Clean Cities Technical Response Service (TRS) Question of the Month
July, 2013

Question of the Month:
What are the key terms to know when discussing natural gas vehicles (NGVs) and their fueling infrastructure?

Answer:
As with all alternative fuels, it is important to know how to "talk the talk" when it comes to natural gas. Becoming familiar with the terms below will help you better understand NGVs and the associated fueling infrastructure, so that you can ask the right questions and make informed decisions:

Fuel Types

- **Compressed Natural Gas (CNG):** CNG is one of two forms of natural gas used to power vehicles. CNG is a gaseous fuel stored in a cylinder on the vehicle at a high pressure (see "psi" below). It may be kept in the vehicle cylinder for long periods of time without venting. A CNG vehicle gets about the same fuel economy as a conventional gasoline vehicle on a gasoline gallon equivalent basis (see "GGE" below). CNG is used in light-, medium-, and heavy-duty vehicle applications.

- **Liquefied Natural Gas (LNG):** LNG is produced by super-cooling natural gas to negative 260°F in order to convert it to a liquid. The fuel is stored in a double-walled, vacuum-sealed pressure vessel. LNG is appropriate for trucks and other heavy-duty applications that require a long range because liquid is more dense than gas (CNG) and more energy can be stored by volume in the vehicle's tank. LNG stored in a vehicle will increase in temperature and pressure over time and vent; therefore, LNG should be used within a week or two of fueling.

- **Renewable Natural Gas (RNG):** Also known as biogas or biomethane, this emerging fuel source is derived from decaying organic materials, such as waste from plants, landfills, wastewater, and livestock. After purification, RNG may be compressed or liquefied to fuel vehicles.

Vehicle Types

- **Natural Gas Vehicle (NGV):** There are three different types of NGVs available:

    - **Dedicated Vehicle:** Dedicated vehicles are designed to run only on natural gas and are used in both light-duty and heavy-duty applications. In general, dedicated NGVs demonstrate better performance and have lower emissions than bi-fuel vehicles (see below).

    - **Bi-fuel Vehicle:** These vehicles are able to run on either natural gas or gasoline because they have two separate fueling systems. Bi-fuel vehicles are typically light-duty models.

    - **Dual-fuel Vehicle:** These vehicles are traditionally used in heavy-duty applications and have fuel systems that run on natural gas, but use diesel fuel for ignition.

Fuel Measurement and Characteristics

- CNG and LNG may be measured in:
    - **Gasoline Gallon Equivalents (GGE):** A unit of measure that represents the quantity of fuel that contains the same amount of energy as one gallon of gasoline. Measuring fuel in GGEs is a good way of comparing natural gas to gasoline, particularly when looking at fuel price or range. A GGE is equal to about 5.66 pounds of CNG and 1.55 gallons of LNG.*
    - **Diesel Gallon Equivalent (DGE):** A unit of measure that represents the quantity of fuel that contains the same amount of energy as one gallon of diesel. A GGE is equal to about 6.34 pounds of CNG and 1.72 gallons of LNG.
- CNG is also measured in:
    - **Cubic feet (ft^3):** CNG is a gas, so it may be measured by volume. **MCF** represents 1,000 cubic feet. Approximately 21 cubic feet of CNG equals one pound.
    - **Pounds (lbs.):** CNG may also be measured in mass. Approximately 21 lbs. of CNG equals one cubic foot.
- LNG is also measured in **gallons**, much like gasoline or diesel.
- **Pounds per Square Inch (psi):** Psi is a measurement of the CNG pressure when it is stored in a dispenser or vehicle cylinder. CNG is typically stored onboard a vehicle at a pressure of 3,000 to 3,600 psi. The vehicle psi rating is important because it indicates the psi that the fuel system, vehicle cylinder, and the safety hardware are capable of handling safely.

Station Components

- CNG stations have the following components:
    - **Compressor:** The device used to compress CNG to a high pressure.
    - **Storage Tank:** Once the gas is compressed, the CNG is moved to storage vessel(s) or tank(s) specially designed for the fuel.
    - **Temperature Compensation:** The temperature of CNG is important because it affects the density and energy per unit volume of the fuel. At higher temperatures, CNG expands and becomes less dense, causing it to contain less energy per unit volume as it would at a lower temperature. The temperature compensation devices ensure that the CNG is delivered to the vehicle at the appropriate temperature.
    - **Dispenser:** The device used to transfer CNG into a vehicle's tank. A CNG typically dispenser displays the pressure and temperature at which the tank is being filled and then calculates the amount of fuel being delivered.
- LNG stations also have storage tanks and dispensers, but do not require a compressor or temperature compensation devices.

CNG Infrastructure Types

- The following are two different types of CNG infrastructure:

    - **Fast-fill:** Drivers fueling their vehicles at a fast-fill station can fill up in approximately the same amount of time as a conventional vehicle at a gasoline or diesel station. This set-up is best suited for retail stations, where vehicles arrive in need of a quick fill, and CNG can be dispensed alongside gasoline or other fuel dispensers. Fast-fill stations receive low-pressure fuel from the local utility line and employ a compressor on site. Once compressed, the CNG is stored at high pressures so it can be delivered quickly to a vehicle. As such, fast-fill stations may have smaller compressors but a larger storage capacity than time-fill stations.

    - **Time-fill:** At a time-fill station, a vehicle may take several minutes to many hours to fill up; the time depends on the number of vehicles fueling, compressor size, and storage. Time-fill stations are typically used for fleets with central refueling locations or private stations that allow vehicles to fill up overnight. Time-fill stations can also work for smaller applications, such as residential fueling infrastructure. The fuel is also drawn from a local utility line into a compressor on site. Time-fill stations may have larger compressors and the vehicles are generally filled directly from the compressor, not from fuel stored in tanks. Time-fill stations have an advantage over fast-fill stations in that their heat of recompression is less so that vehicles at these stations usually get a fuller tank of fuel than with fast-fill.

Additional information on natural gas production and distribution, NGVs, and natural gas infrastructure can be found on the Alternative Fuel Data Center website (http://www.afdc.energy.gov/fuels/natural_gas.html). The NGVAmerica website also provides a wealth of information on natural gas and NGVs (http://www.ngvc.org/)

Clean Cities Technical Response Service Team

* The equivalency values provided here were calculated based on lower heating values for gasoline and diesel. These metrics vary across the country. The TRS encourages readers to contact their local gas provider and/or state weights and measures agency for the values used in their jurisdictions.