



Designation: D6681—08 Designation: D 6681 – 09

Standard Test Method for Evaluation of Engine Oils in a High Speed, Single-Cylinder Diesel Engine—Caterpillar 1P Test Procedure¹

This standard is issued under the fixed designation D 6681; 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

Any properly equipped laboratory without outside assistance can use the test method described in this standard. However, the ASTM Test Monitoring Center (TMC)² provides calibration 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 has such a requirement in some of its engine oil specifications. Accordingly, this test method is written for those laboratories that use the TMC services. Laboratories that choose not to use these services should ignore those portions of the test method that refer to the TMC. Information Letters issued periodically by the TMC may modify this method.³ In addition, the TMC may issue supplementary memoranda related to the test method.

1. Scope

1.1 This test method covers and is required to evaluate the performance of engine oils intended to satisfy certain American Petroleum Institute (API) C service categories (included in Specification D 4485). It is performed in a laboratory using a standardized high-speed, single-cylinder diesel engine.⁴ Piston and ring groove deposit-forming tendency and oil consumption is measured. The piston, the rings, and the liner are also examined for distress and the rings for mobility.

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

1.2.1 *Exceptions*—Where there is no direct SI equivalent such as screw threads, National Pipe Threads/diameters, tubing size, or where there is a sole source supply equipment specification.

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.* Being an engine test method, this standard does have definite hazards that require safe practices (see Appendix X2 on Safety).

1.4 The following is the Table of Contents:

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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.

Current edition approved Oct. April 15, 2008; 2009. Published November 2008; August 2009. Originally approved in 2001. Last previous edition approved in 2005 as D 6681–05 ϵ .

² ASTM Test Monitoring Center (TMC), 6555 Penn Ave., Pittsburgh, PA 15206–4489.

³ This edition incorporates revisions contained in all information letters through 07-1. Users of this test method shall contact the ASTM Test Monitoring Center to obtain the most recent information letters.

⁴ Available from Caterpillar Inc., Engine System Technology Development, P.O. Box 610, Mossville, IL 61552-0610.

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Various Examples for Reference Purposes
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2. Referenced Documents

2.1 ASTM Standards:⁵

D86

D 86 Test Method for Distillation of Petroleum Products at Atmospheric Pressure

D93

D 93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

D97

D 97 Test Method for Pour Point of Petroleum Products

D130

D 130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

D 235 Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)

D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D482

D 482 Test Method for Ash from Petroleum Products

D524

D 524 Test Method for Ramsbottom Carbon Residue of Petroleum Products

D613

D 613 Test Method for Cetane Number of Diesel Fuel Oil

D 664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration

D1319

D 1319 Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption

D2274

D 2274 Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method)

D2425

D 2425 Test Method for Hydrocarbon Types in Middle Distillates by Mass Spectrometry

D2500

D 2500 Test Method for Cloud Point of Petroleum Products

D2622

D 2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry

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D 2709 Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge

D3227

D 3227 Test Method for (Thiol Mercaptan) Sulfur in Gasoline, Kerosine, Aviation Turbine, and Distillate Fuels (Potentiometric Method)

D 3524 Test Method for Diesel Fuel Diluent in Used Diesel Engine Oils by Gas Chromatography

D 4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants

D4052

D 4052 Test Method for Density and Relative Density of Liquids by Digital Density Meter

D 4485 Specification for Performance of Engine Oils

D 4739 Test Method for Base Number Determination by Potentiometric Hydrochloric Acid Titration

D 4863 Test Method for Determination of Lubricity of Two-Stroke-Cycle Gasoline Engine Lubricants

D 5185 Test Method for Determination of Additive Elements, Wear Metals, and Contaminants in Used Lubricating Oils and Determination of Selected Elements in Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

~~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~~

⁵ 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.

- ~~D 5844 Test Method for Evaluation of Automotive Engine Oils for Inhibition of Rusting (Sequence IID)~~
D 5862 Test Method for Evaluation of Engine Oils in Two-Stroke Cycle Turbo-Supercharged 6V92TA Diesel Engine
D 6202 Test Method for Automotive Engine Oils on the Fuel Economy of Passenger Cars and Light-Duty Trucks in the Sequence VIA Spark Ignition Engine
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications ~~E 344 Terminology Relating to Thermometry and Hy-~~
~~drometry~~

G 40 Terminology Relating to Wear and Erosion

2.2 SAE Standard:

SAE J183 Engine Oil Performance and Engine Service Classification⁶

2.3 API Standard:

API 1509 Engine Service Classification and Guide to Crankcase Oil Selection⁷

3. Terminology

3.1 Definitions:

3.1.1 *additive, n*—a material added to another, usually in a small amount, to impart or enhance desirable properties or to suppress undesirable properties. **D 4175**

3.1.2 *automotive, adj*—descriptive of equipment associated with self-propelled machinery, usually vehicles driven by internal combustion engines. **D 4485**

3.1.3 *blind reference oil, n*—a reference oil, the identity of which is unknown by the test facility. — ~~D 5844~~ **D 4175**

3.1.3.1 *Discussion*—This is a coded reference oil which is submitted by a source independent from the test facility.

3.1.4 *blowby, n*—in internal combustion engine, the combustion products and unburned air-and-fuel mixture that enter the crankcase. — ~~D 5302~~ **D 4175**

3.1.5 *calibrate, v*—to determine the indication or output of a measuring device with respect to that of a standard. — ~~E 344~~ **D 4175**

3.1.6 *calibrated test stand, n*—a test stand on which the testing of reference material(s), conducted as specified in the standard, provided acceptable test results. **Sub. B Glossary**²

3.1.6.1 *Discussion*—In several automotive lubricant standard test methods, the ASTM Test Monitoring Center provides testing guidance and determines acceptability.

3.1.7 *candidate oil, n*—an oil which is intended to have the performance characteristics necessary to satisfy a specification and is to be tested against that specification. — ~~D 5844~~ **D 4175**

3.1.7.1 *Discussion*—These oils are mainly submitted for testing as *candidates* to satisfy a specified performance; hence the designation of the term.

3.1.8 *debris, n*—in internal combustion engines, solid contaminant materials unintentionally introduced into the engine or resulting from wear. **D 5862**

3.1.9 *dispersant, n*—in engine oil, an additive that reduces deposits on oil-wetted engine surfaces primarily through suspension of particles. **D 4175**

3.1.10 *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. **D 5862**

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

3.1.11 *heavy-duty, adj*— in internal combustion engine operation, characterized by average speeds, power output, and internal temperatures that are generally close to the potential maximums. **D 4485**

3.1.12 *lubricant, n*—any material interposed between two surfaces that reduces the friction or wear, or both, between them. **D 5862**

3.1.13 *lubricating oil, n*—a liquid lubricant, usually comprising several ingredients, including a major portion of base oil and minor portions of various additives. — **Sub. B Glossary**² **D 4175**²

3.1.14 *oxidation, n*—of engine oil, the reaction of the oil with an electron acceptor, generally oxygen, that can produce deleterious acidic or resinous materials often manifested as sludge formation, varnish formation, viscosity increase, or corrosion, or a combination thereof. — **Sub. B Glossary**² **D 4175**

3.1.15 *non-reference oil, n*—any oil other than a reference oil; such as a research formulation, commercial oil, or candidate oil. — ~~D 5844~~ **D 4175**

3.1.16 *purchaser, n*—of an ASTM test, person or organization that pays for the conduct of an ASTM test method on a specified product. **D 6202**

⁶ Available from the Society of Automotive Engineers Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

⁷ Available from the American Petroleum Institute, 1220 L Street NW, Washington DC, 20005.