Understanding Oil & Gas
Just the basics!
The time is coming when fuel sources like coal, oil and natural gas will not be economically available or required, but until then, natural gas is a clean and economical bridge fuel – a low carbon alternative to coal that will help us make the transition to cleaner energy - and an accompaniment to renewable resources.

What are Hydrocarbons?

In chemistry, a hydrocarbon is an organic compound consisting entirely of carbon and hydrogen. Oil and gas are hydrocarbons.

What are unconventional hydrocarbon resources?

Unlike the conventional oil and gas, unconventional resources are much more difficult to produce because oil and natural gas do not move through the rock very easily. The majority of oil and gas wells being drilled in Canada today are considered "unconventional" because they target unconventional reservoirs.

Natural Gas/Shale Gas/Tight Gas/Tight Oil

Natural gas consists mainly of methane, but it may also contain small amounts of other hydrocarbons, for example, propane. Natural gas is one of the cleanest burning fossil fuels, and releases fewer greenhouse gas emissions than coal, or oil.

Both natural gas and oil were formed millions of years ago as heat and pressure transformed decaying plant and animal matter. The gas or oil produced is trapped under solid layers of rock that keeps it from flowing to surface.

Both Shale Gas and Tight Gas are the same gas as Natural Gas. The name describes only the rocks where the gas is found.

Rocks with holes so small or poorly connected that gas or oil can't easily flow through them are referred to as tight. They have very low permeability - a measure of how easily fluids flow through them.

Gas and oil that occur in these kinds of rocks are often referred to as tight gas or tight oil. There are many rocks like this and shale, a very common, extremely fine grained rock, is one of them. Natural gas that occurs in shale is called shale gas.
Do I need them?

It takes a mixture of hydrocarbons to create crude oil. When that oil is then sent to a refinery, petroleum products are produced, including gasoline, diesel, and many other products:

Hydrocarbons → Crude Oil → Petroleum Products

The work that the oil and gas industry does helps provide the energy we need to heat our homes and businesses, generate electricity, drive our vehicles and power our devices, but it doesn’t count for much if we harm our planet while doing it. That’s why best practices, developed over many years, and various levels of regulations are in place—to ensure that any surface effects of oil and gas operations are temporary, and that there are no long term issues above or below ground that we’ll live to regret.

Petroleum is a valuable natural resource because of the products it can make and because of its many uses:
- Fuel (gasoline, diesel, jet fuel, heating and cooling, propane, electricity generation, etc.)
- Plastics (cars, home building materials, computers, housewares, toys, furniture, etc.)
- Other synthetic materials (bires, paints, packaging, film, fabric, upholstery, carpet backing, surfboards, detergents, vitamins, medication, make-up, shampoo, toothpaste, doddle, perfume, clothing, shoes, etc., etc.)
- Road construction (asphalt, tar)
- Agricultural products (fertilizers, pesticides, herbicides, etc.)
- Paraffin wax
- Lubricants
- Gases (helium, sulfur, etc.)

Explore the image to the right to see all the ways in which petroleum products are part of our lives. If it’s coloured, it’s most often petroleum-based.
Many steps are taken by the producer (oil & gas company) to determine the potential of a reservoir. The producer will:

- study the surrounding geology (land)
- purchase mineral rights
- get a licence and permits from the government
- get agreement with the landowner
- plan safety and emergency procedures, and identify other stakeholders
- prepare the location for drilling.

The industry used to drill multiple wells vertically (going straight down from ground level), each on its own site, in order to achieve many contact points with the reservoir. Horizontal drilling allows many wells to be drilled from one pad, enabling the surface footprint for a well to be minimized, meaning less of an impact on the environment.

If the well looks promising, the company will likely produce the well. The drilling company will run production casing—a long section of oil field pipe—down the wellbore.

Layers of casing and cement serve various purposes, including:

- protecting the groundwater
- anchoring a device called the Blowout Preventer (BOP) to the top of the well, to ensure the well pressure is contained, and ensure the safety of the well, the crew and the equipment during drilling
- providing wellbore stability
- sealing and isolating all zones from one another along the length of the wellbore
- protecting surrounding rock from the high pressure used during stimulation and production.

