Designation: D7484 – 23

Standard Test Method for Evaluation of Automotive Engine Oils for Valve-Train Wear Performance in Cummins ISB Medium-Duty Diesel Engine[1]

This standard is issued under the fixed designation D7484; 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 procedure described in this test method. 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 these means, the laboratory will know whether its 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 these 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.[2] In addition, the TMC may issue supplementary memoranda related to the method.

ASTM International policy is to encourage the development of test procedures based on generic equipment. It is recognized that there are occasions where critical/sole-source equipment has been approved by the technical committee (surveillance panel/task force) and is required by the test procedure. The technical committee that oversees the test procedure is encouraged to clearly identify if the part is considered critical in the test procedure. If a part is deemed to be critical, ASTM encourages alternative suppliers to be given the opportunity for consideration of supplying the critical part/component providing they meet the approval process set forth by the technical committee.

An alternative supplier can start the process by initiating contact with the technical committee (current chairs shown on ASTM TMC website). The supplier should advise on the details of the part that is intended to be supplied. The technical committee will review the request and determine feasibility of an alternative supplier for the requested replacement critical part. In the event that a replacement critical part has been identified and proven equivalent the sole-source supplier footnote shall be removed from the test procedure.

1. Scope*

1.1 This test method, commonly referred to as the Cummins ISB Test, covers the utilization of a modern, 5.9 L, diesel engine equipped with exhaust gas recirculation and is used to evaluate oil performance with regard to valve-train wear.

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*—SI units are provided for all parameters except where there is no direct equivalent such as the units for screw threads, National Pipe Threads/diameters, tubing size, or where there is a sole source of supply equipment specification.

1.2.2 See also A7.1 for clarification; it does not supersede 1.2 and 1.2.1.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

[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 on Automotive Lubricants.

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[2] Until the next revision of this test method, the ASTM Test Monitoring Center will update changes in the test method by means of information letters. Information letters may be obtained from the ASTM Test Monitoring Center, 203 Armstrong Drive, Freeport, PA 16229. Attention Administrator. This edition incorporates revisions in all information letters through No. 22-1. www.astmtmc.org.

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

responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. See Annex A1 for general safety precautions.

1.4 *Table of Contents:*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D86 Test Method for Distillation of Petroleum Products and Liquid Fuels 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

D976 Test Method for Calculated Cetane Index of Distillate Fuels

D1319 Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption

D2274 Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method)

D2500 Test Method for Cloud Point of Petroleum Products and Liquid Fuels

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

D2709 Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge

D3338 Test Method for Estimation of Net Heat of Combustion of Aviation Fuels

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

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

D4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy Dispersive X-ray Fluorescence Spectrometry

D4739 Test Method for Base Number Determination by Potentiometric Hydrochloric Acid Titration

D5185 Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

D5186 Test Method for Determination of the Aromatic Content and Polynuclear Aromatic Content of Diesel Fuels By Supercritical Fluid Chromatography

D5453 Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence

D5967 Test Method for Evaluation of Diesel Engine Oils in T-8 Diesel Engine

D6078 Test Method for Evaluating Lubricity of Diesel Fuels by the Scuffing Load Ball-on-Cylinder Lubricity Evaluator (SLBOCLE) (Withdrawn 2021)[4]

D6838 Test Method for Cummins M11 High Soot Test (Withdrawn 2019)[4]

D6975 Test Method for Cummins M11 EGR Test (Withdrawn 2019)[4]

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E178 Practice for Dealing With Outlying Observations

3. Terminology

3.1 *Definitions:*

3.1.1 *blind reference oil, n*—a reference oil, the identity of which is unknown by the test facility.

3.1.1.1 *Discussion*—This is a coded reference oil that is submitted by a source independent from the test facility. **D4175**

3.1.2 *blowby, n—in internal combustion engines*, that portion of the combustion products and unburned air/fuel mixture that leaks past piston rings into the engine crankcase during operation.

[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.

3.1.3 *calibrate, v*—to determine the indication or output of a device (for example, thermometer, manometer, engine) with respect to that of a standard.

3.1.4 *candidate oil, n*—an oil that is intended to have the performance characteristics necessary to satisfy a specification and is to be tested against that specification. **D4175**

3.1.5 *crosshead, n*—an overhead component, located between the rocker arm and each intake-valve and exhaust-valve pair, that transfers rocker arm travel to the opening and closing of each valve pair.

