Designation: D7959 – 19

Standard Test Method for Chloride Content Determination of Aviation Turbine Fuels using Chloride Test Strip[1]

This standard is issued under the fixed designation D7959; 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 test method covers a rapid means of determining chloride content of aviation turbine fuel. This methodology is applicable for chloride concentrations between 0 mg/L to 0.5 mg/L. This methodology will not detect chlorine originating from chlorinated organic compounds (that is, covalent bond).

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D6300 Practice for Determination of Precision and Bias Data for Use in Test Methods for Petroleum Products, Liquid Fuels, and Lubricants

2.2 *ASTM Adjuncts:*

Distillate Fuel Bar Chart[3]

3. Summary of Test Method

3.1 A 3 L sample of aviation turbine fuel is extracted with pH 7 buffer solution by a magnetic stir plate and stir bar. The chloride in the aviation turbine fuel sample transfers to the buffer solution. A portion of the aqueous extract solution is then removed and analyzed with a chloride test strip. Silver ions within the test strip combine with chloride ions in the extract as it is drawn up by capillary action to form a white column of silver chloride. The chloride concentration of the extract, determined by the height of the column, is then related back to the chloride content of the aviation turbine fuel sample.

4. Significance and Use

4.1 Chloride present in aviation turbine fuel can originate from refinery salt drier carryover or possibly from seawater contamination (for example, product transferred by barge). Elevated chloride levels have caused corrosive and abrasive wear of aircraft fuel control systems leading to engine failure.[4]

5. Interferences

5.1 Some pH 7 buffer solution can contain trace levels of chloride compounds and therefore produce a false positive reading on the chloride test strip. Prior to using a new batch of pH 7 buffer solution, a sample should be confirmed to produce no reading on the chloride test strip.

5.2 The test strip[5] will react with halides other than chloride (for example, bromide, iodide). The concentration of chloride in salt used in refinery salt driers (predominantly NaCl and $CaCl_2$) and in seawater, however, is in great excess compared to that of other halides.

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

Current edition approved May 1, 2019. Published June 2019. Originally approved in 2015. Last previous edition approved in 2016 as D7959 – 16. DOI: 10.1520/D7959-19.

[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 ASTM International Headquarters. Order Adjunct No. ADJD417601. Original adjunct produced in 1991.

[4] *Guidelines for Sodium Chloride Contamination Troubleshooting and Decontamination of Airframe and Engine Fuel Systems*, International Air Transport Association, 2nd Ed., February 1998, pg. 1.

[5] The sole source of supply of the apparatus (Chloride QuanTab (trademarked) Test Strips, 30 – 600 mg/L) known to the committee at this time is Hach Company, P.O. Box 389, Loveland, Colorado 80539-0389, http://www.hach.com. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

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

6. Apparatus

6.1 *Magnetic Stir Plate and Stir Bar*—The magnetic stir plate shall be capable of producing the stirring energy described in Section 11.11. A magnetic stir bar in the form of a cross or "starburst" approximately 32 mm by 32 mm has proven to be more stable than the traditional bar shape. The stir bar shall have a chemically inert coating such as polytetrafluoroethylene (PTFE).

6.2 *Distillate Fuel Bar Chart.*[3]

7. Reagents and Materials

7.1 Iso*octane* (2,2,4–trimethylpentane, CAS #540-84-1)—Minimum ACS reagent grade purity.

7.2 *pH 7 Buffer Solution*—Some pH 7 buffer solution can contain trace levels of chloride compounds and therefore produce a false positive reading on the chloride test strip. Prior to using a new batch of pH 7 buffer solution, a sample should be confirmed to produce no reading on the chloride test strip.

NOTE 1—Prior batches of Fisher Scientific pH 7 buffer solution, catalog number SB108, have produced no reading on the chloride test strips.

7.3 *Chloride Test Strips*[5]—The conversion of the dimensionless test strip value to chloride concentration in mg/L found on the test strip container varies slightly from one lot of chloride test strips to the next.

