Hydraulic fracture stimulation

A safe way to extract coal seam gas

What is hydraulic fracture stimulation or fraccing?

Hydraulic fracture stimulation, hydraulic fracturing or fraccing is an existing, proven and accepted well completion technology to increase the flow of fluids and gas from the target formation to the wellbore. Fraccing is not new to Australia, and has been used on an ongoing basis for more than 40 years. More than half a million fracs have been performed globally in the last six years and more than one million in the last 60 years.

A fluid called fraccing fluid, or frac fluid, which primarily consists of water and sand (about 99%), is pumped down the well under pressure. The aim of the frac is to open, connect and create fractures, as well as placing sand in existing and new fractures which in turn, holds them open to provide a pathway for gas to flow more easily into the wellbore for extraction.

Why do we use fraccing in coal seam gas extraction?

As the cleanest fossil fuel, natural gas meets a variety of our energy needs; from generating electricity to cooking to heating homes and powering vehicles.

Increasingly, natural gas is produced from unconventional sources, such as coal seam gas (CSG). CSG is cleaner than natural gas from conventional sources.

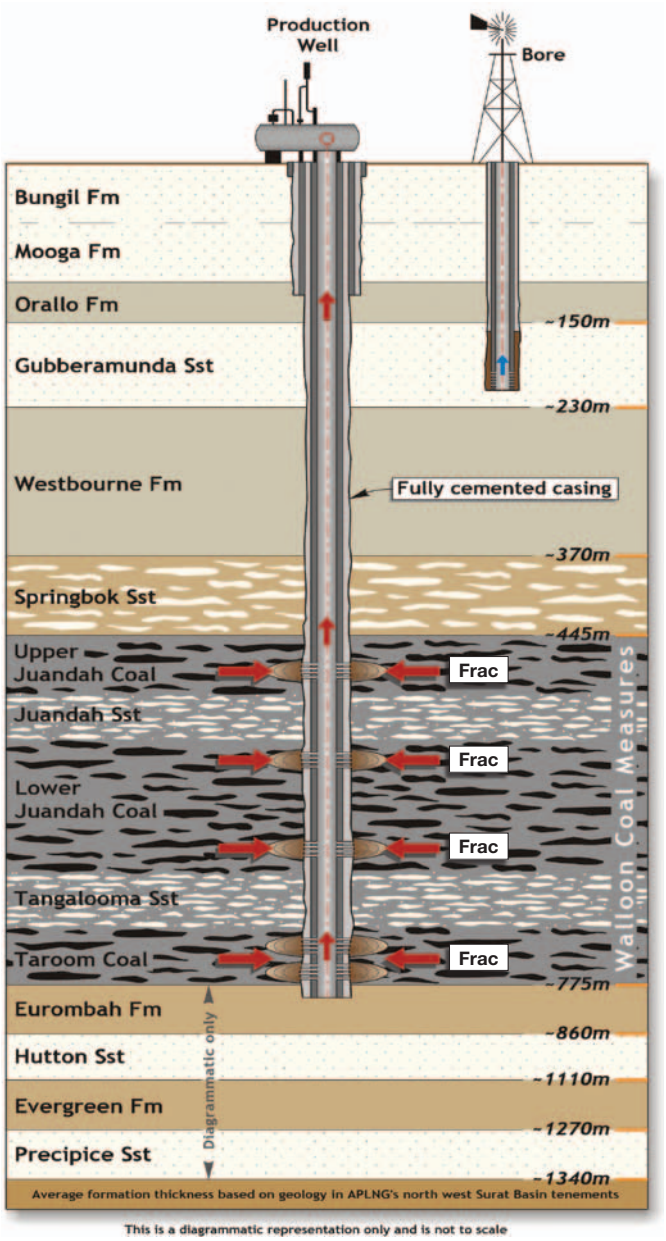
In some areas, such as low permeability coals, fraccing is necessary to enable a more effective release and flow of gas from the coal seam.

Fraccing can unlock an area of low productivity potential, it can convert a non productive well into a productive one and it can increase the drainage area of each well. This means that fewer wells need to be drilled in order to produce the same amount of gas.

Fraccing significantly reduces the overall environmental impact of CSG operations in areas of low permeability coals.

While hydraulic fracture stimulation technology supports the efficient development of CSG reserves, not all CSG wells need to be fracced. Approximately 30% of the Australia Pacific LNG Project's wells are expected to be completed by hydraulic fracture stimulation over the life of the business.

Gas production from a hydraulically fractured well



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Why are chemical additives used in hydraulic fracture stimulation?

Chemicals are an integral component of food and pharmaceutical processing, industrial processes and manufacturing.

