Designation: D4858 – 13

Standard Test Method for Determination of the Tendency of Lubricants to Promote Preignition in Two-Stroke-Cycle Gasoline Engines[1]

This standard is issued under the fixed designation D4858; 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[2] evaluates the performance of lubricants intended for use in two-stroke-cycle spark-ignition gasoline engines that are prone to preignition.

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

D439 Specification for Automotive Gasoline (Withdrawn 1990)[4]

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

D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration

D874 Test Method for Sulfated Ash from Lubricating Oils and Additives

D910 Specification for Leaded Aviation Gasolines

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

D2699 Test Method for Research Octane Number of Spark-Ignition Engine Fuel

D2700 Test Method for Motor Octane Number of Spark-Ignition Engine Fuel

D2885 Test Method for Determination of Octane Number of Spark-Ignition Engine Fuels by On-Line Direct Comparison Technique

D2896 Test Method for Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration

D4857 Test Method for Determination of the Ability of Lubricants to Minimize Ring Sticking and Piston Deposits in Two-Stroke-Cycle Gasoline Engines Other Than Outboards

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

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

2.2 *ANSI Standard:*

ANSI MC 96.1 American National Standard for Temperature Measurement Thermocouples[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *combustion chamber—in reciprocating internal combustion engines*, the volume bounded by the piston crown 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.

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

3.1.3 *scuff, scuffing—in lubrication* , damage caused by instantaneous localized welding between surfaces in relative

[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.B0.06 on Two-Stroke Cycle Gasoline.

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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. 01–3.

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

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

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

motion that does not result in immobilization of the parts. D4863

3.1.4 *spark plug fouling*—deposition of essentially nonconducting material onto the electrodes of a spark plug that may, but will not necessarily, prevent the plug from operating. D4857

3.1.5 *spark plug whiskering, also spark plug bridging*—a deposit of conductive material on the spark plug electrodes which tends to form a bridge between them, thus shorting out the plug. D4857

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *major preignition*—preignition that causes a temperature increase of 10°C or more measured at the inner surface of the cylinder head.

3.2.2 *minor preignition*—preignition that causes a temperature increase of more than 7°C and less than 10°C measured at the inner surface of the cylinder head.

4. Summary of Test Method

4.1 The test is run in a 49 cm^3 single-cylinder air-cooled engine operated under the conditions required by the specification against which it is being run. These are typically 4000 rpm wide open throttle (WOT) using a 20:1 ratio of gasoline-to-oil by volume for a minimum of 50 h. The number of incidences of preignition, as indicated by a rapid increase in combustion chamber temperature, is recorded.

NOTE 1—*Pass-Fail Criterion*—The number of occurrences of preignition during the test of a candidate oil shall not exceed that permitted by the specification against which it is run.

5. Significance and Use

5.1 Two-stroke-cycle gasoline engines are generally more prone to preignition than are four-stroke-cycle engines due to the absence of the internal cooling that takes place during the induction stroke of the four-stroke-cycle engines. Preignition can lead to major piston damage, either directly due to localized overheating or as the result of preignition-induced detonation. Some lubricant additives that are widely used in four-stroke-cycle gasoline engine oils are known to increase the probability of preignition in gasoline two-stroke-cycle engines. This procedure is used to determine the tendency of an oil to induce preignition in both water-cooled and air-cooled two-stroke-cycle gasoline engines.

6. Apparatus

6.1 *Test Engine and Stand:*

6.1.1 *Test Engine Configuration*—A Yamaha CE-50 49 cm^3 loop-scavenged air-cooled two-stroke-cycle engine is used.[6] This has 40 mm bore, 39.2 mm stroke, with an aluminum piston operating in a cast iron cylinder bore. The cylinder head is removable, with a hemispherical combustion chamber. For the purposes of this test, modify the head as specified in 6.3.1.1. Further details are given in Annex A1.

