Designation: D5798 – 09b

Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines[1]

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

1. Scope*

1.1 This specification covers a fuel blend, nominally 75 to 85 volume % denatured fuel ethanol and 25 to 15 additional volume % hydrocarbons for use in ground vehicles with automotive spark-ignition engines. Appendix X1 discusses the significance of the properties specified.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D86 Test Method for Distillation of Petroleum Products at Atmospheric Pressure

D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

D381 Test Method for Gum Content in Fuels by Jet Evaporation

D512 Test Methods for Chloride Ion In Water

D525 Test Method for Oxidation Stability of Gasoline (Induction Period Method)

D1266 Test Method for Sulfur in Petroleum Products (Lamp Method)

D1613 Test Method for Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer, and Related Products

D1688 Test Methods for Copper in Water

D2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry

D3120 Test Method for Trace Quantities of Sulfur in Light Liquid Petroleum Hydrocarbons by Oxidative Microcoulometry

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products

D4306 Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination

D4806 Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel

D4814 Specification for Automotive Spark-Ignition Engine Fuel

D4815 Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C_1 to C_4 Alcohols in Gasoline by Gas Chromatography

D4953 Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method)

D5190 Test Method for Vapor Pressure of Petroleum Products (Automatic Method)

D5191 Test Method for Vapor Pressure of Petroleum Products (Mini Method)

D5453 Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence

D5501 Test Method for Determination of Ethanol Content of Denatured Fuel Ethanol by Gas Chromatography

D5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products

D6423 Test Method for Determination of pHe of Ethanol, Denatured Fuel Ethanol, and Fuel Ethanol (Ed75-Ed85)

D7319 Test Method for Determination of Total and Potential Sulfate and Inorganic Chloride in Fuel Ethanol by Direct Injection Suppressed Ion Chromatography

D7328 Test Method for Determination of Total and Potential Inorganic Sulfate and Total Inorganic Chloride in Fuel Ethanol by Ion Chromatography Using Aqueous Sample Injection

[1] This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is under the direct responsibility of Subcommittee D02.A0.01 on Gasoline and Gasoline-Oxygenate Blends.

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[2] 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.

***A Summary of Changes section appears at the end of this standard.**

E203 Test Method for Water Using Volumetric Karl Fischer Titration

E1064 Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration

2.2 *Government Standards:*[3]

40 CFR Part 80 Code of Federal Regulations

3. Terminology

3.1 *Definitions:*

3.1.1 *ethanol*, *n*—ethyl alcohol, the chemical compound C_2H_5OH.

3.1.2 *methanol*, *n*—methyl alcohol, the chemical compound CH_3OH.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *aliphatic ether*—an oxygen-containing, ashless, organic compound in which the oxygen atom is interposed between two carbon atoms (organic groups), has the general formula $C_nH_{2n+2}O$ with *n* being 5 to 8, and in which the carbon atoms are connected in open chains and not closed rings.

3.2.1.1 *Discussion*—Aliphatic compounds can be straight or branched chains and saturated or unsaturated. The term aliphatic ether, as used in this specification, refers only to the saturated compounds.

3.2.2 *denaturants*—natural gasoline, gasoline components, unleaded gasoline, or toxic or noxious materials added to fuel ethanol to make it unsuitable for beverage use but not unsuitable for automotive use.

3.2.3 *denatured fuel ethanol*—fuel ethanol made unfit for beverage use by the addition of denaturants.

3.2.4 *fuel ethanol*—ethanol with impurities common to its production (including water but excluding denaturants).

3.2.5 *fuel ethanol (Ed75-Ed85)*—blend of ethanol and hydrocarbon of which the ethanol portion is nominally 70 to 85 volume % denatured fuel ethanol.

3.2.6 *higher alcohols*—aliphatic alcohols of general formula $C_nH_{2n+1}OH$ with N being 3 to 8.

3.2.7 *hydrocarbon*—those components in an ethanol-hydrocarbon blend containing only hydrogen and carbon.

3.2.8 *pH_e*—a measure of the acid strength of alcohol fuels.

