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Converting Mass of Natural Gas Liquids and Vapors to Equivalent Liquid Volumes

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Contents

1 Scope 1

2 Normative References 1

3 Terms, Definitions, Abbreviations, and Symbols 1
3.1 Terms and Definitions 1
3.2 Abbreviations and Symbols 2

4 Summary of Method 3
4.1 General 3

5 Limitations of the Standard 3
5.1 General 3

6 Calculations 3
6.1 General 3
6.2 Unrounded Method 4
6.3 Adjusted Method 6

Annex A (informative) Example Calculations—Component Volume from Volume Percent (USC) 60 °F 8

Annex B (informative) Example Calculations—Component Volume from Mass Percent (USC) 60 °F 12

Annex C (informative) Example Calculations—Component Volume from Mole Percent (Metric) 20 °C 14

Annex D (informative) Calculating Gas Equivalent Energy from Mass 18

Annex E (informative) Calculating Equivalent Gas Volumes from Mass 20

Tables

A.1a Unrounded Method 8
A.1b Unrounded Method (continued) 9
A.2a Adjusted Method 10
A.2b Adjusted Method (continued) 11
B.1 Unrounded Method 12
B.2 Adjusted Method 13
C.1a Unrounded Method 14
C.1b Unrounded Method (continued) 15
C.2a Adjusted Method 16
C.2b Adjusted Method (continued) 17
D.1 Example Gas Equivalent Energy Calculation—USC @ 60 °F 18
D.2 Example Gas Equivalent Energy Calculation—Metric @ 20 °C 19
E.1 Example Real Gas Equivalent Volume Calculation—USC @ 14.696 psia and 60 °F 20
E.2 Example Real Gas Equivalent Volume Calculation—Metric @ 101.325 kPa and 20 °C 21

Introduction

Measurement by mass is often preferred for chemical reactions and for various processes where the mass ratios of components are of primary interest in affecting control of the operation. Mass quantities may be converted to volumes at reference conditions to facilitate commercial transactions.

Since the 1970s, the gas processing industry has recognized the importance of measuring mixed natural gas liquid (NGL) streams using mass measurement techniques. Mass measurement is preferred because, unlike volumetric measurement, the mass measurement process is not sensitive to the effects that pressure, temperature, intermolecular adhesion, and solution mixing have upon the measured stream. Solution mixing/intermolecular adhesion occurs when smaller molecules fill the spaces between the larger molecules in the solution. Temperature and pressure also affect the change in volume caused by solution mixing/intermolecular adhesion. Due to these behaviors, the sum of the volumes of individual components in their pure state is greater than the volume of the mixture.

Measured mass, for NGL liquid or vapor mixtures, may be converted to units of liquid volume by determining each component's mass from the total measured mass via sample analysis, then dividing each component's mass by its absolute density at reference conditions. The component volumes are based on the pure component's equilibrium vapor pressures. The total liquid volume is not at the equilibrium vapor pressure of the mixture.

This standard was developed jointly by the GPA Midstream Measurement and Quantity Determination (MAQD) Committee and the API Committee on Gas Fluids Measurement (COGFM) in an effort to provide consistent methods for calculating liquid volumes from mass. GPA 8173 was published as a tentative standard in 1973 and became a technical standard in 1976. It is referenced by API as Chapter 14, Section 4 (14.4) of the API Manual of Petroleum Measurement Standards (MPMS). The participation of COGFM in developing this standard is gratefully appreciated and acknowledged.

Summary of Method

This standard provides methods that can be used to calculate equivalent liquid volumes, gas volumes, and energy from a measured mass and composition. This standard considers that different analytical methods may be used as starting points and provides methods for calculation from each potential starting point. It should be used by entities that desire more accurate balancing of systems utilizing mass measurement, as well as entities wanting to report more accurate quantities.

Summary of Changes

There were four significant changes to this revision: the addition of an unrounded method of calculation; the method for choosing which component value to adjust when the sum of values does not equal the expected total; and annexes for the calculation of energy and equivalent gas volume from mass.

The previous revision used an adjustment method to ensure that reported component concentrations totaled exactly 100 % and reported component mass quantities totaled the measured mass. This method remains and is labeled the "adjusted method." This revision added a full numerical precision method that is labeled the "unrounded method."

In the previous revision, the value to be adjusted was based on the component with the lowest number of carbon atoms. This revision adjusts the value of the component with the highest absolute density.

Annex D and Annex E were added to the standard. Annex D provides an informative method to calculate gas equivalent energy from mass. Annex E provides an informative method for calculating gas equivalent volumes from mass.

Converting Mass Of Natural Gas Liquids or Vapors to Equivalent Liquid Volumes

1 Scope

This standard prescribes a method for calculating liquid volumes at equilibrium pressures and at temperatures of 60 °F, 15 °C, and 20 °C from the mass of a natural gas fluid (liquid or vapor) measured at operating conditions, in conjunction with a representative compositional analysis and published values for each component's molar mass and absolute density.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GPA 2145, *Table of Physical Properties for Hydrocarbons and Other Compounds of Interest to the Natural Gas Industry*

3 Terms, Definitions, Abbreviations, and Symbols

3.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
absolute density
The mass of a substance per unit of volume at a specified temperature and pressure.

3.1.2
equilibrium vapor pressure (EVP)
The pressure at which a liquid and its vapor are in equilibrium at a given temperature.

3.1.3
molar mass (M)
The mass of a substance divided by its amount of substance in moles.

3.1.4
mole
The amount of substance of a system that contains as many elementary entities as there are atoms in 0.012 kg of Carbon-12.

3.1.5
mole fraction
The amount of a component in moles divided by the total number of moles of all components in a mixture.

3.1.6
mole percent
Mole fraction multiplied by 100.