSTEC closing ceremony on Thursday 28th Nov 2013.

Location: Room GM15 (same room as closing ceremony), Law Building, The University of Melbourne, Pelham Street, Parkville.

A new format for the AWA Membrane Speciality Group Conference, Brisbane July 2013 – Meeting Feedback

In July 2013, AWA organised and hosted two parallel events at the Brisbane Convention Centre: The "Asian Pacific Water Recycling" and the "Membranes and Desalination" Conferences, sponsored by the Australian Water Recycling Centre of Excellence and the National Centre of Excellence in Desalination, respectively. This effort can be considered as the new format for the successful "Membrane Speciality Conference" organised by AWA for the last few years.

With two parallel streams in each conference and a large number of workshops and keynote speakers, the program was of high interest for any "membrane in water" enthusiast. Presentations at the meeting span a wide range of topics from technological development to asset management, validation and regulation.

During the pre-conference workshop, a large emphasis was indeed brought to the socio-economic and regulatory challenges for the use of water recycling in regional and remote Australia. Although most of the topics have been widely recognised in the past, limited progress seems to have been achieved, given the roundtable discussion organised during the day. Still, very insightful case studies were presented.

The conferences started with keynotes from **Shane Snyder** (University of Arizona) and **Peter Moore** (COO of Water Corporation). Both presented the many current challenges faced by the industry, characterising Australia as "the canary in goldmine of climate change". Interesting feedbacks on the recently developed groundwater replenishment project in Perth were also presented by Peter.

Based on few case studies, **Ian Law** (from IBL Solutions) questioned the need to use reverse osmosis systems in potable reuse schemes. Indeed, competitive treatment trains processes including ozone and (biological) activated carbon have demonstrated higher sustainability for similar removal performances.

Discussion focusing on validation and regulation of membrane systems included presentations by **Sally Williamson**, CH2MHill and **Amos Branch**, UNSW on membrane bioreactors and **Jim Lozier** (CH2MHill) and **Marlene Cran** (VU) on high pressure membrane systems.

Many interesting case studies were also presented, including membrane autopsy from **Luke Zappia** (Water Corporation), use of ultrafiltation membranes in gravity fed system for developing countries by **Rhett Butler** (Skyjuice foundation), hot standby operation of the Gold Coast Desalination plant by **Sean McCagh** (Seqwater) and the setup of the largest Australian desalination plant in Victoria by **Veronique Bonnelye** (Degremont).

Day two started with an impressive insight of the South African's Water Research Commission by **Jo Burgess**. This independent agency has been successfully funding high quality research in South Africa for many years, and features internal organisation and funding process which, to be perfectly honest, appears to be ideal and should be implemented in any countries facing water challenges.

The now famous multi million Dollars Sea Hero project developed in South Korea was then introduced by **In Kim**, bringing focus on novel technologies such as forward osmosis and membrane distillation.

By Pierre Le-Clech, UNSW

Report on the AMS8 July 2013 in Xi'an China

This year has seen another successful AMS conference. AMS8 was held in the charming and historical city of Xi'an China. With over 300 delegates from many different States and Territories in Asia including a several from Europe and North America, AMS8 was truly a platform to showcase the progress in membrane science and technology. MSA was well presented at the conference with a record number of 13 delegates. Their presentations highlight the latest research development in membrane fouling and scaling monitoring and prevention, development of membrane distillation, novel membrane processes for water reuse and coal seam gas water treatment,

Prof Sandra Kentish delivered her plenary lecture at AMS8 and polymer inclusion membranes. Prof Sandra Kentish (University of Melbourne) delivered an inspiring plenary lecture on the implementation of membrane technology for industrial outcomes with a specific focus on separation applications for carbon capture and storage and food processing. MSA delegates would like to take this opportunity to thank the organisers for their warm hospitality and assistance that makes AMS8 a memorable event.