The chemical additives used in hydraulic fracturing enable:

- the fluid to form a gel and hold the sand in suspension (allowing more sand to be spread throughout the fractures and less water to be used)
- the gel to break down once the process is complete
- clays to be stabilised and to prevent swelling
- pH levels to be balanced, and
- the prevention of bacteria transfer from surface water to the coal seams.

What chemical additives are used in hydraulic fracture stimulation?

Australia Pacific LNG exclusively uses water based hydraulic fracturing fluids. The viscosity (or thickness) of the frac fluid is engineered to cater to specific formation characteristics and to optimise the volume of sand placed in the coal seams.

A low viscosity, or low thickness, frac fluid usually called a water frac, consists of treated water, sand and a small amount of additives (0.1%).

A higher viscosity, or thicker, frac fluid usually called a gel frac, is used in different formations and has an additive content of (0.33% to 1.21%) depending if produced or fresh water is used. The significant difference between the various frac fluids is the inclusion or exclusion of guar and KCl (potassium chloride, a common salt). Guar is a natural gummy substance that forms a gel when mixed with water. Both guar and KCl have many common uses. The extra additives make the fluid thicker and enable more sand to be suspended in the same volume of fluid (up to six times more) and reduces the amount of water used.

The additives used are all commonly occurring and are contained in many standard household products. They are used in very diluted concentrations in frac fluids and at lower concentrations than normally used in other common products. Additives include sodium bicarbonate (bicarb of soda), acetic acid (vinegar), sodium hydroxide (caustic soda, used in toothpaste), and calcium chloride (found in sports drinks and pickles).

The table on the back page explains the additives we use in hydraulic fracture stimulation. It also shows the percentage range of the additives used in our frac fluids and how these additives are also used for everyday purposes.

The number of chemicals used in a particular frac can vary from 2 to 16. Many of the chemical additives are included in the Therapeutic Goods Administration (TGA) list for therapeutic use in hospitals (www.tga.gov.au).

Importantly, Australia Pacific LNG does not use BTEX (benzene, toluene, ethylene, zylene) in its frac fluids.

What happens to the hydraulic fracturing fluids after they are pumped into the formation?

The majority of fluids which are pumped into the coal seam during the hydraulic fracturing process are recovered from the well after the well is placed into production. These fluids are then removed and disposed of appropriately in accordance with strict regulatory guidelines.

Much of the frac fluid that remains in the formation is brought back to the surface during normal CSG production and operations. All recovered fluids are collected along with the CSG water produced and transported to a water treatment facility.

The small amounts of fluids that remain in the formation will degrade over time, turning into water similar to the existing salty water in the formation. The sand is designed to stay in the fractures to keep them open.

How safe is hydraulic fracture stimulation and the use of these chemical additives?

Fraccing is a highly regulated and controlled process. The frac fluid is pumped into isolated coal seams, deep underground and in the diluted concentrations used, the chemical additives are not considered harmful.

It is safe to say that we eat, drink or wash in the chemical additives that we use in fraccing. These additives do not remain in the environment after use because they quickly degrade.

During the course of the fraccing process, the chemicals are further diluted when injected into the coal seams by the water already present in the seams.

The additives we use are commonly found within homes as ingredients in foods, toothpastes, personal and hair care products and soap. Their functions in these products are similar to their functions in frac fluid – for example, the suspension of other ingredients (sand in the frac fluid and herbs and spices in salad dressings).

To restrict frac fluids and gas from entering surrounding aquifers, rigid design standards are followed and well integrity is confirmed prior to fraccing. All wells have multiple steel casings with cement sheaths that isolate surrounding formations from each other and the well bore. The wellhead system used is designed specifically to manage the fraccing process.

Hydraulic fracture stimulation is designed to only frac the target coal seams which are typically separated by more than 140m of very low permeability barriers of siltstones and mudstones. The cemented casings and the siltstone and mudstone barriers prevent cross-contamination of the fluids into surrounding aquifers.

Only experienced contractors are used to provide fraccing services and their equipment is certified and tested prior to every frac.

The technology used in fraccing continually improves and the additives have become much cleaner and safer over the past 60 years.

