



Standard Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels¹

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1. Scope

1.1 This practice covers procedures for calculating heating value, relative density, and compressibility factor at base conditions (14.696 psia and 60°F (15.6°C)) for natural gas mixtures from compositional analysis.² It applies to all common types of utility gaseous fuels, for example, dry natural gas, reformed gas, oil gas (both high and low Btu), propane-air, carbureted water gas, coke oven gas, and retort coal gas, for which suitable methods of analysis as described in Section 6 are available. Calculation procedures for other base conditions are given.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.3 *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. Referenced Documents

2.1 ASTM Standards:

- D 1717 Method for Analysis of Commercial Butane-Butene Mixtures and Isobutylene by Gas Chromatography³
- D 1945 Test Method for Analysis of Natural Gas by Gas Chromatography⁴
- D 1946 Practice for Analysis of Reformed Gas by Gas Chromatography⁴
- D 2163 Test Method for Analysis of Liquefied Petroleum (LP) Gases and Propane Concentrates by Gas Chromatography⁵

D 2650 Test Method for Chemical Composition of Gases by Mass Spectrometry⁵

2.2 GPA Standards:

GPA 2145 Physical Constants for the Paraffin Hydrocarbons and Other Components in Natural Gas⁶

GPA Standard 2166 Methods of Obtaining Natural Gas Samples for Analysis by Gas Chromatography⁶

GPA 2172 Calculation of Gross Heating Value, Relative Density, and Compressibility Factor for Natural Gas Mixtures from Compositional Analysis^{6,7}

GPA Standard 2261 Method of Analysis for Natural Gas and Similar Gaseous Mixtures by Gas Chromatography⁶

GPA Technical Publication TP-17 Table of Physical Properties of Hydrocarbons for Extended Analysis of Natural Gases⁶

GPSA Data Book, Fig. 23-2, Physical Constants⁶

2.3 TRC Document:

TRC Thermodynamic Tables—Hydrocarbons⁸

2.4 ANSI Standard:

ANSI Z 132.1-1969: Base Conditions of Pressure and Temperature for the Volumetric Measurement of Natural Gas^{9,10}

3. Terminology

3.1 Definitions:

3.1.1 *British thermal unit*—the defined International Tables British thermal unit (Btu).

3.1.1.1 *Discussion*—The defining relationships are:

$$1 \text{ Btu} \cdot \text{lb}^{-1} = 2.326 \text{ J} \cdot \text{g}^{-1} \text{ (exact)}$$

$$1 \text{ lb} = 453.592 37 \text{ g (exact)}$$

¹ This practice is under the jurisdiction of ASTM Committee D03 on Gaseous Fuels and is the direct responsibility of Subcommittee D03.03 on Determination of Heating Value and Relative Density of Gaseous Fuels.

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² A more rigorous calculation of $Z(T,P)$ at both base conditions and higher pressures can be made using the calculation procedures in "Compressibility and Super Compressibility for Natural Gas and Other Hydrocarbon Gases," American Gas Association Transmission Measurement Committee Report 8, AGA Cat. No. XQ1285, 1985, AGA, 1515 Wilson Blvd., Arlington, VA 22209.

³ Discontinued. See 1981 *Annual Book of ASTM Standards*, Vol 05.01.

⁴ *Annual Book of ASTM Standards*, Vol 05.06.

⁵ *Annual Book of ASTM Standards*, Vol 05.01.

⁶ Available from Gas Processors Association, 6526 E. 60th, Tulsa, OK 74145.

⁷ The sole source of supply of the program in either BASIC or FORTRAN suitable for running on computers known to the committee at this time is the Gas Processors Association. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee¹, which you may attend.

⁸ Available from Thermodynamics Research Center, The Texas A&M University, College Station, TX 77843-3111.

⁹ Available from the American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

¹⁰ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: D03–1007.