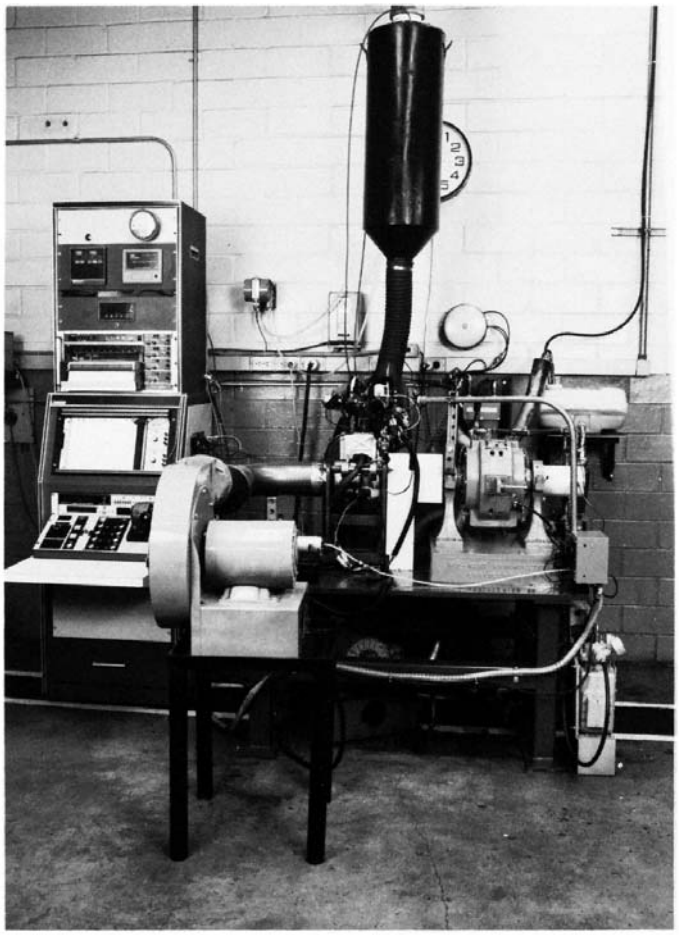

FIG. 1 Test Stand

NOTE 2—The engine designation normally includes a final letter indicating the model, such as CE-50S, the model on which this test was developed. If this model is not available check the suitability for this test of available models with the manufacturer.[6]

6.1.2 *Test Stand*—The dynamometer shall be able to absorb 2.5 kW at (4000 to 6000) rpm with an inherent torque measurement accuracy of ±0.5 % or better, and be capable of maintaining (4000 ± 30) rpm with varying power input. A direct shaft drive or a belt drive from the engine crankshaft may be used. A complete test stand assembly, as shown in Fig. 1, is available.[7]

6.1.3 *Cooling Blower*—Remove the original internal engine fan or have its blades machined off. A variable delivery blower with a free flow capacity of about 34 m^3/min of air is recommended. Direct the flow from the blower toward the intake side of the engine. A suitable arrangement is shown in Fig. 1.

[6] The sole source of supply of the apparatus known to the committee at this time is Engineering and Service Dept., Yamaha Motor Corp., 6555 Katella Ave Cypress, CA 90630. Parts, but not complete engines, may be obtained from Yamaha motorcycle dealers. 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.

[7] Order from Southwest Research Institute, Automotive Products and Emissions Research Division, 6220 Culebra Rd., San Antonio, TX 78238–5166.

6.1.4 *Fuel System*—Maintain fuel delivery pressure at (19 to 21) kPa. The temperature of the fuel entering the carburetor shall not exceed 25 °C, and this might require cooling in hot climates.

6.2 *Instrumentation:*

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

6.2.2 *Measurement of Ambient Conditions*—6.2.2 is written on the assumption that the engine draws ambient air from the test room. If it is supplied with air from a controlled source, references to ambient temperature, pressure and humidity apply to the air from the controlled source.

6.2.2.1 *Temperature*—Provide a thermocouple or thermometer to read air temperature in the range (10 to 50) °C.

6.2.2.2 *Barometric Pressure*—A barometer recording the pressure in the test room is required.

6.2.2.3 *Humidity*—A hygrometer or a wet and dry bulb thermometer is also required.

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

6.2.3 *Calibration*— Calibrate the tachometer, ambient temperature, and pressure measurement devices every 90 days. The calibration standard shall be traceable to NIST.

6.3 *Engine and System Temperatures:*

6.3.1 *Combustion Chamber Temperature:*

6.3.1.1 *Modification of Cylinder Head*—Fit the cylinder head with a shielded thermocouple. A thermocouple of the iron-constantan type meeting the requirements of ANSI 91.6 Type J (summarized very briefly in Specification E230) is recommended, but any thermocouple capable of performing satisfactorily under the conditions of the test can be used.[8] The general dimensions and machining requirements are shown in Fig. 2. The through hole, in which the thermocouple is required to fit closely, is about 3 mm diameter, and the counterbore shall not extend closer than 4 mm to the combustion chamber surface. The dimensions of the counterbore and thread are not critical, being suitable to available thermocouples, but the thread diameter shall be less than 14 mm. A ⅛ 27-NPTF thread is recommended. Make the thermocouple so that the last (3 to 4) mm of its tip is a snug fit into the 3 mm diameter portion of the hole, and be mounted in the head so that its tip protrudes sufficiently to allow it to be ground flush with the internal surface of the head without penetrating the shield. When a head has been newly fitted with a thermocouple, run a break-in in accordance with 10.2 and Table 1. The thermocouple reading normally requires about 90 min to stabilize.

