Gas Injection trial for Gas storage Potential – Bonanza CSG Field

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Gas Injection Well Name: BNZ-119 — Gas Injection Modelling Details

Surrounding wells6/9 inner/outer radius wells (15 Gas Producers) — Geological model : Petrel RESCUE model

Field summary ~ 100 CSG producers — CMG GEM simulator is used

Cumulative Production 64 TCF (out of 125 TCF GIP) — Dimension: 101 X 101 X 12

Argyle Coal seam is located at 8th layer (see *Well completion Diagram*)

Reservoir Pressure Pi= 647 Psia, Initial gas content 210 scf/ton

Current Pressure 360 Psia, gas content 133.5 scf/ton

(see *Analytical model Plot*)

Detail of Simulation and results

Simulation model was built using BUILDER with 150 m grid size for global cells and 50 m for wells around the gas injector for more accurate modelling of saturation and pressure changes during and after gas injection. Gas injection pressure was constrained to 2000 psia which is threshold pressure of fracturing cap rock. However, in actual gas injection case, only gas injection rate of 2MMSCF/D was attempted to achieve 20 MMSCF of cumulative gas injected into a target coal seam (Argyle coal seam).

Field injection task was designed to inject CH4 along with CD4 and SF6 as tracers. CD4 is considered a clone of CH4 and expected to see together when gas samples were collected from surrounding wells after continuous and stable gas injection rate of 2 MMSCF/D is achieved. SF6 on the other hand, is an indicator of how fast injected gas migrates. In the simulation model, the interest is to measure how much injected CH4 gas re-adsorbed in the coal as a result of 20 MMSCF of gas injected into 3.1 m net coal seam.

Simulation model used CH4 as main injected gas and CD4 as a tracer to determine how much adsorption changes around wellbore of Gas Injector. The model was built with appropriate coal properties (1-3 % porosity, 180 mD permeability) using GEM package to include PVT properties of CH4 and desorption data (Isotherms, Diffusion time etc.)

The simulation results presented here are considered most important and appropriate to understanding gas injection trial results since not all results can be presented here, these are selected slides to present the gas injection trial results on one target coal seam (~ 3m) for 2 MMSCF/D continuous gas injection for 10 days.

Increased gas adsorption around the wellbore of GI is observed

Injected gas (CH4) migrates much faster than the model anticipated due to large fracture along maximum stress direction of 10 degree N.

From field test, most of the surrounding wells show pressure increase caused by gas injection, this is history matched in the individual surrounding wells (all together 15 wells; 6 inner ring wells (within 1 km radius) and 9 outer ring wells (more than 1 km – 2 km radius).

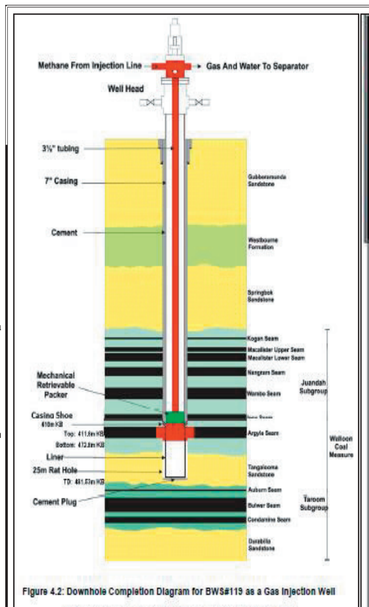
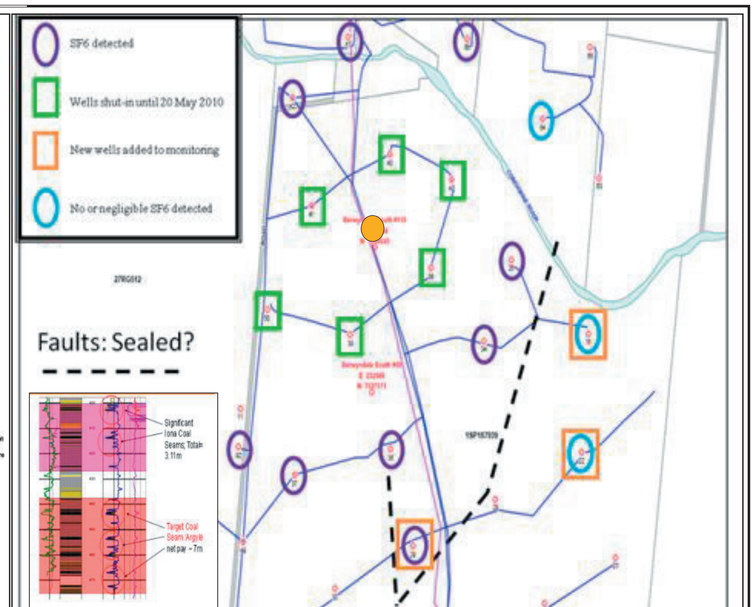
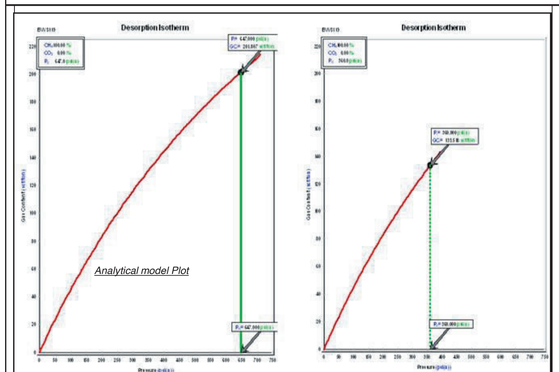


