Designation: D381 – 22

Standard Test Method for Gum Content in Fuels by Jet Evaporation[1]

This standard is issued under the fixed designation D381; 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 U.S. Department of Defense.

1. Scope*

1.1 This test method covers the determination of the existent gum content of aviation fuels, and the gum content of motor gasolines or other volatile distillates in their finished form, (including those containing alcohol and ether type oxygenates and deposit control additives—see Note 7 for additional information) at the time of test.

1.2 Provisions are made for the determination of the heptane insoluble portion of the residue of non-aviation fuels.

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

1.3.1 The accepted SI unit of pressure is the Pascal (Pa); the accepted SI unit for temperature is degrees Celsius.

1.4 **WARNING**—Mercury has been designated by many regulatory agencies as a hazardous substance that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Use caution when handling mercury and mercury-containing products. See the applicable product Safety Data Sheet (SDS) for additional information. The potential exists that selling mercury or mercury-containing products, or both, is prohibited by local or national law. Users must determine legality of sales in their location.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific warning statements, see 6.4, 7.4, and 9.1.

1.6 *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]

D1655 Specification for Aviation Turbine Fuels

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

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

E1 Specification for ASTM Liquid-in-Glass Thermometers

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *Energy Institute Standard:*[3]

IP Standard Methods for Analysis and Testing of Petroleum Products

IP 540 Determination of the existent gum content of aviation turbine fuel – jet evaporation method

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminology D4175.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *existent gum, n*—the evaporation residue of aviation fuels, without any further treatment.

3.2.2 *solvent washed gum content, n*—the residue remaining when the evaporation residue (see 3.2.3) has been washed with heptane and the washings discarded.

3.2.2.1 *Discussion*—For motor gasoline or non-aviation gasoline, solvent washed gum content was previously referred to as existent gum.

3.2.3 *unwashed gum content, n*—the evaporation residue of the product or component under test, without any further treatment.

[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] Available from Energy Institute, 61 New Cavendish St., London, W1G 7AR, U.K., http://www.energyinst.org.

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

TABLE 1 Schedule of Test Conditions

Sample Type	Vaporizing Medium	Operating Temperature	
		Bath	Test Well
Aviation and motor gasoline	air	160 °C to 165 °C	150 °C to 160 °C
Aviation turbine fuel	steam	232 °C to 246 °C	229 °C to 235 °C

4. Summary of Test Method

4.1 When testing either aviation or motor gasoline, a 50 mL ± 0.5 mL quantity of fuel is evaporated under controlled conditions of temperature and flow of air (see Table 1). When testing aviation turbine fuel, a 50 mL ± 0.5 mL quantity of fuel is evaporated under controlled conditions of temperature and flow of steam (see Table 1). For aviation gasoline and aviation turbine fuel, the resulting residue is weighed and reported as milligrams per 100 mL. For motor gasoline, the residue is weighed before and after extracting with heptane and the results reported as milligrams per 100 mL.

NOTE 1—Specification D1655 allows the existent gum of aviation turbine fuels to be determined by either Test Method D381 or IP 540, with Test Method D381 identified as the referee test method. Test Method D381 specifically requires the use of steam as the evaporating medium for aviation turbine fuels, whereas IP 540 allows either air or steam as the evaporating medium for aviation turbine fuels.

5. Significance and Use

5.1 The true significance of this test method for determining gum in motor gasoline is not firmly established. It has been proved that high gum can cause induction-system deposits and sticking of intake valves, and in most instances, it can be assumed that low gum will ensure absence of induction-system difficulties. The user should, however, realize that the test method is not of itself correlative to induction-system deposits. The primary purpose of the test method, as applied to motor gasoline, is the measurement of the oxidation products formed in the sample prior to or during the comparatively mild conditions of the test procedure. Since many motor gasolines are purposely blended with nonvolatile oils or additives, the heptane extraction step is necessary to remove these from the evaporation residue so that the deleterious material, gum, may be determined. With respect to aviation turbine fuels, large quantities of gum are indicative of contamination of fuel by higher boiling oils or particulate matter and generally reflect poor handling practices in distribution downstream of the refinery.

6. Apparatus

6.1 *Balance,* capable of weighing test specimens to the nearest 0.1 mg.

6.2 *Beakers,* of 100 mL capacity, as illustrated in Fig. 1. Arrange the beakers in sets, the number in each set depending upon the number of beaker wells in the evaporating bath. Mark each beaker in the set, including the tare beaker, with an identifying number or letter.

6.3 *Cooling Vessel*—A tightly covered vessel, such as a desiccator without desiccant, for cooling the beakers before weighing.

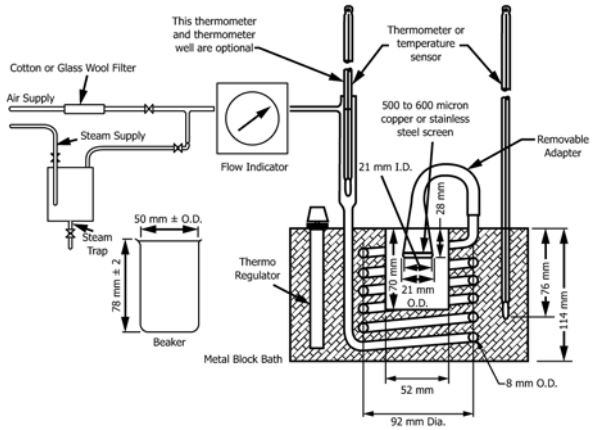

FIG. 1 Apparatus for Determining Gum Content by Jet Evaporation

NOTE 2—The use of a desiccant could lead to erroneous results.

6.4 *Evaporation Bath* (**Warning—**If a liquid-filled evaporation bath is used, care must be taken that the flash point of the liquid used is at least 30 °C higher than the highest bath temperature expected.) Either a solid metal block bath or a liquid bath, electrically heated, and constructed in accordance with the general principles shown in Fig. 1 may be used. (Although all dimensions are given in SI units, older baths conforming to Test Method D381 – 94, or earlier, are suitable.) The bath should have wells and jets for two or more beakers. The rate of flow from each outlet when fitted with the conical adapters with 500 µm to 600 µm copper or stainless steel screens should not differ from 1000 mL⁄s by more than 15 %. A liquid bath, if used, shall be filled to within 25 mm of the top with a suitable liquid. Temperature shall be maintained by means of thermostatic controls or by refluxing liquids of suitable composition.

6.5 *Flow Indicator,* as illustrated in Fig. 1, such as a flowmeter, capable of metering a flow of air or steam equivalent to 1000 mL⁄s for each outlet.

NOTE 3—Alternatively, a pressure gage may be used to meter the flow of air or steam equivalent to 1000 mL⁄s ± 150 mL⁄s for each outlet.

6.6 *Sintered Glass Filtering Funnel,* coarse porosity, 150 mL capacity.

6.7 *Steam*—Supply by suitable means capable of delivering to the bath inlet the required amount of steam at 232 °C to 246 °C.

6.8 *Temperature Sensor,* liquid-in-glass thermometer conforming to the requirements in the specification(s) for ASTM 3C/IP73C, found in Specification E1, or another temperature measuring device or system, or both, of at least equivalent accuracy and precision over a temperature range from –5 °C to 400 °C.

6.9 *Graduated Cylinders,* with spout, capable of measuring 50 mL ± 0.5 mL.

6.10 *Handling Equipment,* forceps (stainless steel, spade ended) or tongs (stainless steel) for use in handling the beakers and conical jets, as required by this test method.