Designation: D2421 – 02 (Reapproved 2007)

Standard Practice for Interconversion of Analysis of C_5 and Lighter Hydrocarbons to Gas-Volume, Liquid-Volume, or Mass Basis[1]

This standard is issued under the fixed designation D2421; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes the procedure for the interconversion of the analysis of C_5 and lighter hydrocarbon mixtures to gas-volume (mole), liquid-volume, or mass basis.

1.2 The computation procedures described assume that gas-volume percentages have already been corrected for nonideality of the components as a part of the analytical process by which they have been obtained. These are numerically the same as mole percentages.

1.3 The procedure assumes the absence of nonadditivity corrections for mixtures of the pure liquid compounds. This is approximately true only for mixtures of hydrocarbons of the same number of carbon atoms, and in the absence of diolefins and acetylenic compounds.

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

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Source of Data

2.1 The basic values for the relative density 15.6/15.6°C (60/60°F) of the pure compounds have been obtained from the Thermodynamics Research Center, Texas A & M University, except where otherwise noted. The values for methane, ethylene, and acetylene are not those of pure materials but are assumed to apply as a component of a liquid mixture.

2.2 The conversion factors for 1 mL of ideal gas at 15.6°C (60°F) and 101.3 kPa (760 mm Hg) to millilitres of liquid at 15.6°C (60°F) have been calculated as follows:

1 mL gas at 15.6°C (60°F), 101.3 kPa (760 mm Hg),

$$L = (273.16/288.72) \times (M/22414) \times [1/[(\text{relative density}) \times (0.99904)]] \quad (1)$$

$$4.2251 \times 10^{-5} \times (M/\text{relative density}) = \text{millilitres liquid at } 15.6°C\ (60°F)$$

where:

M = molecular mass of the pure compound, and

Relative density = relative density, 15.6/15.6°C (60/60°F) (vacuum), of the pure compound.

2.3 Where ideal gas volumes have been measured at temperatures and pressures different from 15.6°C (60°F) at 101.3 kPa (760 mm Hg), they must be corrected to these conditions.

3. Significance and Use

3.1 For custody transfer and other purposes, it is frequently necessary to convert a component analysis of light hydrocarbon mixture from one basis (either gas-volume, liquid volume, or mass) to another.

3.2 The component distribution data of light hydrocarbon mixtures can be used to calculate physical properties such as relative density, vapor-pressure, and calorific value. Consistent and accurate conversion data are extremely important when calculating vapor, liquid, or mass equivalence.

4. Procedure

4.1 To convert from the original to the desired basis, multiply or divide the percent of each compound in the original basis according to the schedule shown in Table 1. Perform the calculation, using the corresponding factor indicated in Table 2. Carry at least one more significant figure in all of the calculations than the number of significant figures in the original analysis.

NOTE 1—The factors or percentages can be multiplied by any constant number for convenience (such as moving the decimal) without changing the end result.

4.2 Add the products or quotients obtained in accordance with 4.1.

[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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TABLE 1 Conversion Factors Scheduled

Original Basis	Desired Basis	Operation	Factor Column in Table 2
Gas-volume	mass	multiply by	1
Gas-volume	liquid-volume	multiply by	2
Mass	gas-volume	divide by	1
Mass	liquid-volume	divide by	3
Liquid-volume	gas-volume	divide by	2
Liquid-volume	mass	multiply by	3

TABLE 2 Mass-Volume Data for Liquefied Petroleum Gases and Low Boiling Hydrocarbons