8. Hazards

8.1 If a combination heater and stir plate is to be used, ensure the heater is off.

9. Sampling, Test Specimens, and Test Units

9.1 The sample should be obtained for testing in either a 1 gal or 5 L container.

9.2 Collect a sample of at least 3 L.

10. Preparation of Apparatus

10.1 Unless otherwise stated, all glassware should be cleaned prior to use. No special cleaning or rinsing procedure is required.

11. Procedure

11.1 Vigorously shake the sample container by hand for approximately 15 s before analysis.

11.2 Add 3 L of the aviation turbine fuel test sample to a 4 L beaker by filling and emptying a 1 L graduated cylinder three times.

11.3 Remove the remaining fuel from the sample container.

11.4 Completely drain the sample container (discarding any residual fuel) by means of one of the following methods.

11.4.1 If the sample container has a spout and can be effectively drained (see Fig. 1), drain upside down for 2 min, tilting and shaking occasionally to remove any residual fuel.

11.4.2 If the sample container does not have a spout and cannot be effectively drained, tilt the sample container to the side or to a corner so that any residual fuel collects beneath the sample container opening (see Fig. 2). Wait approximately 2 min. Remove any residual fuel with a clean pipette. Wait an additional approximate 2 min and repeat (the same pipette may be used).

11.5 Add 5 mL pH 7 buffer solution by pipette to the now empty sample container.

11.6 Cap the sample container tightly and hand shake vigorously for approximately 1 min. Try to have the pH 7 buffer solution contact all inside surfaces of the container. The use of a shaker table is not recommended since the buffer solution will not contact all inside surfaces of the container.

11.7 Transfer the contents to the 4 L beaker via one of the following methods.

11.7.1 If the sample container has a spout and can be effectively drained, drain upside down for approximately 30 s, tilting and shaking occasionally to transfer any residual buffer solution.

11.7.2 If the sample container does not have a spout and cannot be effectively drained, tilt the sample container to the side or to a corner so that the buffer solution collects beneath the sample container opening. Tap the side or corner a few times lightly on a benchtop to encourage the buffer solution to collect. Wait approximately 30 s. Transfer the buffer solution with a clean, 20 mL (or larger) pipette. Wait an additional approximate 30 s and repeat to ensure all the buffer solution is delivered to the 4 L beaker. Set the pipette aside for later use; do not clean. Lay the pipette down horizontally with no contact to the tip so that any residual buffer solution is not lost.

11.8 Add 20 mL *iso*octane to the sample container with a new, clean pipette.

11.9 Cap the sample container tightly and hand shake vigorously for approximately 1 min.

11.10 Transfer the *iso*octane rinse to the 4 L beaker by means of one of the following methods.

11.10.1 If the sample container has a spout and can be effectively drained, drain upside down for approximately 30 s, tilting and shaking occasionally to transfer any residual *iso*octane.

11.10.2 If the sample container does not have a spout and cannot be effectively drained, tilt the sample container to the side or to a corner so that the *iso*octane collects beneath the sample container opening. Tap the side or corner a few times lightly on a benchtop to encourage the *iso*octane to collect. Wait approximately 30 s. Remove *iso*octane with the pipette, previously set aside. Wait an additional approximate 30 s and repeat to ensure all *iso*octane is delivered to the 4 L beaker.

NOTE 2—Despite the *iso*octane rinse, there will most likely be buffer solution residue remaining within the pipette.

11.11 Tape a Distillate Fuel Bar Chart to the beaker (see Fig. 3). The chart, which is double-sided, should be taped so that the left and right sides conform to and make contact with the 4 L beaker and so the bottom of the card is flush with the stir plate surface. Add a magnetic stir bar to the 4 L beaker. Ensuring the stir bar is centered in the bottom of the beaker will help minimize any splashing. Stir at a setting at which line 5 of the Distillate Fuel Bar Chart is no longer visible. Figs. 4 and 5 illustrate inadequate and adequate stirring, respectively. Stir for

10 min. After 10 min, remove the 4 L beaker from the stir plate and remove the stir bar.

11.12 Obtain a few millilitres of the extract (lower layer) by means of one of the following methods and place into a suitable container (an 8 dram vial is ideal). Removing some aviation turbine fuel with the extract will not impact test results.

