



Standard Test Method for Determination of the Ability of Lubricants to Minimize Ring Sticking and Piston Deposits in Two-Stroke-Cycle Gasoline Engines Other Than Outboards¹

This standard is issued under the fixed designation D4857; 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 method² evaluates the performance of lubricants intended for use in two-stroke-cycle spark-ignition gasoline engines that are particularly prone to ring sticking. Piston varnish and spark plug fouling are also evaluated.

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

2. Referenced Documents

2.1 ASTM Standards:³

- B152/B152M** Specification for Copper Sheet, Strip, Plate, and Rolled Bar
- D93** Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- D235** Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
- 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

D2270 Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 and 100°C

D2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry

D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

D4629 Test Method for Trace Nitrogen in Liquid Petroleum Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection

D4858 Test Method for Determination of the Tendency of Lubricants to Promote Preignition in Two-Stroke-Cycle Gasoline Engines

D4859 Specification for Lubricants for Two-Stroke-Cycle Spark-Ignition Gasoline Engines-TC

D4863 Test Method for Determination of Lubricity of Two-Stroke-Cycle Gasoline Engine Lubricants

D4951 Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry

E230 Specification and Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples

G40 Terminology Relating to Wear and Erosion

2.2 ANSI Standard:

ANSI MC 96.1 American National Standard for Temperature Measurement Thermocouples⁴

3. Terminology

3.1 Definitions:

3.1.1 *cold sticking*, *adj—of piston rings*, a condition in which the ring is free in its groove while the engine is running but stuck when the piston is cold, normally indicated by the absence of varnish or other deposits on the outer face of the ring and of signs of blowby on the piston skirt.

3.1.2 *combustion chamber*, *n—in reciprocating internal combustion engines*, the volume bounded by the piston crown

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² Until the next revision of this test method, the ASTM Test Monitoring Center will update changes in this test method by means of Information Letters. These can be obtained from the ASTM Test Monitoring Center, 6555 Penn Ave., Pittsburgh, PA 15206-4489. Attention: Administrator. This edition incorporates revisions in all Information Letters through No. 12-1.

³ 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.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

and any portion of the cylinder walls extending above the piston crown when in the top dead center position, and the inner surface of the cylinder head including any spark plugs and other inserted components. **D4858**

3.1.3 *hot sticking*, *adj—of piston rings*, a condition in which the ring is stuck in its groove while the engine is running, normally indicated by varnish or other deposits on the outer face of the ring, by signs of blowby on the piston skirt, or both.

3.1.4 *lubricity*, *n*—a qualitative term describing the ability of a lubricant to minimize friction between and damage to surfaces in relative motion under load. **D4863**

3.1.5 *preignition*, *n—in a spark-ignition engine*, ignition of the mixture of fuel and air in the combustion chamber before the passage of the spark. **D4858**

3.1.6 *scoring*, *v—in tribology*, a severe form of wear characterized by the formation of extensive grooves and scratches in the direction of sliding. **G40**

3.1.7 *scuff*, *scuffing*, *v—in lubrication*, damage caused by instantaneous localized welding between surfaces in relative motion which does not result in immobilization of the parts. **D4863**

3.1.8 *seizure*, *n—in lubrication*, welding between surfaces in relative motion that results in immobilization of the parts.

3.1.9 *spark plug fouling*, *v*—deposition of essentially non-conducting material onto the electrodes of a spark plug that may, but will not necessarily, prevent the plug from operating.

3.1.10 *spark plug whiskering*, or *spark plug bridging*, *v*—a deposit of conductive material on the spark plug electrodes that tends to form a bridge between them, thus shorting out the plug.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *benchmark reference oil*, *n*—an oil whose performance in this test method is compared with the performance of the non-reference oil.

3.2.2 *major preignition*, *n*—preignition that causes a temperature increase of 10°C or more measured at the spark plug gasket.

3.2.3 *minor preignition*, *n*—preignition that causes a temperature increase of more than 7°C and less than 10°C measured at the spark plug gasket.

