Designation: D2421 – 13

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 non-ideality 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 TRC (formerly the Thermodynamics Research Center, and now part of NIST), 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 101.325 kPa (760 mm Hg) to millilitres of liquid at 15.6°C (60°F) have been calculated as follows:

For 1 mL gas at 15.6°C (60°F), 101.325 kPa (760 mm Hg),

$$L = (273.15/288.71) \times (M/22414) \times [1/[(\text{relative density}) \times (0.999016)]] \quad (1)$$

$$4.2252 \times 10^{-5} \times (M/\text{relative density}) = \text{millilitres liquid at } 15.6°C\ (60°F)$$

where:

22414 = calculated from V=nRT/P,
n = 1 g-mole,
R = 8314.472,
T = 273.15, and
P = 101.325 kPa.

2.3 Where ideal gas volumes have been measured at temperatures and pressures different from 15.6°C (60°F) at 101.325 kPa (760 mm Hg), they shall 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.

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

[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.

Current edition approved June 15, 2013. Published August 2013. Originally approved in 1965. Last previous edition approved in 2002 as D2421 – 02 (2007). DOI: 10.1520/D2421-13.

***A Summary of Changes section appears at the end of this standard**

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[A]

	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 101.325 kPa (760 mm Hg)	Relative Density 15.6/15.6°C (60/60°F) (Vacuum)
Methane[B]	16.0425	0.0022594	0.3
Ethane[C]	30.0690	0.0035657	0.35630
Ethyne (acetylene)[B]	26.037	0.002601	0.423
Ethylene[B]	28.0532	0.0032	0.37[D]
Propane[C]	44.0956	0.0036733	0.50721
Propene (propylene)[C]	42.0797	0.0034020	0.52262
Propadiene (allene)[C]	40.065	0.002844	0.5953
Propyne (methylacetylene)[C]	40.065	0.002698	0.6273
n-Butane[C]	58.1222	0.004204	0.58420
Methyl propane (isobutane)[C]	58.1222	0.0043630	0.56286
1-Butene[C]	56.106	0.003948	0.6004
trans-2-Butene[C]	56.106	0.003887	0.6099
cis-2-Butene[C]	56.106	0.003778	0.62753
2-Methyl propene (isobutylene)[C]	56.106	0.003948	0.60044
1,2-Butadiene[C]	54.090	0.003465	0.6595
1,3-Butadiene[C]	54.090	0.003647	0.6267
1-Butyne (ethylacetylene)[C]	54.090	0.003457	0.6610
n-Pentane	72.1488	0.004833	0.63071
2-Methyl butane (isopentane)	72.1488	0.004876	0.62514
Dimethyl propane (neopentane)[C]	72.1488	0.005114	0.59610
1-Pentene	70.133	0.004559	0.6500
trans-2-Pentene	70.133	0.004537	0.6531
cis-2-Pentene	70.133	0.004490	0.660
2-Methyl-1-butene	70.133	0.004519	0.6557
3-Methyl-1-butene	70.133	0.004672	0.6342
2-Methyl-2-butene	70.133	0.004461	0.6643
Cyclopentane	70.133	0.003949	0.7503
2-Methyl-1,3-butadiene (isoprene)	68.117	0.004201	0.6851
1-*trans*-3-Pentadiene	68.117	0.004182	0.6883
1-*cis*-3-Pentadiene	68.117	0.004134	0.6962
1,2-Pentadiene	68.117	0.004125	0.6976

[A] Sources (except as noted):
Column 1, Molecular Mass—D2421–02, GPA 2145–09, and GPSA Engineering Data Book (12th edition)
Column 2, Liquid Volume—Calculated from the relative density (column 3) and molecular mass (column 1), using Eq 1
Column 3, Relative Density—Provided by TRC (NIST)
[B] Apparent values for dissolved gas at 15.6°C (60°F).
[C] Property of liquid phase measured at its saturation pressure at 15.6°C (60°F).
[D] The relative density of ethylene is estimated and consistent with the historical value in D2421–95. Later revisions of D2421 used a theoretical, calculated value from GPA 2145–00. Uncertainties in the equations of state used in the calculation for ethylene at typical pressures and temperatures of LPG caused GPA to later retract that value.

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

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. If the sum total of the components does not equal 100 % after distributing the error, adjustment of the remainder shall be made to the largest percentage component to force the sum total to 100 %.

NOTE 1—For sample calculations, see the Appendix.

5. Keywords

5.1 analysis; gas volume; interconversion; liquefied petroleum gases; natural gas liquids

APPENDIX

(Nonmandatory Information)

X1. EXAMPLES

X1.1 ***Example 1:***

X1.1 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	×	16.0425	=	534.2
Ethane	33.3	×	30.0690	=	1001.3
Propane	33.4	×	44.0956	=	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:***

X1.2 Original basis: Mass

Desired basis: Liquid volume

Compound	Original Basis Mass, %	Operation (Table 1)	Factor Column 3 (Table 2)		Quotient
Ethane	5.10	÷	0.35630	=	14.31
Propane	92.77	÷	0.50721	=	182.90
Isobutane	2.13	÷	0.56286	=	3.78
Total	100.00				200.99

100.00/200.99 = 0.4975

Compound	Quotient		% by Liquid Volume, 15.6°C (60°F)
Ethane	14.31 × 0.4975	=	7.12
Propane	182.90 × 0.4975	=	90.99
Isobutane	3.78 × 0.4975	=	1.88
Total			99.99

Remainder is assigned to largest percentage component (100.00 – 99.99 = 0.01):

Compound	Remainder	% by Liquid Volume, 15.6°C (60°F)
Ethane		7.12
Propane	+0.01	91.00
Isobutane		1.88
Total		100.00

X1.3 ***Example 3:***

X1.3 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	÷	0.0036733	=	2722.3
n-butane	84.3	÷	0.004204	=	20052.3
Isopentane	5.7	÷	0.004876	=	1169.0
Total	100.00				23943.6

100.0/23943.6 = 0.004176

Compound	Quotient		% by Gas Volume (Ideal, 98.1 kPa, 15.6°C 1atm, 60°F)
Propane	2722.3 × 0.004176	=	11.4
n-Butane	20052.3 × 0.004176	=	83.7
Isopentane	1169.0 × 0.004176	=	4.9
Total			100.0

SUMMARY OF CHANGES

Subcommittee D02.H0 has identified the location of selected changes to this standard since the last issue (D2421 – 02(2007)) that may impact the use of this standard.

(1) Hydrocarbon data values were updated in Table 1, and examples in the Appendix were correspondingly edited.
(2) Note 1 became 4.1.1, and subsequent notes were renumbered.
(3) Subsection 4.4 was edited to include directions for consistent handling of rounding remainders.