



Standard Test Methods for Calculated Cetane Index of Distillate Fuels¹

This standard is issued under the fixed designation D 976; 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 is also a standard of the Institute of Petroleum issued under the fixed designation IP 218. The final number indicates the year of last revision.

These test methods have been approved by the sponsoring committees and accepted by the cooperating societies in accordance with established procedures.

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

^{ε1} NOTE—Editorial corrections were made throughout in April 2000.

1. Scope

1.1 The Calculated Cetane Index formula 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 for predicting 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 D 976 and aromatics concentration. Test Method D 4737 is the preferred method as estimator of cetane number. Test method D 976 is intended to be letter balloted for withdrawal from the book of standards in 1993.

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 appro-*

priate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:

- D 86 Test Method for Distillation of Petroleum Products³
- D 287 Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)³
- D 613 Test Method for Cetane Number of Diesel Fuel Oil⁴
- D 1298 Test Method for Density, Relative Density, (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method³
- D 4737 Test Method for Calculated Cetane Index by Four Variable Equation⁵

2.2 ASTM Adjuncts:

- Nomograph for Calculated Cetane Index⁶

3. Significance and Use

3.1 The Calculated Cetane Index is a useful tool for estimating ASTM cetane number where a test engine is not available for determining this property. It may be conveniently 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.

¹ These test methods are under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and are the direct responsibility of Subcommittee D02.E on Burner, Diesel, and Gas Turbine Fuel Oils.

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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 H. D. Young, "Methods for Estimating Cetane Number," *Proceedings*, PPIRA, Am. Petroleum Inst., Vol. 30 M [III], 1950. This method was revised in 1960 by Research Division I of Committee D-2 to conform to the revised Test Method D 613.

³ *Annual Book of ASTM Standards*, Vol 05.01.

⁴ *Annual Book of ASTM Standards*, Vol 05.05.

⁵ *Annual Book of ASTM Standards*, Vol 05.02.

⁶ Copies of the Nomograph for Calculated Cetane Index, 8½ by 11 in. in size, are available at a nominal cost from ASTM. Request Adjunct ADJDO976.

4. Equation for Calculated Cetane Index

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

$$\text{Calculated cetane index} = -420.34 + 0.016 G^2 + 0.192 G \log M + 65.01 (\log M)^2 - 0.0001809 M^2. \quad (1)$$

or

$$\text{Calculated cetane index} = 454.74 - 1641.416 D + 774.74 D^2 - 0.554 B + 97.803 (\log B)^2. \quad (2)$$

where:

G = API gravity, determined by Test Method D 287 or D 1298,

M = mid-boiling temperature, °F, determined by Test Method D 86 and corrected to standard barometric pressure,

D = density at 15°C, g/mL, determined by Test Method D 1298, and

B = mid-boiling temperature, °C, determined by Test Method D 86 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. The method of using this chart is indicated by the illustrative example thereon.

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 end point.

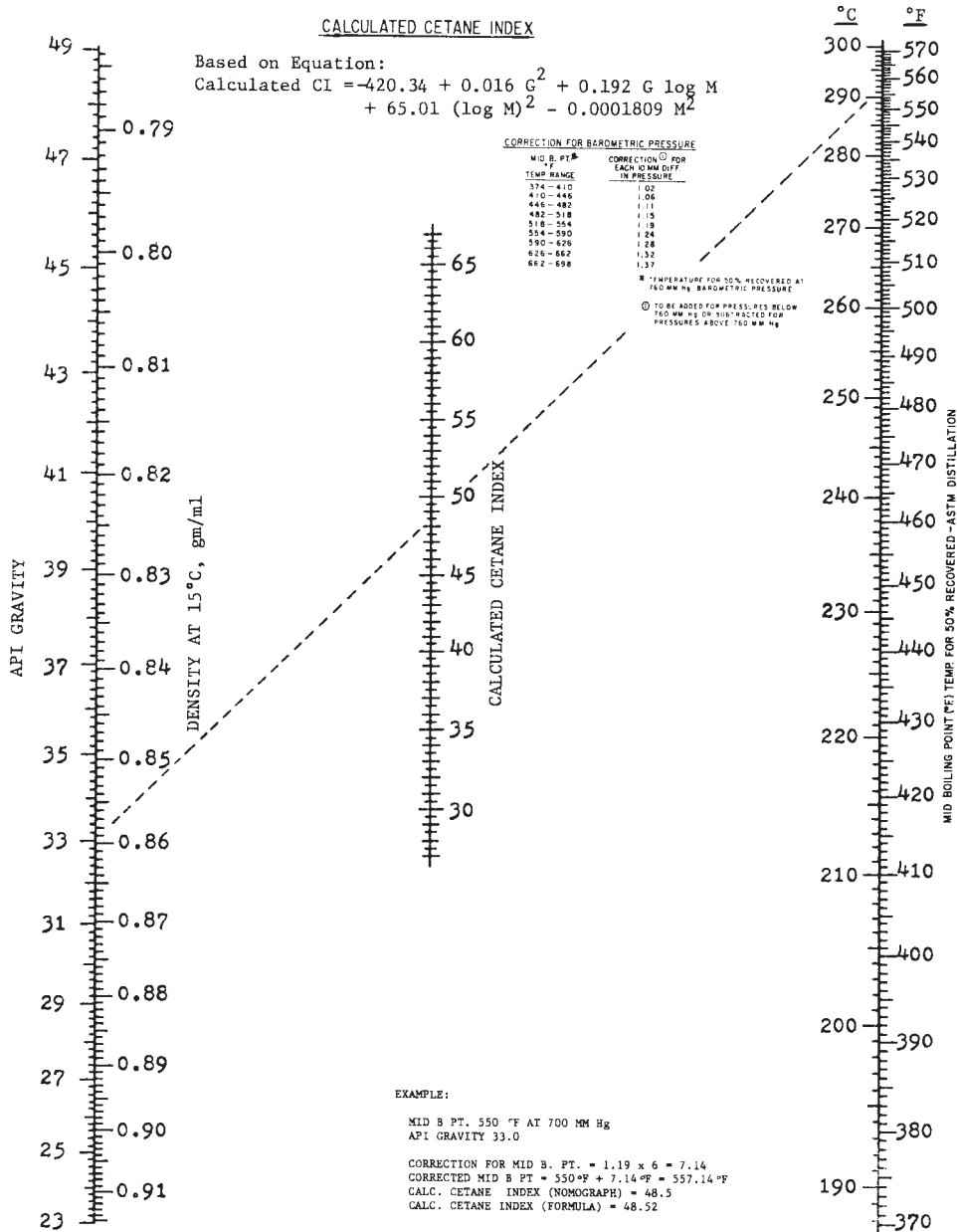
6. Precision

6.1 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.

6.2 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 be greater for fuels whose cetane numbers are outside this range. Correlation is best for straight-run and catalytically cracked distillates and blends of the two, and least satisfactory for blends containing substantial proportions of thermally cracked stocks.

7. Keywords

7.1 cetane; cetane index; diesel fuel



NOTE 1—The Calculated Cetane Index equation represents a useful tool for *estimating* cetane number. Due to inherent limitations in its application, Index values may not be a valid substitute for ASTM Cetane Numbers as determined in a test engine.

FIG. 1 Nomograph for Calculated Cetane Index (ECS-1 Meter Basis—Test Method D 613)

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