~~Designation:D1094–00 (Reapproved 2005)~~ Designation: D 1094 – 07

An American National Standard

Standard Test Method for Water Reaction of Aviation Fuels[1]

This standard is issued under the fixed designation D 1094; 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 standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method covers the determination of the presence of water-miscible components in aviation gasoline and turbine fuels, and the effect of these components on volume change and on the fuel-water interface.

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

1.3 *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.* This standard involves the use of hazardous chemicals identified in Section 7. Before using this standard, refer to suppliers' safety labels, Material Safety Data Sheets and other technical literature.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 381 Test Method for Gum Content in Fuels by Jet Evaporation

D 611 Test Methods for Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents

D 1836 Specification for Commercial Hexanes

D 2699 Test Method for Research Octane Number of Spark-Ignition Engine Fuel

D 2700 Test Method for Motor Octane Number of Spark-Ignition Engine Fuel

D 3948 Test Method for Determining Water Separation Characteristics of Aviation Turbine Fuels by Portable Separometer

2.2 ~~*IP Standard:*~~ *Energy Institute Standard:*

IP Standard Test Methods Vol 2, Appendix B, Specification for Petroleum Spirits[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *film*, *n*—thin, translucent layer that does not adhere to the wall of the glass cylinder.

3.1.2 *lace*, *n*—fibers thicker than hairlike shred or of which more than 10 % are interlocking, or both.

3.1.3 *loose lace or slight scum, or both (Table 2, Rating 3)*, *n*—an assessment that the fuel/buffer solution interface is covered with more than 10 % but less than 50 % of lace or scum that does not extend into either of the two layers.

3.1.4 *scum*, *n*—layer thicker than film or that adheres to the wall of the glass cylinder, or both.

3.1.5 *shred*, *n*—hairlike fibers of which less than 10 % are interlocking.

3.1.6 *shred, lace or film at interface (Table 2, Rating 2)*, *n*—an assessment that fuel/buffer solution interface contains more than 50 % clear bubbles or some but less than 10 % shred, lace, film or both.

3.1.7 *tight lace or heavy scum, or both (Table 2, Rating 4)*, *n*—an assessment that the fuel/buffer solution interface is covered with more than 50 % of lace or scum, or both, that extends into either of the two layers or forms an emulsion, or both.

3.1.8 *water reaction interface conditions rating*, *n*—a qualitative assessment of the tendency of a mixture of water and aviation turbine fuel to form interface films or precipitates.

3.1.9 *water reaction separation rating*, *n*— a qualitative assessment of the tendency of insufficiently cleaned glassware to produce emulsions or precipitates, or both, in separated fuel and water layers.

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[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.J0.05 on ~~Aviation Fuels.~~Fuel Cleanliness.

Current edition approved ~~Nov.~~Dec. 1, ~~2005.~~2007. Published ~~November 2005.~~January 2008. Originally approved in 1950. Last previous edition approved in ~~2000~~2005 as ~~D1094–00.~~D 1094–00(2005).

[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.

[3] ~~Available from the Institute of Petroleum, 61 New Cavendish St., London, W1M 8AR.~~

[3] Available from Energy Institute, 61 New Cavendish St., London, WIG 7AR, U.K., http://www.energyinst.org.uk.

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

3.1.10 *water reaction volume change*, *n*—a qualitative indication of the presence in aviation gasoline of water-soluble components.

4. Summary of Test Method

4.1 A sample of the fuel is shaken, using a standardized technique, at room temperature with a phosphate buffer solution in scrupulously cleaned glassware. The cleanliness of the glass cylinder is tested. The change in volume of the aqueous layer and the appearance of the interface are taken as the water reaction of the fuel.

5. Significance and Use

5.1 When applied to aviation gasoline, water reaction volume change using the technique reveals the presence of water–soluble components such as alcohols. When applied to aviation turbine fuels, water reaction interface rating using the technique ~~reveals the presence of relatively large quantities~~is not reliable in revealing the presence of ~~partially soluble contaminants such as surfactants. Contaminants that affect the interface are apt~~ surfactants which disarm filter-separators quickly and allow free water and particulates to ~~disarm filter-separators quickly and allow free water and particulates to pass.~~pass; but can reveal the presence of other types of contaminants. Other tests, such as Test Method D 3948, are capable of detecting surfactants in aviation fuels.

6. Apparatus

6.1 *Graduated Glass Cylinder*, glass-stoppered, 100 mL, with 1-mL graduations. The distance between the 100-mL mark and the top of the shoulder of the cylinder must be within the range from 50 to 60 mm.

7. Reagents

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[4] Other grades may be used, provided it is first ascertained that the reagent is of sufficient purity to permit its use without lessening the accuracy of the determination.

7.2 *Purity of Water*— Unless otherwise indicated, reference to water shall be understood to mean distilled water, or water of equivalent purity.

7.3 *Acetone*—(**Warning**—Flammable. Health hazard.)

7.4 *Glass-Cleaning Solution*—Saturate concentrated sulfuric acid (H_2SO_4, sp gr 1.84) with potassium dichromate ($K_2Cr_2O_7$) or sodium dichromate ($Na_2Cr_2O_7$). (**Warning**—Corrosive. Health hazard. Oxidizing agent.)

7.5 *n-Hexane*—Conforming to Specification D 1836 or *n*-heptane conforming to material used in Test Methods D 611, D 381, D 2699, and D 2700 or petroleum spirit 60/80 conforming to IP Appendix B Specification, or equivalent. (**Warning** —Flammable. Health hazard.)

7.6 *Phosphate Buffer Solution (pH 7)*—Dissolve 1.15 g of potassium monohydrogen phosphate, anhydrous (K_2HPO_4) and 0.47 g of potassium dihydrogen phosphate, anhydrous (KH_2PO_4) in 100 mL of water. Larger volumes of the phosphate buffer solution may be prepared provided the concentration of K_2HPO_4 and KH_2PO_4 in the water solution is equivalent to that described above. As an alternative, the laboratory may use a commercially prepared solution.

8. Preparation of Apparatus

8.1 Clean the graduated cylinder thoroughly before carrying out this test. Only cylinders that are adequately cleaned can be used.

8.1.1 Remove traces of oil from the graduated cylinder and stopper by flushing with hot tap water, brushing if necessary. Alternately, remove all traces of oil from the graduated cylinder and stopper, using either *n*-hexane or *n*-heptane or the IP petroleum solvent 60/80. Rinse with acetone followed by tap water.

8.1.2 Following the washing described in 8.1.1, immerse the cylinder and stopper in either (1) a non-ionic detergent cleaning solution, or (2) glass cleaning solution described in 7.4. The type of non-ionic detergent and conditions for its use need to be established in each laboratory. The criterion for satisfactory cleaning shall be a matching of the quality of that obtained with chromic acid cleaning solution. Non-ionic detergent cleaning avoids the potential hazards and inconveniences related to handling corrosive chromic acid solutions. The latter remains as the reference cleaning practice and as such may function as an alternate to the preferred procedure-cleaning with non-ionic detergent solutions. Following cleaning with non-ionic detergent or glass cleaning solution, rinse with tap water, then distilled water, and finally rinse with phosphate buffer solution and drain.

8.1.3 Inadequately cleaned glassware used in this test can give misleading indications of fuel contaminants. Use only cylinders that are adequately cleaned. Cylinders that drain cleanly are adequately cleaned. Alternatively, a separation rating (see Table 1) of 2 or less is indicative of adequately cleaned glassware.

[4] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.