

# eReport

Issue 14, July 2015

## **ANLEC R&D Report Summaries** (February 2015 – July 2015)

The following reports are available from the ANLEC R&D website:

### [Geochemical and Geo-mechanical Testing of Near Wellbore CO<sub>2</sub> Injectivity](#)

#### ***Research shows advantageous CO<sub>2</sub> injectivity prospects for the Surat Basin***

This project delivers an integrated study to assess both geochemical and geo-mechanical changes to reservoir and seal rocks with CO<sub>2</sub> injection. The report presents specific results that provide a positive outlook for Surat Basin. Research results suggest that injection will generally lower pH locally causing some dissolution of minerals in the formation. This dissolution near wellbore zones delivers substantially improved injectivity, which can have significant (beneficial) design and commercial consequences.

### [Pore and core-scale investigation of CO<sub>2</sub> mobility: Final report](#)

#### ***Evidence that residual trapping is enhanced in weakly water-wet conditions***

CO<sub>2</sub> wettability has important implications for understanding reservoir capacity and seal performance. This project uses several different techniques in order to investigate the CO<sub>2</sub> wettability of storage and seal rock and how it may change over time. Early results from the project have delivered continuous injection capillary pressure measurements and yielded three highly reproducible primary drainage curves for Berea sandstone. Collected data indicates that structural and residual trapping are enhanced in rock reservoirs that exhibit weakly water-wet characteristics.

### [Chemical Looping Oxygen Generation for Oxy-Fuel Combustion](#)

#### ***Integrated Chemical Looping Air Separation systems can be feasible under favourable carbon pricing conditions***

Oxygen separation is a high cost component of oxy-fuel combustion systems. This project assesses the viability of introducing novel chemical looping systems in oxy-fuel combustion. These systems can be retrofitted into existing coal-fired power plants. The report outlines the project's methodology and the results of the design, construction and testing of a pilot-scale prototype chemical looping reactor. It concludes that these systems are technically viable, and may become economically competitive in specific conditions of low-cost natural gas and/or when a sufficiently high electricity wholesale prices occur e.g. under a carbon price regime.

### [Mercury capture by fabric filter and CPU in oxy-fuel technology](#)

#### ***Mercury removal in fabric filter avoids need for costly impurity reduction units in oxy-fuel processes***

This study quantifies the extent of removal and the impact of impurity levels in the CO<sub>2</sub> using a fabric filter. Two trials at the Callide Oxy-fuel Project have validated the results from laboratory studies and predictions.

Key findings are that:

- Greater Mercury (Hg) and Sulphur (S) capture occurs if fabric filter ash has a lower carbon content, i.e. is 'clean ash'
- Where possible, oxyfuel processing units should operate at a temperature over the acid dew-point temperature to avoid acid attack.

Under these conditions, the fabric filter can reduce mercury levels in CO<sub>2</sub> rich gas to 0.01 µg/m<sup>3</sup>. This, combined with the reduction of up to 100% SO<sub>x</sub> and 80% NO<sub>x</sub> levels, avoids the need for costly unit operations in the power plant or CO<sub>2</sub> processing unit.

### [Alloy membrane reactor for pre-combustion CO<sub>2</sub> capture](#)

#### ***Development of membrane reactor enables intensified hydrogen production***

Pre-combustion CO<sub>2</sub> capture is a process that shifts the energy content of coal to Hydrogen with the by-product of Carbon Dioxide. This project developed a catalytic membrane reactor (CMR), which intensifies hydrogen production processes and has the potential to achieve near-complete hydrogen conversion, purification and pre-combustion CO<sub>2</sub> capture in a single device, with the additional benefit of reduced energy consumption and plant volume.

A 3-stage membrane reactor is demonstrated with separated catalysts and membranes to overcome the narrow temperature window and consistent fracture of traditional packed-bed arrangements. The

developed CMR manufacturing process is at a much lower inlet pressure which indicates potential for further cost reduction with alternative tubing material.

