Designation: D8049 – 21

Standard Test Method for Determining Concentration, Count, and Size Distribution of Solid Particles and Water in Light and Middle Distillate Fuels by Direct Imaging Analyzer[1]

This standard is issued under the fixed designation D8049; 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 uses a direct imaging analyzer to count and measure the size and shape of dispersed solid particles and water droplets in light and middle distillate fuels in the overall range from 4 µm to 100 µm and in size bands of ≥4 µm, ≥6 µm, and ≥14 µm.

NOTE 1—Particle size data from 0.7 µm through 300 µm is available for use or reporting if deemed helpful.

NOTE 2—Shape is used to classify particles, droplets, and bubbles and is not a reporting requirement.

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]

D2276 Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling

D3240 Test Method for Undissolved Water In Aviation Turbine Fuels

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products

D4306 Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination

F658 Practice for Calibration of a Liquid-Borne Particle Counter Using an Optical System Based Upon Light Extinction (Withdrawn 2007)[3]

2.2 *ISO Standard:*[4]

ISO 11171 Hydraulic Fluid Power—Calibration of Automatic Particle Counters for Liquids

ISO 12103-1 Road Vehicles—Test Contaminants for Filter Evaluation—Part 1: Arizona Test Dust

SRM 2806 (ISO Medium Test Dust in Hydraulic Oil): A Particle-contamination Standard Reference Material for the Fluid Power Industry

2.3 *MIL Standard:*[5]

MIL-PRF-5606 Hydraulic Fluid, Petroleum Base; Aircraft, Missile and Ordinance

3. Terminology

3.1 For definitions of terms used in this standard, refer to Terminology D4175.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *air bubble, n*—non-fuel, gaseous formations within the fuel, generally spherical in shape and visible as a heavy wall ring due to the diffraction of light around and through them.

3.2.2 *droplet, n*—non-fuel liquid formations within the fuel, generally spherical in shape and visible as a thin wall ring due to the diffraction of light around and through them.

[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 D02.14 on Stability, Cleanliness and Compatibility of Liquid Fuels.

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[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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] For referenced MIL standards, visit the Defense Logistics Agency, Document Services website at http://quicksearch.dla.mil

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

3.2.3 *major particle diameter µm, n*—the maximum two-dimensional length of the particle measured.

3.2.4 *minor particle diameter µm, n*—the maximum two-dimensional length of the particle measured perpendicular to the *major particle diameter*.

3.2.5 *particle, n*—non-liquid, non-gaseous, solid objects in the fuel.

3.2.6 *projected equivalent particle diameter µm, n*—the diameter calculated from the projected area of a particle if that area formed a circle, and in equation form is:

$$\text{Projected Equivalent Particle Diameter} = \sqrt{(\text{area}/0.785)}$$

4. Summary of Test Method

4.1 The optical measurement cell comprises a light source and an optical sensor. The principle of operation is the illumination and digital capture of actual particle images which are then analyzed for size and shape by the system software. The visual capability of the instrument allows for the differentiation between solid, water, and air particles and thus the detection of water and elimination of air bubbles from the analysis.

4.2 This standard presents a preferred and an alternate method. In the preferred method fuel is delivered by a metering pump and in the alternate method fuel is delivered by gravity.

4.2.1 In the preferred method the test specimen is filled into an ultraclean specimen jar of approximately 100 mL volume. The specimen should fill the jar to the 80 % level. A clean suction tube is inserted into the container and fuel is delivered to the analyzer by the pump.

4.2.2 In the alternate method, the test specimen, approximately 4 L, is agitated in its container. The container is then fitted with a spigot to allow delivery to the analyzer. Fluid flows through the analyzer and is tested for solids and water content. Larger or smaller volume test specimen maybe used as appropriate for the instrument.

4.3 The method requires reporting of particle counts in the ≥4 µm, ≥6 µm, and ≥14 µm categories, however particle counts in the 0.7 µm to <4 µm size range may also be reported as well as additional ranges the user deems important. Particle size is determined per 3.2.6. Water volume content is also reported.

5. Significance and Use

5.1 This test method is intended for use in the laboratory or in the field for evaluating the cleanliness of fuels identified in the scope.

5.2 Detection of particles and water can indicate degradation of the fuel condition. Particles, whether inorganic or organic, can cause fouling of fuel filters and damage pumps, injectors, and pistons. Knowledge of particle size in relation to metallurgy can provide vital information, especially if the hardness of the solid particles are known from other sources.

NOTE 3—The method includes the detection of water, solids, and air bubbles. The air bubbles are screened out of the data prior to analysis of results, based on shape and transparency, and are not reported in the results.

6. Apparatus[6]

6.1 *Preferred Procedure:*

6.1.1 *Direct Imaging Analyzer*—Operating on visual imaging principles comprising a flow cell with camera and optics, a light source, a metering pump, test specimen container, instrument stand and software to analyze the test specimen and display the particle measurement data.

6.1.2 *Test Specimen Container*—A clean fuel container used to supply the metering pump with fuel for testing.

6.1.3 *Metering Pump,* capable of supplying fuel to the analyzer at a rate of 30 mL/min ± 1 mL/min accuracy.

6.1.4 *Collection Container,* equivalent to test specimen container for capturing analyzed specimen.

6.2 *Alternate Procedure:*

6.2.1 *Direct Imaging Analyzer*—Operating on visual imaging principles, comprising a flow cell with camera/optics, light, test specimen container, and stand and software to analyze the test specimen and display the particle measurement data.

6.2.2 *Test Specimen Container*—A clean fuel container for sample storage, transport, and transfer into the instrument. An epoxy-lined container of approximately 5 L in volume has been found to be suitable, along with a nominal 19 mm or larger opening in the top lid for installation of a tube manifold assembly to allow fuel transfer to the instrument and air into the epoxy-lined container for venting.

6.2.3 *Tube Manifold Assembly*—Consists of a stopper or threaded cap, which inserts into the top opening in the test specimen container to seal it, and has through-holes which accept tubing for venting and tubing for flow of fuel to the instrument.

6.2.4 *Flow Restrictor*—The flow of fuel through the instrument is restricted by an orifice located in the outflow line to the collection container.

6.2.5 *Collection Container*—For collecting analyzed fuel specimen for possible retesting. Equivalent to the test specimen container.

7. Reagents and Materials

7.1 *Heptane*—Reagent-grade.

7.2 *Reticle*—NIST traceable with 100 µm grids and 10 µm subdivisions.

7.3 *Particle Size Standard,* monodisperse polymer beads with a nominal diameter between 8 µm and 12 µm, and a coefficient of variation <10 %.

7.4 *Particle Count Verification Standard,* meeting NIST SRM 2806.

7.5 *Partistan Super Clean Fluid.*

[6] The sole source of supply of the apparatus known to the committee at this time is Jet Fuel InFlow available from J.M. Canty Inc, 6100 Donner Rd., Lockport, New York USA 14094. 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.