4. Fuel Ethanol (Ed75-Ed85) Performance Requirements

4.1 Fuel ethanol (Ed75-Ed85) shall conform to the requirements of Table 1.

NOTE 1—Most of the requirements cited are based on the best technical information currently available. Requirements for sulfur, phosphorus, and lead are based on the use of gasoline defined in Specification D4814 and the understanding that control of these elements will affect catalyst lifetime. The lead maximum is limited for Class 1 and Class 2 fuels to the lower limit of the test method. As greater experience is gained from field use of Ed75-Ed85 vehicles and further vehicle hardware developments for the use of ethanol content fuels occurs, it is expected that many of these requirements will change.

4.1.1 Vapor pressure is varied for seasonal and climatic changes by providing three vapor pressure classes for fuel ethanol (Ed75-Ed85). The seasonal and geographical distribution for three vapor pressure classes is shown in Table 2. Class 1 encompasses geographical areas with 6-h tenth percentile minimum ambient temperature of greater than 5°C (41°F). Class 2 encompasses geographical areas with 6-h tenth percentile minimum ambient temperature of greater than −5°C (23°F) but less than +5°C (41°F). Class 3 encompasses geographical areas with 6-h tenth percentile minimum ambient temperature less than or equal to −5°C (23°F).

TABLE 1 Requirements for Fuel Ethanol (Ed75-Ed85)

Properties	Class 1[A]	Class 2	Class 3
Ethanol + higher alcohols, min, volume %	79	74	70
Hydrocarbon/aliphatic ether, volume %	17–21	17–26	17–30
Vapor pressure, kPa (psi)	38–59 (5.5–8.5)	48–65 (7.0–9.5)	66–83 (9.5–12.0)
Sulfur, max, mg/kg	80[B]	80[B]	80[B]
		All Classes	
Methanol, volume %, max		0.5	
Higher alcohols (C_3–C_8), max, volume %		2	
Acidity, (as acetic acid CH3COOH), mass % (mg/L), max		0.005 (40)	
Solvent-washed gum content, max, mg/100 mL		5	
pH_e		6.5 to 9.0	
Unwashed gum content, max, mg/100 mL		20	
Inorganic chloride, max, mg/kg		1	
Copper, max, mg/L		0.07	
Water, max, mass %		1.0	
Appearance	This product shall be visibly free of suspended or precipitated contaminants (clear and bright). This shall be determined at ambient temperature or 21°C (70°F), whichever is higher.		

[A] See 4.1.1 for volatility class criteria.

[B] Qualified small refineries have varying maximum sulfur limits for gasoline up to 0.0450 mass%, which are based on their 1997–1998 sulfur level baseline. If gasoline from qualified refineries is used to blend Ed75–Ed85, the maximum sulfur level shall be for Class 1: 92 mg/kg; for Class 2: 113 mg/kg; and for Class 3: 130 mg/kg.

4.1.2 The hydrocarbons blended with the denatured fuel ethanol shall have a maximum boiling point of 225°C (437°F) by Test Method D86, oxidation stability of 240-min minimum by Test Method D525, and No. 1 maximum copper strip corrosion by Test Method D130. The hydrocarbons may contain aliphatic ethers as blending components as are customarily used for automotive spark-ignition engine fuel.

4.1.3 The denaturant for the denatured fuel ethanol used in making fuel ethanol (Ed75-Ed85) shall meet the requirements of Specification D4806 (see Section 6).

4.1.4 Fuel ethanol (Ed75–Ed85) of any volatility class shall meet the same limits for lead and phosphorus as required by U.S. Environmental Protection Agency (EPA) regulations for unleaded gasoline.

4.1.4.1 The intentional addition of lead or phophorus compounds to fuel ethanol (Ed75–Ed85) is not permitted. EPA regulations limit their maximum concentrations in unleaded gasoline to 0.05 g lead/US gal (0.013 g/L) and 0.005 g phosphorus/US gal (0.0013 g/L), respectively. Details of the EPA regulations and test methods are available in 40 CFR Part 80, Part 80 of Title 40 of the Code of Federal Regulations.