Unconventional gas development: opportunity for membrane desalination processes

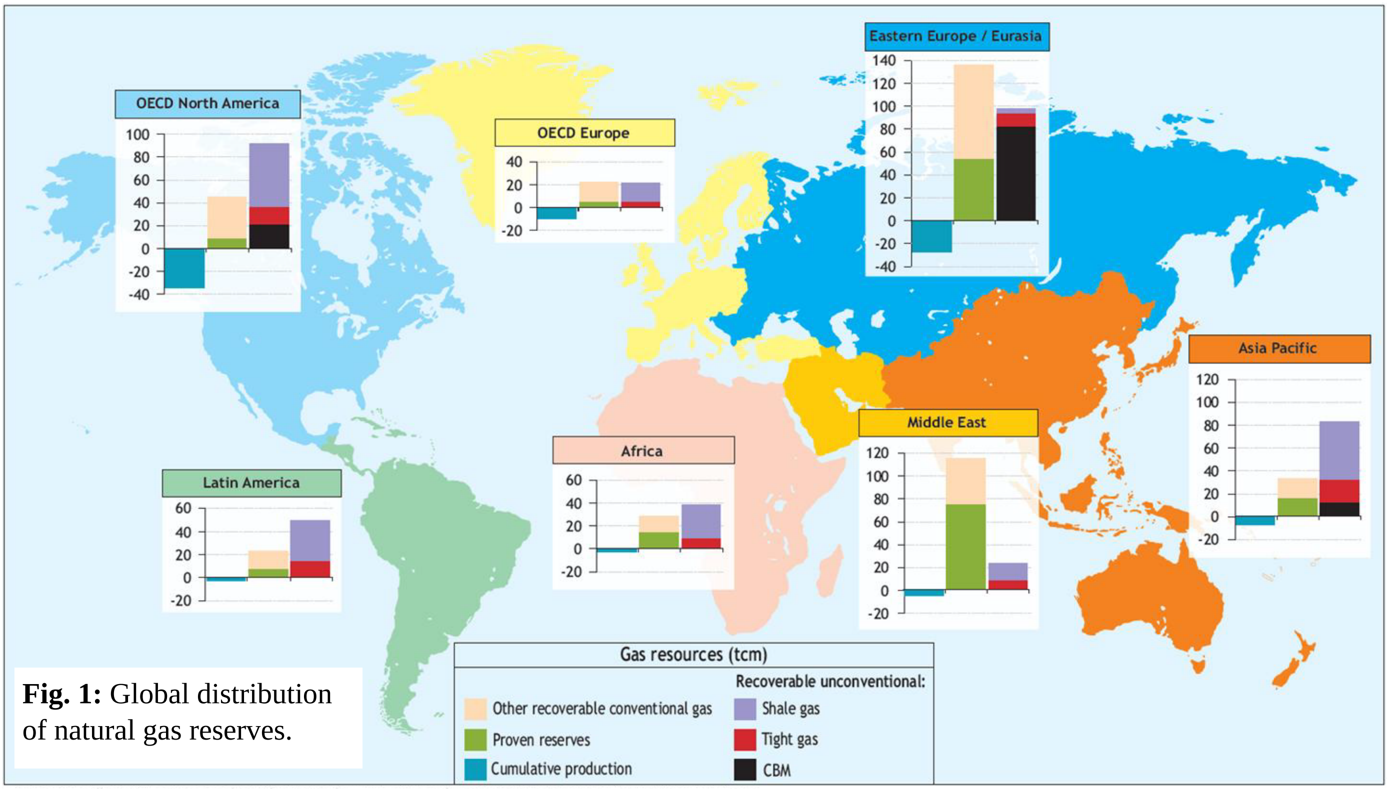


Fig. 1: Global distribution of natural gas reserves.

Water and energy production are intimately related. As such, the rapid global development of unconventional natural gas resources presents a unique set of challenges and opportunities to the water industry [1-3].

Natural gas mostly from conventional sources currently account for about 24% of the global primary energy consumption. The global natural gas resource (both conventional and unconventional) is geographically dispersed (Figure 1).