11.12.1 Tilt beaker on its side, let settle for approximately 15 min. Carefully and slowly decant approximately 2.5 L of the aviation turbine fuel. Swirl remaining material and tilt beaker on its side for an additional approximate 2 min. Obtain extract by pipette. See Figs. 6-8.

11.12.2 Let beaker settle for approximately 15 min, carefully and slowly decant approximately 2.5 L of the aviation turbine fuel, swirl the remaining material then transfer to an appropriate sized separatory funnel, let settle an additional 5 min, then drain extract.

11.13 Add a chloride test strip to the extract and wait until yellow, horizontal band at the top of the scale turns dark (see Fig. 9). The test strip reading can change after prolonged exposure to the extract and therefore should be read shortly after horizontal band turns dark.

12. Calculation or Interpretation of Results

12.1 Read the test strip to the nearest 0.1 (the graduations on the test strip are 0.2). Convert the test strip reading to mg/L chloride (to the nearest whole number) for the extract using the scale on the test strip container.

12.1.1 The operator may need to interpolate between scale readings.

12.2 Multiply this value by 0.0017 to determine chloride content in mg/L of the aviation turbine fuel. The factor of 0.0017 converts the chloride concentration in the 5 mL extract back to that of the 3 L test sample as follows:

5 mL extract (1 L/1000 mL) (X mg Cl-/L) / (3 L aviation turbine fuel sample)

13. Report

13.1 Report the following information:

13.1.1 Date of analysis.

13.1.2 Operator.

13.1.3 pH 7 buffer manufacturer, lot number, and use by date.

13.1.4 Chloride test strip lot number and use by date (for example, Use By: 02/2013 Lot A3253).

13.1.5 Chloride test strip result to the nearest 0.1 (for example, 1.9).

13.1.6 Chloride concentration of the extract, mg/L, to the nearest whole number (for example, 50).

13.1.7 Chloride concentration of the aviation turbine fuel sample to two decimal places (for example, 0.08 mg/L).

13.1.8 Reference this test method.

14. Precision and Bias

14.1 *Precision*—The precision of this test method, which was determined by statistical examination of interlaboratory results using Practice D6300, is as follows.

14.2 *Repeatability*—The difference between two independent results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would exceed the following value with an approximate probability of 5 % (one case in 20 in the long run) in the normal and correct operation of the test method:

$$\text{Repeatability} = 0.2478(X + 0.0001)^{0.5432}\text{mg/L} \quad (1)$$

where:

x = the average of the two results.

14.3 *Reproducibility*—The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would exceed the following value with an approximate probability of 5 % (one case in 20 in the long run) in the normal and correct operation of the test method:

$$\text{Reproducibility} = 0.3631(X + 0.0001)^{0.5432}\text{mg/L} \quad (2)$$

where:

x = the average of the two results.

14.4 The final statement of precision of a test method shall be based on acceptable test results from at least six (6) laboratories and at least thirty (30) degrees of freedom for R and r. In this study, nine laboratories submitted triplicate test results for seven different samples.

14.4.1 Following a power transformation of the data, the degrees of freedom for repeatability were 120, and 57 for reproducibility.

14.5 The interlaboratory program data has been preserved for general reference. A research report containing details of the test program, including description of the samples, the raw data, and the calculations described herein has been filed at ASTM Headquarters as RR:D02-1898.[6]

14.6 *Bias*—Since there is no accepted reference material suitable for determining the bias in this test method, bias has not been determined.

15. Keywords

15.1 aviation turbine fuel; chloride; cleanliness; contamination; jet fuel; Jet A; Jet A-1; salt; seawater

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1898. Contact ASTM Customer Service at service@astm.org.