[3] Available from the U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

TABLE 2 Seasonal and Geographical Volatility Specifications for Fuel Ethanol (Ed75-Ed85)

NOTE 1—This schedule, subject to agreement between the purchaser and the seller, denotes the vapor pressure class of the fuel at the time and place of bulk delivery to fuel-dispensing facilities for the end user. Shipments should anticipate this schedule.

NOTE 2—Where alternative classes are listed, either class is acceptable; the option shall be exercised by the seller.

State	Jan	Feb	March	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Alabama	2	2	2	2	2/1	1	1	1	1	1/2	2	2
Alaska												
Southern Region	3	3	3	3	3/2	2/1	1	1/2	2/3	3	3	3
South Mainland	3	3	3	3	3/2	2/1	1/2	2	2/3	3	3	3
Arizona												
N of 34° Latitude	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
S of 34° Latitude	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Arkansas	3	3	3/2	2/1	1	1	1	1	1/2	2	2/3	3
California[A]												
North Coast	2	2	2	2	2	2/1	1	1	1	1/2	2	2
South Coast	3/2	2	2	2	2/1	1	1	1	1	1/2	2/3	3
Southeast	3	3/2	2	2	2/1	1	1	1	1/2	2	2/3	3
Interior	2	2	2	2	2	2/1	1	1	1	1/2	2	2
Colorado												
E of 105° Longitude	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
W of 105° Longitude	3	3	3	3	3/2	2	2/1	1/2	2/3	3	3	3
Connecticut	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
Delaware	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
District of Columbia	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Florida												
N of 29° Latitude	2	2	2	2/1	1	1	1	1	1	1/2	2	2
S of 29° Latitude	2	2/1	1	1	1	1	1	1	1	1	1/2	2
Georgia	3	3/2	2	2/1	1	1	1	1	1	1/2	2	2/3
Hawaii	1	1	1	1	1	1	1	1	1	1	1	1
Idaho	3	3	3	3/2	2	2	2/1	1/2	2	2/3	3	3
Illinois												
N of 40° Latitude	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
S of 40° Latitude	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Indiana	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Iowa	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Kansas	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Kentucky	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Louisiana	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Maine	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Maryland	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Massachusetts	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
Michigan												
Lower Michigan	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Upper Michigan	3	3	3	3	3/2	2/1	1	1/2	2	2/3	3	3
Minnesota	3	3	3	3	3/2	2/1	1	1/2	2	2/3	3	3
Mississippi	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Missouri	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Montana	3	3	3	3	3/2	2	2/1	1/2	2/3	3	3	3
Nebraska	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Nevada												
N of 38° Latitude	3	3	3	3/2	2	2	2/1	1/2	2	2/3	3	3
S of 38° Latitude	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
New Hampshire	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
New Jersey	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
New Mexico												
N of 34° Latitude	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
S of 34° Latitude	3	3	3/2	2/1	1	1	1	1	1	1/2	2/3	3
New York												
N of 42° Latitude	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
S of 42° Latitude	3	3	3	3/2	2/1	1	1	1	1/2	2	2/3	3
North Carolina	3	3	3/2	2	2/1	1	1	1	1/2	2/3	3	3
North Dakota	3	3	3	3	3/2	2/1	1	1/2	2	2/3	3	3
Ohio	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Oklahoma	3	3	3	3/2	2/1	1	1	1	1/2	2	2/3	3
Oregon												
E of 122° Longitude	3	3	3	3/2	2	2	2/1	1/2	2	2/3	3	3
W of 122° Longitude	3	3/2	2	2	2	2/1	1	1	1/2	2	2	2/3
Pennsylvania												
N of 41° Latitude	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
S of 41° Latitude	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
Rhode Island	3	3	3	3/2	2/1	1	1	1	1/2	2	2/3	3
South Carolina	2	2	2	2/1	1	1	1	1	1	1/2	2	2
South Dakota	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Tennessee	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Texas												

TABLE 2 *Continued*

State	Jan	Feb	March	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
N of 31° Latitude	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
S of 31° Latitude	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Utah	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Vermont	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Virginia	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Washington												
E of 122° Longitude	3	3	3/2	2	2	2/1	1	1	1/2	2/3	3	3
W of 122° Longitude	3	3/2	2	2	2	2/1	1	1	1/2	2	2	2/3
West Virginia	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Wisconsin	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Wyoming	3	3	3	3	3/2	2	2/1	1/2	2	2/3	3	3

