INTERNATIONAL

Designation: ~~D976 – 06 (Reapproved 2011)~~ D976 – 06 (Reapproved 2016)

Standard Test Method for Calculated Cetane Index of Distillate Fuels[1]

This standard is issued under the fixed designation D976; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers the Calculated Cetane Index formula, which represents a means for directly *estimating* the ASTM cetane number of distillate fuels from API gravity and mid-boiling point. The index value, as computed from the formula, is termed the Calculated Cetane Index.[2]

1.2 The Calculated Cetane Index is not an optional method for expressing ASTM cetane number. It is a supplementary tool to estimate cetane number when used with due regard for its limitations.

1.3 The Calculated Cetane Index formula is particularly applicable to straight-run fuels, catalytically cracked stocks, and blends of the two.

NOTE 1—This test method is temporarily retained because the proposal to the U.S. EPA to control diesel fuel aromatics concentrations via a 40 Calculated Cetane Index minimum is based on the correlation between Test Method D976 and aromatics concentration. Test Method D4737 is the preferred method as estimator of cetane number.

1.4 *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:*[3]

D86 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure

D287 Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)

D613 Test Method for Cetane Number of Diesel Fuel Oil

D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

D2887 Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography

D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

D4737 Test Method for Calculated Cetane Index by Four Variable Equation

2.2 *ASTM Adjuncts:*[4]

Nomograph for Calculated Cetane Index

3. Significance and Use

3.1 The Calculated Cetane Index is one tool available for estimating ASTM cetane number where a test engine is not available for determining this property. It may be employed for approximating cetane number where the quantity of sample is too small for an engine rating. In cases where the cetane number of a fuel has been initially established, the index is useful as a cetane number check on subsequent samples of that fuel, provided its source and mode of manufacture remain unchanged.

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[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.E0 on Burner, Diesel, Non-Aviation Gas Turbine, and Marine Fuels.

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[2] A method of calculating cetane index was developed by the Diesel Fuels Division, Coordinating Fuel and Equipment Research Committee of the Coordinating Research Council. See Young, H. D., "Methods for Estimating Cetane Number," *Proceedings*, PPIRA, American Petroleum Institute, Vol. 30 M [III], 1950. This method was revised in 1960 by Research Division I of Committee D02 to conform to the revised Test Method D613.

[3] 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.

[4] Available from ASTM International Headquarters. Order Adjunct No. ADJD0976. Original adjunct produced in 1989.

3.2 Test Method D4737 may also be used to approximate the ASTM cetane number of diesel fuels.

3.2.1 Procedure A of Test Method D4737 was developed as a result of a larger degree of offset between Test Method D976 Cetane Index and the results of Test Method D613 over the entire range of the correlation. Generally, it has been found that use of Test Method D4737 results in less offset than use of Test Method D976, but there can be specific cases where this is not true.

3.2.2 Procedure A of Test Method D4737 is recommended to estimate the cetane number of diesel fuels with sulfur contents above 500 ppm or No. 1–D diesel fuels.

3.2.3 Procedure B of Test Method D4737 is recommended to estimate the cetane number of No. 2–D diesel fuels with sulfur contents at or below 500 ppm.

3.3 Calculated Cetane Index, as described in Test Method D976–80, is recognized by the United States EPA as an alternative method to meet the U.S. Federal Diesel aromatics limit for diesel fuels containing less than 500 ppm sulfur. The equation for Calculated Cetane Index in Test Method D976–80 and in this version (D976–06) of the test method are the same.

4. Equation for Calculated Cetane Index

4.1 The Calculated Cetane Index is determined from the following equation:

$$\text{Calculated cetane index} = -420.34 + 0.016\,G^2 + 0.192\,G\log M \quad (1)$$

$$+65.01\,(\log M)^2 - 0.0001809\,M^2$$

or

$$\text{Calculated cetane index} = 454.74 - 1641.416\,D + 774.74\,D^2 \quad (2)$$

$$-0.554\,B + 97.803\,(\log B)^2$$

where:

G = API gravity, determined by Test Method D287, D1298, or D4052,
M = mid-boiling temperature, °F, determined by Test Method D86 and corrected to standard barometric pressure,
~~D = density at 15°C, g/mL, determined by Test Method D1298 or D4052, and~~
D = density at 15 °C, g/mL, determined by Test Method D1298 or D4052, and
B = mid-boiling temperature, °C, determined by Test Method D86 and corrected to standard barometric pressure.

4.2 Calculated Cetane Index values for distillate fuels may be conveniently determined by means of the alignment chart in Fig. 1 rather than by direct application of the equation. Use of the chart is illustrated by the example shown on the chart.

4.3 Test Method D2887 may be used as an alternative to Test Method D86 to determine the mid-boiling temperature of the fuel.

4.3.1 If Test Method D2887 is used, convert the data to estimated Test Method D86 data following Appendix X5, Correlation of Jet and Diesel Fuel of test Method D2887 and use the data from Test Method D86 in place of the actual Test Method D86 data in the calculations.

NOTE 2—Current U.S. EPA regulations for low sulfur (500 ppm maximum) No. 1–D and No. 2–D diesel fuel require the use of Test Method D976–80 to calculate Cetane Index.

5. Limitations of Equation

5.1 The Calculated Cetane Index equation possesses certain inherent limitations which must be recognized in its application. These are:

5.1.1 It is not applicable to fuels containing additives for raising cetane number.

5.1.2 It is not applicable to pure hydrocarbons, synthetic fuels, such as certain products derived from shale oils and tar sands, alkylates, or coal-tar products.

5.1.3 Substantial inaccuracies in correlation may occur if used for crude oils, residuals, or products having a volatility of below ~~500°F~~500 °F end point.

6. Report

6.1 Round and report the calculated cetane index to the nearest tenth. Any calculated cetane index value ending in exactly "5" in the second decimal place shall be rounded to the nearest even tenth number. For example, round "35.55" and "35.65" to "35.6 cetane index."

7. Precision and Bias

7.1 Correlation of index values with ASTM cetane number is dependent to a great extent upon the accuracy of determination of both API gravity and midboiling point.

7.2 Within the range from 30 to 60 cetane number, the expected correlation of the Calculated Cetane Index with the ASTM cetane number will be somewhat less than ±2 cetane numbers for 75 % of the distillate fuels evaluated. Errors in correlation may