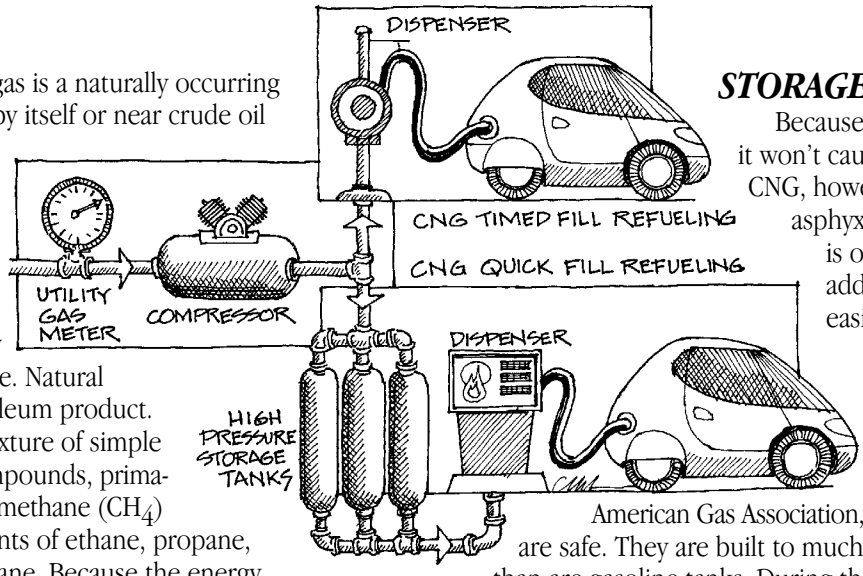
NATURAL GAS



Natural gas is a naturally occurring fossil fuel found by itself or near crude oil deposits in deep underground pockets. These pockets, formed by porous rock, are 3,000 to 15,000 feet below the earth's surface. Natural gas is not a petroleum product. It is a gaseous mixture of simple hydrocarbon compounds, primarily composed of methane (CH_4) with minor amounts of ethane, propane, butane, and pentane. Because the energy density of natural gas is low, when used as a fuel it is either compressed or liquefied by extreme cooling.

HISTORY AND CURRENT USES

In 1860, Etienne Lenoir of France developed and built an engine of a design practical for natural gas that ran on illuminating coal gas stored in a rubber bladder. Coal gas, a by-product of the production of coke, is made up largely of methane, the primary component of natural gas, and hydrogen. In 1862 Lenoir built a vehicle powered by one of his engines.

Natural gas now accounts for approximately one-fourth of the energy consumed in the United States. For many years it has been used reliably and efficiently in stationary internal combustion engines, supplying energy for commercial and industrial processes, home heating, and electricity generation. Many households use compressed natural gas for cooking and heating.

Natural gas vehicles are widely used in Italy, the former Soviet Union, New Zealand, Australia, Canada, Argentina, and the United States. Compressed natural gas (CNG) is used in vehicles of all weights and sizes; CNG fueling stations are located in most major cities and in many rural areas. Liquefied natural gas (LNG) is most suitably used by large trucks, locomotives, and transit buses; LNG is currently available through suppliers of cryogenic liquids.

SOURCE AND AVAILABILITY

There is a finite supply of natural gas. Natural gas currently used in the United States comes from domestic sources. At current levels of consumption, reserves are expected to last 120 years. An extensive network of natural gas pipelines can deliver fuel directly to many sites, including individual homes.

STORAGE AND SAFETY

Because natural gas is nontoxic, it won't cause injury; breathing of CNG, however, could cause asphyxiation. Since the fuel is odorless, odorants are added to make leaks easier to detect.

Sturdy, heavy tanks are used for safe high-pressure storage. According to the American Gas Association, CNG cylinders themselves are safe. They are built to much more rigorous standards than are gasoline tanks. During their development, they have undergone stringent tests, including being dropped from heights, exposed to explosions, being shot at with high-powered weapons, and burning in fires.

Danger to the environment is possible during extraction and processing, and through accidental releases of gas in distribution systems, fueling hook-ups, tank venting, or vehicle emissions. Mishaps can occur when corrosion causes the pressure-relief devices on fuel tanks to vent gas prematurely.

Gasoline and diesel fuels are heavier than air and stay near the surface. Natural gas is lighter than air and rises, a characteristic that creates a possible risk of explosion in enclosed areas. (LNG vehicles should never be parked indoors where possible ignition sources exist.)

PERFORMANCE

CNG burns more completely than gasoline and has a high octane rating of 130 (compared with 87 for regular unleaded gasoline). In a dedicated light-duty CNG vehicle, whose compression ratio is changed to take advantage of the higher octane rating, there may be up to a 10 percent increase in power. CNG also performs better than gasoline-powered vehicles under cold-start conditions.

The location and number of fuel cylinders may reduce the payload capacity, particularly in converted or dual-fuel vehicles.

