TECH TUESDAY

Tip of the Week

CNG - Compressed Natural Gas

Natural Gas Fuel Basics

Natural gas is an odorless, nontoxic, gaseous mixture of hydrocarbons—predominantly methane (CH4). It accounts for about a quarter of the energy used in the United States. About one-third goes to residential and commercial uses, such as heating and cooking; one-third to industrial uses; and one-third to electric power production. Although natural gas is a clean-burning alternative fuel that has long been used to power natural gas vehicles, only about one-tenth of 1% is used for transportation fuel.

Between 80%-90% of the natural gas used in the United States is domestically produced. Most natural gas is drawn from wells or extracted in conjunction with crude oil production. Natural gas can also be mined from subsurface porous rock reservoirs through extraction processes, such as hydraulic fracturing (see a list of supplemental sources from the Energy Information Administration (EIA). Renewable natural gas is an emerging fuel produced from decaying organic materials, such as waste from plants, landfills, wastewater, and livestock.

CNG as Alternative Fuel

CNG is clean-burning, domestically produced, relatively low priced, and widely available. Because of the gaseous nature of this fuel, when stored onboard a vehicle, it must be in either a compressed gaseous (CNG) or liquefied (LNG) state. CNG and LNG are considered alternative fuels under the Energy Policy Act of 1992.

Natural gas is sold in units of diesel or gasoline gallon equivalents (DGEs or GGEs) based on the energy content of a gallon of gasoline or diesel fuel. To provide adequate driving range for a vehicle, CNG is stored in cylinders at a pressure of 3,000 to 3,600 pounds per square inch. A CNG-powered vehicle gets about the same fuel economy as a conventional gasoline vehicle on a GGE basis. A GGE equals about 5.66 pounds of CNG. CNG is used in light-, medium-, and heavy duty applications.

CNG Fuel System and Cylinder Maintenance

Compressed natural gas (CNG) fuel systems require less maintenance than conventional fuel systems. Mechanics should regularly inspect and replace a filter in the fuel supply line, which removes any oil in the CNG. This filter generally needs to be replaced annually by a qualified service facility; owners should check their owner's manual for the specific requirements of their vehicle. In some cases filters should be drained of any contaminants on a more regular basis, depending upon the application.

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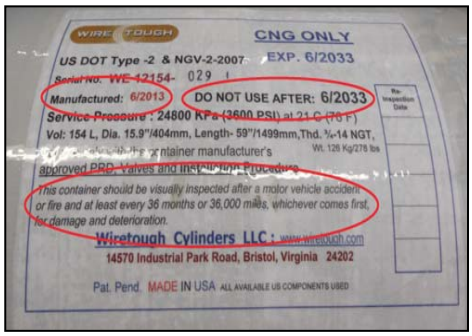
Cylinder End-of-Life



CNG fuel cylinders have a useful life of 15, 20, or 25 years, depending on their construction and how they were certified by the original manufacturer. Because there is no way to safely “requalify” cylinders for extended use, once a cylinder reaches its expiration date, it must be replaced. All CNG cylinders carry a label that says “DO NOT USE AFTER (EXPIRATION DATE).” For instance, it might say “DO NOT USE AFTER 01/2027.”

The CNG cylinder expiration date can also be found on a label near the fueling connector, and on the label under the hood. CNG vehicle owners should make a habit of noting the expiration date each time they refuel. Also, be aware that there is no national system to notify owners when their cylinders reach their expiration date; it is the vehicle owner’s or fleet manager’s responsibility to have the cylinder replaced at the end of its life.

Cylinder Replacement

CNG cylinders should be replaced by a qualified service facility. This type of service facility will be properly trained and have the right equipment to safely vent the CNG from the cylinder and purge the cylinder with nitrogen to eliminate any pressure or fire danger associated with the cylinder. Once the cylinder is safely purged of any natural gas, the expired CNG cylinder must be destroyed and discarded. Labels should be removed in order to invalidate them, and the cylinder should be drilled or cut so that it can no longer hold gas.

Cylinder Inspection

Performing a regular safety inspection of the CNG cylinders that serve as the fuel tank is a critical maintenance requirement for CNG fuel systems. While gouges from road debris can threaten the integrity of CNG cylinders, these cylinders can also corrode and crack when exposed to certain chemicals. Because these cylinders are pressurized to 3,600 pounds per square inch, even a small hole or crack could pose a danger. For these reasons, cylinders should be inspected in a qualified service facility every three years (36 months) or every 36,000 miles, whichever comes first (U.S. DOT National Highway Traffic Safety Administration FMVSS 304)(PDF).