Unconventional natural gas currently being explored or produced includes coal seam gas (CSG) and shale gas. Gas production from these sources is almost always associated with major water management issues. CSG is natural gas that occurs in coal seams at up to about 1000 m depth where it is trapped within cleats or fractures and cracks in the coal. Natural gas production from CSG entails the handling and disposal of a large volume of produced water. CSG produced water must be treated prior to environmental discharge or beneficial reuse. Shale gas occurs in low permeability organic-rich sediments usually at 2000 to 3000 m depth. The shale is both the source rock and the reservoir rock. It is necessary to create permeability to allow the gas to flow by a process known as fracking, which is a water intensive process. Thus, the supply and treatment of fracking water present a major challenge to the shale gas industry.

In the context of growing restrictions on produced water disposal and water reuse opportunities, desalination technology will play a critical role in protecting the environment and preserving the economic viability of this fast growing industry. Indeed, the industry has eagerly participated in the development of several emerging desalination processes. Most of these are membrane based, such as forward osmosis, membrane distillation, membrane electrolysis in addition to the already mature reverse osmosis process.

This article highlights the intimate relationship between CSG and shale gas production and produced water management. The second aims of this article is to review re-

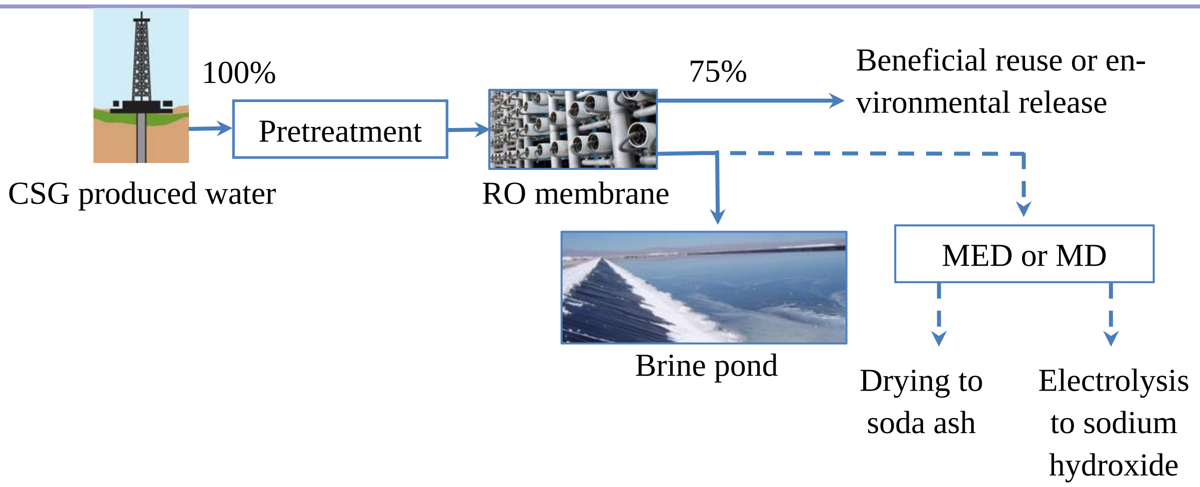


Fig. 2: Current and future CSG produced water treatment train.

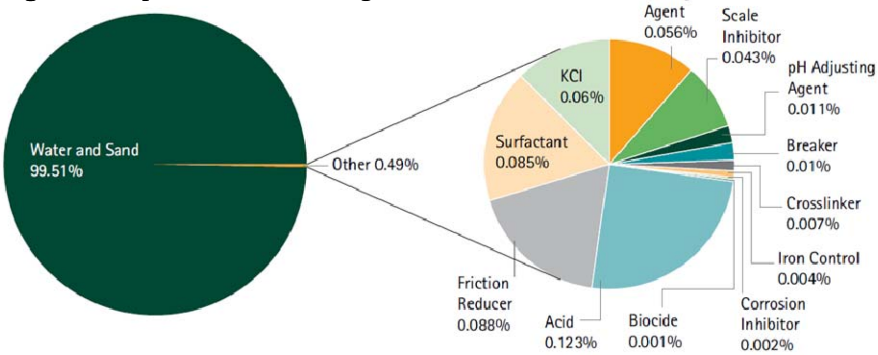
cent development of membrane based desalination technologies that may be suitable for CSG and shale gas operations.

