Membrane Society of Australasia

www.membrane-australasia.org

July – September 2012 Newsletter

Message from the President

Dear MSA members. As the year is now coming close to the end, MSA activities have been running smoothly.

Most work has focussed on planning for IMSTEC 2013 and the 3rd Early Career Researchers Membrane Symposium. Also, the MSA was actively involved in the recent AMS7 conference in Busan, Korea, which had record attendance for any AMS conference. A report on this is included in this newsletter. The MSA sponsored a travel award for a student to attend AMS7, receiving $500 towards their travel costs. The winner selected by the judging panel was Zongli Xie at CSIRO. Congratulations Zongli!

Also, at the time of writing, Euromembrane is about to commence (23rd September), so I wish all those attending an enjoyable conference. The programme looks to bring together an interesting and diverse range of talks on the current developments of membrane technology worldwide.

Thanks again for taking the time to read the latest MSA newsletter. We look forward to bringing you soon our next event, the 3rd Early Career Researchers Symposium in Brisbane this November. Finally, please consider joining the active MSA group on Linked in!

Associate Professor Mikel Duke – President, MSA

ASSOC. PROF. M. DUKE PRESENTING AT AMS7 IN BUSAN, KOREA

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In this issue:

Carbon Capture through Membranes

The Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC) is currently capturing carbon emissions from industry through the operation of a world-class membrane gas separation pilot plant in Victoria, Australia.

It has been well established that increasing carbon dioxide levels in the atmosphere is linked to global change in climate. One proposed strategy to reduce emissions is Carbon Capture and Storage (CCS), where carbon dioxide is separated from an industrial process before it can be released to the atmosphere and the captured carbon dioxide is stored in a safe manner over the long term. The biggest obstacle to implementing CCS is cost, and developing cheap carbon dioxide capture technologies is of paramount importance, since the capturing process is estimated to be as much as 85% of the total cost of CCS.

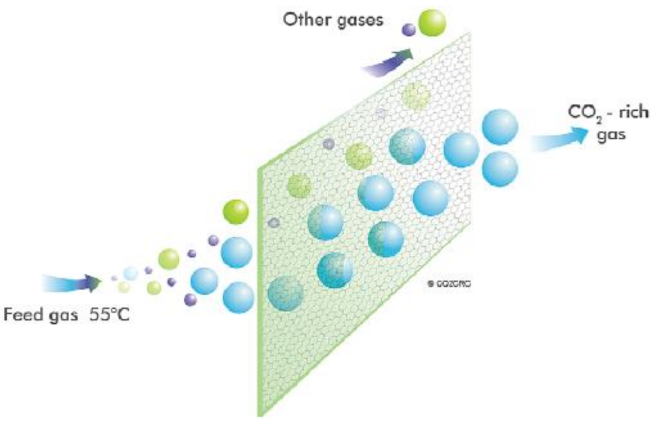

FIG. 1: HOW A MEMBRANE SEPARATES CARBON DIOXIDE FROM OTHER GASES (SOURCE CO2CRC).

Membrane technology has the potential to significantly reduce the cost of capture. A simple membrane based separation process has advantages over traditional CO2 selective solvent based technology due to the lower energy demand,because there is no heating or cooling of solutions involved. The membrane process relies on a semi-permeable material, often a polymer or plastic, which allows carbon dioxide to easily pass through while preventing other gases, such as nitrogen and oxygen, from doing likewise. This removes carbon dioxide from a gas stream by concentrating it on the other side of the membrane material. Once the carbon dioxide is concentrated, it can then easily be transported to the storage process.

A range of polymeric materials can be used for manufacturing carbon dioxide membranes. It is surprising the number of polymers that can actually act as a carbon dioxide membrane, with even simple plastics used in food packaging having some ability to separate carbon dioxide. Polymers that have excellent performance are defined by two criteria; a high carbon dioxide flux and high carbon dioxide selectivity compared to other gases. Some examples of good polymers are polysulfone, polyimide, polyethylene glycol and poly dimethylsiloxane. Membrane gas separation research, occurring worldwide, has developed a range of potential polymeric systems that can be fabricated as excellent membranes for carbon dioxide capture.

However, creating a high performing membrane in the laboratory is only half the story – the membrane must actually be practical for use in industrial processes which have considerably harsher environments than those tested in laboratories. For instance, a range of other gases and chemicals are often present in industry at low concentrations, including sulfur oxides, nitric oxides, hydrogen sulfide, ammonia as well as heavy hydrocarbons such as hexane. Furthermore, the process gas is usually saturated with water, which with the combination of chemicals present makes for a corrosive environment. This can have a dramatic impact on membrane performance as well as rapidly degrading the polymer, leading to membrane rupture. This is why the CO2CRC operates an industry based membrane carbon dioxide capture facility, to determine the performance of membranes in real processes.

