TECH TUESDAY

Tip of the Week

LNG - Liquefied Natural Gas

Liquefied Natural Gas Fuel Basics

Liquefied natural gas is an increasingly important pillar of the global energy industry. Long used to heat homes and power industry, natural gas is traditionally extracted from the ground and shipped through pipelines.

In recent decades, some of the world's largest energy companies started shipping gas between continents by feeding those pipelines into enormous export terminals. There, the natural gas is run through a production "train" that super cools the gas into a liquid one-600th the size of its gaseous volume – essentially, from a beach ball of gas to a Ping-Pong ball of liquid thus creating Liquefied Natural Gas.

Liquefied natural gas, or LNG, is natural gas in its liquid form. When natural gas is cooled to minus 259 degrees Fahrenheit (-161 degrees Celsius), it becomes a clear, colorless, odorless liquid. LNG is neither corrosive nor toxic. Natural gas is primarily methane, with low concentrations of other hydrocarbons, water, carbon dioxide, nitrogen, oxygen and some sulfur compounds. During the process known as liquefaction, natural gas is cooled below its boiling point, removing most of these compounds. The remaining natural gas is primarily methane with only small amounts of other hydrocarbons. LNG weighs less than half the weight of water so it will float if spilled on water.

When returned to its gaseous state, LNG is used across the residential, commercial and industrial sectors for purposes as diverse as heating and cooling homes, cooking, generating electricity and manufacturing paper, metal, glass and other materials. LNG is also increasingly being used to fuel heavy-duty vehicles. Clean burning natural gas is used to heat and cool over half of all American homes and power 23 percent of the nation's electricity. Even though America has an abundance of natural gas, LNG is essential to providing the U.S. with the ability to import or export natural gas depending on market conditions.

LNG is not stored under pressure and it is not explosive. Although a large amount of energy is stored in LNG, it cannot be released rapidly enough if released into the open environment to cause the overpressures associated with an explosion. LNG vapors (methane) mixed with air are not explosive in an unconfined environment. A major incident resulting in a large release of LNG could result in a fire, but only if there is the right concentration of LNG vapor in the air (5% – 15%) and a source of ignition.
The LNG industry provides appropriate security, planning, prevention and risk mitigation in close coordination with local, state, and federal authorities, including the U.S. Coast Guard. These measures significantly reduce risks from intentional events such as terrorist acts.

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SHIP SAFETY

More than 135,000 LNG carrier voyages have taken place without major accidents or safety or security problems, either in port or at sea. (The International Group of Liquefied Natural Gas Importers (GIIGNL) – 2011).

The U.S. Coast Guard determines the suitability of every LNG ship that delivers cargoes into and out of the U.S. through a rigorous annual inspection. If a ship fails the inspection, all deficiencies must be fixed before it can unload its cargo or leave the country. LNG ships are issued a Certificate of Compliance by the Coast Guard to state that they are in complete compliance with U.S. regulations.

Studies undertaken by various technical authorities and Sandia National Laboratories on LNG shipping safety and security confirm that risks from accidental LNG spills, including as a result of collisions and groundings, are highly unlikely due to the rigorous safety policies and practices put in place by the LNG industry. Risks resulting from intentional events, such as terrorist acts, can be greatly reduced with appropriate security, planning, mitigation, and prevention. The industry has these precautions in place.

How is LNG transported?

LNG is transported in double-hulled ships specifically designed to handle the low temperature of LNG. These carriers are insulated to limit the amount of LNG that boils off or evaporates. This boils off gas is sometimes used to supplement fuel for the carriers. LNG carriers are up to 1000 feet long, and require a minimum water depth of 40 feet when fully loaded. As of 2012, there were 360 ships transporting more than 220 million metric tons of LNG every year. (Source: Bureau of Economic Geology, University of Texas at Austin, Introduction to LNG.)

How is LNG stored?

When LNG is received at most terminals, it is transferred to insulated storage tanks that are built to specifically hold LNG. These tanks can be found above or below ground and keep the liquid at a low temperature to minimize the amount of evaporation. If LNG vapors are not released, the pressure and temperature within the tank will continue to rise. LNG is characterized as a cryogen, a liquefied gas kept in its liquid state at very low temperatures. The temperature within the tank will remain constant if the pressure is kept constant by allowing the boil off gas to escape from the tank. This is known as auto-refrigeration. The boil-off gas is collected and used as a fuel source in the facility or on the tanker transporting it. When natural gas is needed, the LNG is warmed to a point where it converts back to its gaseous state. This is accomplished using a regasification process involving heat exchangers.

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Why use LNG?

Natural gas is the cleanest burning fossil fuel. It produces less emissions and pollutants than either coal or oil. Historically the United States imported LNG to numerous import facilities along the Gulf Coast and on the East Coast, but as shale gas production has grown in numerous U.S. supply basins, many existing and proposed LNG facilities have applied for licenses to export LNG to foreign countries. Since LNG occupies only a fraction (1/600) of the volume of natural gas, and takes up less space, it is more economical to transport across large distances and can be stored in larger quantities. LNG is a price-competitive source of energy that could help meet future economic needs in many foreign countries.

LNG Applications

Road Transport with LNG

LNG as an alternative fuel to diesel for road transportation. LNG is also a practical and cost effective way to reduce road transport emissions. Natural gas as a vehicle fuel has a long and established record in Europe, the UK, Canada, and in the USA. Many countries have natural gas vehicles today. It is estimated that there are 4,000 plus LNG vehicles globally. LNG powered vehicle technology has matured over the last 15 years. Technology improvements have all contributed to this. Engine manufacturers, such as Cummins and Caterpillar, have also assisted by providing engines for natural gas. LNG powered vehicles have range and refueling times comparable to diesel.

Power Generation

LNG is a suitable alternative to diesel for the remote power generation market. These remote power generating plants provide electricity for towns or mine sites and can vary in size from 1 MW to 50MW. Replacing the current diesel fuel supply with LNG is a cost effective, safe and clean option. Customers either replace existing diesel generators with gas generators or convert existing units to dual fuel. This typically occurs during expansion or with new projects, or by converting existing sets to dual fuel operation.

Mining and Industrial

Mining and industrial markets have considerable potential employ LNG into their operations.
Large quantities of diesel are consumed by mining vehicles. These vehicles are typically used only on a particular site with short repetitive routes. This makes them ideal for refueling at a one site location.

Rail and Ships

Rail is also a potential LNG application. LNG to replace diesel for locomotives has increased substantially in the past few years and LNG powered locomotives are already in use in other countries. Ships with short repetitive routes are also a viable LNG use. Ferries are a prime example of this application.

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LNG - Liquefied Natural Gas

GLOSSARY

- **Import terminal** – Facility that has the capability of accepting and storing LNG from overseas. There are currently 12 terminals operating in the United States and one in Puerto Rico.
- **Export terminal** – Facility that has the capability to liquefy and store natural gas so it can be loaded on to ships and sent overseas.
- **Liquefaction** – The process of cooling natural gas to -260° Fahrenheit until it becomes a liquid, i.e. liquefied natural gas (LNG).
- **Liquefaction plant** – Facility that has the capability of cooling natural gas to form LNG. This is also called an LNG export facility.
- **LNG** – Liquefied natural gas, or natural gas cooled until it becomes a liquid.
- **Peak-shaving facilities** – Facilities at which LNG is stored during periods of low natural gas demand. When it is needed, it is warmed back to gas and shipped to end users.
- **Regasification** – The process of warming (LNG) until it returns to its gaseous state.

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