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Standard Specification for Miscibility with Gasoline and Fluidity of Two-Stroke-Cycle Gasoline Engine Lubricants¹

This standard is issued under the fixed designation D4682; 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 specification covers four categories of lubricants intended for use in two-stroke-cycle spark-ignition gasoline engines based on their miscibility with gasoline and their low-temperature fluidity.

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 The following safety hazards caveat pertains only to the test methods described in this specification. *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.*

2. Referenced Documents

2.1 *ASTM Standards*:²

D97 Test Method for Pour Point of Petroleum Products

D439 Specification for Automotive Gasoline (Withdrawn 1990)³

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D874 Test Method for Sulfated Ash from Lubricating Oils and Additives

D2983 Test Method for Low-Temperature Viscosity of Lubricants Measured by Brookfield Viscometer

3. Terminology

3.1 *Definitions of Terms Specific to This Standard*:

¹ This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.B0.06 on Two-Stroke Cycle Gasoline.

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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.

3.1.1 *fluidity*—of two-stroke-cycle gasoline engine lubricants, following industry practice, this term is used to designate the absolute viscosity in millipascal-seconds (centipoises) of the lubricant under test. In general usage, fluidity is the reciprocal of absolute viscosity.

3.1.2 *miscibility*—of two-stroke-cycle gasoline engine lubricants, an inverse function of the time required for a fuel and lubricant introduced into the apparatus as separate phases to produce a single-phase mixture by agitation under controlled conditions.

4. Classification

4.1 The candidate oils are classified into Categories 1 through 4 according to the temperature at which the tests are conducted; respectively, 0°C, –10°C, –25°C, and –40°C. Each category has its own reference oil, which is the same for both the miscibility and fluidity tests.

5. Qualification Requirements

5.1 *Miscibility*—When tested in accordance with Section 6, candidate oils that mix with the gasoline in not more than 110 % of the number of inversions of the apparatus required to mix the reference oil, and that do not separate on standing, qualify as miscible.

5.2 *Fluidity*—When tested in accordance with Section 7, candidate oils meet the requirements for fluidity if their viscosity is not more than 10 % higher than that of the reference oil.

TEST METHODS

6. Miscibility Test Method

6.1 *Summary of Test Method*—The candidate oil and gasoline are placed as separate phases in a stoppered-glass cylinder and mixed by end-over-end rotation of the cylinder under controlled conditions at the temperature appropriate to the category of the oil.

NOTE 1—This procedure specifies that the lubricant be mixed with gasoline. Some fuels in current use are partially or predominately composed of oxygenated compounds such as alcohols, and some lubricants that mix readily with gasoline may not mix with such fuels. A variant procedure can be run to determine the ability of a lubricant to mix

satisfactorily with a fuel consisting partially or wholly of oxygenates. In this case, run the miscibility test using the candidate oil in the oxygenate or oxygenate-containing fuel against the reference oil in gasoline.

6.2 Significance and Use:

6.2.1 The lubricants used in two-stroke-cycle gasoline engines normally reach the surfaces to be lubricated as a mixture with the fuel. This mixture can either be prepared in advance, usually in the engine fuel tank, or can be produced by the metered injection of oil into the fuel stream at some point before its entry into the engine crankcase. In either case, the fuel and lubricant shall be readily miscible, and if the lubricant is metered into the fuel stream, it shall be readily pumpable. As it cannot be known in advance whether a given lubricant will be mixed with the fuel in advance or be injected into the fuel stream by a metering pump, both miscibility and fluidity shall be determined.

6.2.2 The temperature at which the miscibility and fluidity of an oil is determined does not necessarily reflect the expected temperature of use. For example, outboard motor manufacturers normally require the use of oils of Category 3, which are tested at -25°C , even though outboards are rarely used at such temperatures. The reason is that Category 3 oils are readily pumpable and will mix quite rapidly with gasoline at temperatures above about 5°C with little or no agitation. This is an important consideration for boats with outboard motors using a fuel-oil mix that is made up in large built-in tanks which cannot readily be stirred or shaken.