[A] Details of State Climatological Division by county as indicated:

California, North Coast—Alameda, Contra Costa, Del Norte, Humbolt, Lake, Marin, Mendocino, Monterey, Napa, San Benito, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma, Trinity

California, Interior—Lassen, Modoc, Plumas, Sierra, Siskiyou, Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Fresno, Glenn, Kern (except that portion lying east of Los Angeles County Aqueduct), Kings, Madera, Mariposa, Merced, Placer, Sacramento, San Joaquin, Shasta, Stanislaus, Sutter, Tehama, Tulare, Tuolumne, Yolo, Yuba, Nevada

California, South Coast—Orange, San Diego, San Luis Obispo, Santa Barbara, Ventura, Los Angeles (except that portion north of the San Gabriel Mountain range and east of the Los Angeles County Aqueduct)

California, Southeast—Imperial, Riverside, San Bernadino, Los Angeles (that portion north of the San Gabriel Mountain range and east of the Los Angeles County Aqueduct), Mono, Inyo, Kern (that portion lying east of the Los Angeles County Aqueduct)

4.1.5 Use of unprotected aluminum in fuel ethanol (Ed75-Ed85) distribution and dispensing equipment will introduce insoluble aluminum compounds into the fuel, causing plugged vehicle fuel filters. Furthermore, this effect can be exaggerated even with protected aluminum by elevated fuel conductivity caused by contact with nitrile rubber dispensing hose. Therefore, unprotected aluminum and unlined nitrile rubber dispensing hose should be avoided in fuel ethanol (Ed75-Ed85) fuel distribution and dispensing systems.[4]

5. Workmanship

5.1 Fuel ethanol (Ed75–Ed85) shall be visually free of sediment and suspended matter. It shall be clear and bright at the ambient temperature or 21°C (70°F), whichever is higher.

5.2 The specification defines only a basic purity for fuel ethanol (Ed75–Ed85). The product shall be free of any adulterant or contaminant that can render the material unacceptable for its commonly used applications.

6. Sampling, Containers, and Sample Handling

6.1 The reader is strongly advised to review all intended test methods prior to sampling to better understand the importance and effects of sampling technique, proper containers, and special handling required for each test method.

6.2 Correct sampling procedures are critical to obtain a sample representative of the lot intended to be tested. Use appropriate procedures in Practice D4057 for manual method sampling and in Practice D4177 for automatic sampling, as applicable.

6.3 The correct sample volume and appropriate container selection are important decisions that can impact test results. Refer to Practice D4306 for aviation fuel container selection for tests sensitive to trace contamination. Refer to Practice D5854 for procedures on container selection and sample mixing and handling. Where practical, fuel ethanol (Ed75–Ed85) should be sampled in glass containers. If samples must be collected in metal containers, do not use soldered metal containers. This is because the soldering flux in the containers and the lead in the solder can contaminate the sample. Plastic containers should be avoided.

6.4 A minimum sample size of about 1 L (1 US qt) is recommended.

7. Test Methods

7.1 Determine the requirements enumerated in this specification in accordance with the following test methods:

NOTE 2—The appropriateness of ASTM test methods cited has not been demonstrated for use with fuel ethanol (Ed75-Ed85).

7.1.1 *Ethanol*—Test Method D5501.

7.1.2 *Hydrocarbon/Aliphatic Ether Blend Content*—Use Test Method D4815 to determine other alcohols, methyl *tertiary*-butyl ether (MTBE), and other ethers. Determine water by the Karl Fischer test method (see 7.1.8). Subtract the concentration of alcohols and water from 100 to get the percent hydrocarbon/aliphatic ether.

7.1.3 *Vapor Pressure*—Test Method D4953, D5190, or D5191.

7.1.4 *Acidity*—Test Method D1613.

7.1.5 pH_e—Test Method D6423.

7.1.6 *Gum Content, Solvent Washed and Unwashed*—Test Method D381.

7.1.7 *Inorganic Chloride*—Test Methods D512, D7319, or D7328.

