Power from Natural Gas

History

In ancient times, lightning strikes would ignite natural gas that was escaping from under the earth's crust, creating a fire burning the natural gas as it seeped out from underground. These fires were the root of myth and superstition in ancient cultures and became prominent in the religions of India, Greece and Persia. Unable to explain where these fires came from, they were often regarded as divine, or supernatural. Around 500 B.C. the Chinese discovered the potential to use these fires, creating crude pipelines out of bamboo shoots to transport the gas and used it to boil sea water.

Naturally occurring natural gas was identified in America as early as 1626, when French explorers discovered Native Americans igniting gases that were seeping into and around Lake Erie. The American natural gas industry got its beginnings in this area. In 1859, Colonel Edwin Drake dug the first well and struck oil and natural gas. A two-inch diameter pipeline was built, running 5.5 miles from the well to the village of Titusville, PA, proving that natural gas could be brought safely and relatively easily from its underground source to be used for practical purposes.

In 1821, the first well specifically intended to obtain natural gas was dug in Fredonia, NY, by William Hart, who is regarded by many as the 'father of natural gas' in America. During most of the 19th century, natural gas was used almost exclusively as a source of light. In 1885, Robert Bunsen invented what is now known as the Bunsen burner. He managed to create a device that mixed natural gas with air in the right proportions, creating a flame that could be safely used, adjusted and monitored for cooking and heating.

In the 20th century, significant effort was put into building a pipeline infrastructure as new welding techniques and advances in metallurgy improved pipe reliability. Once the transportation of natural gas was possible, new uses for natural gas were discovered, including using natural gas to heat homes and operate appliances such as water heaters, ovens, and cooktops. Industry began to use natural gas in manufacturing and processing plants. Also, natural gas was used to heat boilers used to generate electricity.

Pros and Cons

Natural Gas is a non-renewable resource, meaning that a finite amount exists, and like all other energy sources, it has both pros and cons. Recent advances in exploration and extraction have become controversial as well.

Pros:

- As compared to other fossil fuels, natural gas causes less damage to the environment, with emissions of carbon dioxide 30% - 45% less than coal and oil.

- Natural gas is easy to transport through pipelines, small storage units, cylinders and tankers on land and sea.

- It is very versatile, and can be used for heating, drying clothes, cooking, backing up generator power and much more.

Cons:

- Natural gas leaks are very dangerous, and may cause fire or explosions. It is also highly toxic, and since it is colorless and odorless, it cannot easily be detected.

- Although it is cleaner than oil or coal as far as by-products are concerned, the burning of natural gas releases carbon dioxide, carbon monoxide and other carbon compounds which are greenhouse gases and contribute to global warming and climate change.

- The most recent method of natural gas extraction is hydraulic fracturing (a.k.a. fracking). This method is controversial and often pits environmentalists against the energy corporations. More about hydraulic fracturing is in the next section. The Resources session also contains links to information about potential environmental impacts of gas extraction.

How It Becomes Usable Energy

Natural gas exploration and extraction is a fascinating process. Here's a quick look at how scientists find natural gas deposits:

Geologists can start looking for natural gas by looking for certain geologic features on the Earth's surface. It was discovered in the mid-1800s that *anticlinal slopes* had a strong chance of containing gas deposits. These anticlinal slopes are areas where the earth has folded up on itself, forming a dome shape. By surveying and mapping the surface and sub-surface characteristics of the area, the geologist can find which areas are most likely to contain a natural gas reservoir. The geologist has many tools to do this, such as outcroppings of rocks on the surface or in valleys and gorges, or the geologic information attained from rock cuttings and samples.

One of the biggest breakthroughs in natural gas exploration came through the use of basic seismology - the study of how energy, in the form of seismic waves, moves through the Earth's crust and interacts with underground formations. As the Earth's crust is composed of different layers, each with its own properties, energy (in the form of seismic waves) traveling underground interacts differently with each of these layers. These seismic waves, emitted from a source, will travel through the earth, and are reflected back toward the source by the different underground layers. Through seismology, geophysicists are able to artificially create vibrations on the surface and record how these vibrations are reflected back to the surface. Think of this like bouncing a rubber ball. A rubber ball that is dropped on concrete will bounce in a much different way than a rubber ball dropped on carpeting or on sand. These seismic waves sent underground will reflect off dense layers of rock much differently than extremely porous layers of rock. Through this process, scientists can get a "picture" of what lies beneath without having to drill or dig.

Once natural gas deposits are found, they can be differentiated in terms of conventional and unconventional (or non-conventional) reservoirs. Conventional gas deposits are typically found in highly

porous, permeable reservoirs. The gas did not actually form in this area, but migrated there and became trapped. This gas can be easily reached by drilling a standard, vertical well.

Unconventional gas deposits are more difficult to reach and extract. Shale gas is the fastest growing natural gas resource in the United States and worldwide. These natural gas deposits are trapped deep within the Earth, in less porous rock than conventional deposits. However, recent advancements have improved access to these shale gas deposits.

The development of hydraulic fracturing technology (also known as hydro-fracturing, hydro-fracking, or simply fracking) requires injecting large volumes of water mixed with sand and fluid chemicals into the well at high pressure to fracture the rock, increasing its permeability – basically allowing the trapped gas to move freely. To extract shale gas, a production well is drilled vertically until it reaches the shale formation. From here, the wellbore turns to follow the shale horizontally. Steel tubing, called "casing," is inserted into the well to keep it open. Cement is then pumped into the well and forced up the outside of the steel casing to seal the well and prevent natural gas, fluids and chemicals from leaking into groundwater supplies. Next, small explosive charges are detonated in the horizontal portion of the well to create holes in the casing at intervals where hydraulic fracturing is to occur. Fracturing fluid is pumped in at a carefully controlled pressure to crack, or fracture, the rock out to several hundred feet from the well. Sand mixed with the fracturing fluid props these cracks open when the fluids are pumped out. Then, gas will flow into the well bore and up to the surface, where it is collected.

Natural gas is then processed, where pollutants and some useful products such as light oils and propane are separated and removed/recovered. Gas travels through pipelines that are regulated by compressor stations, which keep the gas flowing at the right pressure and speed. The gas then goes to your local gas company, who then sends the gas to you, along with other homes and businesses, using a network of smaller pipes. Once the gas reaches your house, it is useable energy for heating, cooking and more. Natural gas is also used to generate electricity in a variety of ways. The most basic natural gas-fired electric generation consists of a steam generation unit, where natural gas is burned in a boiler to heat water and produce steam that then turns a turbine to generate electricity. Gas turbines and combustion engines are also used to generate electricity, where the heat from the burning gas itself is used to turn the turbine and generate electricity. Many of the new natural gas fired power plants are known as "combined-cycle" units, where there is both a gas turbine and a steam unit, all in one.

Cool Facts

- Natural gas is used to heat over 50% of the homes in the United States.
- Natural gas provides 24% of the United States' energy, and comes primarily from North America.
- Besides being a heating fuel, natural gas has other cool uses – like chilling the glycol used to produce ice for hockey and skating rinks.
- If all the natural gas pipelines in the United States were connected to each other they would stretch to and from the moon almost three times!

Activities

Here are some natural gas related resources for teachers

Here are some resources for students to learn how natural gas is produced and used

Balancing the Fracking Debate