Produced water from CSG is essentially brackish groundwater dominated by sodium bicarbonate [4-8]. A major challenge in CSG operation is to sustainably manage a large volume of produced water which must be treated to reduce salinity before environmental release or beneficial reuse. Australia is on track to become the world's largest liquefied natural gas (LNG) producer by about 2018 [9]. It is estimated that 70% of the global LNG capacity under construction is taking place in Australia to tap into its vast CSG reserve. The volume of produced water associated with LNG production is enormous. For example, a recent study commissioned by the Queensland Government estimates that volume of CSG produced water from southern Queensland generated each year can be up to 175 GL, spanning until 2060 with an accumulative volume of 5,100 GL.

A typical CSG produced water treatment system includes pretreatment (e.g. coagulation, sand filtration or microfiltration/ultrafiltration) followed by RO desalination (Figure 2). The desalted water can be used for a range of beneficial use including coal washing, dust suppression, irrigation, livestock watering, industrial consumption and even drinking water supply [10]. The RO process can only achieve about 75% water recovery and it is still necessary to manage the remaining 25% RO brine. In the absence of any technically and economically proven technologies for CSG brine management, it is being stored in brine ponds.

Brine storage is an expensive, temporary, and environmentally risky option until the water sector can catch up with the fast pace of growth of the CSG industry. As demonstrated in Figure 2 by the broken line, several CSG brine management techniques are being developed. They involve further concentration of the brine to near the point of saturation by well-established as well as emerging technologies (e.g. multi-effect distillation and membrane distillation) followed by a mineral recovery step. CSG brine is rich in sodium bicarbonate. Penrice in collaboration with GE and QGC has announced a pilot project to demonstrate the recovery of soda ash from CSG brine. Another notable technique being developed by the University of Wollongong with funding from the National Centre of Excellence in Desalination in Australia is to use the saturated CSG brine as feed stock for the production of sodium hydroxide. Early research results confirm that the electrolysis of sodium biocarbonate is thermodynamically more favourable than that of sodium chloride. The process produces carbon dioxide instead of chlorine gas. More importantly, since commercial sodium hydroxide grade is in the range of 12 – 50% (wt./wt.) this technique does not require complete removal of water. The productions of soda ash and sodium hydroxide are based on well-establish technologies (namely selective precipitation

Fig. 3: Composition of fracking fluid.



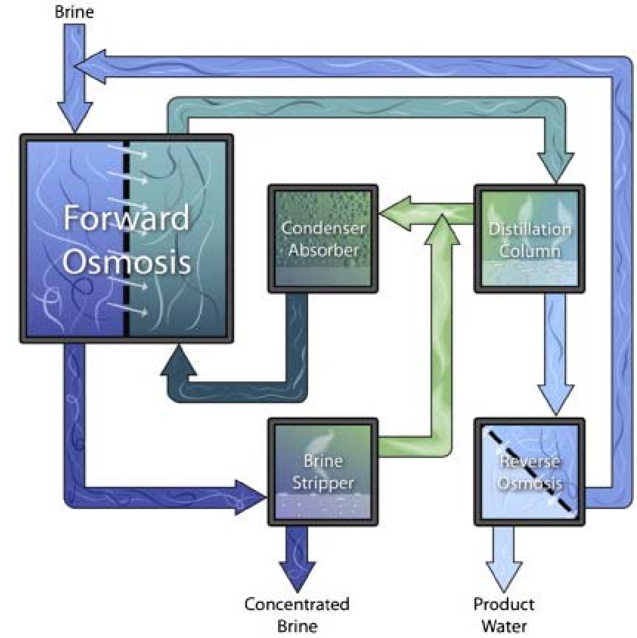


Fig. 4: Novel FO Membrane Brine Concentrator system developed by Oasys Water (From [14]).

and membrane electrolysis, respectively). Thus, they both have the potential of being commercialised over a very short time frame to meet the short projected lifetime of the CSG industry.

