GISERA Gas Industry Social & Environmental Research Alliance

Coal seam gas - produced water and site management

August 2014

Coal seam gas production

Target coal seams for coal seam gas (CSG) production are generally 300-1000 metres below the ground surface. Production normally requires the drilling of many wells at a more dense spacing than normally required for conventional gas production.

CSG is adsorbed into the coal matrix and is held in place by the pressure of formation water. To extract the gas, a well is drilled into the coal seam and formation water from the coal cleats and fractures is pumped and withdrawn.

The removal of water in the coal seam reduces the pressure, enabling the CSG to be released (desorbed) from the coal micropores and cleats, and allowing the gas and 'produced water' to be carried to the surface.

In some cases the coal permeability is low and gas production is small (sub-economic). In these cases, the coal can be hydraulically fractured (see *Hydraulic fracturing* fact sheet for further information), to further assist the flow of gas through the coal to the producing well.

Figure 1. Water treatment plant (photo source: Australia Pacific LNG).

Coal seam gas produced water

Produced water (also known as CSG water or associated water) is the combination of hydraulic fracturing fluid and formation water, which is water that is already present in the coal seam. The water is pumped out of coal seams in order to release CSG. Over time, the volume of produced water normally declines and the volume of produced gas increases.

Once they reach the surface, the produced water and the gas, which consists mostly of methane, are separated. The methane is collected and passed to a central compressor station where it is added to a pipeline network for delivery to users. The produced water is piped elsewhere for use or further treatment (see *Produced water treatment and uses* section).

How much water is produced from CSG production?

No two wells or coal seams behave identically and water production can vary from a few thousand to hundreds of thousands of litres a day, depending on the underground water pressures and geology. In Queensland, water production has, to date, averaged about 30,000 litres per well per day.*

Whether or not the process of water extraction poses a problem will depend largely on the interaction, if any, between CSG production and aquifer systems and on what is done with the produced water.

What is the water quality like?

The water that is produced from a coal seam has generally been underground for a long time with very little fresh water penetration. As a result, the water often contains salt. CSG water contains mainly sodium chloride (varying from 200 to more than 10,000 milligrams per litre), sodium bicarbonate and traces of other compounds. Total dissolved solids in produced water in Queensland has, to date, averaged about 6 grams per litre (g/L), which is about one sixth that of sea water.

*based on data from Queensland Government (https://data.qld.gov.au/dataset/coal-seam-gas-production-and-reserve-statistics/resource/63a8a6cc-7fb6-4040-b4e7-9d453b14d3ed)

Produced water treatment and uses

Produced water quality is highly variable from site to site, but it is generally not fit for human consumption. Depending on its intended use and quality, produced water can be used directly, treated and then used, or directly reinjected.

What are the potential uses for coal seam gas water?

CSG produced water has a number of uses, depending on its quality and quantity. Generally, however, the beneficial uses of CSG water are limited without treatment.

The potential uses for produced water include:

- water as a supply for local farmers and communities
- irrigation of agricultural crops or plantation forestry
- dust suppression
- industrial purposes (e.g. drilling, coal washing for coal mining, cooling in power stations)
- discharge of interim or occasional surpluses of treated water into local river or weir/dam systems (if the water is treated and conditioned to equal standards for discharge into rivers, it can contribute favourably to environmental outcomes for river systems already exposed to heavy irrigation demand)
- reinjection into suitable underground aquifers or discharge as surface water.

How is produced water treated?

Treatment of CSG water depends on the quality and quantity of the produced water, the intended use of the water, and the prevailing environmental laws and regulations.

To treat the water to a standard suitable for town water supply or other purposes, such as farm irrigation, would require at least reverse osmosis (RO), or a similar technology to remove the dissolved salts and other chemical compounds. Water treatment also often involves balancing the water chemistry.

RO is a robust and well-proven technology that can filter out up to 95 per cent of the salts and organic compounds. Some operators have used RO to treat produced water, which is then used on plantations, in fish ponds or for other beneficial uses.

The treatment process results in a super saline brine or solid salt, depending on the process used, which can require further treatment or disposal. For instance, brine can be disposed of by injection into deep geological formations.

How is produced water disposed of?

In Queensland most untreated produced water was, historically, disposed of in evaporation ponds ranging from 1 to 100 hectares in area. In 2010 evaporation ponds were discontinued as a primary means for the disposal of CSG water because of concerns over leakage of saline waters into soils, aquifers and rivers. Remediation of all evaporation ponds is anticipated to occur within three years.

Treated CSG water can also be reinjected into suitable aquifers or surface water systems but impacts on those aquifers need to be considered.

Monitoring and management of coal seam gas sites

Characterising CSG sites for production and for drilling wells is important in assessing the potential of CSG production.

Technologies such as three-dimensional geophysical surveying techniques, mathematical based modelling and imaging of underground reservoirs can be used to observe subsurface aquifers and geological strata, determine how coal seams are connected to aquifers and assess the potential for groundwater contamination.

Groundwater modelling can assist in indicating the extent to which coal seams are connected to aquifers, and to predict whether drawing water from one can impact levels in the other. Seismic mapping technologies can be used to map fracture locations and channels for water movement underground.

Although absolute guarantees about potential impacts are not possible, existing knowledge from research on aquifers and groundwater models make it possible to estimate the risks and uncertainties of adverse impacts.

What monitoring and management procedures are used to assess the suitability of a site for CSG operations?

A number of detailed evaluation tests and analyses can be used to help determine the suitability of a site for drilling and extraction of CSG.

These analyses can include:

- geological site descriptions from well data – to characterise the rock layers associated with each coal seam well and their distribution, deposition and age
- seismic surveys – to define the geological structure beneath the ground surface and identify faults or fractures that could potentially create leakage pathways that may also be associated with subsurface water movement
- hydrodynamic assessments – to map the rate and direction of groundwater movement and to determine the connectivity of aquifers in the subsurface
- analysis of water quality samples – to measure barriers to flow between the deep and shallow groundwater zones or areas
- analysis of groundwater samples – to determine the existing water quality levels at the site before CSG production, and to use as a baseline to monitor any changes during and after production.

Information gathered from all the analyses and geological characterisations can be used to build computer models of the site. These models can then be used to make predictions of the impacts of CSG production and groundwater systems.