Designation: D8221 – 23

Standard Practice for Determining the Calculated Methane Number (MN_C) of Gaseous Fuels Used in Internal Combustion Engines[1]

This standard is issued under the fixed designation D8221; 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 covers the method to determine the calculated methane number (MN_C) of a gaseous fuel used in internal combustion engines. The basis for the method is a dynamic link library (DLL) suitable for running on computers with Microsoft Windows operating systems.

1.2 This practice pertains to commercially available natural gas products that have been processed and are suitable for use in internal combustion engines. These fuels can be from traditional geological or renewable sources and include pipeline gas, compressed natural gas (CNG), liquefied natural gas, liquefied petroleum gas, and renewable natural gas as defined in Section 3.

1.3 The calculation method within this practice is based on the MWM Method as defined in EN 16726, Annex A.[2] The calculation method is an optimization algorithm that uses varying sequences of ternary and binary gas component tables generated from the composition of a gaseous fuel sample.[3] Both the source code and a Microsoft Excel-based calculator are available for this method.

1.4 This calculation method applies to gaseous fuels comprising of hydrocarbons from methane to hexane and greater (C6+); carbon monoxide; hydrogen; hydrogen sulfide; nitrogen; and carbon dioxide. The calculation method addresses pentanes (C5) and higher hydrocarbons and limits the individual volume fraction of C5 and C6+ to 3 % each and a combined total of 5 %. (See EN 16726, Annex A.) The calculation method is performed on a dry, oxygen-free basis.

1.5 *Units*—The values stated in SI units are to be regarded as standard. Other units of measurement included in this standard are provided for information only and are not considered standard.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[4]

D4150 Terminology Relating to Gaseous Fuels

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *CEN Standard:*[5]

EN 16726 Gas infrastructure—Quality of gas—Group H, Annex A—Calculation of methane number of gaseous fuels for engines

2.3 *ISO Standard:*[6]

ISO 14912 Gas analysis—Conversion of gas mixture composition data

2.4 *ASTM Adjuncts:*[7]

ASTM_D8221_mzdll_ver2.32.0.dll

ASTM_D8221_MNc_Method_ver1.32.1.xlsb

NOTE 1—The adjuncts listed above are the Microsoft Office 32-bit

[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] European Standards (ENs) are documents that have been ratified by one of the three European Standardization Organizations (ESOs), CEN, CENELEC or ETSI; recognized as competent in the area of voluntary technical standardization as for the EU Regulation 1025/2012. EN16726 was developed by the Technical Committee CEN/TC 234.

[3] Leiker, M., Christoph, K., Rankl, M., Cartellieri, W., and Pfeifer, U., “Evaluation of Antiknocking Property of Gaseous Fuels by Means of Methane Number and its Practical Application to Gas Engines,” ASME, 72-DGP-4, 1972.

[4] 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.

[5] Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, http://www.cen.eu.

[6] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[7] Available from ASTM International Headquarters. Order Adjunct No. ADJD822119-EA. Original adjunct produced in 2018.

version.

ASTM_D8221_mzdll_ver2.64.0.dll
ASTM_D8221_MNc_Method_ver1.64.1.xlsb

NOTE 2—The adjuncts listed above are the Microsoft Office 64-bit version.

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of general terms used in D03 Gaseous Fuels Standards, refer to Terminology D4150.

3.1.2 *methane number (MN), n*—an experimental determination of a gaseous fuel's resistance to knock based on a Cooperative Fuel Research (CFR) Motor Octane Number (MON) test engine and indicated by the volume of methane in a blend with hydrogen.

3.1.2.1 *Discussion*—Methane has a value of MN = 100 and hydrogen has a value of MN = 0.

3.1.3 *methane number, calculated (MN_C), n*—a calculation of a rating index, indicating the resistance to knock of a gaseous fuel when compared to a reference methane/hydrogen mixture.

3.1.3.1 *Discussion*—Multiple methods have been developed in the past for providing this analytical estimate based on gas composition. A MN_C is determined using volumetric fuel composition. Sometimes MN_C is described as "methane index (MI)."

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *commercially available, adj*—a natural gas product from more than one non-governmental entity that may be distributed to more than one user.

3.2.1.1 *Discussion*—Examples of commercially available natural gas products are pipeline gas from a utility, CNG from a fueling station, and so forth.

3.2.1.2 *Discussion*—Examples of natural gas that is not commercially available include well-head gas, landfill gas, methane digester gas, and so forth.

3.3 *Abbreviations:*

3.3.1 *CNG*—Compressed Natural Gas

3.3.2 *DLL*—Dynamic Link Library

3.3.3 *LNG*—Liquefied Natural Gas

3.3.4 *LPG*—Liquefied Petroleum Gas

3.3.5 *RNG*—Renewable Natural Gas

4. Summary of Calculation Method

4.1 The application of analytical methods to groups of ternary and binary mixtures of gas components with known methane numbers that reflect the makeup of the gaseous fuel mixture is the basis for this calculated methane number method.

4.2 This calculation method originates with the data of a research program performed by AVL Deutschland GmbH for FVV and was updated and revised by MWM GmbH and then finally published for global use in EN 16726, Annex A.

5. Significance and Use

5.1 The methane number (MN) is a measure of the resistance of the gaseous fuel to autoignition (knock) when used in an internal combustion engine. The relative merits of gaseous fuels from different sources and having different compositions can be compared readily on the basis of their methane numbers. Therefore, the calculated methane number (MN_C) is used as a parameter for determining the suitability of a gaseous fuel for internal combustion engines in both mobile and stationary applications.

CALCULATION METHOD

6. Scope

6.1 This calculation method applies to gaseous fuels as defined by the Scope, and defined in Section 3, and listed in Procedure 8.1, Table 2.

7. Significance and Use

7.1 The methane number of a gaseous fuel can be calculated based on its composition by various analytical methods which can give different results. The results of the method described in this practice match measured methane numbers (see X1.1 and X2.1) with reasonable certainty for the fuels as defined in this practice.

7.2 The method requires input of composition in the form of volume fractions at reference conditions of 15.55 °C and 101.325 kPa and expressed as a percentage. Compositions available as either mole fraction or mass fraction are to be converted to volume fraction using the methods cited in ISO 14912. For general use, it may be assumed that mole fraction and volume fraction are equivalent.

7.3 The final result, the calculated methane number, is expressed as an integer per Practice E29.

7.4 While this calculation method will provide results for gaseous fuel compositions outside the scope of this practice, the results may have a higher degree of uncertainty.

7.5 *Errors*—This calculation method may not apply to certain gas compositions based on the component inputs violating input limit requirements or due to the method's internal calculations and regressions being unable to develop a calculated methane number value. Error messages are provided to the user and are listed in Table 1 and described in 7.5.1 to 7.5.4.

TABLE 1 Error Messages

Error Message	Comment
"The input sample total must be from 99 % to 101 %, inclusive; please correct!"	No MN_C value displayed
"The MNc calculation is not possible due to internal program errors!"	No MN_C value displayed
"A valid MNc value cannot be calculated!"	No MN_C value displayed
"A MNc value with reasonable certainty is not possible due to high C5+ content!"	No MN_C value displayed