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An American National Standard

Standard Specification for High Aromatic Content Unleaded Hydrocarbon Aviation Gasoline[1]

This standard is issued under the fixed designation D7719; 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 specification covers formulating specifications for purchases of a high aromatic content unleaded hydrocarbon aviation gasoline under contract and is intended solely for use by purchasing agencies.[2]

1.2 This specification defines a specific type of high aromatic content unleaded hydrocarbon aviation gasoline (hereafter also referred to as "D7719 fuel") for use as an aviation spark-ignition fuel. It does not include all fuels satisfactory for reciprocating aviation engines. Certain equipment or conditions of use may permit a wider, or require a narrower, range of characteristics than is shown by this specification.

1.3 The D7719 fuel defined by this specification does not exhibit identical performance to those leaded fuels for which the existing aircraft and ground-based fuel handling equipment have been designed to operate on. Therefore, the suitability of this fuel for use on any specific aircraft, aircraft engine, or ground-based fuel handling equipment should be evaluated before use on that equipment.

1.4 Issuance of this specification does not constitute approval to operate certificated aircraft with this fuel. Fuels used in certified engines and aircraft are ultimately approved by the certifying authority subsequent to formal submission of evidence to the authority as part of the certification program for that aircraft and engine model.

1.5 This specification, unless otherwise provided, prescribes the required properties of unleaded fuel at the time and place of delivery.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *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
D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
D323 Test Method for Vapor Pressure of Petroleum Products (Reid Method)
D873 Test Method for Oxidation Stability of Aviation Fuels (Potential Residue Method)
D909 Test Method for Supercharge Rating of Spark-Ignition Aviation Gasoline
D910 Specification for Leaded Aviation Gasolines
D1094 Test Method for Water Reaction of Aviation Fuels
D1266 Test Method for Sulfur in Petroleum Products (Lamp Method)
D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
D2386 Test Method for Freezing Point of Aviation Fuels

[1] This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.J0.02 on Spark and Compression Ignition Aviation Engine Fuels.

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[2] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1721.

[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.

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

D2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
D2624 Test Methods for Electrical Conductivity of Aviation and Distillate Fuels
D2700 Test Method for Motor Octane Number of Spark-Ignition Engine Fuel
D3237 Test Method for Lead in Gasoline by Atomic Absorption Spectroscopy
D3606 Test Method for Determination of Benzene and Toluene in Finished Motor and Aviation Gasoline by Gas Chromatography
D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
D4057 Practice for Manual Sampling of Petroleum and Petroleum Products
D4171 Specification for Fuel System Icing Inhibitors
D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products
D4306 Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination
D4809 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)
D4814 Specification for Automotive Spark-Ignition Engine Fuel
D4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems
D5006 Test Method for Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation Fuels
D5059 Test Methods for Lead in Gasoline by X-Ray Spectroscopy
D5191 Test Method for Vapor Pressure of Petroleum Products (Mini Method)
D5580 Test Method for Determination of Benzene, Toluene, Ethylbenzene, *p/m*-Xylene, *o*-Xylene, C_9 and Heavier Aromatics, and Total Aromatics in Finished Gasoline by Gas Chromatography
D6469 Guide for Microbial Contamination in Fuels and Fuel Systems
D6733 Test Method for Determination of Individual Components in Spark Ignition Engine Fuels by 50-Metre Capillary High Resolution Gas Chromatography
D7826 Guide for Evaluation of New Aviation Gasolines and New Aviation Gasoline Additives
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

3. Terminology

3.1 *Definitions:*

3.1.1 *binary, adj*—characterized by, or consisting of, two components.

3.1.2 *biomass, n*—biological material including any material other than fossil fuels which is or was a living organism or component or product of a living organism.

3.1.3 *non-hydrocarbon, n*—compound or compounds composed of carbon, hydrogen, and other elements such as oxygen, nitrogen, sulfur, and phosphorus.

3.1.4 *unleaded hydrocarbon aviation gasoline, n*—gasoline intended for use in aircraft powered by reciprocating spark-ignition engines, where lead and lead-containing compounds are not intentionally added for the purpose of enhancing octane performance and which excludes non-hydrocarbons, except for additives approved in this specification.

4. General

4.1 This specification, unless otherwise provided, prescribes the required properties of a high aromatic content unleaded hydrocarbon aviation gasoline at the time and place of delivery.