## Solid Particles Recirculation Distribution in Chemical Looping Post-Combustion Carbon Capture

### ***The use of tailored adsorbents to reduce costs and improve efficiency in PCC systems***

Aiming to assess the performance of new sorbent materials in low cost post-combustion capture of CO<sub>2</sub>, this project has produced a journal article which assesses the suitability of CaO-based tailored sorbents to replace limestone by adapting decay models. The suitability is judged by comparing the efficiency, costs and necessary rate of sorbent replacement in the two systems. The paper finds that the use of tailored sorbents can result in higher carbonator efficiencies and lower costs than in limestone systems. ***This journal article is accessible from the Journal of Energy & Environmental Science.***

## ANLEC R&D Technical Presentations

Abbas, A 2015, *Dynamic modelling of solar thermal repowering for power plants with carbon*, proceedings presented at 2<sup>nd</sup> International Conference and Exhibition on Solar Energy (ICESE), May 19-20, 2015, Tehran University

Abbas, A 2015, *Dynamic models and control strategies for absorption based carbon capture processes*, proceedings presented at HiPerCap - High Performance Capture, Melbourne, Australia, 25-27 March 2015

Allinson, G 2015, *CO<sub>2</sub> injection research team completes another SW Hub CO<sub>2</sub> injection report*, proceedings presented at Web story – UNSW

Allinson, G 2015, *Engineering climate change - cutting edge research achieves a national flagship status for carbon dioxide storage to reduce Australia's greenhouse gas emissions. But there is a cost*, proceedings presented at Web story – UNSW, accessible from <http://engineering.unsw.edu.au/emag/featured-story/engineering-climate-change>

Barifcani, A et al. 2015, *Receding and advancing CO<sub>2</sub> brine-quartz contact angles as a function of pressure, temperature, surface roughness and salinity*, paper manuscript submitted to the Journal of Chemical Thermodynamics

Cousins, A et al. 2014, *Pilot-scale parametric evaluation of concentrated piperazine: duration experiments*, paper manuscript submitted to Greenhouse Gases: Science and Technology

D'Angelo, A & Chaffee, A 2015, *Determination of oxygen vacancies and Ce<sup>3+</sup> in Tm-CeO<sub>2</sub> mixed oxides using EELS*, proceedings presented at 13<sup>th</sup> Biennial Australian Microbeam Analysis Symposium, Hobart, Tasmania, 11-13 February 2015

D'Angelo, A et al. 2015, *Oxygen vacancies in Tb-CeO<sub>2</sub> mixed oxides for air separation*, proceedings presented at 2015 MRS Spring Meeting & Exhibit San Francisco, California, 6-10 April 2015

Hla, S et al. 2014, *Model and experimental study of a water gas shift catalytic membrane reactor*, paper manuscript submitted to Journal of Separation and Purification Technology

Ludovic, R et al. 2015, *Evolution of salinity in the Latrobe aquifer in the Gippsland Basin and the simulation of impacts by CO<sub>2</sub> injection*, proceedings presented at EAGE/TNO Workshop 'Basin Hydrodynamics & Resources' 6-8 May 2015, Utrecht, Netherlands

Palamara, D et al. 2015, *Review of pressure, temperature and salinity on contact angles in CO<sub>2</sub>-brine-quartz systems*, manuscript submitted to International Journal of Greenhouse Gas Control

Parvareh, F et al. 2015, *Solar repowering of PCC-retrofitted power plants; solar thermal plant dynamic modelling and control strategies*, manuscript submitted to Journal of Solar energy

Rahman, T et al. 2015, *Measurements of the representative elementary volume (REV) of porous rocks using x-ray micro computed tomography*, manuscript submitted to Journal of Sedimentology

Rezaee, R et al. 2014, *Shale alteration after exposure to supercritical CO<sub>2</sub>*, paper manuscript submitted to Journal of applied polymer science

Saeedi, A et al. 2014, *Supercritical CO<sub>2</sub>-brine characteristics of Sandstone Rocks-South West Hub, Western Australia*, paper manuscript submitted to Journal of Petroleum Science and Engineering

Sharma, M et al. 2015, *Flexible operation of solar-integrated power plant with solvent based post-combustion capture (PCC) process*, manuscript submitted to Journal of Energy Conversion and Management

Stanger, R et al. 2015, *Oxyfuel derived CO<sub>2</sub> compression experiments with NO<sub>x</sub>, SO<sub>x</sub> and mercury removal – Experiments involving compression of slip-streams from the Callide Oxyfuel Project (COP)*, manuscript submitted to International Journal of Greenhouse Gas Control

Tertyshnikov, K et al. 2014, *Application of diffraction imaging and steered migration to 3D seismic data from the South West Hub CCS project*, proceedings presented at 77<sup>th</sup> EAGE Conference & Exhibition, Madrid, Spain, 1-4 June 2015

