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Standard Practice for Calculation of Certain Physical Properties of Liquefied Petroleum (LP) Gases from Compositional Analysis[1]

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1. Scope

1.1 This practice covers, by compositional analysis, the approximate determination of the following physical characteristics of commercial propane and special-duty propane (covered by Specification D1835): vapor pressure, relative density, and motor octane number (MON).

1.2 This practice is not applicable to any product exceeding specifications for nonvolatile residues. (See Test Method D2158.)

1.3 For calculating motor octane number, this practice is applicable only to mixtures containing 20 % or less of propene.

1.4 For calculated motor octane number in method, this practice is based on mixtures containing only components shown in Table 1.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1267 Test Method for Gage Vapor Pressure of Liquefied Petroleum (LP) Gases (LP-Gas Method)

D1657 Test Method for Density or Relative Density of Light Hydrocarbons by Pressure Hydrometer

D1835 Specification for Liquefied Petroleum (LP) Gases

D2158 Test Method for Residues in Liquefied Petroleum (LP) Gases

D2163 Test Method for Analysis of Liquefied Petroleum (LP) Gases and Propene Concentrates by Gas Chromatography[3]

D2421 Practice for Interconversion of Analysis of C_5 and Lighter Hydrocarbons to Gas-Volume, Liquid-Volume, or Mass Basis

TABLE 1 Factors for Determining the Physical Characteristics of LP-Gases[A]

Component	Vapor Pressure Blend Factor, kPa (psig) at 37.8°C (100°F)	Relative Density at 15.6°C (60°F)	MON Blend Value
Methane	17547 (2545)	0.3	. . .
Ethane	4213 (611)	0.35639	100.7
Propane	1200 (174)	0.50736	97.1
Propene	1469 (213)	0.52264	84.9
n-Butane	255 (37)	0.58407	89.6
i-Butane	400 (58)	0.56293	97.6

[A] Constants for vapor pressure and motor octanes are empirical values to be used only in the calculation procedures described in this practice.

3. Summary of Practice

3.1 The composition of a sample of LP-gas is obtained by using Test Method D2163 or other acceptable method. From the analysis (expressed in liquid volume percent), the vapor pressure, relative density, and motor octane number of the sample may be determined.

3.2 Conversion of a compositional analysis from mole, gas-volume, or weight basis to liquid-volume is obtained by using Practice D2421 or other suitable method.

4. Significance and Use

4.1 Vapor pressure is an important specification property of commercial propane and special duty propane that assures adequate vaporization, safety, and compatibility with commercial appliances. Relative density, while not a specification criterion, is necessary for determination of filling densities and custody transfer. The motor octane number (MON) is useful in determining the products' suitability as a fuel for internal combustion engines.

5. Calculation

5.1 *Calculated LP-Gas Vapor Pressure* (see Test Method D1267):

5.1.1 Calculate the partial gage vapor pressure due to each component in the mixture as follows:

[1] This practice is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.H0 on Liquefied Petroleum Gas.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

$$\text{Partial gage vapor pressure} = (vp' \times C)/100 \quad (1)$$

where:

vp' = vapor pressure factor of specific component at 37.8°C (100°F) (see Table 1), and

C = liquid volume percent of component in the mixture.

5.1.2 Add the partial gage vapor pressures due to all components, rounding to the nearest 7kPa (1psi). The total is reported as the LP-gas vapor pressure of the sample, kPa gage at 37.8°C (100°F).

5.2 *Calculated Relative Density* (see Test Method D1657):

5.2.1 Calculate the relative mass of each component in the mixture as follows:

$$\text{Relative mass of component} = (sg' \times C)/100 \quad (2)$$

where:

sg' = relative density of the pure component at 15.6°C (60°F) (see Table 1), and

C = liquid volume percent of component in the mixture.

5.2.2 Add the relative mass of all components, rounding the total to three decimal places. The total is reported as the relative density of the mixture.

5.3 *Calculated Motor Octane Number* (see ASTM Data Series DS 4B.[4]).

5.3.1 Calculate the partial motor octane number of each component in the mixture to the nearest 0.1 MON as follows:

$$\text{Partial motor octane number of component} = (m \times C)/100 \quad (3)$$

where:

m = motor octane number of component (see Table 1), and

C = liquid volume percent of component in mixture.

5.3.2 Add the partial motor octane numbers of all components and round the total to the nearest one-half number. The total is reported as the calculated motor octane number of the mixture.

6. Keywords

6.1 liquefied petroleum gases; motor octane; relative density; vapor pressure

[4] DS 4B, *Physical Constants of Hydrocarbon and Non-Hydrocarbon Compounds*, ASTM International, W. Conshohocken, PA, 1987.