Oil and gas well cement is very different from what you see above ground. Unlike sidewalk or building concrete, well cement has no gravel, and once placed into the warm well, does not experience the above ground freeze and thaw cycle, so the cement does not crack or crumble.
In order to release hydrocarbons from these tighter reservoirs, often techniques need to be used to stimulate the flow of oil and gas. Oil or gas will flow more easily from the formation rock to the wellbore when stimulated by:

- hydraulic fracturing
- acidizing (see sidebar)

A producer will hire a service company to stimulate the well. The service company will design a program, outlining the proposed technological solution for the job, and the proposed cost for the job.

Hydraulic fracturing, one of the stimulation methods, requires typically just a few days during the whole drilling and production procedure. After stimulating the potential zone(s), the well is ready to be equipped for production. This subject is covered in detail on pages 10-15.

### 4. Stimulation (Fracturing)

**Acidizing:** Acid is used to stimulate production by dissolving damaged rock and scale in all types of wells: gas and/or oil producing, injection, and disposal wells.

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### 5. Production and Ongoing Testing (Development)

Development requires drilling many wells over a period of time and connecting them to a pipeline system. For each well or group of wells, the process is similar. After a well has been stimulated, it is ready for production. At this point, everything needed for producing and transporting the oil or gas is connected. Putting the well into production is the responsibility of the oil and gas company and can take a few days or weeks. Once the well is in production, it can produce for 10 to 30 years, sometimes more.

At least 40% of the well pad site can be restored to its original condition once a well is brought into production. All waste fluids and solids are removed to licensed treatment facilities, and the reclaimed space is landscaped according to local or government requirements.

Most producing wells in North America are monitored daily, and periodically inspected for natural gas leaks. If any issues are identified, they can be fixed.

Wells that are no longer producing commercially viable amounts of oil or gas, or wells that are unsuccessful, must be properly plugged and sealed. Then, the land must be restored by the well owner/company. Restoration processes at the well site include cleaning or remediating any contamination detected, removing foreign materials, restoring soil profiles and seeding or planting vegetation according to regulatory requirements.

### 6. End of Production and Reclamation

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Let's Just Talk About Fracturing!

What is Hydraulic Fracturing? (Fracking? Fracing?)

Hydraulic fracturing involves pumping a fluid - consisting most often of water and sand - down the wellbore with sufficient pressure to crack the rock, creating a pathway for hydrocarbons to rise to surface. The process is sometimes called "fracking" or "fracing."

Let's Just Talk About Fracturing!

Hydraulic fracturing is a proven technology that is being safely used in North America and in many other parts of the world. This technology has helped meet global energy needs for commercial and personal consumption.

Key points:
- Fracturing has been practiced for more than 60 years.
- Wells are cased and cemented prior to fracturing.
- Fracturing of shale and other tight formations is done far below drinking water sources.
- Hydraulic fracturing uses only a small percentage of available fresh water - for a short but intense period of time - and companies are increasingly finding ways to reduce, reuse and recycle the water that industry does use.
- Service companies are voluntarily disclosing additives used in frac fluids.
- Most additives used in fracturing are found in common household products.
- Fracturing does cause seismic activity, but these tremors are very small and unnoticeable, and are contained close to the fracture.

Let’s define what fracturing is and where it came from. Then we’ll talk about why we frac, how we frac, what concerns are being expressed about the process, and what we know about fracturing.

In fracturing, the intense demand for water usually lasts less than a week. About 4.5 million gallons of water are needed to drill and fracture a typical deep shale gas well, which is equivalent to the amount of water consumed by:
- New York City in approximately 6 minutes
- A 1,000 megawatt coal-fired power plant in 12 hours
- A golf course in 25 days
- 38,331 (metric) 0.1 acres) of corn in a season
- Tight oil wells often use less water for hydraulic fracturing, although the volumes can be similar to shale gas in some regions.

How Big is a Fracture?

The average fracture, or crack, is less than half a centimetre (1/4 inch) in width, and surrounding rocks determine its height and length.

Fractures are a bit lazy. They follow the path of least resistance and will only travel up and down to a harder rock that acts as a barrier, and then stop and go sideways (laterally) within the "easy to fracture" rock until the pumps are shut off. The distance has been measured, and it's not very far: 50 - 200 metres (150 - 700 feet) is typical.

