

SECTION 2

Product Specifications

The Product Specifications section contains specifications and guidelines for natural gas liquid products. Fig. 2-1 contains GPA specifications for commercial propane, commercial butane, commercial butane-propane mixtures, and Propane HD-5.¹

These are “official” industry standards, representing a broad industry consensus for minimum quality products. Producers, purchasers, or pipeline companies may adopt variations of these specifications

The gas plant designer and operator, as well as purchasers, will also be concerned with specifications for other plant products, including residue gas, raw mix streams, ethane, propane, ethane-propane mixes, normal butane, iso-butane, and plant condensate. Although there are no “official” industry specifications for these products, GPA Technical Section C developed

a new set of product specifications for use in the natural gas industry. These specifications would be used to establish consistent, minimum specifications across the industry. Fig 2-2 (adapted from GPA Standard 2108) shows fractionation grade product specifications for the following products:

- Fractionation Ethane,
- Fractionation Ethane/Propane (E/P) Mix,
- Fractionation Propane,
- Fractionation Iso-butane,
- Fractionation Normal Butane,
- Fractionation Natural Gasoline.

FIG. 2-1

GPA Liquefied Petroleum Gas Specifications
(This Table Extracted from GPA Standard 2140)

Product Characteristics	Product Designation				
	Commercial Propane	Commercial Butane	Commercial B-P Mixtures	Propane HD-5	Test Methods
Composition	Predominantly propane and/or propylene.	Predominantly butanes and/or butylenes.	Predominantly mixtures of butanes and/or butylenes with propane and/or propylene.	Not less than 90 liquid volume percent propane; not more than 5 liquid volume percent propylene.	ASTM D2163
Vapor pressure at 100 °F, psig, max. at 37.8 °C, kPa (ga), max.	208 1434	70 483	208 1434	208 1434	ASTM D1267 or D2598 (NOTE D)
Volatile residue: temperature at 95% evaporation, °F,max. or °C, max. butane and heavier, liquid volume percent max. pentane and heavier, liquid volume percent max.	-37 -38.3 2.5 —	36 2.2 — 2.0	36 2.2 — 2.0	-37 -38.3 2.5 —	ASTM D1837 ASTM D2163 ASTM D2163
Residual matter: residue on evaporation of 100 cm ³ , max. oil stain observation	0.05 cm ³ pass (1)	— —	— —	0.05 cm ³ pass (1)	ASTM D2158 ASTM D2158
Corrosion, copper strip, max.	No. 1	No. 1	No. 1	No. 1	ASTM D1838 (NOTE A)
Total sulfur, mg/kg	185	140	140	123	ASTM D6667 or D5623 (NOTE B)
Moisture content	pass	—	—	pass	ASTM D2713
Free water content	—	none	none	—	(NOTE C)
(1) An acceptable product shall not yield a persistent oil ring when 0.3 cm ³ of solvent residue mixture is added to a filter paper in 0.1 increments and examined in daylight after 2 minutes as described in ASTM D2158.					
NOTE A: “This method may not accurately determine the corrosivity of the liquefied petroleum gas if the sample contains corrosion inhibitors or other chemicals which diminish the corrosivity of the sample to the copper strip. Therefore, the addition of such compounds for the sole purpose of biasing the test is prohibited.”					
NOTE B: Be advised that the total volatile sulfur limits in these specifications do include sulfur compounds used for odorization purposes. In case of dispute, ASTM D6667 is the reference method.					
NOTE C: Visual based on sight glass in filter/Karl Fischer or equivalent.					
NOTE D: In case of dispute, ASTM D1267 is the reference method.					

The Liquefied Petroleum Gas Specification Table (Fig. 2-1) has been adopted as GPA Standard 2140.

Likewise, there are no industry standard specifications for ethane or ethane-propane (EP) mixes. However, GPA Technical Section C has provided a summary of quality criteria in industry use as shown in Fig. 2-3.