6.3.1.2 *Shutdown Provision*—Make provision for shutdown of the engine in the case of a rapid (1 min or less) combustion chamber temperature increase of 10 °C or more. This normally indicates an incidence of *major preignition*, and is required to minimize the risk of damage to the engine. An automatic shut down when such an increase is experienced is recommended. At the least, 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 °C limit is exceeded.

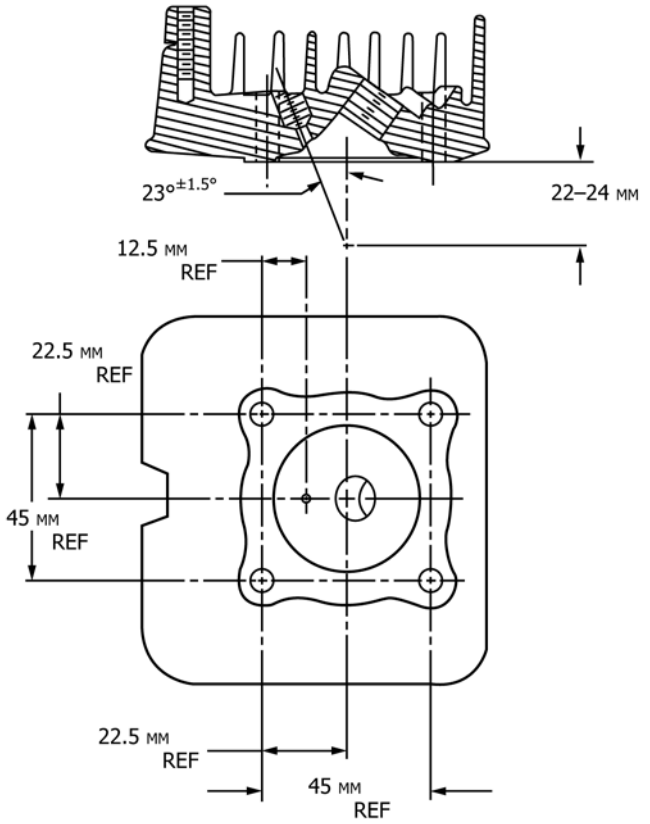

FIG. 2 Machining of Cylinder Head

6.3.2 *Exhaust Temperature*—A thermocouple is required in the exhaust elbow within about 65 mm of the cylinder exhaust port to monitor exhaust temperature.[7] Locate the thermocouple junction within ±3 mm of the center of the pipe.

6.3.3 *Spark Plug Gasket Temperature*— The spark plug gasket may be fitted with one or two thermocouples, the number depending on the instrumentation used. A design that has been found satisfactory is described in Appendix X1.[9]

6.3.4 *Combustion Chamber and Spark Plug Gasket Temperature Recorders*—Record these temperatures using a system capable of storing the data for later retrieval. Maximum interval between successive recordings of the combustion chamber temperature is 2 s. A system with a range from (40 to 750) °C and an overall accuracy of ±2 °C is suitable.

6.3.5 *Calibration*— Calibrate the combustion chamber, exhaust and spark plug gasket temperature measurement devices every 90 days. The calibration standard shall be traceable to NIST.

6.4 *Fuel System:*

6.4.1 *Flow Meter*—Any type accurate to ±0.01 kg/h at about 1 kg/h flow rate can be used. Instruments measuring mass directly are preferred. If a volumetric measurement meter is used, determine the temperature-density relationship over the operating range for the actual fuel-non-reference oil mixture used. Employ that relationship in the volume-mass conversion.

[8] A suitable instrument is available from Omega Engineering Inc., P.O. Box 4047, One Omega Dr., Stanford, CT 06907–0047.

[9] A thermocouple basket that has been found satisfactory may be obtained from The Lewis Engineering Company, 238 Water St., Naugatuck, CT 06770.