



Designation: D5620 – 94 (Reapproved 2004)

Standard Test Method for Evaluating Thin Film Fluid Lubricants in a Drain and Dry Mode Using a Pin and Vee Block Test Machine¹

This standard is issued under the fixed designation D5620; 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.

1. Scope

1.1 This test method covers the determination of the endurance (wear) life and load carrying capacity of thin film fluid lubricants that are intended to operate after a single application and after excess material has drained from the contact area of sliding metal to metal surfaces, and which operates in what functionally is a drain and dry mode with no additional lubricant being applied.

1.2 The values stated in SI units are to be regarded as the standard except where equipment is supplied using inch-pound units which would then be regarded as the standard. The values in parenthesis are given 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.*

2. Referenced Documents

2.1 ASTM Standards:²

B16/B16M Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines

D2625 Test Method for Endurance (Wear) Life and Load-Carrying Capacity of Solid Film Lubricants (Falex Pin and Vee Method)

F22 Test Method for Hydrophobic Surface Films by the Water-Break Test

2.2 U.S. Military Specifications:³

Mil-P-16232 Phosphate Coatings, Heavy, Manganese or Zinc Base (for ferrous metals)

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.L0 on Industrial Lubricants.

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² 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.

³ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

TT-C-490 Cleaning Methods for Ferrous Surfaces and Pre-treatment for Organic Coatings

3. Terminology

3.1 Definitions:

3.1.1 *drain and dry mode, n*—the effect from being sprayed, dipped, or brushed with a fluid lubricant and the excess material draining from the surface leaving behind a thin film that remains wet and must act as a lubricant on its own, without benefit of recirculation or continuous supply.

3.1.2 *Newtonian flow, n*—a Newtonian liquid is one that flows immediately on application of even the smallest force, and for which the rate of flow is directly proportional to the force applied.

3.1.3 *non-Newtonian flow, n*—a non-Newtonian liquid is one whose viscosity depends on the rate of shear. Some will not flow until the force applied is greater than a definite value called the yield point.

3.1.4 *thin film fluid lubricant, n*—fluid lubricants consisting of a primary liquid with or without additives of lubricating powders and without binders or adhesives, which form a film on one or both surfaces to be lubricated and perform their function after application and after excess material has drained from the application area, and without additional material being supplied by either a continuous or intermittent method.

3.1.5 *wear, n*—damage to a solid surface, generally involving progressive loss of material, due to the relative motion between that surface and a contacting substance or substances.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *direct load, n*—the load that is applied linearly, bisecting the angle of the vee block corrected to either the 800-lbf (3550-N) gage reference or the 3000-lbf (13 300-N) gage reference.

3.2.1.1 *Discussion*—This load is equivalent to the true load times the $\cos 42^\circ$.

3.2.2 *endurance (wear) life*—the length of the test time before failure under a constant loaded condition, in minutes, in which the applied test lubricant performs its function.

3.2.3 *gage load, n*—the value obtained from the gage while running the test after being corrected to the standard curve using the calibration procedure for the 4500-lbf (20 000-N) reference gage.

3.2.4 *load carrying capacity*—the highest indicated load sustained for a minimum of 1 min.

4. Summary of Test Method

4.1 Prior to both tests, the thin film lubricant test fluid is deposited on the pin and vee blocks and allowed to drain for a minimum of 1 min and not to exceed 4 min unless deemed necessary by the user, such as under conditions where component evaporation is a consideration for the final data base desired.

4.2 The endurance (wear) life test (Procedure A) consists of running two stationary steel vee blocks loaded to a predetermined value against a steel pin rotating at 290 rev/min $\pm$ 10 rev/min. The endurance (wear) life is determined from the test duration in minutes until the steady state torque is interrupted by a sharp increase in torque of an additional 10 in-lbf (1.13 N·m), breakage of the shear pin is experienced, or failure to maintain the load. Typically during the test, a rise in temperature of the test apparatus from friction occurs which may generate a gradual increase in the steady state torque which is not to be considered a failure.

4.3 The load carrying capacity test (Procedure B) consists of running two stationary steel vee block specimens against a steel pin rotating at 290 rev/min $\pm$ 10 rev/min, and increasing the load on the pin after a 3 min break-in period with 1 min intervals at each individual load above the break-in load, until a sharp increase in torque of an additional 10 in-lbf (1.13 N·m) over the operating torque, breakage of the shear pin is experienced, or failure to maintain the load.