FIG. 1 Draining of Sample Container with a Spout

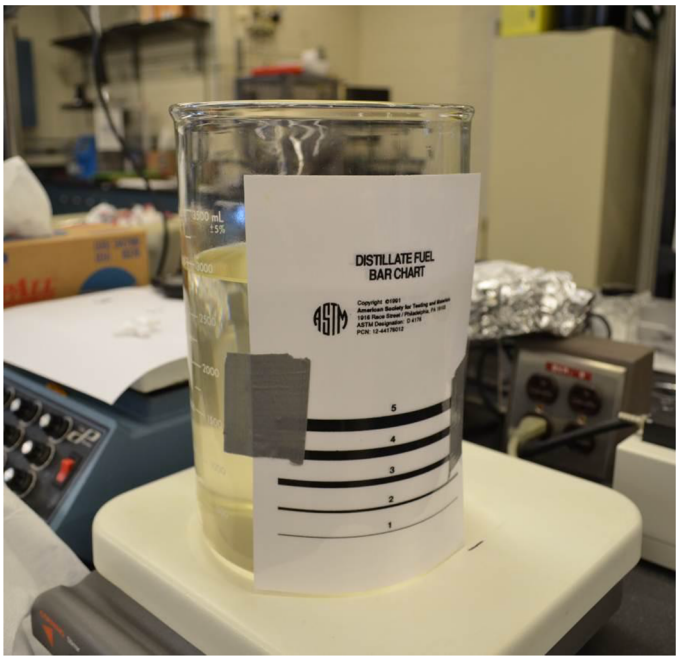

FIG. 3 Taping of Double-Sided Distillate Fuel Bar Chart to 4 L Beaker

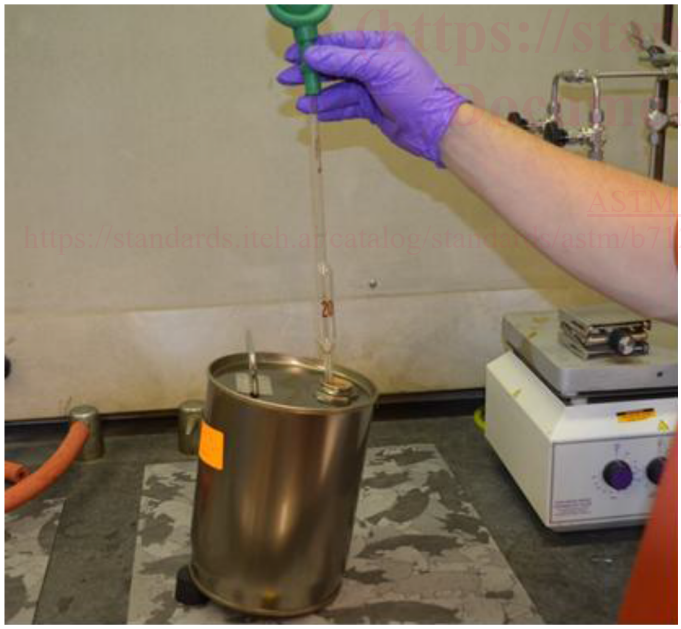

FIG. 2 Draining of Sample Container with No Spout

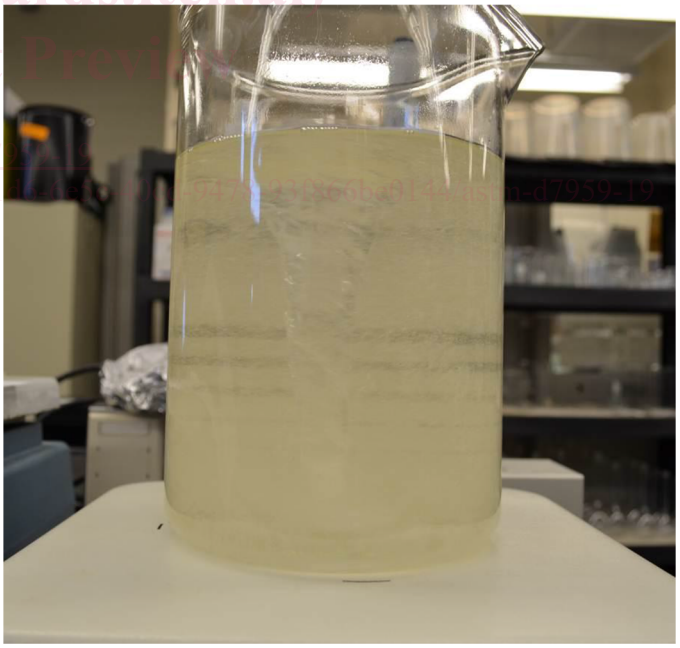

FIG. 4 Inadequate Stir Speed (that is, Bars Still Visible)