Gas Innovations UHP filling facility, La Porte, Texas

Large propane-style LPG tanks

What are Ultra High Purity Hydrocarbons?

One Question Begs Another: What Are You Looking For?

By Ashley Madray

Any discussion of ultra high purity (UHP) grade hydrocarbons must start with a qualifier: since there are multiple industries using these products — for multiple applications — definitions of the "highest grade" are fluid. For example, the industrial gas industry, and its line of atmospheric products, differs greatly from the oil and gas industry's line of products and hydrocarbons, as relates to measurements, nomenclature, and certificates of purity.

Even within the industrial gas space, with its focus on atmospheric products, there are some differences in nomenclature, but most agree on the same general reporting and contaminant identification for the different grades of gases and what constitutes UHP is generally agreed upon. To set the stage, it's helpful to look at the oil and gas industry and its reporting of purities and contaminants. This industry very rarely deals with grades such as Zero or UHP, instead operating with crude, refinery, chemical, polymer, refrigerant, aerosol, wet, dry, lean, and rich grades, among others. Purity in the oil and gas industry typically means 90 percent plus assay.

Higher grades of hydrocarbons, such as UHP or even research grade, are more commonly used in the industrial gas industry, and the products available at these grades are: butane, isobutane, ethane, ethylene, propane, propylene, methane, 1-butene, isobutylene, cis-2-butene, trans-2-butene, and others.

Propane, the 3-carbon, simple hydrocarbon containing eight hydrogen atoms may be the most common. Propane most commonly comes from natural gas wells and the natural gas stream. It is one of the basic/simple hydrocarbons generally referred to as a natural gas liquid (NGL), of which there are five: ethane, propane, butane, isobutane, and pentane.

Each of these NGLs may carry a nomenclature for particular specification, which alludes to levels of certain contaminants in each. These specifications begin at the well-head or other initial point of identification, such as the refinery output, well-head, or by-product stream from a petrochemical plant. Some of these identifiers include pipeline, crude, treated, etc. Propane carries four initial grades, which refer to the assay, or percentage of the pure product. The grades, including EPmix, HD5, HD10 and Commercial Grade, are specific for intended user groups at the most industrial and commercial levels. HD5 is generally considered the consumer grade, used for fuel or barbecue pits. HD10 and Commercial Grade are sub-HD5 grades and are commonly found as fuels in California.

Ethane primarily carries a Y Grade designation following its initial separation after the well head; the alternative grade for ethane is "purity." Y Grade designation comes from the mix characteristics that this product has and the fact that it is at a Y juncture of separation from the stream. The pressure at which ethane liquefies is much higher than the other NGLs. This Y of separation is relevant to steps taken to purify ethane and may be better understood by viewing Figure 1 (next page).

Hydrocarbons, then, can be liquefied via pressurization. While temperature may pro-

vide an assist in the liquefaction of these gases, cryogenic temperatures are not required. Methane, though the primary constituent of natural gas, is not a liquefied gas and may only be liquefied via cryogenic liquefaction. Initial separation of the NGLs can be successful with only pressure differences or minor refrigeration, and is the first major step in creating a more purified grade of hydrocarbon. The minor contaminants such as moisture, sulfur, carbon dioxide, and others are removed with sieves, drying agents, and membranes to get the natural gas to a state acceptable for pipeline transport, gathering plants, and fractionaters.

Desulfurization is basic to the oil and gas industry as sulfur is naturally occurring in many, if not most, natural gas streams. It is critical to remove sulfur to less than 0.5 ppm in most cases for the sake of both environmental protection and process efficiency, as most next steps of purification and/or processing involve catalysts that are extremely sensitive to sulfur.

Moisture removal is also critical. For the industrial gas industry, levels of moisture less than 5 ppm are required and, in most cases, even less than 1 or 2 ppm.

These are the basic steps in purification, and for most applications within the oil and gas industry, no further steps are required. In industrial gas, however, further processing is required, particularly to attain UHP grades and our industry's laboratory standards. We see stages of purification, which might start with initial separation of the NGLs and then further processing by the aerosol providers. The aerosol providers must make certain that the sulfur levels are non-detectable and that un-saturates (such as propylene or ethylene) are at a minimum, as odors from these contaminants may make a product unappealing. They must also make sure that the moisture levels are minimal and do not impact the performance of the aerosol products.

After this stage, purity levels are in the 98–99 percent assay and represent what might be called Chemically Pure, Aerosol Grade, or Refrigerant Grade. Still further processing is required, though, to move the hydrocarbons to 99.5+ percent or into a UHP Grade, sometimes also known as Instrument Grade.

Making UHP for our industry includes an acceptable assay typically at 99.5+ percent, key natural contaminant identification, and quality control with the identification of atmospheric contaminants of oxygen and nitrogen, as well as moisture.

Vapor Pressures and Boiling Points			
Ethane	liquefies at 543 psig	vaporizes at -126°F	-88°C
Propane	liquefies at 100 psig	vaporizes at -44°F	-43°C
Butane	liquefies at 17 psig	vaporizes at 32°F	0°C
Isobutane	liquefies at 30.7 psig	vaporizes at 11°F	-12°C

Figure 1 Source: Gas Innovations

Methane HP tank

For enhanced applications such as electronics, pharmaceutical, and exotic research and development applications, we see requirements for 99.9+ percent assay and even 4.0 and 5.0 grades. There is, as yet, no uniform nomenclature for this level of purity, and our industry has treated each as a special designation. Generally, though, we know this extremely high (higher than UHP) grade of hydrocarbon as "research grade."

Mention should also go to the phase of analysis. In the liquefied petroleum gas (LPG) products, we typically refer to a liquid phase analysis, not a vapor phase. Gaseous, high pressure products such as methane, ethane, and ethylene are typically vapor phase analyses. However, as methane, ethane, and ethylene may exist in liquid phase, some analyses of liquid samples will also exist.

As relates to the markets and future demand for these products, we look again to the oil and gas industry. With the advent of the shale gas technologies and production that these technologies have yielded, natural gas and NGLs are most competitive in the United States. Examples of this are most clearly demonstrated in the differences in pricing between Brent Crude versus West Texas Intermediate as well as the difference between what we pay for natural gas in the US versus what is paid in Europe, Asia, and the rest of the world. How does this translate into opportunities for our specialty grades of NGLs and high pressure gases such as ethane, ethylene and methane? The NGLs come from the natural gas streams and the residual crude oil. Their corresponding lower prices in the US have made petrochemical production most competitive due to the reduced cost of raw materials. Any petrochemical periodical will document this new growth in billions of dollars of expansion. With all of this expansion will come many opportunities for the hydrocarbon standards, blends, refrigerants, and pure products to be supplied by our industry.

So whether we are supplying refrigerants to start a liquefied natural gas plant, supplying propane for cleansing heart valves, or supplying butane to a cannabis oil refining facility, UHP hydrocarbons are going to be required, and our industry will be called upon to make and refine the products, control the quality, and package and deliver the products. SGR

About the Author

Ashley Madray is Vice President and Co-founder of Gas Innovations, a leading supplier of high purity hydrocarbons serving the industrial gas and welding supply industry. He has 32 years of experience in the industrial and specialty gas business. He founded his current company in 2002, and it now has 12 US locations/shipping points. For more information, visit www.gasinnovations.com