5. Classification

5.1 One grade of high aromatic content unleaded hydrocarbon aviation gasoline is provided, known as UL102.

6. Materials and Manufacture

6.1 D7719 fuel, except as otherwise specified in this specification, shall consist of blends of refined hydrocarbons. The sources for these hydrocarbons include biomass, natural gas, or crude petroleum.

6.1.1 See Appendix X1 for one particular composition that meets the parameters of Table 1.

6.2 *Additives*—These can be added to each grade of D7719 fuel in the amount, and of the composition, specified in the following list of approved materials:

6.2.1 *Dyes*—The total maximum concentration of dye in the fuel is 6.0 mg/L. (See X1.1.1 and X2.2.7.)

6.2.1.1 The only blue dye present in the finished fuel shall be essentially 1,4-dialkylaminoanthraquinone.

6.2.1.2 The only yellow dyes in the finished fuel shall be essentially p-diethylaminoazobenzene (Color Index No. 11021) or 1,3-benzenediol 2,4-bis [(alkylphenyl)azo-].

6.2.1.3 The only red dye present in the finished fuel shall be essentially alkyl derivatives of azobenzene-4-azo-2-naphthol.

6.2.1.4 The only orange dye present in the finished fuel shall be essentially benzene-azo-2-napthol (Color Index No. 12055).

6.2.2 *Other Additives*—These may be added in the amount and of the composition specified in the following list of approved materials. The quantities and types shall be declared by the manufacturer. Additives added after the point of manufacture shall also be declared.

TABLE 1 Detailed Requirements for High Aromatic Content Unleaded Hydrocarbon Aviation Gasoline[A]

Property		Grade UL102	ASTM Test Method[B]
COMBUSTION			
Octane Rating Knock value, Motor Octane Number[C]	min	102.2	D2700
Net heat of combustion, MJ/kg	min	41.5	D4809
COMPOSITION			
Sulfur, mass %	max	0.05	D1266 or D2622
Tetraethyl Lead, g Pb/L	max	0.013	D3237 or D5059
Total Aromatics, % (*m/m*)	min	70	D6733
Benzene, % (*m/m*)	max	0.1	D3606[D] or D5580
Requirements for All Grades			
VOLATILITY			
Vapor pressure, 37.8 °C, kPa	min	38.0	D323 or D5191[E]
	max	49.0	
Density at 15 °C, kg/m^3	min	790	D1298 or D4052
	max	825	
Distillation			D86
Initial boiling point, °C		Report	D86
Fuel Evaporated			D86
10 volume % at °C	max	75	D86
40 volume % at °C	min	75	D86
50 volume % at °C	max	165	D86
90 volume % at °C	max	165	D86
Final boiling point, °C	max	180	D86
Sum of 10 % + 50 % evaporated temperatures, °C	min	135	D86
Recovery, volume %	min	97	D86
Residue, volume %	max	1.5	D86
Loss, volume %	max	1.5	D86
FLUIDITY			
Freezing point, °C	max	–58[F]	D2386
CORROSION			
Copper strip, 2 h at 100 °C	max	No. 1	D130
CONTAMINANTS			
Oxidation stability (5 h aging)[G] Potential gum, mg/100 mL	max	6	D873
Water reaction Volume change, mL	max	±2	D1094
OTHER			
Electrical conductivity, pS/m	max	450[H]	D2624

[A] For compliance of test results against the requirements of Table 1, see 7.2.
[B] The test methods indicated in this table are referred to in Section 11.
[C] Knock ratings shall be reported to the nearest 0.1 octane number.
[D] In case of dispute, Test Method D3606 shall be used as the referee method.
[E] Test Method D5191 shall be the referee vapor pressure method.
[F] If no crystals have appeared on cooling to –58 °C, the freezing point may be reported as less than –58 °C.
[G] If mutually agreed upon between the purchaser and the supplier, a 16 h aging gum requirement may be specified instead of the 5 h aging gum test; in such case the gum content shall not exceed 10 mg/100 mL. In such fuel the permissible antioxidant shall not exceed 24 mg/L.
[H] Applies only when an electrical conductivity additive is used; when a customer specifies fuel containing conductivity additive, the following conductivity limits shall apply under the condition at point of use:
Minimum 50 pS/m
Maximum 450 pS/m.
The supplier shall report the amount of additive added.

6.2.2.1 *Antioxidants*—The following oxidation inhibitors may be added to the fuel separately, or in combination, in total concentration not to exceed 12 mg of inhibitor (not including weight of solvent) per litre of fuel.