Shale gas development is another potential desalination technology incubator. Until now, the United States remains the only country with notable shale gas development. However, with the quest for energy security and vast and geographically disperse shale gas reserve amongst many growing economies including both China and India, shale gas development is expecting an imminent boom. As a notable example, China has the world's largest shale gas reserves and arguably the world's largest energy demand growth [4]. The Chinese Government has set a target to produce 6.5 billion m^3 of shale gas by 2015 [2]. This is a truly ambitious target since most of the Chinese shale gas reserves are in severe water stress area. Water is integral to shale gas development. Unlike CSG production where fracking is not usually required, almost all shale gas developments required fracking. The fracking process consumes a large volume of water mixed with sand and a range of chemicals (Figure 3). The volume of water to make up the fracking fluid varies from 10 – 22 ML for each well. To meet its target share set by the central government, Sichuan will require 170 million m^3 of water, which is about 10.5% of the province's current domestic water demand [2]. In addition, up to 70% of this fracking fluid returns to the surface after being mixed with the saline water within the shale as 'flowback water'. The flowback water contains a many constituents, including the fracking chemicals (e.g. friction reducer, scaling inhibitor, biocides, and corrosion inhibitor), suspended solids, and other constituents present in the shale formation (e.g. sodium, calcium, barium, sulphate, organic contaminants, and naturally occurring radioactive materials). Because the shale water can be extremely saline, the flowback water can have a very high level of salinity of up to 200,000 mg/L. The supply of fracking and treatment of flowback water present arguably some of the most difficult technical challenges and remarkable opportunities. The water management market to support shale gas in the United States alone is estimated to be up to $100 billion [11]. This market will grow by several times when shale gas development in countries like China, India, and Australia comes online.

There are four options to manage flowback water. The first option is to reuse it without treatment. Reusing untreated water is frequently performed in the United States, but continued reuse can dramatically lower fracking effectiveness by reducing the permeability of the gas wells with residual chemicals, precipitates or shale fines. The second option is deep well injection. Although it has been deployed in some parts of the United States, this option is facing very strong public opposition. The third option is to remove total suspended solids (TSS) and materials (e.g. barium, calcium, iron, magnesium and strontium) that are likely to clog the gas wells. The treated water is then mixed with fresh water and re-used for fracking. All treatment processes can be done on-site to reduce transport costs. The fourth option is to treat the fracking water for environmental release. Because the salinity of flowback water is usually very high, desalination is also part of the third and fourth options.

The TSS content of flowback water is in the range of 500 - 1,000 mg/L. TSS treatment typically involves several processes. In the first step, chlorine dioxide or ozone are used to breaks oil/grease emulsions and oxidise organic chemical additives (e.g. friction reducers and surfactants). In step two, dissolved air flotation is used to remove floatable TSS (e.g. oil and grease). Then, activated carbon is used to remove hydrocarbons and other organics. Subsequently, chemical precipitation removes sparingly soluble salts (e.g. barium, calcium, iron, magnesium and strontium). The effluent is further treated with either sand filtration or microfiltration to remove any remaining TSS.

In addition to TSS removal, salinity reduction is also a primary consideration for treating flowback water to a quality suitable for discharge or for external reuse. As shale gas development continues to grow, there is an urgent need to develop desalination technologies suitable for flowback water treatment. According to Shaffer et al., [12] membrane based technologies best suited for desalination of high-salinity produced water for reuse outside the shale gas industry include membrane distillation (MD) and forward osmosis (FO). MD and FO are emerging technologies that show promise for low-energy desalination of high-salinity water. A notable development in this area includes the recent pilot scale study by Oasys Water (Figure 4), demonstrating the feasibility of a comprehensive FO Membrane Brine Concentrator system for flowback water treatment. The system could achieve over 60% water recovery and reach a final brine concentration of 180 g/L in TDS (from flowback water with TDS of 73 g/L) [14]. Full scale evaluation of these technologies for flowback water treatment are eagerly anticipated.

Water and energy have always had a close relationship. Water management underpins the development of unconventional gas resources. In return, the natural gas industry will provide an important stimulus for the development of innovative water treatment technologies, particularly those for desalination and brine management purposes.

By Long Nghiem, University of Wollongong

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