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Standard Test Method for Evaluation of Engine Oils in Diesel Four-Stroke Cycle Supercharged 1M-PC Single Cylinder Oil Test Engine[1]

This standard is issued under the fixed designation D6618; 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.

INTRODUCTION

This test method can be used by any properly equipped laboratory, without outside assistance. However, the ASTM Test Monitoring Center (TMC)[2] provides reference oils and an assessment of the test results obtained on those oils by the laboratory. By this means, the laboratory will know whether their use of the test method gives results statistically similar to those obtained by other laboratories. Furthermore, various agencies require that a laboratory utilize the TMC services in seeking qualification of oils against specifications. For example, the U.S. Army imposes such a requirement, in connection with several Army engine lubricating oil specifications.

Accordingly, this test method is written for use by laboratories that utilize the TMC services. Laboratories that choose not to use those services may simply ignore those portions of the test method that refer to the TMC.

This test method may be modified by means of Information Letters issued by the TMC. In addition, the TMC may issue supplementary memoranda related to the test method.

1. Scope

1.1 This test method covers a four-stroke cycle diesel engine test procedure for evaluating engine oils for certain high-temperature performance characteristics, particularly ring sticking, ring and cylinder wear, and accumulation of piston deposits. Such oils include both single viscosity SAE grade and multiviscosity SAE grade oils used in diesel engines. It is commonly known as the 1M-PC test (PC for Pre-Chamber) and is used in several API oil categories, notably the CF and CF-2 and the military category described in MIL-PRF-2104 (see Note 1).

NOTE 1—Companion test methods used to evaluate other engine oil performance characteristics for API oil categories CF and CF-2 are discussed in SAE J304. The companion tests used by the military can be found in MIL-PRF-2104.

1.2 The values stated in SI units are to be regarded as standard. The values in parentheses are provided for information only.

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.*

1.4 This test method is arranged as follows:

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[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.B0.02 on Heavy Duty Engine Oils. The test engine sequences were originally developed in 1956 by ASTM Committee D02. Subsequently, the procedures were published in an ASTM Special Technical Publication.

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[2] ASTM Test Monitoring Center, 6555 Penn Avenue, Pittsburgh, PA 15206-4489. The TMC issues Information Letters that supplement this test method. This edition incorporates revisions contained in all information letters through No. ~~07-1.~~09-1.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D86 Test Method for Distillation of Petroleum Products at Atmospheric Pressure
D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
D97 Test Method for Pour Point of Petroleum Products
D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
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)
D482 Test Method for Ash from Petroleum Products
D524 Test Method for Ramsbottom Carbon Residue of Petroleum Products
D613 Test Method for Cetane Number of Diesel Fuel Oil
D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
D1319 Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption
D1796 Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure)
D2422 Classification of Industrial Fluid Lubricants by Viscosity System
D2425 Test Method for Hydrocarbon Types in Middle Distillates by Mass Spectrometry
D2500 Test Method for Cloud Point of Petroleum Products
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
D4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants
D4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy Dispersive X-ray Fluorescence Spectrometry
D4485 Specification for Performance of Engine Oils
D4863 Test Method for Determination of Lubricity of Two-Stroke-Cycle Gasoline Engine Lubricants
D5302 Test Method for Evaluation of Automotive Engine Oils for Inhibition of Deposit Formation and Wear in a Spark-Ignition Internal Combustion Engine Fueled with Gasoline and Operated Under Low-Temperature, Light-Duty Conditions
D5844 Test Method for Evaluation of Automotive Engine Oils for Inhibition of Rusting (Sequence IID)
D5862 Test Method for Evaluation of Engine Oils in Two-Stroke Cycle Turbo-Supercharged 6V92TA Diesel Engine
D6202 Test Method for Automotive Engine Oils on the Fuel Economy of Passenger Cars and Light-Duty Trucks in the Sequence VIA Spark Ignition Engine

2.2 *SAE Standard:*[4]

SAE J304 Engine Oil Tests

2.3 *Military Standard:*[5]

MIL-PRF-2104 Lubricating Oil, Internal Combustion Engine, Combat/Tactical Service

3. Terminology

3.1 *Definitions:*

3.1.1 *calibrate*, *v*—to determine the indication or output of a measuring device with respect to that of a standard. **D4175**

3.1.2 *candidate oil*, *n*—an oil that is intended to have the performance characteristics necessary to satisfy a specification and is tested against that specification. **D5844**

3.1.3 *clogging*, *n*—the restriction of a flow path due to the accumulation of material along the flow path boundaries. **D5844**

3.1.4 *engine oil*, *n*—a liquid that reduces friction or wear, or both, between the moving parts within an engine; removes heat, particularly from the underside of pistons; and serves as a combustion gas sealant for the piston rings. **D5862**

3.1.4.1 *Discussion*—It may contain additives to enhance certain properties. Inhibition of engine rusting, deposit formation, valve train wear, oil oxidation, and foaming are examples.

3.1.5 *non-reference oil*, *n*—any oil other than a reference oil: such as a research formulation, commercial oil, or candidate oil. **D5844**

3.1.6 *purchaser*, *n—of an ASTM test*, a person or organization that pays for the conduct of an ASTM test method on a specified product. **D6202**

3.1.6.1 *Discussion*—The preferred term is *purchaser*. Deprecated terms that have been used are *client*, *requester*, *sponsor*, and *customer*.