The CO2CRC H3 Capture project separates carbon dioxide from flue gas exiting a coal-fired power station in the Latrobe valley, Victoria. The membrane plant is designed to separate out 15 tonnes of carbon dioxide per annum, which is the equivalent of capturing the emissions of one Australian per year. The pilot plant is part of the bigger H3 Capture project which has the purpose of demonstrating three capture technologies, and evaluating their performance in a power plant environment. Specifically for the membrane pilot plant the objective is to separate carbon dioxide from flue gas, which is ~10% carbon dioxide, as well as verify that membrane separation performance can withstand the flue gas environment. Of particular interest is the effect water in the flue gas will have on the membrane, given that sulfur oxides and nitric oxides are also present (generated by the coal combustion process), producing acidic conditions. The plant was commissioned in July 2009 and has been successfully capturing carbon dioxide intermittently since then.

The next stage in applying membranes to carbon dioxide capture will be dictated by the continual operation of this facility. Successful outcomes will demonstrate the potential of membranes in carbon capture and allow the efficiency of the technology to be determined. This will allow larger scale demonstration facilities to be designed and constructed in the future, which will display the viability of this technology to Australian industry as well as capture carbon in significant quantities over a longer period. This will facilitate the growth of membrane technology for carbon dioxide capture over the next 5 to 10 years, in keeping with international targets for carbon emission reduction.

FIG. 2: CO2CRC H3 CAPTURE PROJECT MEMBRANE FACILITY (SOURCE: CO2CRC).

The author would like to acknowledge the financial support from Brown Coal Innovation Australia (BCIA) and the Australian Government through its Cooperative Research Centre program and all CO2CRC participants. The author also acknowledges Renato Anthony Innocenzi and his group at International Power Hazelwood (IPRH) for access to equipment and their support.

Colin Scholes
University of Melbourne

Feature: Permeate in Milk

Milk comes in a wide range of choices, including no fat, low fat, calcium enriched and with extra dollop. A recent addition has been 'permeate free' milk, promoted by the dairy industry as pure milk and avoids the use of permeate in dairy processing, labelled by the tabloid media as the dairy industry's "dirty little secret". This raises the question what is permeate, and if it is "dirty", why has it been used for so long?

Consumers today want consistency in the products they purchase, for milk this means consistency in taste. In milk, taste is dependent on the level of fat and proteins present, and the reason why many people can distinctly separate the taste of low fat milk from whole milk. The problem with milk is that being a natural product from cows, the level of fat and proteins varies. It is dependent on the farm; breed of cow, what the cows eat, as well as the cows' lactation cycle. Regional and seasonal factors also contribute to differences in milk composition, and the level of fat and proteins. All of this alters the taste of fresh milk constantly, but to provide the consumer with a consistent product the raw milk needs to be processed and standardised.

A common approach for processing milk is ultra-filtration. This process uses very fine membranes with pores on the order of 0.001 - 0.1 µm to separate out the various components of milk. Lactose (milk-sugars), vitamins and minerals pass through the membrane along with water and are termed the permeate, while the fats remain on the feed side of the ultra-filtration membrane. The presence of B vitamins in the permeate makes the solution a slightly green colour, which makes the permeate visually unappealing. This makes it easy for the tabloid media to present permeate as not milk and a problem, but the permeate remains a valuable part of the milk and no chemicals are added. After ultra-filtration the various components of fresh milk are recombined to standardise the milk composition and ensure the consumers receive the same quality product year around. This includes the addition of permeate, with most standard milks containing up to 16% permeate. The inclusion of permeate does not always occur, only when the composition varies significantly from the standard product that it is necessary to add extra vitamins, proteins or minerals to the milk product to ensure consistency. By law, whole milk purchased from the supermarket must contain at least 32 g/kg of fat (3.2%) and 30 g/kg of protein (3.0%). In this debate it is important to recognised that the permeate originates from milk and is returned to the milk, it is not a by-product of other dairy processing, such as cheese or yoghurt, and no additional chemicals or additives are added. Equally important, there has never been any health issues raised with using permeate to maintain milk consistency. Hence, the current debate about permeate in milk does not come from a safety perspective but rather from a marketing perspective.