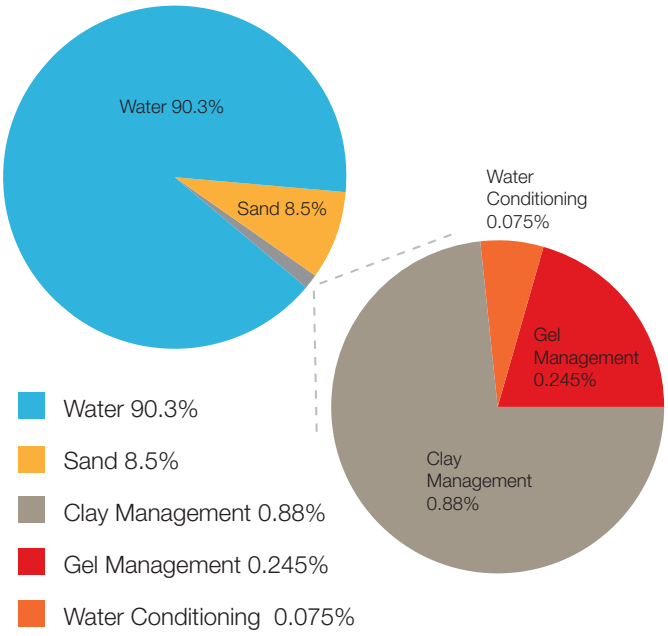
Regulatory and Compliance Requirements

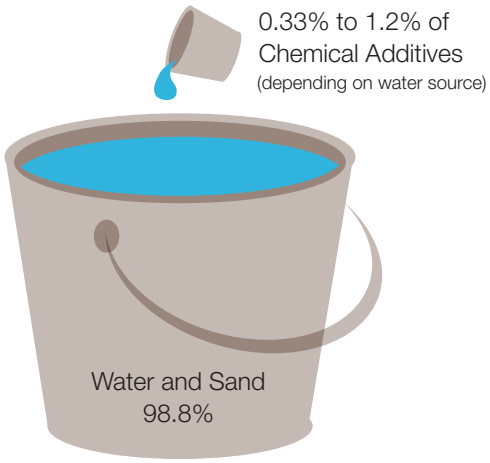
The Queensland Government has introduced strict regulatory requirements covering the fracture stimulation process and the additives used in frac fluids. Australia Pacific LNG has developed and applies very stringent procedures for its fraccing activities.

Compliance requirements include:

- Over 13 specific hydraulic fracture stimulation conditions and over 20 monitoring conditions, with a monitoring regime for over 45 analytes (chemical, chemical compound or physical property).
- Source water sampling prior to any fraccing activity. The mixed frac fluid is sampled and tested before being used to ensure it meets regulatory requirements. Samples of the frac fluid being pumped are taken and tested. The testing is undertaken by independent NATA certified laboratories. All testing results are available to the regulator. Water bores adjacent to a hydraulically fractured well site are baseline tested prior to any activity and then, on a regular basis as per regulation.
- Taking samples of produced fluid following completion of fraccing, which are tested on a regular basis as per regulation.
- Compliance with Queensland Government restrictions on the use of BTEX.
- Compliance with on-site audits of fracture stimulation activities implemented by DEHP (Department of Environment and Heritage Protection).
- Listings of chemicals used and MSDS sheets on the Australia Pacific LNG website.
- Discussion with landholders about each frac job.
- A copy of the post fraccing summary report is provided to the landholder and the regulator within 10 days, with a comprehensive final report provided to the regulator two months after the fraccing activity.

Typical composition of a gel frac fluid





About Australia Pacific LNG

Australia Pacific LNG is the largest producer of natural gas in eastern Australia, delivering a reliable energy source to customers in Australia and Asia.

Our domestic production is currently equivalent to more than 40 per cent of Queensland's gas requirements.

Australia Pacific LNG's two train liquefied natural gas (LNG) production facility will supply 9mtpa of LNG to export customers in Japan and China.

Australia Pacific LNG is owned by Origin Energy (37.5%), ConocoPhillips (37.5%) and Sinopec (25%).

