Australia Coal Sector Update to the 20th Session of the Global Methane Initiative (GMI) Coal Subcommittee

22 October 2014
Geneva, Switzerland
Department of Industry
Australian Coal Sector Update

In 2013-14:

- Australian black coal production reached 432 Mt (184.4Mt - metallurgical and 247.6Mt thermal coal), an 8 per cent increase on 2012-13 production
- Six per cent of the world’s coal production
- Coal exports increased to 375.1Mt, worth $41 billion
- 26% of world trade
- Second largest coal exporter (after Indonesia)
- 28.5Mt CO₂-e emissions from Australian coal mines, 5.3% of net emissions.
- 64% of Australia’s electricity generation from coal
CMM Project Outlook

- Australian Government Direct Action Plan (replaced Clean Energy Future Plan)
- 5 percent reduction on 2000 levels of CO$_2$-e emissions by 2020
- Includes $2.55 billion Emissions Reduction Fund
  - Australian Government will purchase lowest cost abatement from a wide range of sources through reverse auction
  - Financial incentive for businesses, households and landowners to proactively reduce emissions
- GMI Partner Country Action Plan and Coal Sector Action Plan in process of being updated
Coal Methane Abatement Projects

- Five Projects - Funded by Government and Industry ($35.5 million government funds / $81 million total value)
- Projects support the development and demonstration of technologies to safely reduce fugitive methane emissions from coal mines
- Knowledge sharing through the GMI
University of Newcastle
VAM Abatement Safety Project

- $12.5 million (Australian Government) $27 million (Total project value)
- Demonstration of a large-scale VAM capture duct complete with safety control measures and supporting design and testing information
- Understanding the underlying scientific and engineering principles behind methane ignition, deflagration and detonation
Application:

- Examine flame and shock wave velocities in methane and coal dust environments
- Examination of pressure profiles from the methane explosion
- Investigation of the separation between the shock and flame
- Investigation of shock wave mitigation system

30 m Long Detonation Tube
0.5 m Diameter with 2 Stage Silencer
University of Newcastle
Chemical Looping VAM Abatement

- $2.7 million (Govt funds)
- $8.5 million (Total value)
- Mitigates VAM flows with methane concentrations between 0.005% and 2.0%
- 1 m$^3$/s VAMCO prototype and then a 10 m$^3$/s pilot-scale demonstration unit
Chemical Looping VAM Abatement
Advanced Chemical Looping Applications

1 = Air reactor
2 = CH4 reforming
3 = Carbon deposition
4 = Carbon reforming

Unfolded side view
Folded top view

CLG
CaO and Heat
Calciner

CLC
Note: C&D waste is the source of CaO
Gasifier

IGCLC
Novel carbon reformer reactor
1 = Air reactor
2 = CH4 reforming
3 = Carbon deposition
4 = Carbon reforming

CLCR
CO2 reforming of methane
Methanol synthesis

CL-VAM
O2, N2 and H2O
Sweeping gas

Reaction 1
MO + CH4 + 2O2 → MCO3 + 2H2O (Exothermic)

Reaction 2
MCO3 → MO + CO2 (Endothermic)

B1
B2

Step 1
Step 2

CLAS
Isotherms
Red. Air
Red. Air

ICLAS
Effective integration for highest CO2 recovery
Recycled Flue gas @ 35°C
Recycled Flue gas @ 600-700°C

CL-VAM
VAM

Reaction 1
MO + CH4 + 2O2 → MCO3 + 2H2O (Exothermic)

Reaction 2
MCO3 → MO + CO2 (Endothermic)

O2, N2, CO2
H2O
Sweeping gas

O2, N2, CO2
H2O
Sweeping gas

Reaction 1 & 2
B1
B2
Chemical Looping VAM Abatement
Chemical Looping Research Facilities

Bench-scale cold-flow setup
Bench-scale fixed-bed setup

10 kW pilot-plant

500 kW demonstration unit
Chemical Looping VAM Abatement
Experimental Results

VAM oxidation temperature can be dropped by 250-400 °C

Comparison of different materials

Fe-Al$_2$O$_3$ found to be the most reactive material !!!
Milestone 1 (3 mths)
Site Characterisation
- Site characterisation of
  - Geology & hydrogeology
  - Strata properties
  - Gas reservoir parameters
  - Mining and drainage experience
- Project detailed planning and monitoring design

Milestone 2 (10 mths)
Monitoring and measurement
- Drilling
- Instrumentation installation
- Monitoring
- Measurements
- Tests
- Data analysis

Milestone 3 (10 mths)
Fundamental modelling study
- Coupled strata, gas and water responses to mining
- Goaf gas flow dynamics
- Gas drainage mechanisms
- Key factors affecting drainage performance

Milestone 4 (11 mths)
Approach development
- Identification of
  - Gas emission sources
  - Drainage targets
  - Key factors
- Drainage approach development
- Site trial design

Milestone 5 (18 mths)
Site trial
- Site trial implementation
- Performance monitoring and tests

Milestone 6 (27 mths)
Approach refinement
- Site trial evaluation
- Integrated analysis of all project data
- Drainage design approach refinement

Milestone 7 (30 mths)
Summary and dissemination
- Preparation of project final report
- Knowledge sharing
Methane Capture and Abatement Optimisation
Optimal Gas Drainage Design and Trial at LW4

- Optimal gas drainage design was implemented as a trial in LW4, based on site monitoring, measurement, and numerical studies.
- Underground lateral boreholes, consisting of 5 roof holes and 5 floor holes, were designed to replace surface vertical goaf wells and trialled in the first 500m of LW4 extraction.
Methane Capture and Abatement Optimisation

Result: Increased CMM Capture & Reduced CMM Emissions

Longwall 3 Specific Gas Emissions from real time monitoring

<table>
<thead>
<tr>
<th>Week Ending</th>
<th>Longwall Retreat</th>
<th>Longwall Tonnes</th>
<th>Total seam gas m3</th>
<th>SGE l/s aver.</th>
<th>Capture Efficiency</th>
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Longwall 4 Specific Gas Emissions from real time monitoring

<table>
<thead>
<tr>
<th>Week Ending</th>
<th>Longwall Retreat</th>
<th>Longwall Tonnes</th>
<th>Total seam gas m3</th>
<th>SGE l/s aver.</th>
<th>Av. Capture Efficiency</th>
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</table>

- Gas capture efficiency overall was improved from 60% to 80% with optimised gas drainage method, resulting in significant reduction of methane emission to the atmosphere.
- Increase in gas capture efficiency for start-up area was dramatic.
Improved longwall gas control resulted in significant reduction of gas related coal production delays and remarkable increase of coal production in the initial mining stage (an increase of 79% from LW3).

Longwall return CH4 concentration maintained consistently around 1% whereas previously concentration frequently exceeded 2%.
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