	Column 1	Column 2	Column 3	
Compound	Molecular Mass	Liquid Volume in mL of 1 mL of ideal gas at 15.6°C (60°F) and 101.3 kPa (760 mm Hg)	Relative Density 15.6/15.6°C (60/60°F) (Vacuum)	Source
Methane[A]	16.043	0.002261	0.3	GPA 2145-00
Ethane[B]	30.07	0.003565	0.35639	GPA 2145-00
Acetylene[A]	26.038	0.00263	0.418	estimate
Ethylene[A]	28.054	0.005029	0.23569	GPA 2145–00
Propane[B]	44.097	0.003672	0.50736	GPA 2145-00
Propylene[B]	42.081	0.003402	0.52264	GPA 2145–00
Propadiene (Allene)[B]	40.06	0.00282	0.6	API-88
Methylacetylene[B]	40.06	0.00273	0.621	API-88
n-Butane[B]	58.123	0.004205	0.58407	GPA 2145-00
Isobutane[B]	58.123	0.004362	0.56293	GPA 2145-00
1-Butene[B]	56.108	0.003949	0.60035	GPSA
trans-2-Butene[B]	56.108	0.003879	0.61116	GPSA
cis-2-Butene[B]	56.108	0.003772	0.62858	GPSA
Isobutylene[B]	56.108	0.003941	0.60153	GPSA
1,2-Butadiene[B]	54.092	0.003474	0.65798	GPSA
1,3-Butadiene[B]	54.092	0.003644	0.62722	GPSA
Ethylacetylene[B]	54.09	0.00328	0.696	API-88
n-Pentane	72.15	0.00483	0.63111	GPA 2145-00
Isopentane	72.15	0.004881	0.62459	GPA 2145-00
Neopentane[B]	72.15	0.00511	0.59665	GPSA
1-Pentene	70.134	0.004591	0.64538	GPSA
trans-2-Pentene	70.13	0.004537	0.653	TRC
cis-2-Pentene	70.13	0.004482	0.6611	TRC
2-Methyl-1-butene	70.13	0.004519	0.6557	TRC
3-Methyl-1-butene	70.13	0.004684	0.6325	TRC
2-Methyl-2-butene	70.13	0.00447	0.663	TRC
Cyclopentane	70.134	0.003947	0.75077	GPSA
Isoprene	68.119	0.004195	0.68614	GPSA
1-*trans*-3-Pentadiene	68.12	0.004224	0.6815	API
1-*cis*-Pentadiene	68.12	0.004133	0.6964	API
1,2-Pentadiene	68.12	0.004125	0.6976	API

[A] Apparent values for dissolved gas at 15.6°C (60°F).
[B] Property of liquid phase measured at its saturation pressure at 15.6°C (60°F).
Sources: GPA 2145-00 Revision 2: "Table of Physical Constants for Hydrocarbons and Other Compounds of Interest to the Natural Gas Industry", Gas Processors Association,
GPSA: "Engineering Data Book, 11th Edition", Gas Processors Suppliers Association,
API: "Technical Data Book", American Petroleum Institute, and
TRC: Thermodynamic Research Center, Texas A&M University.

4.3 Multiply the products or quotients obtained in accordance with 4.1 by 100 divided by the sum of the products or quotients. Round off the results so that the same number of significant figures is obtained in the final answer as was used in the original analysis.

4.4 Add the percentages of the desired basis from 4.3 and distribute the round-off error (difference between the sum and 100 %) proportionately. Usually only the largest percentage will be changed in the final digit.

NOTE 2—For sample calculations, see the Appendix.

5. Keywords

5.1 analysis; liquefied petroleum gases; natural gas liquids

APPENDIX

(Nonmandatory Information)

X1. EXAMPLES

X1.1 *Example 1:*

Original basis: Gas-volume or mole, %
Desired basis: Mass

Compound	Original Basis Mole, %	Operation (Table 1)	Factor Column 1 (Table 2)		Product
Methane	33.3	×	16.043	=	534.2
Ethane	33.3	×	30.07	=	1001.3
Propane	33.4	×	44.097	=	1472.8
Total	100.0				3008.3

100.0/3008.3 = 0.03324

Compound	Product	Mass, %
Methane	534.2 × 0.03324 =	17.8
Ethane	1001.3 × 0.03324 =	33.3
Propane	1472.8 × 0.03324 =	48.9
Total		100.0

X1.2 *Example 2:*

Original basis: Mass
Desired basis: Liquid-volume

Compound	Original Basis Mass, %	Operation (Table 1)	Factor Column 3 (Table 2)		Quotient
Ethane	5.06	÷	0.35639	=	14.2
Propane	92.91	÷	0.50736	=	183.12
Isobutane	2.03	÷	0.56293	=	3.61
Total					200.93

100/200.93 = 0.4977

Compound	Quotient		% by Liquid Volume, 15.6°C (60°F)
Ethane	14.2× 0.4977	=	7.07
Propane	183.12× 0.4977	=	91.14
Isobutane	3.61 × 0.4977	=	1.79
Total			100.0

X1.3 *Example 3:*

Original basis: Liquid-volume
Desired basis: Gas-volume

Compound	Original Basis Liquid Volume, %	Operation (Table 1)	Factor Column 2 (Table 2)		Quotient
Propane	10.0	÷	0.003672	=	2723
n-butane	84.3	÷	0.004205	=	20048

TABLE *Continued*

Compound	Original Basis Liquid Volume, %	Operation (Table 1)	Factor Column 2 (Table 2)		Quotient
Isopentane	5.7	÷	0.004881	=	1168
Total					23939

100/23939 = 0.004177

Compound	Quotient		% by Gas Volume (Ideal, 98.1 kPa, 15.6°C 1atm, 60°F)
Propane	2723 × 0.004177	=	11.37
n-Butane	20048 × 0.004177	=	83.75
Isopentane	1168 × 0.004177	=	4.88
Total			100.0