6.3 Apparatus:

6.3.1 *Rotator*—This consists of three or four standard apparatus clamps to carry the cylinders specified in 6.3.2 mounted on a horizontal shaft of about 12- to 14-mm diameter and about 300 mm long mounted between antifriction bearings, driven by an electric motor, and provided with a revolution counter. The shaft is rotated at about 10 to 14 rpm so that the cylinders are continuously being inverted as the shaft rotates. A maximum of three candidate oils can be run against one reference oil. While it would be possible to design apparatus to handle a greater number of samples, four appears to be a practical limit for ease of operation. In Fig. 1 a photograph of a suitable rotator is shown.

6.3.2 *Four (or Fewer) Graduated Cylinders, 500 mL*, capable of remaining securely stoppered in any attitude. The length-to-diameter ratio of the cylinders may be in the range from 10 to 12:1, but all cylinders used in the same test shall be identical within normal commercial glassware tolerance.

6.3.3 *Stoppered Flask* of about 500-mL capacity for each graduated cylinder.

6.3.4 *Freezer* capable of maintaining a temperature controllable within $\pm 1^{\circ}\text{C}$ in the range from 0 to -40°C . The freezer shall be provided with a transparent cover and be capable of accommodating the complete rotator assembly while in operation, together with space for the storage of additional cylinders and flasks. A cover with two panes of glass or plastic separated by an air space of about 10 to 15 mm is advised.

6.4 Reagents and Materials:

6.4.1 *Reference Oils*—A different reference oil is required for each miscibility/fluidity category. These are: for Category

1, ASTM reference oil VI-GG;⁴ for Category 2, ASTM reference oil VI-FF; for Category 3, ASTM reference oil VI-D;⁵ and for Category 4, ASTM reference oil VI-II. See Annex A1 for information on the composition and properties of these oils.

6.4.2 Any full-boiling-range gasoline meeting the general requirements of Specification D439 volatility Classes A, B, or C can be used. When this procedure is run in conjunction with an engine performance test, it is the normal practice to use the gasoline specified for the performance test. Oxygenate blends and other fuels containing nonhydrocarbon blending components shall not be used.

6.5 *Calibration and Standardization*—As a reference oil is tested simultaneously with each set of candidate oils, no other standardization procedure is required.

6.6 Procedure:

6.6.1 Approximately 25 mL of the oil to be tested and 450 mL of gasoline shall be available for each sample to be run, including the reference oil.

6.6.2 Pour 19 to 21 mL each of the reference oil and of the candidate oil(s) into separate 500-mL mixing cylinders and insert their stoppers.

6.6.3 It is preferred, but not mandatory, to purge the cylinders with nitrogen before inserting the stoppers.

6.6.4 Prepare one 395- to 405-mL sample of gasoline in a stoppered flask for each oil sample to be tested, including the reference oil.

6.6.5 Place the cylinders and the gasoline samples with the rotator into a freezer at the required test temperature for a minimum of 16 h. The cylinders may be attached to the rotator or may be stored separately in the freezer at this time.

6.6.6 At the end of the soak period (if this has not already been done), mount the mixing cylinders onto the rotator at about 30° to the vertical, clamping them at about the 350-mL mark.

6.6.7 Remove the stopper and empty one of the gasoline samples into each cylinder in turn, pouring carefully down the side so as to minimize mixing. Replace and secure the stopper of each cylinder as soon as it has been filled.

6.6.8 When all cylinders are charged with gasoline, replace the freezer cover and start the rotator.

6.6.9 Watch the cylinders, and record for each the number of revolutions required for complete mixing of the gasoline and oil (no unmixed oil visible on the bottom with the cylinder upside down). If difficulty is experienced with fogging of the transparent freezer cover, proprietary antifogging compounds are usually effective.

⁴ The sole source of supply of the reference oil known to the committee at this time is Lubrizol Corp., 29400 Lakeland Blvd, Wickliffe, OH 44092. 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.

⁵ The sole source of supply of the reference oil known to the committee at this time is Citgo No. 93734 from Citgo Petroleum Corp., 555 E. Butterfield Rd., Lombard, IL 60148. 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, which you may attend.