



Designation: ~~D7544-10~~ Designation: D7544 - 12

Standard Specification for Pyrolysis Liquid Biofuel¹

This standard is issued under the fixed designation D7544; 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 a pyrolysis liquid biofuel produced from biomass intended for use in industrial burners equipped to handle these types of fuels. This type of biofuel is not intended for use in residential heaters, small commercial boilers, engines, or marine applications:

1.1 This specification covers grades of pyrolysis liquid biofuel produced from biomass intended for use in various types of fuel-burning equipment under various climatic and operating conditions. These grades are described as follows:

1.1.1 Grade G is intended for use in industrial burners equipped to handle the pyrolysis liquid biofuels meeting the requirements listed for Grade G in Table 1. The pyrolysis liquid biofuel listed under Grade G in Table 1 is not intended for use in residential heaters, small commercial boilers, engines, or marine applications.

1.1.2 Grade D is intended for use in commercial/industrial burners requiring lower solids and ash content and which are equipped to handle the pyrolysis liquid biofuels meeting the requirements listed for Grade D in Table 1. The pyrolysis liquid biofuel listed under Grade D in Table 1 is not intended for use in residential heaters, engines, or marine applications not modified to handle these types of fuels.

NOTE 1—For information on the significance of the physical, chemical, and performance properties identified in this specification, see Appendix X1.

1.2 This specification is for use in contracts for the purchase of pyrolysis liquid biofuel and for guidance of consumers of this type of fuel.

1.3 Nothing in this specification should preclude observance of national or local regulations, which may be more restrictive.

NOTE 2—The generation and dissipation of static electricity may create problems in the handling of pyrolysis liquid biofuel. For more information on the subject, see Guide D4865.

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

1.4.1 *Exception*—BTU units are included for information only in 3.1.4.3.1.5.1.

1.5 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*:²

D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

D97 Test Method for Pour Point of Petroleum Products

D240 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter

D396 Specification for Fuel Oils

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D482 Test Method for Ash from Petroleum Products

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

D4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy Dispersive X-ray Fluorescence Spectrometry

D4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems

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

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

Current edition approved Oct. 1, 2010. Published November 2010. Originally approved in 2009. Last previous edition approved in 2009 as D7544-09. DOI:10.1520/D7544-10.

Current edition approved June 1, 2012. Published September 2012. Originally approved in 2009. Last previous edition approved in 2010 as D7544-10. DOI:10.1520/D7544-12.

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.

TABLE 1 Detailed Requirements for Pyrolysis Liquid Biofuels

| Property | Test Method | Specific Gravity @ 20°C | Units/Grade D |
|--|-------------------|-------------------------|--------------------|
| Gross Heat of Combustion | D240 | 15 min | MJ/kg |
| Gross Heat of Combustion, MJ/kg, min | D240 | 15 | 15 |
| Water Content | E203 | 30 max | mass-% |
| Water Content, % mass, max | E203 | 30 | 30 |
| Pyrolysis Solids Content | D7579 | 2.5 max | mass-% |
| Pyrolysis Solids Content, % mass, max | D7579 | 2.5 | 0.25 |
| Kinematic Viscosity at 40°C | D445 ^A | 125 max | mm ² /s |
| Kinematic Viscosity at 40°C, mm ² /s, max | D445 ^A | 125 | 125 |
| Density at 20°C, kg/dm ³ | | | |
| Density at 20°C, kg/dm ³ | D4052 | 1.1–1.3 | kg/dm ³ |
| Density at 20°C | D4052 | 1.1–1.3 | 1.1–1.3 |
| Sulfur Content | D4294 | 0.05 max | mass-% |
| Sulfur Content, % mass, max | D4294 | 0.05 | 0.05 |
| Ash Content | D482 | 0.25 max | mass-% |
| Ash Content, % mass, max | D482 | 0.25 | 0.15 |
| pH | E70 | Report | — |
| pH | E70 | Report | Report |
| Flash Point | D93, Procedure B | 45 min | °C |
| Flash Point, °C, min | D93, Procedure B | 45 | 45 |
| Pour Point | D97 | –9 max | °C |
| Pour Point, °C, max | D97 | –9 | –9 |

^A Without filtering.

D6469 [Guide for Microbial Contamination in Fuels and Fuel Systems](#)

D7579 [Test Method for Pyrolysis Solids Content in Pyrolysis Liquids by Filtration of Solids in Methanol](#)

E70 [Test Method for pH of Aqueous Solutions With the Glass Electrode](#)

E203 [Test Method for Water Using Volumetric Karl Fischer Titration](#)

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *bulk fuel, n*—fuel in the storage facility in quantities over 190 L.

3.1.2 *char, n*—fine carbonaceous powder that is separated from the vapors of biomass during pyrolysis.

3.1.2.1 *Discussion*—Pyrolysis liquid biofuel contains uniformly suspended char.

3.1.3

3.1.3 *commercial burner, n*—device which produces heat for commercial use through the combustion of liquid fuels.

