Designation: D 4308 – 95

An American National Standard

Standard Test Method for Electrical Conductivity of Liquid Hydrocarbons by Precision Meter[1]

This standard is issued under the fixed designation D 4308; 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 applies to the determination of the "rest" electrical conductivity of aviation fuels and other similar low-conductivity hydrocarbon liquids in the range from 0.1 to 2000 pS/m (see 3.2). This test method can be used in the laboratory or in the field.

1.2 The values stated in SI units are to be regarded as the 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.* For specific hazard statements, see Notes 2-4.

2. Referenced Documents

2.1 *ASTM Standards:*

D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials[2]

D 2624 Test Methods for Electrical Conductivity of Aviation and Distillate Fuels[3]

D 4306 Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination[3]

E 1 Specification for ASTM Thermometers[4]

3. Terminology

3.1 *picosiemens per metre*—the unit of electrical conductivity is also called a conductivity unit (CU). A siemen is the SI definition of reciprocal ohm sometimes called mho.

$$1\ \text{pS/m} = 1 \times 10^{-12}\ \Omega^{-1}\ \text{m}^{-1} = 1\ \text{cu} = 1\ \text{picomho/m} \qquad (1)$$

3.2 *rest conductivity*—the reciprocal of the resistance of uncharged fuel in the absence of ionic depletion or polarization. It is the electrical conductivity at the initial instant of current measurement after a d-c voltage is impressed between electrodes.

4. Summary of Test Method

4.1 A sample of liquid hydrocarbon is introduced into a clean conductivity cell which is connected in series to a battery voltage source and a sensitive dc ammeter. The conductivity, automatically calculated from the observed peak current reading dc voltage and cell constant using Ohm's law, appears as a digital value in either a manual or automatic mode of meter operation.

5. Significance and Use

5.1 The generation and dissipation of electrostatic charge in fuel due to handling depend largely on the ionic species present which may be characterized by the rest or equilibrium electrical conductivity. The time for static charge to dissipate is inversely related to conductivity. This test method can supplement Test Method D 2624 which is limited to fuels containing static dissipator additive.

NOTE 1—For low-conductivity fluids below 1 pS/m in conductivity, an a-c measurement technique is preferable to a d-c test method for sensing the electrical conductivity of bulk fluid. This d-c test method can be used at conductivities from 0.1 to 1 pS/m if precautions are observed in cell cleaning and sample handling. A waiting period of 15 min is required after filling the cell before measuring d-c conductivities below 1 pS/m. A single-laboratory program was conducted comparing this test method with a-c Test Method D 150. The results are on file at ASTM Headquarters. Request RR: D02-1241.

6. Apparatus

6.1 *Conductivity Apparatus*—Components of the dc conductivity apparatus are shown in Fig. 1.[5]

6.1.1 The conductivity cell shown in Fig. 1 consists of an inner electrode and an outer electrode separated by an insulator. The outer electrode and cap provide a ground path and electrostatic (Faraday) shield.

6.1.2 The electrometer shown in Fig. 1 contains a battery which supplies a voltage to the cell and a bridge circuit which senses the flow of current and converts the output signal

[1] This test method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.J on Aviation Fuels.

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[2] *Annual Book of ASTM Standards*, Vol 10.01.

[3] *Annual Book of ASTM Standards*, Vol 05.02.

[4] *Annual Book of ASTM Standards*, Vol 14.03.

[5] The KSLA Cell and Precision Conductivity Meter System, Emcee Model #1154 are available from Emcee Electronics, Inc., 520 Cypress Ave., Venice, FL 34292.