3.1.5.1 *Discussion*—Each cylinder has two crossheads, one for each pair of intake valves and exhaust valves. **D6838**

3.1.6 *exhaust gas recirculation (EGR), n*—a method by which a portion of engine's exhaust is returned to its combustion chambers via its inlet system. **D6975**

3.1.7 *heavy-duty, adj—in internal combustion engine operation*, characterized by average speeds, power output and internal temperatures that are close to the potential maximums. **D4175**

3.1.8 *non-reference oil, n*—any oil other than a reference oil, such as a research formulation, commercial oil or candidate oil. **D4175**

3.1.9 *non-standard test, n*—a test that is not conducted in conformance with the requirements in the standard test method; such as running in an uncalibrated test stand or using different test equipment, applying different equipment assembly procedures, or using modified operating conditions. **D4175**

3.1.10 *overhead, n—in internal combustion engines*, the components of the valve-train located in or above the cylinder head. **D6838**

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

3.1.11.1 *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. **D4175**

3.1.12 *sludge, n—in internal combustion engines*, a deposit, principally composed of insoluble resins and oxidation products from fuel combustion and the lubricant, that does not drain from engine parts but can be removed by wiping with a cloth. **D4175**

3.1.13 *test oil, n*—any oil subjected to evaluation in an established procedure. **D4175**

3.1.14 *valve-train, n—in internal combustion engines*, the series of components such as valves, crossheads, rocker arms, push rods and camshaft, that open and close the intake and exhaust valves. **D6838**

3.1.15 *wear, n*—the loss of material from a surface, generally occurring between two surfaces in relative motion, and resulting from mechanical or chemical action or a combination of both. **D4175**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *lug, v—in internal combustion engine operation*, to run the engine in a condition characterized by a combined mode of relatively low-speed and high-power output, with the potential to cause hesitation.

3.2.2 *ramp, v*—to change an engine condition at a prescribed rate when changing from one set of operating conditions to another set of operating conditions.

3.2.2.1 *Discussion*—When ramping the engine speed down to a condition such that the engine lugs, the speed is forced down by increasing the torque in a such a way that the speed comes to idle before zero torque condition is reached.

3.2.3 *tappet, n—in internal combustion engines*, a valve-train component, located between the camshaft and push rod, that transfers cam lobe travel to the rocker arm, opening and closing a pair of intake or exhaust valves.

4. Summary of Test Method

4.1 This test method uses a Cummins ISB diesel engine with 5.9 L displacement, equipped with exhaust gas recirculation and featuring an EPA 2004 emissions configuration. Test operation includes a 17 min warm-up, an 80 h break-in, and a 350 h test cycle comprising stages A and B. During stage A the engine is operated with retarded, fuel-injection timing to generate excess soot; during stage B the engine is operated at cyclic conditions to induce valve-train wear.

4.2 Prior to each test, the engine is cleaned and assembled with new, valve-train components. All aspects of the assembly are specified.

4.3 A forced oil drain, an oil sampling, and an oil addition are performed at the end of each 25 h period for the first 100 h of the test. Thereafter, oil samples are taken every 50 h. Oil additions are not made during the last 250 h of the test cycle.

4.4 The test stand is equipped with the appropriate instrumentation to control engine speed, fuel flow and other operating parameters.

4.5 Oil performance is determined by assessing crosshead wear, tappet weight loss and camshaft wear.

5. Significance and Use

5.1 This test method was developed to assess the performance of a heavy-duty engine oil in controlling engine wear under operating conditions selected to accelerate soot production and valve-train wear in a turbocharged and aftercooled four-cycle diesel engine with sliding tappet followers equipped with exhaust gas recirculation hardware.

5.2 The design of the engine used in this test method is representative of many, but not all, modern diesel engines. This factor, along with the accelerated operating conditions, shall be considered when extrapolating test results.

6. Apparatus

6.1 *Test-Engine Configuration:*

6.1.1 *Test Engine*—The Cummins ISB is an in-line, six-cylinder, diesel engine with a displacement of 5.9 L. It is turbocharged, aftercooled, and has an overhead valve configuration. It features a 2004 emissions configuration with electronic control of fuel metering and common rail fuel injection. Obtain the test engine and the engine build parts kit from the