Why do we frac?

Just like morning rush hour, there is a lot of congestion when the roads aren’t wide enough to handle the amount of cars trying to get places. In a formation, the “roads,” or spaces, in tight reservoirs are too small for the hydrocarbons to flow outwards. This restriction causes higher flow rates, which is similar to having freeways, rather than narrow roads, to ease traffic congestion.

Because of increased public awareness, many people believe hydraulic fracturing is new. In fact, the first time it was used was 1949, when Stanolind Oil in Velma, Oklahoma pumped the first hydraulic fracture treatment for oil and gas.

Today, wells are stimulated in some way more often than not. Innovation and technology are playing a major role in helping to unlock otherwise unobtainable hydrocarbons.

More than 175,000 wells have been fractured in Western Canada since the 1950s. 6,000 of these wells were horizontal, where multistage fracturing was used. In the USA, hydraulic fracturing has been performed more than 11 million times and it’s estimated that 70% of existing wells have been fractured.
What's in a Frac? Additives

Additives are required in fracturing operations for a variety of reasons:

- To reduce friction.
- To prevent scaling or corrosion of metal pipes.
- To control the growth of bacteria in saline water.
- To thicken the fluid to better carry the proppant.

Additives are a very small part of the mixture that gets pumped during the fracturing process. In most water fracturing jobs, the amount of additives is less than 1%.

The oil and gas industry now lists the chemicals used in hydraulic fracturing on websites in the USA (fracfocus.org) and Canada (fracfocus.ca). Every company has additives that are considered trade secrets, and most of these are non-toxic. Industry is working on ways to improve the disclosure process to include all additives without jeopardizing trade secrets. In some cases, additives are not disclosed, but are registered with regulatory bodies. Although fracturing companies may have a variety of compounds that can be used in a fracturing fluid, any single job would only use a few of the available additives.

Companies prepare their fracturing fluids to achieve certain goals. A company will design a specific “blend” to meet the needs of the job and the customer, considering things like the type of rock, the materials available, and the regulations in that geographic location.

### Additives

<table>
<thead>
<tr>
<th>Additive Type</th>
<th>Main Compound(s)</th>
<th>Purpose</th>
<th>Common use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diluted Acid (15%)</td>
<td>Hydrochloric acid or muriatic acid</td>
<td>Helps dissolve minerals and initiate cracks in the rock</td>
<td>Swimming pool chemical and cleaner, stomach acid</td>
</tr>
<tr>
<td>Biocide</td>
<td>Glutaraldehyde</td>
<td>Prevents the corrosion of the pipe</td>
<td>Used in pharmaceuticals, acrylic fiber, and plastics</td>
</tr>
<tr>
<td>Corrosion inhibitor</td>
<td>N,N-dimethylformamide</td>
<td>Prevents corrosion</td>
<td>Disinfectant, sterilizes medical and dental equipment</td>
</tr>
<tr>
<td>Crosslinker</td>
<td>Borate salts</td>
<td>Maintains fluid viscosity as temperature increases</td>
<td>Laundry detergents, hand soaps and cosmetics</td>
</tr>
<tr>
<td>Friction reducer</td>
<td>Polyacrylamide and Mineral oil</td>
<td>Minimizes friction between the fluid and the pipe</td>
<td>Water treatment, soil conditioner</td>
</tr>
<tr>
<td>Carrier Fluid</td>
<td>Mineral oil</td>
<td>Carrier fluid for powdered additives</td>
<td>Make-up remover, laxatives and candy</td>
</tr>
<tr>
<td>Gel</td>
<td>Guar gum or hydroxyethyl cellulose</td>
<td>Thickens the water in order to suspend the sand</td>
<td>Cosmetics, toothpaste, sauces, baked goods, ice cream</td>
</tr>
<tr>
<td>Breaker</td>
<td>Ammonium persulfate</td>
<td>Allows a delayed breakdown of the gel so water will flow out of the fracture to the well (leaving sand behind)</td>
<td>Bleaching agent in detergent and hair cosmetics, used in manufacture of household plastics and commercial food processing.</td>
</tr>
<tr>
<td>Iron Control</td>
<td>Citric acid</td>
<td>Prevents precipitation of metal oxides</td>
<td>Food additive, flavouring in food and beverages, Lemon juice is about 7% citric acid</td>
</tr>
<tr>
<td>Clay Control</td>
<td>Potassium chloride</td>
<td>Prevents clay swelling</td>
<td>Low sodium table salt substitute</td>
</tr>
<tr>
<td>Oxygen Scavenger</td>
<td>Ammonium bisulfite</td>
<td>Removes oxygen from the water to protect the pipe from corrosion</td>
<td>Cosmetics, food and beverage processing, water treatment</td>
</tr>
<tr>
<td>pH Adjusting Agent</td>
<td>Sodium or potassium carbonate</td>
<td>Maintains the effectiveness of other components, such as crosslinkers</td>
<td>Detergents, soap, water softener, glass and ceramics</td>
</tr>
<tr>
<td>Proppant</td>
<td>Silica, quartz sand</td>
<td>Allows the fractures to remain open so the gas can escape</td>
<td>Drilling water filtration, sand for concrete, brick, mortar and glass</td>
</tr>
<tr>
<td>Scale Inhibitor</td>
<td>Ethylene glycol</td>
<td>Prevents scale deposits in the pipe</td>
<td>Automotive antifreeze, household cleansers and de-icing agent</td>
</tr>
<tr>
<td>Flowback Enhancer</td>
<td>Isopropanol</td>
<td>Used to lower the surface tension of the fracture fluid</td>
<td>Glass cleaner, antiperspirant, and hair colour</td>
</tr>
</tbody>
</table>