4. Summary of Test Method

4.1 The test is run in a 347 cm³ Yamaha RD-350B twin-cylinder air-cooled motorcycle engine.⁵ It is intended primarily to evaluate ring sticking and piston skirt deposits. Spark plug fouling, combustion chamber deposits, and exhaust port blockage are also evaluated. The engine is set up with one cylinder supplied with a fuel and oil mixture made using the non-reference oil and the other with a fuel and oil mixture using the benchmark reference oil. The test is normally run twice,

exchanging the oils between cylinders for the second run. Each run is performed on a 25 min part throttle 5 min idle cycle, with a 60 min shutdown after each 150 min of running time. Total running time per single test is normally 20 h.

5. Significance and Use

5.1 This test method is primarily intended for the evaluation of lubricants for use in two-stroke-cycle engines of high specific output.

NOTE 1—If the test method is being used to satisfy a portion of Specification **D4859**, refer to the specification for the pass-fail criteria.

6. Apparatus

6.1 Test Engine and Stand:

6.1.1 *Test Engine*—A Yamaha RD-350B 347 cm³ twin cylinder motorcycle engine with attached standard transmission (gearbox) is used.⁵ The engine is described more fully in **Annex A1**. It is set up on a dynamometer test stand with a modified fuel system so that each of the cylinders is supplied independently through its associated carburetor. A typical test stand is shown in **Fig. 1**. The dynamometer is located to the left of the engine behind the instrument cabinet, and is driven by the motorcycle transmission output shaft.

6.1.2 *Lubrication System*—The test engine, as manufactured, is provided with an oil injection system by which oil is metered to the carburetor bowls from a common source. Because the test is run using a different fuel and oil mixture in each carburetor, remove the oil pump and its connections and plug the oil connections to the carburetors.

6.1.3 *Dynamometer*—The dynamometer shall be capable of absorbing at least 8 kW. The engine crankshaft speed is 6000 rpm, and the motorcycle transmission can be used to provide speed reduction. No correction is required for the power loss in the transmission.

6.1.4 *Cooling Air*—A variable delivery blower with a free flow capacity of about 300 m³/min of air is required. Direct the flow from the blower toward the exhaust side of the engine so as to deliver an approximately equal stream to each cylinder, and vary the flow as required to maintain the spark plug gasket temperature within the limits specified in Section 9. It is advised that the blower be set up to draw its air from outside the building. Where this is not practicable, or in hot climates, coolers may be required.

6.1.5 *Combustion Air*—The air supply to the engine may be taken from the ambient air in the test cell, but if a controlled air source is used, it is recommended that it be set to (25 to 27) °C with a moisture content of (11 to 12) g/kg of dry air and a maximum pressure at the carburetor inlet of 3.7 kPa. Supply air to each carburetor through a separate flowmeter each having a capacity of 30 kg/h minimum. A plenum chamber is provided at the intake of each carburetor to damp out pulsations. These are shown in **Fig. 1**.

6.1.6 Fuel System:

6.1.6.1 Supply the fuel to each of the carburetors by individual electric fuel pumps, each with a capacity of at least 2.5 L/h, taking the fuel mix from separate tanks through paper or ceramic filters and flowmeters as specified in **Fig. 1**.

⁵ Order from Engineering and Service Dept., Yamaha International Corp., P.O. Box 6555, Cypress, CA 90630. Complete RD-350B engines are no longer available from the manufacturer, but all parts are still available and are expected to remain so. It is suggested that a used RD-350 series motorcycle be purchased for familiarization purposes.