The current chemical additives in use for fracture stimulation

Group/ Function	CSG Stimulation (QLD) - Australia Pacific LNG		Commonly Found	Food Additive Number	% volume of chemical in household items	Group % by volume (average)	% volume range of chemical in frac fluid
	CAS No.	Chemical name					
Sand (Proppant)/ Water	7732-18-5	Di-hydrogen oxide (water)	Drinking, irrigation, bathing, cooking		1% to 100%	98.415% to 99.9%	85% to 97.6%
	14808-60-7	Silicon dioxide (quartz / sand) (Quartz, Crystalline silica)	Hand cleaner, arts & crafts, glass	E551	1% to 100%		2.3% to 13%
Water Conditioning (Microbial / pH Control)	2682-20-4	3-Isothiazolone, 2-methyl-2h (2-methyl-2h-isothiazol-3-one)	Antibacterial hand soap, kitchen and laundry detergent, air / spray freshener, hair shampoo, wipes			0.075% to 0.256%	0.00008% - 0.00014%
	14464-46-1	Cristobalite	(SiO_2, Quartz polymorph)				0.00002% - 0.00009%
	91053-39-3	Diatomaceous earth, calcined	Naturally occurring fossil powder, filtration, toothpaste				0.00442% - 0.00666%
	9000-70-8	Gelatins	Food additive, marshmallows, pharmaceuticals, cosmetics, personal care, cheese, soft sweets	E441			0.0% - 0.012%
	56-81-5	Glycerol / Glycerine	Pharmaceutical industry, hair products, sweetener, personal care, cough syrup, toothpaste, mouthwash, skincare, glycerin soap	E422			0.0% - 0.2818%
	7647-01-0	Hydrochloric acid	Cleaners, disinfectant, air freshener, shampoo, spray insect cleaner, pond fish care	E507			0.22021% - 1.03669%
	7786-30-3	Magnesium chloride ($MgCl_2$)	Fertiliser, de-icing, tofu, Nigari, baby formula, supplements	E511			0.00014% - 0.00044%
	10377-60-3	Magnesium nitrate	Fertiliser, ceramics				0.00071% - 0.00088%
	111-30-8	Pentanedial/Glutaraldehyde	Biocide, freshwater aquariums				0.0% - 0.009%
	1310-73-2	Sodium hydroxide (Na(OH)) (caustic soda)	Food preparation, coffee creamer, body wash, face cleaning pads, soaps, detergents, toothpaste, whitening strips, face mask, eau de cologne, black olives	E524	0.1% to 5%		0.0% - 0.01115%
	26172-55-4	5-chloro-2-methyl-2h-isothiazolol-3-one (Methylchloroisothiazolinone)	Cosmetics				0.00027% - 0.00045%
	10043-35-3	Boric acid (H3BO3)	Used in cosmetics and skin care products.				0.0% - 0.0017%
	110-17-8	Fumaric acid (2-Butenedioic acid, E-)	Used as a food additive and medical treatment of multiple sclerosis.	E297			0.0% - 0.0015%
Clay Management	7447-40-7	Potassium chloride (KCl)	Table salt substitute, medical use, hair care, African violet food	E508	0.5% to 40%	0.85% to 0.91%	0.85263% - 0.91%
Gel Viscosity Management	9000-30-0	Guar	Cosmetics, baked goods, ice cream, toothpaste, sauces, salad dressing, substitute for wheat intolerance instead of flour, chicken, pig and cattle food, medical use	E412	0.5% to 20%	0.0% to 0.297%	0.0% to 0.29702%
	7727-54-0	Diammonium peroxidisulphate (Ammonium persulphate)	Hair bleach			0.0% to 0.189%	0.025556% - 0.05999%
	7631-86-9	Non-crystalline silica (impurity)	Solar cells				0.00022% - 0.00069%
	1332-77-0	Potassium borate	Lubricants and greases, leavening agent				0.0% - 0.05539%
	1310-58-3	Potassium hydroxide	Soap				0.0% - 0.01953%
	7647-14-5	Sodium chloride (NaCl)	Food production and additive, table salt, detergents, hair products, water softener, medical saline drips		0.03% to 99%		0.0% to 0.004%
	14807-96-6	Talc, Magnesium Silicate (Magnesium silicate hydrate (talc))	Baby powder, personal care, makeup, skin soap, pesticide, pet care, paint, putty	E553			0.00001% - 0.00004%
	25038-72-6	Vinylidene chloride/methylacrylate copolymer	Used in plastic wrap for foods				0.00082% - 0.00127%
	107-21-1	1,2-Ethanediol (Ethylene Glycol)	Used as an antifreeze agent, de-icing, printer inks.				0.0% - 0.06%
	102-71-6	2,2',2"-nitilotriethanol	Used in cosmetics and skin care products.				0.03658% - 0.0386%
	1319-33-1	Boronatrocalcite (Ulexite)	Optical fibres				0.0% - 0.0432%
	1330-43-4	Sodium tetraborate	Component of many detergents, cosmetics, texturing agent in cooking.				0.0% - 0.0033%
	7704-73-6	Monosodium fumarate	Used as a food additive.	E365			0.0% - 0.0012%
	125005-87-0	Diutan gum	Used in mining and metal extraction.				0.0% - 0.0001%
To be trialled in 2016							
Tracers	445-29-4, 455-38-9, 456-22-4, 385-00-2, 455-40-3, 455-86-7, 2991-28-8, 1583-58-0, 1201-31-6, 455-24-3, 433-97-6, 454-92-2, 121602-93-5, 446-17-3, 61079-72-9, 4519-39-5	Fluorobenzoic acids	Used in groundwater tracers			0.0% to 0.0015%	0.000015%

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AUSTRALIA PACIFIC LNG

For more information

For landholders, gas field and pipeline general enquiries call **1800 526 369** or **email contact@aplng.com.au**

For enquiries about the Gladstone operations and LNG facility call **1300 776 205** or email **aplng.gladstone@conocophillips.com**

Or visit our website at **www.aplng.com.au**