

Understanding Fuel Quality Standards

ASTM Methods

ASTM International <http://www.astm.org/>

Fuel Type	ASTM Method
Gasoline + E10	ASTM D4814*
Ethanol (E75-E85)	ASTM D5798
Ethanol (100)	ASTM 4806
Diesel + B5	ASTM D975
B6 – B20	ASTM D7467
B20-B99	Biodiesel basestock must meet D6751, diesel basestock must meet D975.
B100	ASTM D6751

*Each ASTM Method listed by fuel types are really a collection of individual test methods combined to address the chemical properties of each fuel type.

ASTM Methods

Water using Volumetric Karl Fischer Titration E 203 (Vol % 1.0 or 10,000 ppm)

European Methods (EN)

Oxidation Stability	EN 14112
Ester Content	EN 14103
Methanol Content*	EN 14110
* can also determine Ethanol content	
(Potassium, Calcium, Magnesium and Sodium)	EN 14538
Biodiesel Blend Determination	EN 14078
Crosswalk with ASTM D7371 (active method, used for B1-20)	
Water Suspended by Karl Fischer	EN 12937 (Max 500 ppm) For Biodiesels
Crosswalk with ASTM D6304 (active method but no limit)	

ASTM D6751 [B100 Biodiesel]

Property	Test Method	Limits	Units
Calcium & Magnesium, combined	UOP 389	5 ppm max	ppm (µg/g)
Sodium and Potassium, combined	UOP 391	5 ppm max	ppm (µg/g)
Alcohol Control One of the following must be met: 1) Methanol content 2) Flash point	EN 14110 D93	0.2 max 130 min	Mass % °C
Flash point (closed cup)	D93	130.0 °C Min	°C
Water & sediment	D2709	0.050 Max	% vol
Kinematic viscosity, 40°C	D445	1.9 – 6.0	mm ² /s
Sulfated ash	D874	0.020 Max	% mass
Sulfur	D5453	Grade S15 0.0015 max (15) Grade S500 0.05 Max (500)	% mass (ppm)
Copper strip corrosion	D130	No. 3 Max	
Cetane number	D613	47 min	
Cloud Pt	D2500	Report	°C
Carbon Residue	D4530	0.050 max	% mass
Acid number	D664	0.50 max	Mg KOH/g
Cold Soak Filterability	Annex A1	360 seconds max	360 seconds max
Free glycerin	D6584	0.020	% mass
Total glycerin	D6584	0.240	% mass
Phosphorus content	D4951	0.001 max	% mass
Oxidation Stability °C	EN 14112	3 hrs min	3 hrs min
Distillation temperature Atmospheric equivalent temperature 90% recovered	D1160	360 max	°C
WSDA REQUIRED TESTS PER WAC 16-6623-115			
Biodiesel Content	D7371		
Water Suspended by Karl Fischer	EN 12937		

ASTM D975 [Diesel and B5]

Property	Test Method	Grade						
		No. 1D S15	No. 1D S500	No. 1D S5000	No. 2D S15	No. 2D S500	No. 2D S5000	No. 4D
Flash point, °C, min	D93	38°C or 100.4°F	38	38	52°C or 125.6°F	52	52	55
Water & Sediment % vol max	D2709	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Distillation, °C 90%, vol recovered	D86							
Min		288	288	288	282	282	282	
Max					338	338	338	
Kinematic viscosity, mm ² /s @40°C	D445							
Min		1.3	1.3	1.3	1.9			
Max		2.4	2.4	2.4	4.1			
Ash % mass, max	D482	0.01	0.01	0.01	0.01	0.01	0.01	0.10
Sulfur, ppm max EPA limits retailers to 80ppm.	D5453							
Copper strip corrosion rating, max	D130	No. 3	No.3	No. 3	No.3	No.3	No.3	No.3
Cetane Number, Min	D613	40	40	40	40	40	40	30
One of the following must be met:								
1) Cetane index, min	D976-80	40	40		40	40		
2) Aromaticity, % vol, max	D1319	35	35		35	35		
Cloud Pt, °C Max	D2500							
Low Temp Flow Test (LTFT)/ Cold Filter Plugging Pt (CFPP) °C Max	D4539/6371							
Ramsbottom Carbon Residue	D524	0.15	0.15	0.15	0.15	0.35	0.35	0.35
Lubricity, High-Frequency Reciprocating Rig (HFRR) @ 60°C, micron max	D6079	520	520	520	520	520	520	520
Conductivity, pS/m or Conductivity Units (C.U.) min	D2624/D4308	25	25	25	25	25	25	25
WSDA REQUIRED TESTS PER WAC 16-6623-115								
Biodiesel Content	D7371							
Water Suspended by Karl Fischer	EN 12937							

ASTM D7467 [B6-B20 Biodiesel]

