eReport

Issue 17, December 2016

ANLEC R&D Report Summaries (May 2016 – November 2016)

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

Research shows spatial diagenetic alteration in the Wonnerup

This project was defined to address some of the uncertainties identified by the previously completed research (Projects 7-1111-0199 (Delle Piane et al., 2013), 7-1111-0200 (Stalker et al., 2013) and 3-1110-0122 (Evans et al., 2013)) around the in-situ fluid-rock interactions at the SW Hub CO_2 storage site. To meet this objective, the project conducted petrophysical and microstructural evaluations of pre and post flooded Harvey-1, 3, and 4 core samples. In addition to these tests, the fluid eluent collected from core-flood experiments were chemically analysed and static, thermodynamic modelling was used to simulate the fluid-rock geochemical interactions under in-situ conditions. The main conclusions drawn from these tests are as follows:

- Chemical reactions between CO_2-saturated brine and minerals are found to be quantitatively low.
- The physical reactions are variable as fines migration confirmed for the majority of the observed petrophysical alterations of the rocks after flooding.
- Fines migration can block pore-throats and reduce permeability or remove particles from major flow paths to increase pore connectivity and permeability.
- Harvey Wonnerup Aii facies is highly variable and these variables influence fines migration and permeability change.
- Diagenetic factors control fluid-rock interactions at the pore scale and have a strong effect on their response to the flooding

Full report: Fluid rock interactions and their impact- SW Hub

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Enabling faster and cheaper model-based analyses of flow and storage for CO_2

This project aimed to combine new Australian developed step-change technologies of 3D Digital Rock Technology (DRT) with conventional oil industry Routine Core Analysis (RCA) and Special Core Analysis (SCAL) on a comprehensive suite of CO_2 storage reservoir and seal rock types from the Surat Basin to obtain fast and detailed analyses of core samples and their properties. DRT presents a paradigm shift in the geoscience industry's approach to core analysis and the program has enabled the acquisition of a comprehensive data set of Surat Basin core material and property data along with an unprecedented understanding of the physics of CO_2-brine systems at the pore scale. Implications to quantitative understanding of properties at larger scales (whole core and log scales) have also been considered. This workflow can be used to assess other potential CO_2 storage sites.

Full report: Maximising the value of digital core analysis for carbon sequestration site assessment

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Passive Seismic Monitoring: Results compare favourably with the best low-noise sites worldwide

This project aimed to innovate a step-change in passive seismic systems to optimise site-specific array design and data analysis/imaging in order to help achieve MMV goals. Four key outcomes have resulted from this work:

1. Geomechanical lab tests on core samples taken from the SW Hub Harvey-1 well indicate that pre-existing reservoir rock fractures (and thus perhaps faults) can be reactivated at injection overpressures of 15-20 MPa (2175-2900 psi) above the initial reservoir pressure, whereas creation of new fractures occurs at much higher differential stress (~136 MPa).
2. A passive seismic monitoring test array was deployed at the Harvey-4 well-site. Results show that signal-to-noise (s/n) conditions were improved by an order of 20-30 dB amplitude. 75 days of passive recordings characterised both natural and cultural ambient noise sources.

3. Full waveform elastic seismic modelling was applied using the Pawsey high performance computing facilities. This methodology simulates the detection of weak microseismic events in very noisy data validating processing methodology for detecting injection induced events.
4. A full 3D geological model of the SW Hub site provided a conceptual model accounting for velocity uncertainties related to faulting predicted possible network configurations. Analysing the set of station configurations related to velocity uncertainty variations into account enabled mapping of zones of optimal station locations.