7.1.8 *Water*—Test Method E203 or E1064.

7.1.9 *Copper*—Modification of Test Method D1688 as outlined in Specification D4806.

7.1.10 *Sulfur*—Test Method D1266, D2622, D3120, or D5453. With Test Method D2622, prepare the calibration standards using ethanol (reagent grade) as the solvent to prevent errors caused by large differences in carbon-hydrogen ratios.

[4] American Automobile Manufacturers Association, *Fuel Methanol Compatibility Standards and Dispensing Equipment List for M85 Fueled Vehicles*, October 1994.

8. Keywords

8.1 acidity; alcohol; automotive spark-ignition engine fuel; chloride; copper corrosion; ether; fuel ethanol (Ed75-Ed85) for automotive spark-ignition engines; hydrocarbon; inorganic chloride; lead; MTBE; oxidation stability; oxygenates; pH_e; phosphorus; solvent washed gum content; sulfur; vapor pressure; volatility; water

APPENDIX

(Nonmandatory Information)

X1. SIGNIFICANCE OF SPECIFICATION FOR FUEL ETHANOL (Ed75-Ed85) FOR AUTOMOTIVE SPARK-IGNITION ENGINES

X1.1 Ethanol

X1.1.1 The ethanol content of fuel ethanol (Ed75-Ed85) is a critical parameter as it affects the capability of the fuel metering system of the dedicated Ed75-Ed85 vehicle to establish the proper air/fuel ratio for optimum vehicle operation. This is much less of a concern for multifuel-capable vehicles than for dedicated Ed75-Ed85 vehicles. Ethanol content may also affect the lubricating properties of the fuel, the water tolerance of the fuel, and the ability to meet cold and cool area volatility requirements.

X1.1.2 The inclusion of impurities, some denaturants, and contaminants, except for the deliberately added hydrocarbons or additives, or both, can impact adversely on the properties and performance of fuel ethanol (Ed75-Ed85) as an automotive spark-ignition engine fuel. The quantities of some of these materials are controlled by specified property limits. The limits on water, higher molecular weight alcohols, and methanol and on types of denaturants as well as minimums on the amount of ethanol and hydrocarbons limit, but do not prevent, the presence of trace materials.

X1.2 Hydrocarbon

X1.2.1 Hydrocarbons are deliberately added to provide improved cold startability and warm up driveability. The addition of hydrocarbon to fuel ethanol changes its volatility and can affect the flammability of fuel tank vapors.

X1.2.2 This specification does not control the composition of the hydrocarbons added to the denatured fuel ethanol. However, the hydrocarbons shall be stable and noncorrosive and be in the boiling range of automotive spark-ignition engine fuel as specified in Specification D4814.

X1.3 Vapor Pressure

X1.3.1 The addition of volatile hydrocarbons is required for adequate cold startability. The addition of hydrocarbons that are too volatile can contribute to hot fuel handling problems. Higher vapor pressures are required at colder ambient temperatures while lower volatility fuels are less prone to hot fuel handling problems at higher (summertime) ambient temperatures. Excessive vapor pressure contributes to evaporative emissions. Lower and upper limits on vapor pressure for the three volatility classes are used to define the acceptable range of volatile components to ensure adequate vehicle performance.

X1.4 Acidity

X1.4.1 Very dilute aqueous solutions of organic acids, such as acetic acid, are highly corrosive to a wide range of metals and alloys. It is therefore necessary to keep such acids at a very low level.

X1.5 pH_e

X1.5.1 When the pH_e of ethanol used as a fuel for automotive spark-ignition engines is below 6.5, fuel pumps can malfunction as a result of a film forming between the brushes and commutator, fuel injectors can fail from corrosive wear, and excessive engine cylinder wear can occur. When the pH_e is above 9.0, fuel pump plastic parts can fail.

X1.6 Gum Content, Solvent Washed and Unwashed

X1.6.1 The test for solvent washed gum content measures the amount of residue after the evaporation of the fuel and following a heptane wash. The heptane wash removes the heptane-soluble, nonvolatile material, such as additives, carrier oils used with the additives, and diesel fuel. Unwashed gum content consists of fuel-insoluble and fuel-soluble gum. The fuel-insoluble portion can clog fuel filters. Both can be deposited on surfaces when the fuel evaporates.