Property	Test Method	Grade		
		S15	S500	S5000
Flash point	D93	52 min	52 min	52 min
Viscosity, mm at 40°C	D445	1.9 – 4.1	1.9 – 4.1	1.9 – 4.1
Acid Number, mg, max	D664	0.3	0.3	0.3
Water & sediment	D2709	0.05 max	0.05 max	0.05 max
Sulfur Content				
Mass % max	D5453	15		
Mass % max	D2622		0.05	
Distillation Temp °C, 90% volume	D86	343	343	343
Ramsbottom Carbon Residue on 10% bottoms, mass % max	D524	0.35	0.35	0.35
Cetane Number, min	D613	40	40	40
One of the following must be met:				
1) Cetane Index, min	D 976-80	40	40	40
2) Aromaticity, % volume, max	D1319-03	35	35	35
Cloud Pt	D2500			
Ash Content, mass % max	D482	0.01	0.01	0.01
Copper strip corrosion	D130	No. 3	No. 3	No. 3
Biodiesel Content % V/V	D7371	6. -20.	6. – 20.	6. – 20.
Oxidation Stability	EN14112	6 hrs min	6 hrs min	6 hrs min
Lubricity @ 60° C, max	D6079	520	520	520
WSDA REQUIRED TESTS PER WAC 16-6623-115				
Biodiesel Content	D7371			
Water Suspended by Karl Fischer	EN 12937			

ASTM D4814 [Gasoline with up to 10% Ethanol]

Property	Test Method	
Distillation	ASTM D86	
Copper Strip Corrosion	ASTM D130	3 hrs at 50°C
API Gravity	ASTM D1298	
Oxidation Stability	ASTM D525	
Sulfur	ASTM D5453/2622	80ppm per EPA
Research Octane Number (RON)	ASTM D2699	
Motor Octane Number (MON)	ASTM D2700	
RON + MON/2 to record actual octane		
2008 NIST Handbook 130 using 0.6 tolerance		
Posted 87 Octane, min 86.4		
Posted 89 Octane, min 88.4		
Posted 91 Octane, min 90.4		
MTBE, ETBE, TAME, DIPE, Methanol, Ethanol	ASTM D4815	Ethanol no greater than 10%.
WSDA REQUIRED TESTS PER WAC 16-6623-115		
Water Content	E1064	

ASTM D5798 [Gasoline with up to 85% Ethanol]

Property	Test Method	Class 1	Class 2	Class 3
Ethanol + higher alcohols, min volume %		Class 1 – 79	Class 2 – 74	Class 3 – 70
Hydrocarbons/aliphatic ether, volume %		Class 1 – 17-21	Class 2 – 17-26	Class 3 – 17-30
Vapor pressure, kPa (psi)		Class 1 – 38-59 psi 5.5 – 8.5	Class 2 – 48-65 psi 7.0 – 9.5	Class 3 – 66-83 psi 9.5 – 12.0
Lead, max, mg/L		Class 1 – 2.6	Class 2 – 2.6	Class 3 – 3.9
Phosphorus, max, mg/L		Class 1 – 0.2	Class 2 – 0.3	Class 3 – 0.4
Sulfur, max mg/kg	D2622/D5453	Class 1 – 210	Class 2 – 260	Class 3 - 300
		All Classes		
Methanol, volume % max	D1152	0.5		
Higher alcohols (C ₃ – C ₈) max vol %		2		
Acidity, (as acetic acid CH ₃ COOH) mass % mg/L max	D1613	0.005		
Solvent-washed gum content	D381	5		
pHe	D6423	6.5 to 9.0		
Unwashed gum content, max mg/100mL		20		
Total chlorine as chlorides, max, mg/kg	D7328	2		
Inorganic chloride, max, mg/kg	D512	1		
Copper, max mg/L	D1688	1		
Water Content, max, mass %	E1064	1.0 or 10,000ppm		
Appearance		This produce 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.		
Determination of Ethanol Content	ASTM D5501	Ethanol no greater than 85%.		

Volatility Class Criteria

Class 1 – geographical areas with ambient temperature of greater than 5°C (41°F)

Class 2 – geographical areas with ambient temperature of greater than – 5° C (23°F) but less than + 5°C (41°F)

Class 3 – geographical areas with ambient temperature of greater than or equal to -5°C (23°F)

ASTM D4806 [Denatured Fuel Ethanol for Blending with Gasolines]

This specification covered nominally anhydrous denatured fuel ethanol intended to be blended with unleaded or leaded gasolines at 1 to 10 volume % for use as a spark-ignition automotive engine fuel.

Property	Test Method	
Ethanol volume %	D5501	92.1 Vol %, min
Methanol volume %	D1152	0.5 Vol %, min
Solvent-washed gum content	D381	5.0 Mg/100mL, max
Water Using Volumetric Karl Fischer Titration	E203 or E1064	1.0 or 10,000ppm
Denaturant content, volume %		1.96 Vol %, min 5.0 Vol %, max Note: The only denaturants used for fuel ethanol shall be natural gasoline, gasoline components, or unleaded gasoline at a minimum concentration of two parts by volume per 100 parts by volume of fuel ethanol.
Inorganic Chloride content, mass ppm	D512	40 ppm (mg/L) max
Copper content	D1688	0.1 mg/kg, max
Acidity (as acetic, acid CH ₃ COOH), mass % (mg/L) max	D1613	0.007
pHe	D6423	6.5 to 9.0
Sulfur, mass ppm, max	D2622/D5453	30 ppm max
Sulfate, mass ppm, max	D7319/D7319/ D7328	4 ppm max
Appearance		Visibly free of suspended or precipitated contaminants (clear and bright). This shall be determined at indoor ambient temperature unless otherwise agreed upon between the supplier and the purchaser.
Denaturant Content		Denaturant is added in the specified range to comply with federal regulations. The content is set by volumetric addition during the denaturing process. There is no standardized test procedure to directly determine the denaturant content in fuel ethanol. Current analytical procedures only provide a calculated estimate of the denaturant content, which is not sufficiently accurate for determining compliance.