Quality specifications for natural gas have historically been individually negotiated and prescribed in contracts between purchasers or pipeline companies and the producer or processor. Specification parameters for pipeline quality natural gas may include heating value, composition, contaminants, water content, and hydrocarbon dew point. Specification limits for these parameters may vary widely depending on the pipeline system, climatological conditions, end use, and other factors. Example pipeline quality gas specification parameters are shown in Fig. 2-4.

LPG SPECIFICATION PARAMETERS

LPG specifications of GPA Standard 2140, shown in Fig. 2-1, are the industry standards in the United States. International specifications, adopted in ISO 9162, are shown in Fig. 2-5.¹⁴

In many cases, specification parameters for LPG are based on simple “pass-fail” test methods that can be performed quickly and easily by field personnel. These specifications and test methods are intended to assure products that can be safely handled in transport systems, and that will perform adequately and safely in their end-use markets. Unfortunately, many of these tests tell the design engineer or plant operator little about product composition or quantitative limits. The following discussion is intended to provide an indication of product composition and quantitative limits imposed by these industry specifications.

Vapor Pressure

Vapor pressure is a critical specification that must be observed for safe and efficient utilization of propane, butane, and butane/propane mixtures in domestic and commercial installations, and to comply with various regulations governing transport vessels and cylinders.³

The GPA vapor pressure specification limit for propane meets the requirements of U.S. Department of Transportation regulations by effectively limiting the ethane content of commercial propane and propane HD-5 to a maximum of approximately 7 volume percent. Any appreciable quantity of propylene, permitted in commercial propane only, would necessarily reduce the amount of permissible ethane due to the higher vapor pressure of propylene relative to that of propane. Likewise, variations in the butane content of propane, limited to 2.5 volume percent, will impact the amount of ethane permitted by the vapor pressure specification.

Moisture Content

Moisture in propane must be controlled to very low concentrations to avoid hydrate formation in pipelines and freezing in tanks, regulating equipment, and other equipment in the distribution system.

Solid desiccant dehydration systems such as molecular sieve are frequently used to remove moisture from LP gas streams. Refer to Dehydration, Section 20, of this Data Book for additional information.

Although a properly designed and operated dehydration system produces very dry propane, moisture can and does enter the transportation and distribution system at many points, such as storage tanks, loading racks, and transport vessels.

One method for determining acceptable levels of moisture in propane products is the Valve Freeze method (ASTM D2713). It is a “pass-fail” test that provides qualitative determination of commercially “dry” propane, but this method does not yield quantitative measures of moisture in the product.

The valve freeze method was developed to detect excessive moisture in liquid propane, and is preferred over the Cobalt Bromide test. The test device is a specially constructed and calibrated orifice valve designed to simulate expansion of propane through a pressure regulator. A liquid sample of the product to be tested is passed through the valve at a preset flow rate. The time required for the valve to freeze and interrupt flow due to moisture in the product determines whether or not the product is commercially “dry.” Test data reveals that a freeze-off time of more than 60 seconds indicates less than 30 mg/kg moisture in the liquid product. The method is not applicable to propane products containing anti-freeze agents such as methanol. It is also affected by the temperature of the liquid sample. The valve freeze method is still in use but it is on the decline due to safety and environmental concerns.

The GPA Cobalt Bromide Test is a retired method to determine moisture and is not being widely used.

A third method, the Bureau of Mines dew point tester, is a simple field test still used by some, but is not recommended because its accuracy is dependent on many poorly controlled variables, such as temperature and pressure of the system. The Bureau of Mines dew point tester method was originally developed by the U.S. Bureau of Mines and is still used as a field method to determine moisture content in natural gas systems.