X1.6.2 Solvent washed gum can contribute to deposits on the surface of carburetors, fuel injectors, and intake manifolds, ports, valves, and valve guides. The impact of solvent washed gum on malfunctions of modern engines that can operate on fuel ethanol (Ed75-Ed85) has not been fully established but is based on limited experience gained with M70-M85 fuels in field tests and from historic gasoline limits. Performance effects depend on where the deposits form; the presence of other deposit precursors, such as airborne debris, blowby and exhaust gas recirculation gases; oxidized engine oil; and the amount of deposit.

X1.6.3 The difference between the unwashed and solvent washed and gum content values can be used to assess the presence and amount of nonvolatile material in the fuel. Additional analytical testing is required to determine if the material is additive, carrier oil, diesel fuel, and so forth.

X1.6.4 The unwashed gum content limit is intended to limit high-boiling contaminants, like diesel fuel, that can affect engine performance, yet allow the use of appropriate levels of deposit control additives with carrier oils in fuel ethanol (Ed75-Ed85).

X1.6.5 Because the precision statements for Test Method D381 were developed using only data on hydrocarbons, they may not be applicable to fuel ethanol (Ed75-Ed85).

X1.7 Inorganic Chloride

X1.7.1 Inorganic (ionic) chloride is corrosive to many metals, and it is desirable to minimize inorganic chloride compounds in fuel ethanol (Ed75-Ed85).

X1.7.2 An inorganic chloride limit of 1 mg/kg, maximum, has been found to be adequate in protecting fuel system components.

X1.8 Lead

X1.8.1 Most vehicles equipped to operate on fuel ethanol (Ed75-Ed85) are equipped with exhaust catalysts that control emissions of aldehydes (formaldehyde and acetaldehyde) as well as regulated emissions. Lead compounds deactivate the catalyst and are therefore limited to trace amounts.

X1.9 Phosphorus

X1.9.1 Like lead, phosphorus deactivates exhaust catalysts and is limited to trace amounts.

X1.10 Appearance

X1.10.1 Turbidity, phase separation, or evidence of precipitation normally indicates contamination.

X1.11 Water

X1.11.1 The solubility of hydrocarbon in fuel ethanol (Ed75-Ed85) and blends with gasoline as may occur in multifuel-capable vehicles decreases with lowering temperature and increasing water content. Separation of the hydrocarbon from the fuel will adversely affect cold starting and driveability and denaturing. Water may affect the calibration of some types of composition sensors of multifuel-capable vehicles. Water also reduces the energy content of the fuel and thus adversely affects fuel economy and power. Because some degree of water contamination is practically unavoidable in transport and handling, and because the fuel ethanol (Ed75-Ed85) is miscible with water, the water content of fuel ethanol (Ed75-Ed85) is limited to reduce the potential for problems.

X1.12 Copper

X1.12.1 Copper is a very active catalyst for low-temperature oxidation of hydrocarbons. Experimental work has shown that copper concentrations higher than 0.012 mg/kg in commercial gasolines may significantly increase the rate of gum formation.

X1.13 Sulfur

X1.13.1 The limit on sulfur content is included to protect against engine wear, deterioration of engine oil, corrosion of exhaust system parts, and exhaust catalyst deactivation.

SUMMARY OF CHANGES

Subcommittee D02.A0 has identified the location of selected changes to this standard since the last issue (D5798–09a) that may impact the use of this standard. (Approved April 15, 2009.)

(*1*) Deleted Test Method D2988 and added Test Methods D7319 and D7328 to the Referenced Documents and 7.1.7.

(*2*) Deleted original Annex A1.

Subcommittee D02.A0 has identified the location of selected changes to this standard since the last issue (D5798–09) that may impact the use of this standard. (Approved March 1, 2009.)

(*1*) Changed sulfur limits in Table 1 and added footnote.

Subcommittee D02.A0 has identified the location of selected changes to this standard since the last issue (D5798–07) that may impact the use of this standard. (Approved Jan. 15, 2009.)

(*1*) Added Note 2 to Table 2.