3.1.3.1 *Discussion*—Commercial burners are typically designed for processes that provide direct heating. Commercial boilers or heaters—small to medium indirect heating units which transfer thermal energy to water or other fluids or gases for use in heating in commercial settings, power generation and in manufacturing processes. These boilers can be classified as small or medium commercial boilers with a heat input of between 10.5 to 105 GJ/h (10 to 100 × 106 BTU/h).

3.1.4 *fuel degradation products, n*—those materials that are formed in fuel during extended storage or exposure to high temperatures.

3.1.4.1

3.1.4.1 *Discussion*—During storage, reactive organic compounds in pyrolysis liquid can act together to form larger molecules (fuel degradation products), which can become insoluble or increase the fuel viscosity, or both.

3.1.4.1.5 *industrial burner, n*—device which produces heat for industrial use through the combustion of liquid fuels.

3.1.4.1

3.1.5.1 *Discussion*—Industrial burners are typically designed for one of two applications: (1) industrial furnaces—integral components of manufacturing processes that provide direct heating; for example, in aggregate, cement, lime, or phosphate kilns; coke ovens; or blast, smelting, melting, refining, or drying ovens and (2) industrial boilers—large indirect heating units which transfer thermal energy to water or other fluids or gases for use in heating in industrial settings, power generation and in manufacturing processes. These boilers can be classified as utility/large industrial boilers with a heat input greater than 105 GJ/h (100 × 106 BTU/h) or small industrial boilers with a heat input of between 10.5 to 105 GJ/h (10 to 100 × 106 BTU/h).

3.1.5

3.1.6 *long-term storage*—storage of fuel for longer than 3 months after it is received by the user.

3.1.6

3.1.7 *medium-term storage*—storage of fuel for up to 3 months after it is received by the user.

3.1.6.1

3.1.7.1 *Discussion*—It is recommended that fuel be consumed within 6 months of receipt.

3.1.7

3.1.8 *pyrolysis, n*—chemical decomposition of organic materials by heating in the absence of oxygen.

3.1.8

3.1.9 *pyrolysis liquid biofuel, n*—liquid product from the pyrolysis of biomass.

3.1.8.†

3.1.9.1 *Discussion*—Pyrolysis liquid biofuel is comprised of a complex mixture of the decomposition products of renewable resources such as ligno-cellulosic biomass including highly oxygenated organic compounds. It is produced from the pyrolysis of biomass, followed by the rapid condensation of its vapors.

3.1.9.3.1.10 *pyrolysis solids, n*—solid particles contained within the pyrolysis liquid biofuel.

3.1.9.†

3.1.10.1 *Discussion*—Pyrolysis solids is comprised of ash and char.

4. General Requirements

4.1 The pyrolysis liquid biofuel specified in this specification shall remain uniform in medium-term storage and not separate by gravity into layers.

NOTE 3—Long-term storage or equipment down time can necessitate circulation of pyrolysis liquid biofuel in-tank to prevent such separation. The buyer and seller should agree on any requirements for long-term storage. If minor separation occurs during medium-term storage, mild agitation or product circulation should reverse such separation.

5. Detailed Requirements

~~5.1 The pyrolysis liquid biofuel specified shall conform to the detailed requirements shown in~~

5.1 The various grades of pyrolysis liquid biofuel shall conform to the detailed requirements shown in Table 1.

5.2 The properties selected for limitation are those that are believed to be of the greatest significance in obtaining acceptable performance of the burner.

6. Sampling

6.1 Review all intended test methods prior to sampling to understand the importance and effects of sampling technique, proper containers, and special handling required for each test method. See Table 2.

6.2 As indicated in 4.1, during medium-term storage, pyrolysis liquid biofuel shall remain uniform and not separate into layers. Note, however, that separation may occur during long-term storage. Therefore, samples should be well mixed when transferring from the primary sampling process or container, or both, to another container or analytical apparatus, or both. Sampling from an active circulation loop or a well mixed or agitated tank is preferred. Refer to Practice D5854 for more guidance on mixing and handling samples.

6.3 *Sample Size*—A minimum of 1 L is recommended.

7. Test Methods

7.1 The requirements enumerated in this specification shall be determined in accordance with the following test methods:

7.1.1 *Gross Heat of Combustion*—Test Method D240.

7.1.2 *Water Content*—Test Method E203.

7.1.3 *Pyrolysis Solids Content*—See Test Method D7579.

7.1.4 *Kinematic Viscosity*—Test Method D445.

7.1.5 *Density*—Test Method D4052.

7.1.6 *Sulfur*—Test Method D4294.

7.1.7 *Ash Content*—Test Method D482.

7.1.8 *pH*—Test Method E70.

7.1.9 *Flash Point*—Test Method D93.

7.1.10 *Pour Point*—Test Method D97.

8. Keywords

8.1 pyrolysis liquid biofuel; bio-oil; pyrolysis oil; pyoil; py-oil; bio-crude-oil; bio-fuel-oil; wood liquids; burner fuel; renewable energy; alternative energy; fuel oils; furnace oils

TABLE 2 Typical Sampling Procedures for Containers

| Type of Container | Procedure |
|---|---------------------------------------|
| Storage tanks that are well-mixed by circulation or agitation | Automatic or Manual Pipeline Sampling |
| Tank cars, tank trucks, or ship tanks | Dipper Sampling or All-Level Sampling |