A modern improvement on moisture measurement is the automated online or laboratory bench dew point tester. The test method for these devices is ASTM D5454, “Standard Test Method for Water Vapor Content of Gaseous Fuels Using Electronic Moisture Analyzers.” These analyzers use sensing cells based on phosphorus pentoxide, P_2O_5 , aluminum oxide, Al_2O_3 , or silicon sensors piezoelectric-type cells and laser based technologies. A commonly used type of sensor is the capacitance-type cell. This cell uses aluminum coated with Al_2O_3 as part of a capacitor. The dielectric Al_2O_3 film changes the capacity of the capacitor in relation to the water vapor present. While these analyzers offer significant improvements in dew point measurement over the original tester, care must still be taken to calibrate properly; also some sensors are subject to methanol, glycol, amine, and/or H_2S interference.

Methanol

Methanol is occasionally injected into various gas and liquid processing systems and is used to control moisture to prevent hydrates and freezing. When fractionated, H_2O will tend to concentrate in the ethane and propane product. Different consumers have wide ranging specifications that determine the allowable levels of methanol. For example, export grade propane shipped internationally may have a tight methanol limit of 100 ppmv or 100 ppmw or less. Methanol has also been known to form low point liquid traps in pipeline distribution systems and interfere with certain processes in olefin plants.

FIG. 2-2

GPA 2108-14 Fractionation Grade Product Specifications

Product characteristic	Test Methods (2)	Fractionation Ethane	Fractionation Ethane/ Propane	Fractionation Propane	Fraction- ation Iso-butane	Fractionation Normal Butane	Fractionation Natural Gasoline
ANALYSIS:							
Liquid Volume %							
Methane	ASTM D2163	3.0 % max.	1.5% max.				
Ethane	ASTM D2163	95.0% min.	75% / 82%				
Ethylene	ASTM D2163		4.0% max.				
Propylene	ASTM D2163		1.0% max.	5.0% max.			
Propane	ASTM D2163	5.0% max.	11.5% / 25%	90.0% min.	3.0% max.(1)	0.35% max.(1)	
Butane & Heavier	ASTM D2163		0.8% max.	2.5% max.			
Iso-butane	ASTM D2163				95.0% min.	6.0% max.	
Normal Butane	ASTM D2163				4.0% max.	94.0% min.	6.0% max. (4)
Pentanes	ASTM D2163					1.5% max.	
Carbon Dioxide and other nonhydrocarbons not specifically listed.	GPA 2177	1000 ppm wt. max.					
Total Sulfur-ppm wt. (maximum)	ASTM D4045 ASTM D6667	30 ppm wt. max.	123 ppm wt. max.	100 ppm wt. max. (3)	140 ppm wt. max.	140 ppm wt. max	
Water content	VISUAL	No Free Water	No Free Water	No Free Water	No Free Water	No Free Water	No Free Water
Vapor Pressure at 37.8 °C	ASTM D1267 or ASTM D2598 or ASTM D6897			1434 kPa (ga) max.	483 kPa (ga) max.	345 kPa (ga) max.	
Vapor Pressure at 37.8 °C	ASTM D323 ASTM D5191						96.5 kPg (ga) RVP max.
VOLATILE RESIDUE:							
Temperature @ 95 % evaporation	ASTM D1837			-38.3 °C max.	-8.9 °C max.	+2.2 °C max.	
End Point	ASTM D86						190.6 °C max.
RESIDUAL MATTER:							
Residue on evaporation of 100 ml, max.	ASTM D2158			0.05 ml			
Oil Stain Observation				Pass			
Corrosion, Copper Strip, max.	ASTM D1838	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1
Corrosion, Copper Strip, max.	ASTM D130						Negative
Doctor Test	ASTM D4952 or GPA 1138						
Color, Saybolt Number, min.	ASTM D156						+25

- Propane and lighter.
- Test methods listed are examples. Equivalent or mutually agreeable methods may also be utilized.
- The 123 ppmw sulfur specification represents a total limit. Odorization could cause this limit to be exceeded. Based on this concern, the fractionation propane specification will be reduced to 100 ppmw max to allow for odorization.
- n-Butane and lighter.