This table lists most of the additives used in hydraulic fracturing and their main compounds. Typically only four to six additive types will be used at any one time, in any one job, however the additive might contain more than one component.
Does Fracturing Cause Environmental Damage?

Though fracturing companies are only part of the overall production process, there are a number of ways they ensure the land at the worksite is safe:

§ Drip trays under pumping units and often under other equipment on location to prevent any ground contamination.
§ Transportation to location is done safely and securely.
§ New technology has changed the way chemicals are mixed at location.

The industry constantly looks for ways to improve the efficiency and reduce the environmental impact of hydraulic fracturing:

§ the fluid ingredients.
§ the pumping time.
§ the horsepower requirements.

Does Fracturing Cause Air Pollution?

In any industry, large trucks or heavy pieces of machinery cause emission challenges, and the oil and gas industry is no exception. As regulations get tougher, emission reducing technology will get better.

Another air quality concern on a hydraulic fracturing site is the fine silica dust from treated sand. In order to protect employees, companies require that all operators wear a full-face respirator within 10 metres of the source of silica dust.

Oil and gas production does result in some emissions entering the atmosphere, mostly through venting or flaring, and both governments and industry are constantly looking for ways to reduce them.

Does Fracturing Cause Earthquakes?

Hydraulic fracturing creates very small cracks in rocks deep underground, creating a pathway for hydrocarbons to access the wellbore. The cracking created by the fracturing process emits slight vibrations that require highly specialized monitors to detect. These micro-seismic events are not felt by regular monitors or by people, except in rare circumstances.

It is estimated that there are more than half a million detectable earthquakes in the world every year. 100,000 of these earthquakes can be felt, yet only 100 of them cause damage.

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On the Richter scale, the majority of fracture-induced seismic events measure from -3 to -1 in size. Of the two occurrences where seismic activity recorded during fracturing measured higher, they were still barely noticeable:

§ Horn River, B.C., Canada (2.2-3.8)
§ Blackpool, England (1.5-2.3)

The effect would have been only slightly more noticeable than the vibration from a passing garbage truck. When we hear of damaging earthquakes in the news, they are measured on the Richter Scale at 6.0 or higher (6.0+ magnitude), with billions of times more energy than typical microseismic events caused by fracturing. Dam and road building, as well as mining activities, are all man-made activities that also induce seismicity.

Even though the majority of scientists and other experts agree that fracturing does not cause destructive earthquakes, the well owner will still conduct geological research before fracturing to avoid areas with major faults.
Still have questions? Contact us!

Canadian Society for Unconventional Resources (CSUR)

Suite 420, 237 - 8th Avenue SE
Calgary, AB T2G 5C3

Phone: 403-233-9298  Toll Free: 1-855-833-9298
Email: info@csur.com  Web: www.csur.com