(1) 2,6-ditertiary butyl-4-methylphenol.
(2) 2,4-dimethyl-6-tertiary butylphenol.
(3) 2,6-ditertiary butylphenol.
(4) 75 % minimum 2,6-ditertiary butylphenol plus 25 % maximum mixed tertiary and tritertiary butylphenols.
(5) 75 % minimum di- and tri-isopropyl phenols plus 25 % maximum di- and tri-tertiary butylphenols.
(6) 72 % minimum 2,4-dimethyl-6-tertiary butylphenol plus 28 % maximum monomethyl and dimethyl tertiary butylphenols.
(7) N,N'-di-isopropyl-para-phenylenediamine.
(8) N,N'-di-secondary-butyl-para-phenylenediamine.

6.2.2.2 *Fuel System Icing Inhibitor (FSII)*—One of the following materials may be used:

(1) Isopropyl Alcohol (IPA, propan-2-ol), in accordance with the requirements of Specification D4171 (Type II). May be used in concentrations recommended by the aircraft manufacturer when required by the aircraft owner/operator.

(2) Di-Ethylene Glycol Monomethyl Ether (Di-EGME), conforming to the requirements of Specification D4171 (Type III). May be used in concentrations of 0.10 to 0.15 volume % when required by the aircraft owner/operator.

(3) Test Method D5006 can be used to determine the concentration of Di-EGME in aviation fuels.

NOTE 1—Addition of isopropyl alcohol (IPA) may reduce knock ratings below minimum specification values. See X2.2.3.

6.2.2.3 *Electrical Conductivity Additive*—Stadis 450 in concentrations up to 3 mg/L is permitted. When loss of fuel conductivity necessitates retreatment with electrical conductivity additive, further addition is permissible

6.2.2.4 *Corrosion Inhibitor Additive*—The following corrosion inhibitors may be added to the fuel in concentrations not to exceed the maximum allowable concentration (MAC) listed for each additive.

DCI-4A MAC = 24.0 g/m^3
DCI-6A MAC = 15.0 g/m^3
HITEC 580 MAC = 22.5 g/m^3
NALCO 5403 MAC = 22.5 g/m^3
NALCO 5405 MAC = 11.0 g/m^3
UNICOR J MAC = 22.5 g/m^3
SPEC-AID 8Q22 MAC = 24.0 g/m^3
TOLAD 351 MAC = 24.0 g/m^3
TOLAD 4410 MAC = 22.5 g/m^3

7. Detailed Requirements

7.1 The D7719 fuel shall conform to the requirements prescribed in Table 1.

7.2 Test results shall not exceed the maximum or be less than the minimum values specified in Table 1. No allowance shall be made for the precision of the test methods. To determine the conformance to the specification requirement, a test result may be rounded to the same number of significant figures as in Table 1 using Practice E29. Where multiple determinations are made, the average result, rounded according to Practice E29, shall be used.

8. Workmanship, Finish, and Appearance

8.1 The D7719 fuel specified in this specification shall be free from undissolved water, sediment, and suspended matter. No substances of known dangerous toxicity, under usual conditions of handling and use, shall be present except as permitted in this specification.

9. Sampling

9.1 Because of the importance of proper sampling procedures in establishing fuel quality, use the appropriate procedures in Practice D4057 or Practice D4177.

9.1.1 Although automatic sampling following Practice D4177 may be useful in certain situations, initial manufacturer/supplier specification compliance testing shall be performed on a sample taken following procedures in Practice D4057.

9.2 A number of D7719 fuel properties, including copper corrosion, electrical conductivity, and others are very sensitive to trace contamination which can originate from sample containers. For recommended sample containers, refer to Practice D4306.

10. Reports

10.1 The type and number of reports to ensure conformance with the requirements of this specification shall be mutually agreed to by the purchaser and the supplier of the D7719 fuel.

11. Test Methods

11.1 The requirements enumerated in this specification shall be determined in accordance with the following ASTM test methods:[4]

11.1.1 *Knock Value (Motor Octane Number)*—Test Method D2700.

11.1.2 *Tetraethyl Lead*—Test Methods D3237 or D5059.

11.1.3 *Density*—Test Methods D1298 or D4052.

11.1.4 *Distillation*—Test Method D86.

11.1.5 *Freezing Point*—Test Method D2386.

11.1.6 *Vapor Pressure*—Test Methods D323 or D5191.

11.1.7 *Net Heat of Combustion*—Test Method D4809.

11.1.8 *Sulfur*—Test Methods D1266 or D2622.

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1808. Contact ASTM Customer Service at service@astm.org.