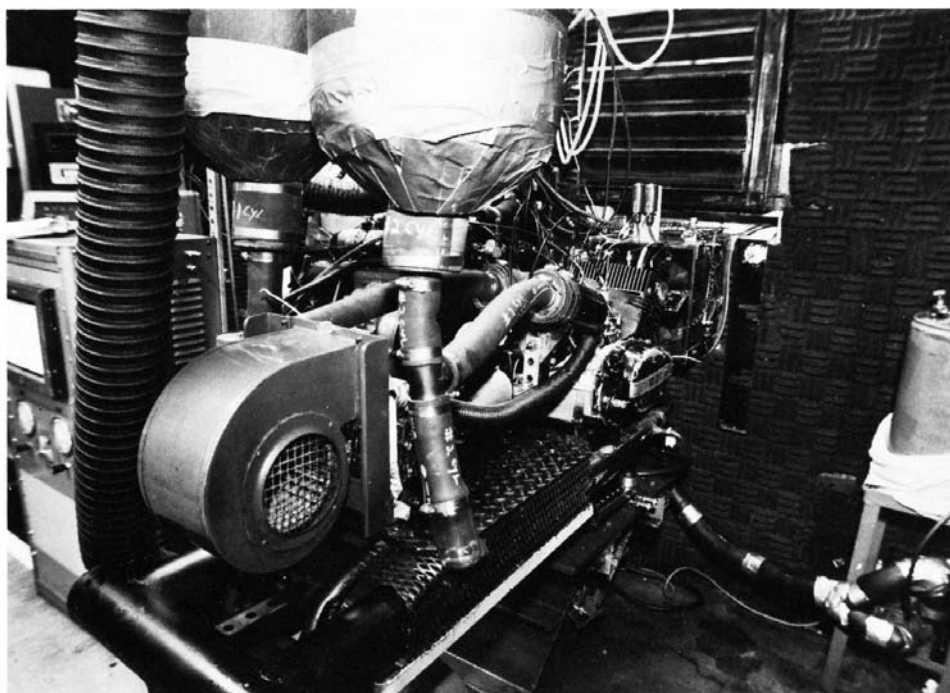


FIG. 1 Test Stand

fuel shall enter the carburetors at a maximum temperature of 25 °C and cooling might be required in a hot climate.

6.1.6.2 Two flowmeters, one for each carburetor, are required. Any type accurate to ± 0.01 kg/h at the flow rate specified in 6.1.6.1 may be used, but those measuring mass directly rather than volume are preferred. If a volume measuring device is used, determine the relationship of density to temperature over the range of fuel temperature experienced for the actual test gasoline and test oil mixtures used, and the appropriate value used for conversion of volume to mass.

6.1.6.3 When permitted by local regulations, portable containers with a capacity of at least 60 L are recommended to facilitate changing of fuels. If the fuel lines to the carburetors cannot be replaced when the fuel and oil mixture is changed, it is necessary to be able to purge the fuel system between the tanks and the carburetors.

6.1.7 *Exhaust System*—Use the standard motorcycle exhaust system, discharging into a pipe of at least 200 mm internal diameter leading out of the test cell. No modification other than axial rotation can be made to the exhaust system as supplied by Yamaha except the installation of thermocouples as specified in 6.2.4. Any rotation of the exhaust system shall be the same for both cylinders and shall not place the exhaust in the cooling air stream.

6.2 Instrumentation:

6.2.1 *Tachometer*—An electronic or vibration tachometer accurate to ± 25 rpm.

6.2.2 *Measurement of Ambient Conditions* —If the air supply to the engine is taken from a controlled source, references to ambient pressure, temperature and humidity apply to the air from the controlled source.

6.2.2.1 *Temperature*—Provide a thermocouple or thermometer to measure air temperature in the range from (10 to 50) °C. The overall accuracy of temperature measurement, including that of recorders, if used, shall be within $\pm 1^\circ\text{C}$.

6.2.2.2 *Barometric Pressure*—A barometer measuring the pressure in the test room is required. Its overall accuracy, including recorder, if used, shall be within ± 0.1 kPa.

6.2.2.3 *Humidity*—A hygrometer accurate to $\pm 3\%$ or a wet and dry bulb thermometer accurate to $\pm 1^\circ\text{C}$ is also required.

6.2.2.4 *Recorder*—Continuous recording of the ambient conditions is recommended.

6.2.3 Spark Plug Gasket Temperature Measurement:

6.2.3.1 *Thermocouples*— The composite gasket normally supplied with the spark plug is not satisfactory for the attachment of thermocouple wires. A design that has been found satisfactory is given in [Appendix X1](#).^{6,7} Make provision for shutdown of the engine in the case of a spark plug gasket temperature increase of 10 °C or more. An automatic shutdown that operates if such an increase occurs is preferred. As a minimum, provide an alarm to operate after a temperature increase of (6 to 7) °C to allow manual shut down by the operator if the 10° limit is exceeded. If the alarm or shutdown is a separate instrument from the temperature recorder, it is usually necessary to provide two thermocouples as shown in [Appendix X1](#), but if it is incorporated into the recorder, only

⁶ The sole source of supply of the thermostat washer known to the committee at this time is Lewis Engineering, 238-T Water St., Naugatuck, CT 06770.

⁷ 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.