4.4 All tests should be conducted under conditions where a starting temperature of 20°C $\pm$ 2° exists for the test apparatus, test specimens, and atmosphere. Any deviation from this can severely affect the data.

4.5 Analysis of the condition of the test specimens can provide valuable data. Color, condition of the test pin, and the condition and size of the wear scar on the vee block are all part of the performance values.

5. Significance and Use

5.1 This test method is intended primarily to differentiate between liquid thin film lubricants which exhibit the properties of Newtonian flow with respect to their endurance (wear) life and load carrying capacity when they are used in a manner similar to the bonded dry solid film lubricants. (See Test Method [D2625](#) for definition of dry solid film lubricants.) The test conditions for thin film lubricants are very critical and must be maintained to ensure reliability of the data when used to compare different lubricants.

5.2 Liquid thin film lubricants which exhibit the properties of non-Newtonian flow can also be tested if the procedure for preparing the pin and vee blocks is modified to account for their different behavior.

6. Apparatus

6.1 *Pin and Vee Block Test Machine*,⁴ illustrated in Figs. 1, Figs. 1A, Figs. 2, and Figs. 4 of Test Method [D2625](#).

6.1.1 *Load Gage*,⁴ 4500-lbf (20 000-N) range, or 3000-lbf (13 300-N) direct-reading gage. An 800-lbf (3550-N) direct reading load gage may be used for Procedure A, but does not have a high enough load range for Procedure B.

6.1.2 *Indicating Torque Meter*,⁴ (with load cell) which provides a digital reading of the resistant torque of the moving test pieces. A torque recorder with optional automatic cutoff and timer may also be used. A data acquisition system for recording the torque is highly recommended for accurate data analysis.

6.2 *Required for Calibration of Load Gage:*

6.2.1 *Standardized Test Coupon*, soft, annealed copper HB 37/39.⁵

6.2.2 *Allen Screw*, with attached 10-mm Brinell Ball.⁴

6.2.3 *Back-up Plug*.⁴

6.2.4 *Brinell Microscope*, or equivalent.

6.2.5 *Rule*, steel, 150 mm (6 in.) long.

6.2.6 *Timer*, graduated in minutes and seconds.

6.2.7 *2 cc micro pipette*, any pipette capable of delivering 2 cc of the test fluid.

7. Reagents and Materials

7.1 *Required for Procedures A and B:*

7.1.1 *Standard Coined Vee Blocks*⁴ of AISI 1137 Steel, 96° angle, Rockwell hardness of Rc 20–24 and surface finish of 1.3×10^{-7} to 2.5×10^{-7} m (5 to 10 μ m.) rms. Eight are required.

7.1.2 *Standard No. 8 Test Pins*,⁴ 6.35-mm (1/4-in.) outside diameter by 31.75-mm (1 1/4-in.) long of AISI 3135 steel, with a Rockwell hardness of Rb 80–N83 on the round and a surface finish of 1.3×10^{-7} to 2.5×10^{-7} m (5 to 10 μ m.) rms.

7.1.3 *Locking Shear Pin*,⁴ 1/2 hard brass conforming to Specification [B16/B16M](#).

7.2 *Required Before Application of the Thin Film Fluid Lubricant (see [Annex A1](#)):*

7.2.1 *Aluminum Oxide White Angular Abrasive*, 180 grit to 220 grit.

7.2.2 *Optional Surface Preparations:*

7.2.2.1 *Phosphate Coating, Manganese*, conforming to [Mil-P-16232](#), Type M, Class 3, with the coating weight controlled from 16 minimum to 22 maximum g/m².

7.2.2.2 *Phosphate Coating, Zinc*, conforming to Specification [TT-C-490](#) with the coating weight controlled to 300 $\pm$ 50 mg.

⁴ The Falex pin and vee block test machine and support equipment, available from Falex Corp., 1020 Airpark Dr., Sugar Grove, IL 60554, has been found satisfactory for this method. A new model of this machine has been available since 1983. Certain operating procedures are different for this new model. Consult instruction manual of machine for this information.

⁵ The Condensed Chemical Dictionary, Eighth Edition, published by Van Nostrand Reinhold Company, New York, NY.