RANGE AND REFUELING

When stored at a pressure of 3,600 psi, CNG provides about one-fourth the energy density of gasoline. The range of a CNG vehicle depends on the capacity to store fuel, but generally it is less than (about one-half) that of gasoline-fueled vehicles.

Refueling of CNG vehicles can be "slow" (generally taking six to eight hours and commonly done overnight) or "quick" (about five minutes, which is comparable with a gasoline fill-up). Overnight refueling is possible in individual homes with small compressors, which may be located in a home's garage and connected to the natural gas supply of the house. Because of the gaseous nature of the fuel, the ambient air temperature can affect the amount of fuel that can be compressed into a tank. If a driver filled CNG cylinders on a hot afternoon, in the cool of the morning they might be only 75 to 85 percent full. CNG refueling dispensers are similar to gasoline or diesel dispensers, except the nozzles have positive-connect pressure fittings.

MAINTENANCE AND VEHICLE ALTERATIONS

Recommended maintenance schedules for CNG vehicles are similar to those for gasoline-fueled automobiles. Because CNG burns more cleanly than gasoline, CNG-powered vehicles require less maintenance, including fewer oil changes and less-frequent spark plug replacement. High-pressure tanks require periodic inspection.

Dedicated CNG vehicles are equipped with high-pressure storage tanks capable of storing natural gas at 3,000 psi to 3,600 psi. They are usually secured to the bottom of the vehicle. The gas travels from the tank through a high-pressure fuel line leading to the engine compartment. The gas is reduced to about 100 psi before being discharged or injected into the engine intake manifold and finally burned in the engine cylinders. These cylindrical tanks are constructed of high-strength steel, aluminum wrapped with a composite material, or all-composite materials. They are designed to withstand severe impact, high external temperatures, and environmental exposure.

EMISSIONS

CNG burns more completely than gasoline and emits lower amounts of all the regulated exhaust pollutants. Evaporative emissions are lower because CNG is stored in a sealed system. Carbon dioxide emissions are also lower than emissions from gasoline-powered vehicles, but methane levels are higher. Methane's ability to trap heat in the atmosphere, or its global warming potential, is 21 times greater than that of carbon dioxide.

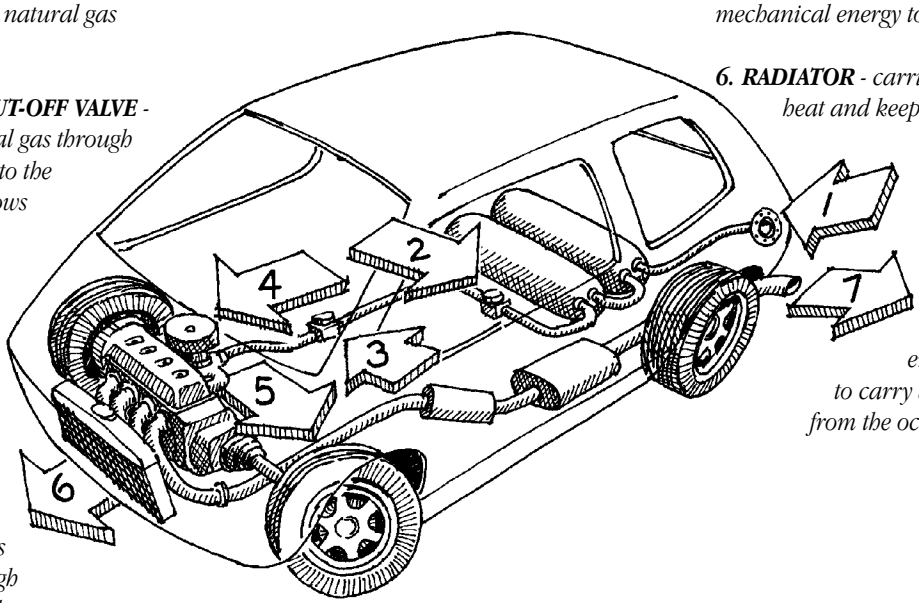
HOW A NATURAL GAS CAR WORKS

1. HIGH-PRESSURE CYLINDERS *- are filled with compressed natural gas through a fill valve.*

2. MASTER MANUAL SHUT-OFF VALVE *- can stop the flow of natural gas through the high-pressure fuel line to the engine. When open, gas flows to the engine as needed.*

3. REGULATOR *- reduces gas pressure to approximately air pressure.*

4. ENGINE *- burns gas to create heat and convert it to mechanical energy. A solenoid valve controls gas flow into the engine through fuel injectors, as signaled by the accelerator pedal.*



5. TRANSMISSION *- carries the mechanical energy to the wheels.*

6. RADIATOR *- carries away waste heat and keeps the engine cool.*

7. EXHAUST SYSTEM *- has a muffler to soften the noise created by the explosion of the gas in the engine, and a tailpipe to carry away the exhaust from the occupants.*