11.1.9 *Corrosion (Copper Strip)*—Test Method D130, 2 h test at 100°C in bomb.

11.1.10 *Potential Gum and Visible Lead Precipitate*—Test Method D873 except that wherever the letter X occurs (referring to oxidation time) insert the number 5, designating the number of hours prescribed in this specification.

11.1.11 *Water Reaction*—Test Method D1094.

11.1.12 *Electrical Conductivity*—Test Method D2624.

11.1.13 *Aromatic Content*—Test Method D6733.

11.1.14 *Benzene Content*—Test Methods D3606 or D5580.

12. Keywords

12.1 aviation gasoline; binary; hydrocarbon; unleaded

APPENDIXES

(Nonmandatory Information)

X1. HIGH AROMATIC CONTENT BINARY UNLEADED HYDROCARBON AVIATION GASOLINE COMPOSITION

X1.1 Introduction

X1.1.1 A new high aromatic content unleaded hydrocarbon aviation gasoline has been developed for reciprocating aircraft engines. The two essential performance parameters of MON and VP are inversely related with respect to composition and thus can uniquely define a composition range of the two components. The values for VP and MON in Table 1 reflect the limiting values of the two components. The ~~binary fuel exhibits a higher volumetric energy density (net heat of combustion times density) which is of great performance interest, although not explicitly stated in Table 1. The~~ distillation parameters reflect the binary compositional effects. This is an unleaded fuel, so the limit of TEL in Table 1 is the same as is used in Specification D4814 for mogas and is meant to mitigate unintentional contamination by TEL. Lastly, references to dyes remain in the specification so that test groups may use them as necessary. This specification covers a high-octane unleaded hydrocarbon aviation gasoline developed for existing spark-ignition aircraft engines.

X1.2 Composition

X1.2.1 The origin of the fuel lies in two essential engine performance parameters: Motor Octane Number, and Vapor Pressure. Fig. X1.1 shows the inverse relationship of these two parameters as a function of mesitylene composition.

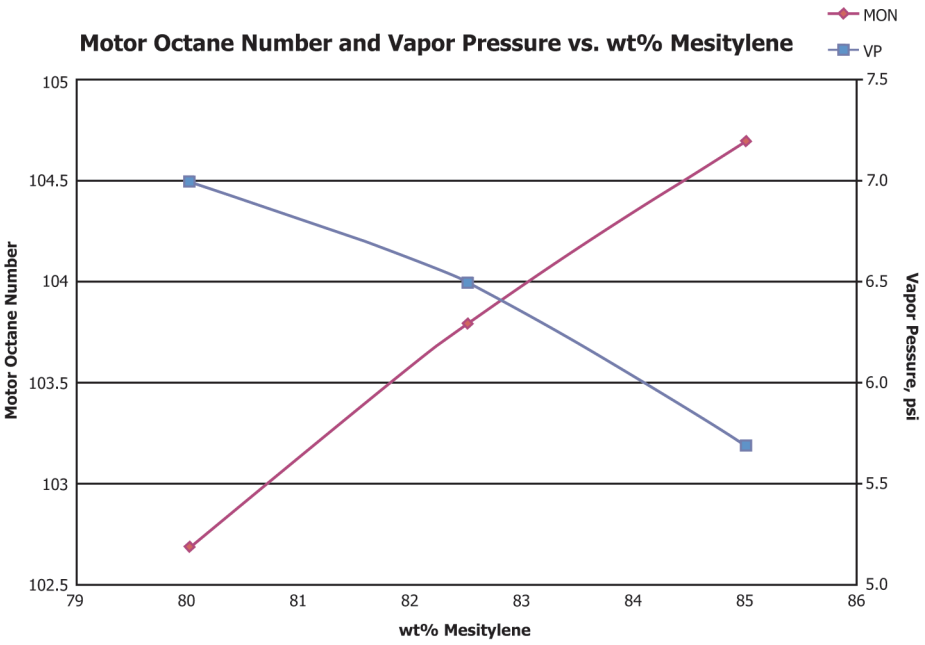

FIG. X1.1 Motor Octane Number and Vapor Pressure versus % Mesitylene

X1.2.2 These two parameters coupled with the fact that the fuel is a binary composition, fix the effective composition range as follows:

(1) High-Octane Composition: 84 % mesitylene 16 % isopentane

(2) High Limit Reid Composition 79 % mesitylene 21 % isopentane

X1.2.3 These limits are proposed to define the binary fuel's specification composition.