Full report: Feasibility and design of robust passive seismic monitoring arrays for CO_2 geosequestration

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Exploring the mineral trapping of CO_2 as carbonates in natural sandstone reservoirs

This project was developed to support CO_2 storage projects in Australian onshore sedimentary basins through investigation of the controls on the formation of authigenic carbonates in low salinity, siliciclastic aquifers of the Great Artesian Basin (GAB) as a natural analogue of mineralisation trapping. Differentiating between carbonate formed via different mechanisms, and determining controls on the extent of authigenic carbonate formation could lead to options for engineered accelerated mineralisation in reservoirs. Key parameters derived from petrological and geochemical analyses of the carbonates were fed into a model for carbonate authigenesis within the GAB and the laboratory experiments designed to demonstrate processes of enhanced carbonate mineral trapping of CO_2 in Precipice and Hutton sandstone core.

Full report: Authigenic carbonates in the Great Artesian Basin as a natural analogue of mineralisation trapping in CO_2 geosequestration

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Reducing costs by combined SO_2 and CO_2 capture and removal

This research project focused on the development of the advanced aqueous ammonia (NH_3)-based post-combustion capture (PCC) technology for significant reduction of CO_2 emissions from coal-fired power stations in Australia. The technical and economic assessment has shown that with the integration of an MEA-based PCC process, the output of the power station dropped from 650 to 473 MW, and the net efficiency decreased from 38.9 to 28.3% – a 27.3 % (relative term) and 10.6% (absolute term) decrease. The Levelised Cost of Electricity (LCOE) increased from US$66.1 to US$131.3 per MWh, and the CO_2 avoided cost was US$96.4/tonne CO_2. In comparison, the net efficiency of the power station with the integration of the advanced aqueous NH3 process dropped to 31.3% – a 19.4 % (relative term) and 7.6% (absolute term) decrease and the CO_2-avoided cost was US$63.6/tonne CO_2, which is 34% lower than that in the MEA-based process.

Full report: Development of the advanced aqueous ammonia based post combustion capture technology

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ANLEC R&D Technical Presentations

1. M. Knackstedt, et al. 2016, Multiscale characterization of plume dynamics, proceedings presented to The 1st Australia-Japan Symposium on Carbon Resource Utilisation, Melbourne, Australia, 27-30 November 2016
2. C. Green, et al. 2016, *Simulation of CO_2 migration for the planning of well-test configurations* at the South West Hub Project, Western Australia, proceedings presented to GHGT-13, 14-18 Nov 2016, Lausanne, Switzerland
3. L. Paterson, et al. 2016, SPE-182456 *Monitoring Wellbore Fluid Displacement in the Perforation Interval Using Multiple Downhole Pressure and Temperature Gauges*, proceedings presented to APOGCE, 25-27 October 2016, Perth Australia
4. J. Pearce, et al. 2016, *Geochemical controls on CO_2 storage in the Precipice Sandstone*, proceedings presented to PESA, 7 Sep 2016, Brisbane
5. L. Ricard, et al. 2016, *Well-based monitoring schemes for the South West Hub Project, Western Australia*, proceedings presented to GHGT13 - 14-18 November 2016 - Lausanne, Switzerland