Cylinders must also be inspected after any fire, accident or other incident that could cause damage to the cylinder—for cylinders mounted in the underbody of a vehicle, hitting debris on the road or even driving over a curb has the potential to damage a cylinder, so an inspection is warranted. Owners can find certified inspectors by searching for “Certified CNG Fuel System Inspector” on the CSA Group website. The CSA Group is the standards-writing body in the United States for natural gas appliances and related equipment. For new CNG vehicles, labels located near the fueling connector and under the hood in the engine compartment should list the cylinder inspection/expiration dates. For used vehicles, owners should

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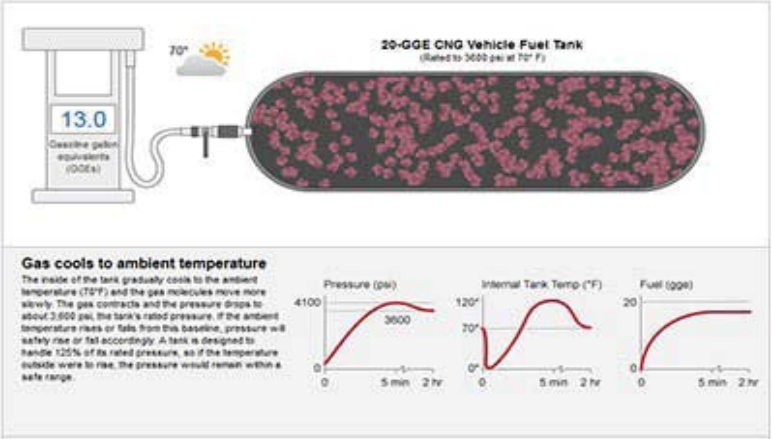
obtain the most recent inspection record from the previous owner, although it would also be wise to have a qualified service facility perform a new inspection before purchasing the vehicle. Likewise, if you are buying one or more used CNG cylinders to install in a converted vehicle, check that the cylinder has a sufficient useful lifetime left before its expiration date (see below) and then have the cylinder inspected by a qualified service facility.

After the first inspection, vehicle owners or fleet managers should keep a record of the most recent inspection and when the next one is due. Many garages provide reminder stickers for oil changes that list the date and mileage when the next oil change is due, and these reminder stickers can also be adopted for CNG cylinder inspections. CNG vehicle owners may even have two reminder stickers, one for oil and one for the cylinder inspection.

Filling CNG Fuel Tanks



Unlike liquid fuel, which consistently holds about the same volume of fuel across a broad range of conditions, compressed natural gas (CNG) can expand and contract significantly depending on temperature. For example, under industry standard conditions, a CNG tank on a vehicle may be able to hold 20 gasoline gallon equivalents, but on a hot day the gas will expand and the tank may only fill to 75% (or less) of its potential. The newer, fast-fill dispensers equipped with a temperature compensation feature help vehicles get the best fill possible.

The amount of CNG that can be stored in a vehicle's tank varies based on the following variables:

• Fueling rate: As the rate of fueling increases, the temperature of the fuel also increases—dramatically. As the fuel warms up, it expands and becomes less dense, therefore containing less energy by volume when the fuel system reaches the rated pressure. For this reason, you are usually able to get more CNG into a tank with a time-fill versus a fast-fill application. This is because when gas molecules are compressed they create heat. The faster they are compressed, the more they heat up and expand. So when you compress the gas rapidly by using a fast-fill station, the molecules will heat up and expand more than if filled slowly over time.

• Ambient temperature: The outside temperature affects the temperature of the CNG. At higher temperatures, CNG is less dense, and therefore does not contain as much energy per unit volume as it would at a lower temperature. When the CNG is stored in warm ambient temperatures, it expands and becomes less dense, so when the tank reaches the rated pressure, the CNG inside does not contain as much energy as it would at lower temperatures.

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• Pressure rating: The typical industry standard for CNG fueling system pressure is 3,600 psi. Some systems in the U.S. and many systems overseas are rated at 3,000 psi. These fill pressures are based on a 70ºF ambient temperature. The cylinders are actually designed to hold up to 125% of their operating pressure. So, a 3,000 psi tank can be filled to 3,750 psi and a 3,600 tank can be filled to 4,500 psi. This makes it possible to fill a tank to a higher pressure on hot days when the gas is expanding, as well as compensate for the heat of recompression. A good rule of thumb is that for every 10ºF plus or minus 70ºF, the pressure will expand or contract 100 psi.

• Cylinder type: There are four types of cylinders (Type 1-4). The type designation is based on the way the cylinder is made and the material it is made out of (aluminum, steel, carbon fiber, etc.). The material used to make the cylinder also affects the temperature in the tank, and thus, affects how “full” you can fill the tank. For example, carbon fiber tanks hold heat better than steel tanks. The temperature inside the tank affects the expansion and contraction of the gas, and therefore, how much gas the tank will hold. Tanks also come in various sizes and hold different volumes of gas depending on their construction.

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