Wang, Y et al. 2015, *Improving the permeation performance of poly(ethylene oxide-*b*-amide) block copolymer membrane through blending with PEO-PDMS copolymers*, paper manuscript submitted to Journal of Applied Polymer Science

Warden, A et al. 2015, *Rational engineering of a mesophilic carbonic anhydrase to an extreme halotolerant biocatalyst*, manuscript submitted to Journal of Nature Communications

## IEACCC Reports

- Barnes, I 2015, *Operating experience of low grade fuels in circulating fluidised bed combustion (CFBC) boilers*, Ref: CCC/253
- Baruya, P 2015, *Wood forest and agricultural crop residue resources for co-firing*, Ref: CCC/249
- Lockwood, T 2015, *Advanced sensors and smart controls for coal-fired power plant*, CCC/251
- Nalbandian, H 2015, *Climate implications of coal to gas substitution in power-generation*, Ref: CCC/248
- Sloss, LL 2015, *Potential for enhanced coalbed methane recovery*, Ref: CCC/252
- Zhang, X 2015, *Microalgae removal of CO<sub>2</sub> from flue gas*, Ref: CCC/250
- Zhu, Q 2015, *High-efficiency power generation – review of alternative systems*, Ref: CCC/247

## IEAGHG Reports

4<sup>th</sup> Social Research Network Meeting, Oct 2014

Assessment of Emerging CO<sub>2</sub> Capture Technologies and Their Potential to Reduce Costs, TR4 2014

Biomass and CCS - Guidance for Accounting Negative Emissions, May 2014

CCS Cluster Projects: Review and Future Opportunities, Feb 2015

CO<sub>2</sub> Capture at Coal-Based Power and Hydrogen Plants, Mar 2014

CO<sub>2</sub> Storage Efficiency in Deep Saline Formations: A Comparison of Volumetric and Resource Estimation Methods, Sep 2014

Comparing Different Approaches to Managing CCS, Jan 2014

Evaluation of Reclaimer Sludge Disposal from CO<sub>2</sub> PCC Process, Feb 2014

IEAGHG 2013 RCSP Peer Review Summary Report, TR2 2014

IEAGHG/IETS iron and Steel Industry CCUS and Process Integration Workshop, July 2014

Monitoring and Modelling Combined Network Meeting, Jan 2015

Performance of Dehydration Units for CO<sub>2</sub> Capture, Apr 2014

Summary Report of the 5<sup>th</sup> HTSLCN Meeting, June 2014

Techno Economic Evaluation of Different Post Combustion CO<sub>2</sub> Capture Process Flow Sheet Modifications, Aug 2014

**IEAGHG reports older than 6 months are freely available to download from the IEAGHG website at [www.ieaghg.org](http://www.ieaghg.org), and all other reports that have been published within the last 6 months can be obtained by contacting Becky Kemp at [becky.kemp@ieaghg.org](mailto:becky.kemp@ieaghg.org).**

## CO<sub>2</sub>CRC Publications

### Journal Papers

Dawson, G et al. 2014, *Experimental mineral dissolution in Berea Sandstone reacted with CO<sub>2</sub>*, Chemical Geology

Fu, Q et al. 2013, *Highly permeable membrane materials for CO<sub>2</sub> capture*, Journal of Materials Chemistry A

Halim, A et al. 2014, *Soft polymeric nanoparticle additives for next generation gas separation membranes*, Journal of Materials Chemistry A

Ho, M et al. 2013, *Comparison of CO<sub>2</sub> capture economics for iron and steel mills*, International Journal of Greenhouse Gas Control

Martens, D et al. 2015, *Modulation of microporous/mesoporous structures in self-templated cobalt-silica*, Scientific Reports

Pearce, J et al. 2014, *SO<sub>2</sub> impurity impacts on experimental and simulated CO<sub>2</sub>-water-reservoir rock reactions at carbon storage conditions*, Chemical Geology

### Reports

Cook, P et al. 2013, *Developing a small scale CO<sub>2</sub> test injection: Experience to date and best practice*, CO<sub>2</sub>CRC Storage Report

Kuske, T et al. 2014, *Ginninderra sub-surface CO<sub>2</sub> release – Experiment 1*, CO<sub>2</sub>CRC Storage Report

Pandit, J & Harkin, T 2014, *Air Cooling for Brown Coal Fired Power Plants with Post Combustion CO<sub>2</sub> capture*, CO<sub>2</sub>CRC Internal Report