Hydrogen Energy California

gasification – taking the pollution out of the fuel before you use it

Gasification is a process that converts carbon based materials, such as coal, petroleum, or biomass, into carbon monoxide and hydrogen by partial oxidation of the material at high temperatures. The resulting gas mixture is called synthesis gas or syngas and is itself a fuel. The syngas can be further reacted with steam to produce carbon dioxide and hydrogen.

Gasification has been reliably used on a commercial scale worldwide for many decades in the refining, fertilizer, and chemical industries, and in the electric power industry. Because the process produces a high pressure gas with a high CO_2 concentration it is relatively easy to separate out the impurities such as sulfur and CO_2.

The Hydrogen Energy California project will be using gasification to extract hydrogen from petroleum coke – a common, plentiful refinery by-product, and from locally delivered coal.

feedstock fuels and their components

Petroleum coke and coal consist primarily of carbon and hydrogen, with minor amounts of sulfur, and other trace elements. At the Hydrogen Energy California project, these components of the feedstock fuels will be separated through gasification, captured and prevented from polluting the environment.

This project, would not only extract hydrogen gas for use as a clean burning fuel, but also capture and contain the carbon and sulfur - elements that could wind up in the environment were the coke or coal to be burned as a conventional fuel. The carbon will be captured as carbon dioxide (CO_2) and kept out of the atmosphere through a technique called “carbon sequestration”. And the sulfur, which could end up in the air as harmful sulfur dioxide, will be captured in its elemental form – a benign yellow powder with many industrial uses.

inside the Hydrogen Energy California gasifier

The fuel to the gasifier is ground to fine powder and injected with a controlled amount of oxygen. The heat and pressure within the gasifier then break apart the chemical bonds of the feedstock forming a “syngas”. The “syngas” is then piped into a “scrubber”, which will wash out any solid, particulate impurities that may have traveled with it. The remaining 1% of the feedstock’s mass – a mixture of various inert, non-toxic substances – will be left at the bottom of the gasifier’s chamber as “slag”, a solid, glass-like matter that can be easily removed and disposed of safely.

This combination of hydrogen, hydrogen sulfide, carbon monoxide and carbon dioxide gases will then be piped into a “shift reactor” which will use water to convert the carbon monoxide into non-toxic carbon dioxide (CO_2). An “acid-gas recovery unit” will capture the hydrogen sulfide gas and send it to a “sulfur recovery unit”, which will break it into elemental sulfur – a benign yellow powder, and water. This leaves hydrogen, which will be used to power the plant, and CO_2 which will be captured and sequestered (stored).

As the petroleum coke or coal may sometimes contain trace amounts of mercury, special mercury recovery systems would be built into the Hydrogen Energy California project’s gasification process. Once the “syngas” mixture has passed through the gasifier and scrubber, it passes through “mercury guard beds” – filters that capture the heavier mercury from the lighter syngas combination. So, while there can be some mercury in feedstock fuels, the amounts are very small, and will be captured and contained.

Since gasification has been used for many decades in the refining, fertilizer and chemical industries, safety measures for gasification are well established, and the Hydrogen Energy California project will be taking lessons from these well established industries and applying them to our project. State of the art electronic measuring devices will be used to monitor conditions inside the gasifier. Were the temperature and pressure to rise above a certain level, the unit would automatically shut down, and, if necessary, release valves would open to relieve excess pressure inside the chamber. Any gas that might escape into the area immediately surrounding the gasifier would be quickly contained, and standard safety protocols would protect plant workers from harm.

a promising overall emissions profile

The Hydrogen Energy California project will employ an “integrated gasification/combined cycle” system. In this process, the hydrogen produced through gasification is fed directly into the plant’s combined cycle power plant in a very similar process to the cleanest natural gas power plants. However, while standard power plants use natural gas to power their turbines, Hydrogen Energy will use hydrogen.

The Hydrogen Energy California project will be using tried and true methods and technologies – gasification and combined cycle turbine generators – to create clean hydrogen power from petroleum coke, a common and plentiful refinery by-product, mixed with coal. The result will be a new standard for the potential of low-carbon energy.