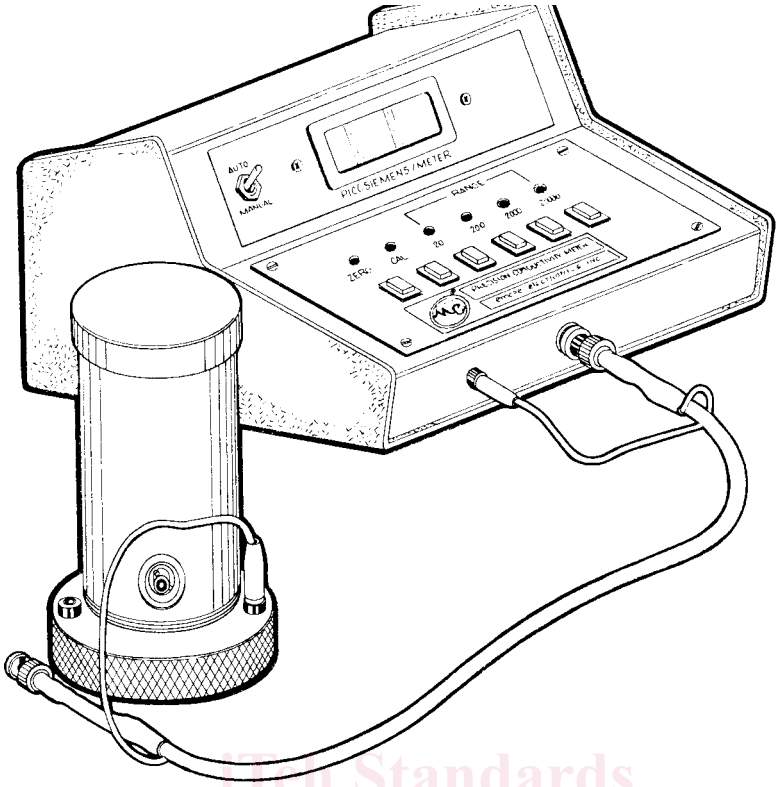

FIG. 1 Precision Conductivity Meter

directly into conductivity units, that is, pS/m. A pushbutton selector allows selection of zero reading, calibration, and four range selections.

6.1.3 The cell and electrometer are connected by a triaxial cable as shown in Fig. 1.

6.2 *Thermometer*, calibrated to 0.5°C and conforming to Specification E 1.

7. Reagents

7.1 *Cleaning Solvent*—The following may be used:

7.1.1 *Toluene-Isopropyl Alcohol Mixture*—(**Warning**—See Note 2) Mix two volumes of toluene and three volumes of isopropyl alcohol both of reagent grade and distill. Discard the first 20 % and last 5 % fractions.

NOTE 2—**Warning:** Flammable. Vapor harmful. See Annex A1.1.

7.2 *n-Heptane*—(**Warning**—See Note 4) Prepare by percolating ASTM reference fuel grade *n*-heptane through silica gel[6] as follows:

NOTE 3—**Warning:** Flammable. Harmful if inhaled. See Annex A1.3.

7.2.1 Activate approximately 2000 g of 100 to 200 mesh silica gel by heating at 180°C for 24 h. Allow it to cool in a desiccator under nitrogen or in vacuum. Soak approximately 0.5 g of glass wool[7] for 24 h in clean *n*-heptane.

7.2.2 Take a tube of borosilicate glass having an inside diameter of 60 to 70 mm, a length 1500 mm, with a conically shaped lower end provided with a glass cock. Place a perforated porcelain disk (diameter 25 mm) in the lower end of the tube and put the soaked glass wool on top of the disk. Fill the tube with the activated silica gel while tapping to achieve homogeneous filling. The silica gel layer will be approximately 1250 mm high. Wrap the column in black paper to exclude light.

7.2.3 Percolate *n*-heptane through the column at a rate of about 2 to 3 L/h. Discard the first 3 L. Never allow the column to run dry. The silica gel charge is sufficient for the percolation of 1000 L of *n*-heptane, provided the conductivity of the untreated *n*-heptane is below 1 pS/m.

NOTE 4—If the conductivity of the *n*-heptane after treatment, measured in accordance with Section 11 in a thoroughly cleaned cell, is higher than 0.1 pS/m, the treatment should be repeated.

7.3 *Hydrocarbon*, for calibration. The dielectric constant must be known to ±5 % at the temperature of calibration.[8]

8. Sampling

8.1 The sample volume should be at least 0.7 L.

8.2 Use a clean epoxy-lined can, or a new glass bottle that has been rinsed successively with hot water, distilled water, acetone, and cleaning solvent then flush with dry nitrogen. Use only non-contaminating caps.

NOTE 5—Test method results are known to be sensitive to trace contamination from sampling containers. For recommended sampling containers refer to Practice D 4306.

[6] A suitable grade is available from W. R. Grace & Co., Davison Chemical Division, Baltimore, MD 21202 by specifying Code 923.

[7] A suitable product is filtering fiber Pyrex Wool. Catalogue No. 3950, supplied by Owens-Corning Fiber Glass Corp.

[8] A standard, such as cyclohexane, with certified dielectric constant, may be obtained from the National Bureau of Standards, Washington, DC 20234.