Hydraulic fracturing (fraccing)

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What is hydraulic fracturing?

Hydraulic fracturing, or fraccing, is a method used by the oil and gas industry since the 1940s to increase the rate of oil and gas extraction and the total amount extracted from reservoirs.

Fracturing has been used to enhance coal seam gas (CSG) production from coal seams since the 1970s in the United States (US) and since the 1990s in Australia. Increased CSG activity, mostly in Queensland and New South Wales, has caused a parallel increase in the use of hydraulic fracturing.

This factsheet contains information about the technology of the fraccing process. Although the technological aspects of fraccing are known, the environmental impacts of fraccing are less well characterised.

The nature of an individual frac is complex, and depends on various factors such as the nature of land use in surrounding areas, geology, and hydrodynamics (see CSG developments - predicting impacts for more information about the social and environmental impacts of CSG).

Technology of the fraccing process

Why is fraccing necessary?

Without the recent and significant technological advancements made in horizontal drilling and fraccing, a portion of the natural gas found in coal seams would be uneconomic and unrecoverable.

Fraccing is the most common method used to increase the production from a CSG well, but not all gas wells require fraccing. Generally only wells that intersect lower permeability coal seams require fraccing and these are usually deeper seams.

Where has fraccing been used in Australia?

Fraccing has been widely used in Australia within the geothermal and gas industries. Fraccing for stimulation of petroleum wells, as distinct from CSG wells, has been used in most states in Australia with most of the activity in South Australia and Queensland. Fracturing for stimulation of CSG wells has been carried out mostly in Queensland and New South Wales.

How is fraccing carried out in coal seam gas production?

The decision to hydraulically fracture a well is often made before drilling commences because the process requires additional considerations in well design and construction procedures.

Typically, a well is fully cased from top to bottom with steel casing. To gain access to the coal, the casing is perforated at specific intervals along the well, where the fracture treatment is to be carried out.

Fraccing typically involves injecting fluid made up of water, sand and additives under high pressure into the cased well. The pressure caused by the injection typically creates a fracture in the coal seam where the well is perforated. For a large CSG treatment, the fracture might typically extend to a distance of 200 to 300 metres from the well.

The fractures grow slowly. For example an average velocity may be less than 10 metres per minute initially and slowing to less than 1 metre per minute at the end of the treatment.

The sand in the fraccing fluid acts to keep the fracture open after injection stops, and forms a conductive channel in the coal through which the water and gas can travel back to the well.

After the fracturing is complete, most of the fraccing fluid is, over time, brought back to the surface and treated before being used again or disposed of.

What does the fraccing fluid contain?

Water and sand make up around 97-99 per cent of the fraccing fluid.

Other materials that make up the remainder of the fluid are added to make the mixture thicker and to break these fluids to a thin fluid at the end of the injection and manage biological growth. Some commonly used chemical additives include:

- sodium hypochlorite (used in bleach and as a biocide in swimming pools)
- hydrochloric acid (a strong corrosive acid)
- surfactants (used in soaps)
- cellulose (the structural component of the primary cell wall of green plants)
- guar (used as a gelling agent, e.g. as a food additive to thicken some food products)
- acetic acid (the basis of vinegar)
- bactericides (to inhibit bacteria forming that may corrode the steel casing or plug the permeability in the fracture and coal seam).

Added chemicals make up about 1-3 per cent of the fraccing fluid.

The exact nature of the fraccing mixtures used by CSG companies may vary depending on the well and may be commercially confidential.

How much water is used during the fracing process?

Generally between 0.1 and 10 mega litres (ML) of water may be used to frac a well. A well may be fractured at different depths along the wellbore.

What happens to the fracing fluid after it is pumped down the well?

Ultimately, 60 to 80 per cent of the fracing fluid flows back to the well from the coal seam. These fluids are brought to the surface inside the steel casing. This fluid is then pumped to lined containment pits or tanks.

Wherever possible, the fluid is recycled for further fracing treatments or taken to an off-site location to be disposed of.

How deep is fracing performed?

Hydraulic fracturing takes place hundreds of metres below ground, generally deeper than local groundwater supplies. Targeted fracing zones are typically located at around 300 to 1000 metres below the freshwater zones and are separated by low permeability shales and sandstones.

The fracture treatments are designed to grow only in the zone of rock that contains coal seams because growth out of zone increases the cost and reduces the effectiveness of the treatment. Each site must be characterised by measuring rock properties and stress so that the potential for fracture growth can be assessed. Depending on the conditions at the site, however, some future growth in the rock around the coal can occur. Remote monitoring is used during many treatments to measure and limit this growth.

What are the strategies undertaken to ensure that groundwater is not contaminated by fracing activities?

A number of techniques are employed to reduce the contamination risks associated with fracing.

Wells to be fractured are fully lined with steel casing, which are cemented in place to isolate all aquifers overlying the target coal seam. Before fracing is conducted, the integrity of the cement bond between the casing and rock needs to be confirmed and verified.

The risk of groundwater contamination is assessed by characterisation of the CSG site and monitoring and management procedures. Characterisation methods are used to assess the rock that separates the coal from any water bearing aquifers.

These include surveying, modelling and imaging. This helps to identify and avoid fracing operations that may cause continuity with surrounding aquifers.

A similarly wide range of geological and geomechanic measurements are made to understand the properties of the coal seam and surrounding rock, to enable each fracing operation to be designed so that the frac is contained within the coal seam.

Monitoring methods also provide quality control on the fracture design and fracture growth, to ensure the fractures extend only in the target coal seams.

The extent of fracturing can be measured at the time of fracing through well logging and remote monitoring such as microseismic monitoring. Tiltmeters can be used to measure the fracture orientation and volume. Offset instrumented wells are sometimes drilled and used to monitor fracture growth and are used later during production to monitor seam pore pressure.

Models that predict fracture growth are used with the remote monitoring methods to assess potential risks of fracturing into zones above or below the coal seams. However, absolute guarantees about fracture growth are not possible because estimation of the growth is based on limited data reflecting the statistical variation of parameters in a sequence of rock layers.

Should a hydraulic fracture grow into an aquifer the fluid flow during production will be from the aquifer towards the CSG well. This minimises the risk of groundwater contamination.

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Contact Us

Phone: 1300 363 400
+61 3 9545 2176

Email: enquiries@csiro.au

Web: www.csiro.au

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