6. K. Li, 2016, *Experimental and Modelling Study of Advanced Aqueous Ammonia Based Post Combustion Capture Process*, proceedings presented to Curtin University PhD Thesis
7. J. Pearce, et al. 2016, *Mineralogical controls on porosity and water chemistry during O_2-SO_2-CO_2 reaction of CO_2 storage reservoir and cap-rock core*, proceedings presented to Maximising the value of digital core analysis for carbon sequestration site assessment Oxyfuel Project
8. N. Issa, et al. 2016, *Seismic Structure of Perth Basin (Australia) and surroundings from Passive Seismic Deployments*, proceedings presented to American Geophysical Union, Fall Meeting 2016
9. L. Turner, et al. 2016, *The evolution of gas dissolution species during sequestration of a CO_2/NO stream*, proceedings presented to Goldschmidt, 26 June-1st July 2016, Yokohama, Japan
10. J. Pearce, et al. 2016, *CO_2 and CO_2-SO_2-O_2 reaction of reservoir and cap-rock cores*, proceedings presented to Goldschmidt, 26 Jun - 1 Jul 2016, Yokohama, Japan
11. K. Li et al 2016, *Techno-economic assessment of an advanced aqueous ammonia-based post-combustion capture process integrated with a 650-MW coal-fired power station*, proceedings presented to Applied Energy
12. K. Li et al 2016, *Techno-economic assessment of stripping modifications in an ammonia-based post-combustion capture process*, proceedings presented to International Journal of Greenhouse Gases
13. R. Stanger, et al. 2016, *Mercury retention on components from the CO_2 compression Unit (CPU) of the Callide Oxy-Fuel Project*, proceedings presented to International Journal of Greenhouse Gas Control - Elsevier"
14. Saeedi, et al. 2016, *Flood Characteristic and Fluid Rock Interactions of a Supercritical CO_2, Brine, Rock System: South West Hub*, Western Australia, proceedings presented to Journal of Greenhouse Gas Control
15. D. Pistellato, et al. 2016, *Virtual and classical outcrop mapping for reservoir analogue modelling*, proceedings presented to AESC 2016, 26-30 June, Adelaide
16. D. Pistellato, et al. 2016, *Virtual and classical precipice sandstone outcrops mapping for reservoir modelling*, proceedings presented to APPEA 2016 Conference and Exhibition, 5-8 June, Brisbane
17. D. Pistellato, et al. 2016, *Virtual and classical precipice sandstone outcrops mapping for reservoir modelling*, proceedings presented to APPEA 2016 Conference and Exhibition, 5-8 June, Brisbane
18. D. Pistellato, et al. 2016, *Virtual Outcrop Mapping for CO_2 Reservoir Analogue Modelling*, proceedings presented to 2nd Virtual Geoscience Conference, 22-23 September 2016, Bergen, Norway
19. D'Angelo, et al. 2016, *Vacancy generation and oxygen uptake in Cu doped Pr-CeO_2 mixed oxides using neutron and in-situ X-ray diffraction*, proceedings presented to Chemistry of Materials
20. D'Angelo, et al. 2017, O*xygen uptake, selectivity and reversibility of Tb-CeO_2 mixed oxides for air separation*, proceedings presented to Adsorption Journal

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ANLEC R&D is a member of the following IEA implementing agreements. For access to their reports please contact admin@anlecrd.com.au

IEA Clean Coal Centre Reports

Mills, S. 2016, *Low quality coals – key commercial, environmental and plant considerations*, Ref: CCC/270

Zhu, Q. 2016, *China – policies, HELE technologies and CO_2 reductions*, Ref: CCC/269

Sloss, L. 2016, *Levelling the intermittency of renewables with coal*, Ref: CCC/268

Zhang, X. 2016, *Emission standards and control of PM2.5 from coal-fired power plant*, Ref: CCC/267

Carpenter, A. 2016, *Potential water sources for coal-fired power plants*, Ref: CCC/266

Lockwood, T. 2016, *Next-generation carbon capture technologies for coal*, Ref: CCC/265

Reid, I. 2016, *Retrofitting lignite plants to improve efficiency and performance*, Ref: CCC/264

IEAGHG R&D Program Reports

Report: 2016-13*, Fault permeability*

Report: 2016-11, *Regional Assessments of the Economic Barriers to CO_2 Enhanced Oil Recovery in the North Sea, Russia and GCC States*

Report: 2016-09, *4th CCS Costs Network Workshop*

Report: 2016-07, *Evaluation of Process Control Strategies for Normal, Flexible and Upset Condition Operation of CO_2 Post Combustion Capture Processes*

Report: 2016-TR2, *Internationals Workshop on Offshore Geological CO_2 Storage*

Report: 2016-08, *A Summary Report of the Risk Management and Environmental Research Networks Combined Meeting*

Report: 2016-TR4, *Review of Project Permits under the London Protocol – An Assessment of the Proposed P18-4 CO_2 storage site (More)*

Report: 2016-TR3, *Review of GHG Accounting Rules for CCS*

Report: 2016-05, *CCS and Unburnable Carbon (More)*

Report: 2016-04, *Operational flexibility of CO_2 transport and storage*