Fuel Type	ASTM	Flashpoint	Water by Karl Fischer (ppm)	Water & Sediment (% vol)	Biodiesel Blend or Content WSDA Allowance	Octane	Sulfur (ppm)	Acid # (mg)	Phosphorus (ppm)	Metals (Sodium, Potassium, Magnesium & Calcium)	Total Glycerin (% mass)	Carbon (% mass)	API Gravity	Lubricity	Dist 90%	Ethanol (% Vol)	Water in Tank 2008 NIST HB 130
B100	D6751	199.4°F or 93°C min	500ppm	0.050 max	B100 ± 0 vol %		15ppm	0.50 max	0.001 ppm max	5 ppm max	0.240 max	0.50			360		2"
B21-99			500ppm	0.050 max	B6-B95 ± 3 vol % B95-B98 ± 1vol %												2"
B6-B20	D7467	125.6°F or 52°C min	500ppm	0.050 max	B6-B20 ± 3 vol %, B6 not less than B6, and B20 not more than B20.		15ppm	0.30 max				0.35		520 max	343		2"
Diesel + B5	D975	100.4°F or 38°C min	500ppm	0.050 max	B2-B5 ± 1 vol % not less than 2% and not more than B5		15ppm	0.50 max				0.15		520 max	No 1-288 No 2 - 282-338		2"
Gas + E10	D4814	-40°F or -	1,500ppm			87 min is 86.4 89 min is 88.4 91 min is 90.4	80ppm EPA reg									2-10%	1/4"
E85	D5798	-28°F to 55°F or 12.8°C min	10,000ppm				210-300 ppm max		0.2 ppm max							75-85%	1/4"

Notes: ppm = mg 1 vol % = 10,000ppm

API Gravity

American Petroleum Institute (API) Gravity measures the density or relative/specific density of a petroleum product. API Gravity measures how heavy or light a petroleum product is compared to water. Density is important for storage, handling and combustion. API Gravity is a test method not required of any fuel type, performed at 60°F, see ASTM D1298. For example, a value of 10 or greater will float on water, a value of 10 or less will sink in water.

This is helpful when loading fuel with two type of fuel being splash blended, the lowest API gravity value will sit lower in the fuel tank.

Kinematic-Viscosity of chemicals (ethanol, gasoline, diesel) http://www.engineeringtoolbox.com/kinematic-viscosity-d_397.html

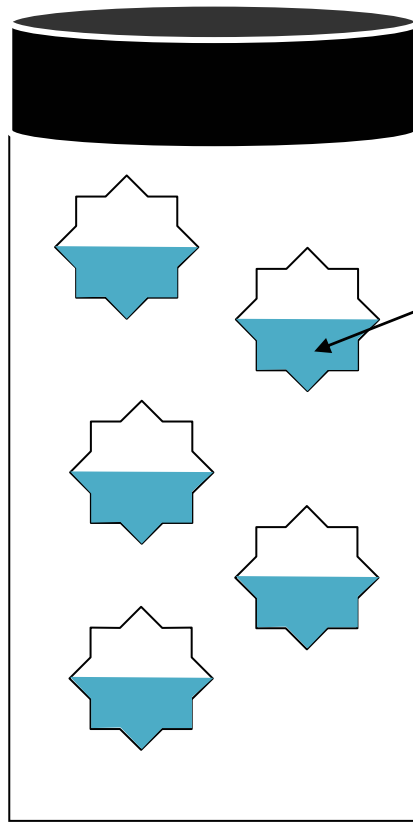
Weight of Fuel

Gasoline: 1 gallon of gasoline weighs approximately 6.213 lb/gal +/- 0.374 lb/gal

Diesel: 1 gallon of diesel weights approximately 7.113 lb/gal +/- 0.202 lb/

Volume & Density

Cooler gas (60°F or less) has a higher density, weighs more, and has more energy than the same quantity of warmer gas (60°F or more).



E10 fuel sample bottle with high amounts of entrained water bound to the fuel. Water content, Water by Karl Fischer and Water Suspended or Entrained all mean the same thing. Once the fuel sample becomes saturated and can hold no more water, the water and sediment or free water is reported by the fuel analysis.

E10 fuel storage tank with a saturated amount of entrained water that the fuel has phase separated and is now also free water. This free water is known as water & sediment and is detected with tank stick and water detecting paste in the fuel storage tank.