3.1.7 *reference oil*, *n*—an oil of known performance characteristics, used as a basis for comparison **D5844**

[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 Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.
[5] Available from Standardization Documents Order Desk, Building 4, Section D, 700 Robbins Avenue, Philadelphia, PA 19111-5904, Attn: NPODS.

3.1.7.1 *Discussion*—Reference oils are used to calibrate testing facilities, to compare the performance of other oils, or to evaluate other materials (such as seals) that interact with oils.

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

3.1.9 *wear*, *n*—the loss of material from, or relocation of material on, a surface. **D5302**

3.1.9.1 *Discussion*—Wear generally occurs between two surfaces moving relative to each other and is the result of mechanical or chemical action or by a combination of mechanical and chemical actions.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration test*, *n*—an engine test conducted on a reference oil under carefully prescribed conditions whose result is used to determine the suitability of the engine stand/laboratory to conduct such tests on non-reference oils.

3.2.1.1 *Discussion*—In this test method, it can also refer to tests conducted on parts to ensure their suitability for use in reference or non-reference tests.

3.2.2 *test*, *n*—any test time accumulated in accordance with this test method.

4. Summary of Test Method

4.1 Prior to each test run, the power section of the engine (excluding piston assembly) is completely disassembled, solvent-cleaned, measured, and rebuilt in strict accordance with furnished specifications. A new piston, piston ring assembly, and cylinder liner are installed each test. The engine crankcase is solvent-cleaned, and worn or defective parts are replaced. The test stand is equipped with appropriate accessories for controlling speed, fuel rate, and various engine operating conditions. A suitable system for supercharging the engine with humidified and heated air shall also be provided.

4.2 Test operation involves the control of the supercharged, single-cylinder diesel test engine for a total of 120 h at a fixed speed and fuel rate, using the test oil as a lubricant. A 1 h engine break-in precedes each test. At the conclusion of the test, the piston, rings, and cylinder liner are examined. Note the degree of cylinder liner and piston ring wear, the amount and nature of piston deposits present, and whether any rings are stuck.

5. Significance and Use

5.1 The test method is designed to relate to high-speed, supercharged diesel engine operation and, in particular, to the deposit control characteristics and antiwear properties of diesel crankcase lubricating oils.

5.2 The test method is useful for the evaluation of diesel engine oil quality and crankcase oil specification acceptance. This test method, along with others, defines the minimum performance level of the API categories CF and CF-2 (detailed information about passing limits for these categories is included in Specification D4485). It is also used in MIL-PRF-2104.

5.3 The results are significant only when *all details* of the procedure are followed. The basic engine used in this test method has a precombustion chamber (as compared to direct injection) and is most useful in predicting performance of engines similarly equipped. This factor should be considered when extrapolating test results. It has been found useful in predicting results with high sulfur fuels (that is, greater than 0.5 wt %) and with certain preemission controlled engines. It has also been found useful when correlated with deposit control in two-stroke cycle diesel engines.

6. Apparatus

6.1 *Test Engine*—A single-cylinder Caterpillar diesel oil test engine having a 2.2 L (134.1 in.^{3}) displacement is required. Bore and stroke are 13.0 cm (5.125 in.) and 16.5 cm (6.5 in.) respectively. The engine arrangement is shown in Fig. A1.1. The supply of test engines and parts is discussed in 6.22. The engine is equipped with the accessories or equipment listed in 6.2 through 6.24.

6.2 *Air Pressure*—Use a supercharging blower or other device arranged to control air pressure.

6.3 *Air Intake System*—Use the 1Y38 surge chamber and the air heater mechanism (see Annex A1) or its equivalent.

6.4 *Humidity*—Use a system to control humidity to the specified test conditions.

6.5 *Cooling System*—Use a closed, pressurized, circulating cooling system having an engine-driven centrifugal water pump.

6.6 *Speed/Load Controls*—Use a dynamometer or suitable loading device to control engine speed and measure load.

6.7 *Starting*—Use a suitable starting arrangement capable of 420 N·m (310 lbf·ft) breakaway and 373 N·m (275 lbf·ft) sustained torque at approximately 200 r/min.

6.8 *Exhaust System*—Use an exhaust system using piping and an exhaust barrel as specified in Annex A1. A restriction valve down stream of the barrel maintains the exhaust gases at a given back pressure as specified in the test conditions.

6.9 *Data Acquisition*—Configure all stands to acquire data automatically for speed, fuel flow, intake air pressure, intake air temperature, coolant temperature, oil-to-bearing temperature, and oil-to-jet pressure (as a minimum) with closed loop control on speed, intake air temperature, coolant temperature, and oil-to-bearing temperature (as a minimum).

6.10 *Cylinder Head and Cylinder Assemblies*—Only cylinder head and cylinder assemblies that have previously passed a calibration test are acceptable for non-reference testing.

6.11 *Piston Cooling Nozzle*:

6.11.1 *Oil Jet Pressure Measurement* —The following is required to allow for measurement of the piston cooling nozzle pressure:

6.11.1.1 Replace the 3B9407 fitting with a ¼ in. tee fitting, and reconnect the 1Y6 oil line.