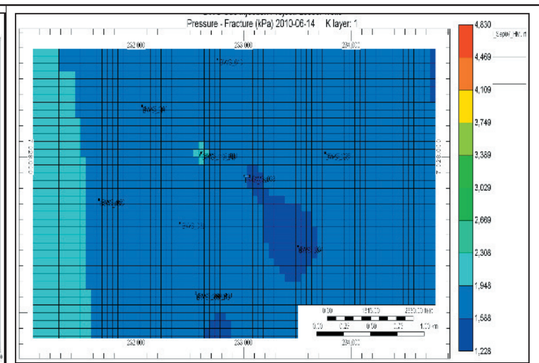
Figure 4.2: Downhole Completion Diagram for BWS#113 as a Gas Injection Well

(NB: completed with 2 ⅞" tubing when converted to a producer)





Analytical model Plot



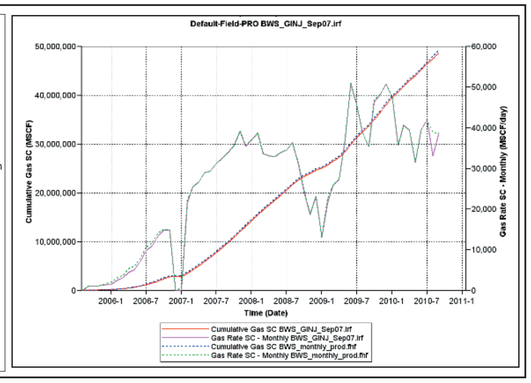
Simulation model input

Initial Pressure 647 Psia and gas content of 210 scf/ton is used from the analytical model (The Plot on the left end)

Initialization and History Matching

The figure in the centre shows initial pressure distribution before gas injection commenced at the Argyle coal seams)

Field gas production rate from observed data were used to validate the model and the plot presented on the right showing a good match.



Gas injection case and results

Figures (presenting from Left to Right in order)

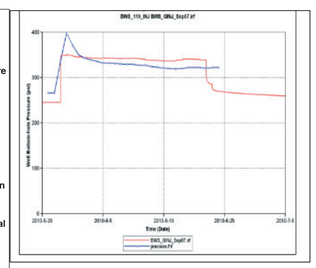
- The model BHP matched measured pressure from Gas Injector

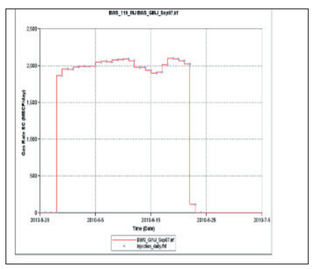
- Gas injection rate 2MMSCF/D is matched in the gas injector

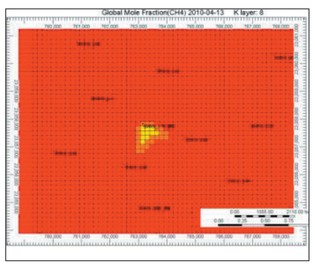
- Initial gas mole fraction of CH4 adsorbed around gas injector.

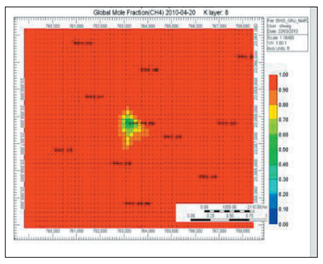
- End of 10 days gas injection, CH4 adsorption around gas injector increase significantly

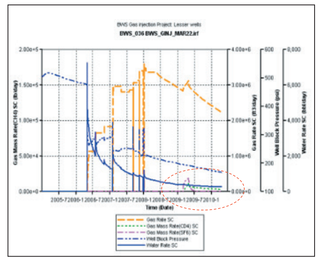
- One of observation well shows tracers arrival after 2 days (see red circle on the plot)











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The Poster depicts real gas injection trial project in which reservoir simulation model was used as a tool to predict migration path of injected gas in the target coal seam (Argyle) and other coal seams in the Walloon coal seams. Two types of tracers (CD4 and SF6) were utilized to track injected methane movement as well as re-adsorbed methane to coal seams during injection process which is the main purpose of the pilot project to assess the potential of using depleted coal seams as a gas storage place in case of producing gas were not needed for LNG plant at a time (Ramp up production for 2nd LNG train before actual delivery date for example).