In 2011, the major Australian supermarkets began a price war, with their private label milk as one of their heavily discounted products. This naturally reduced the market share and profit margins of many branded milk suppliers. Into this environment was thrown the media sensationalism on permeate milk. To counter this branded milk suppliers began to push their milk products as "pure" milk, with the permeate advertised as cheap filler and a watery by product. This naturally is a very emotional issue for consumers, because milk is viewed as a natural product and therefore shouldn't be processed or watered down.

As a result of the very effective marketing campaign, the supermarket private labels have also declared themselves to be going permeate free, and the words ‘permeate free’ are now prominently displayed on milk containers, along with the words ‘low fat’ and ‘calcium enriched’. The unfortunately aspect of this marketing campaign is that it ignores the fact that “pure” supermarket shelved milk is already processed by the need to pasteurise and homogenise. Indeed, these words remain clearly labelled on milk containers. The debate also ignores the fact that the use of permeate and ultra-filtration technology has kept the price of milk down. For “permeate free” milk to keep a consistent composition and therefore taste, it is necessary to use more milk in dairy processing. “Permeate free” milk requires 10 – 15% more milk to be processed than milk where permeate is added. This means purchasing the additional milk from the dairy farmers, at a cost of ~50 cents per litre, compared to using permeate at a cost of ~18 cents per litre (pricing from media reports). Hence, the increased promotion of “permeate free” milk means that someone will have to pay the price. Be it consumers with an increase in the price of milk, the milk processors who sacrifice profits to protect market share or the dairy farmers forced by the dairy processes to sell milk at a reduced price.

In debates on food quality, including milk, it is worthwhile remember that almost all food products we purchase from a supermarket has been processed in some way. To really claim to be drinking pure milk, you would need to be drinking fresh from the cow, which is not permitted by government regulations for food safety reasons.

Conference update – AMS7

The 7th Conference on Aseanian Membrane Society (AMS7) was held in Busan, Korea, on July 4-6. It represented one of the biggest gatherings of membrane technologies in the Asia-Pacific region, with over 550 participants from 16 countries. The conference covered all aspects of membrane technology, including familiar topics on membrane fouling, water treatment, gas separation and desalination, but also covered broader topics such as membrane materials and formation, modification and characterization. Some of the more interesting discussions were about novel membrane surface structures and their potential to increase membrane area on the micron scale, as well as development of fouling resistant membrane approaches and the increasing sophistication of fabrication approaches, including the characterization approaches. One of the most exciting aspects of the conference was the broad range of industries membranes are now being applied to and the evidence that membrane technology has a bright future.

The Membrane Society of Australasia was well representative, with Prof. Stephen Gray, Victoria University, presented one of the plenary sessions on Membranes for Water treatment, and the future directions of research in that field. Other notable MSA members were Long Nghiem, from University of Wollongong, presenting on the effects of salinity on the removal of trace organic contaminants by Membrane Bioreactor treatment for water resuse. Vicki Chen, from University of New South Wales, on preparation and characterization of bio-catalytic PES membrane functionalized with TiO2, and MSA President, Mikel Duke from Victoria University, also presented on his research into direct contact membrane distillation at a power station, which has previously been covered in this newsletter. Special mention and congratulations should go to Zongli Xie at CSIRO for winning the MSA student travel award to attend AMS7.

Upcoming Events

MSA 3rd Early Career Researcher Symposium

http://www.ecr2012.membrane-australasia.org/

Themes

- **Materials**
- **Energy**
- **Health**
- **Food**
- **Water**

When

- 28-30th November

Where

- University of Queensland,
  St Lucia Campus,
  Brisbane, Australia

Abstract Deadline

- 28th September

Guest Speakers:

- Prof. Tang Chuyang *(Nanyang Technological University Singapore)*
- Prof. Joe da Costa *(University of Queensland)*
- Mark Mullett *(Hatch Water)*
- Prof. Dianne Wiley *(University of New South Wales)*

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Other Events

- MSA Early Career Researcher Symposium
  - Brisbane
  - November 28-30, 2012
- North American Membrane Society Meeting
  - Boise, Idaho USA
  - June 8-12, 2013
- 14th Aachener Membran Kolloquium
  - Aachen, Germany
  - November 7-8, 2012
- 2nd Water Research Conference (WRC2)
  - Singapore
  - January 20 - 23, 2012
- 4th International Conference on Organic Solvent Nanofiltration
  - Aachen, Germany
  - March 12-14, 2013
- 1st International Conference on Desalination using Membrane Technology,
  - Sitges, Spain
  - April 7-10, 2013
- European Membrane Society Summer School,
  - Essen, Germany
  - July 22-27, 2013

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