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Standard Guide for Developing and Selecting Wear Tests[1]

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1. Scope

1.1 This guide covers general information for the development and selection of a wear test for an intended application.

1.2 *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:*[2]

D2266 Test Method for Wear Preventive Characteristics of Lubricating Grease (Four-Ball Method)
D2670 Test Method for Measuring Wear Properties of Fluid Lubricants (Falex Pin and Vee Block Method)
D2714 Test Method for Calibration and Operation of the Falex Block-on-Ring Friction and Wear Testing Machine
D3702 Test Method for Wear Rate and Coefficient of Friction of Materials in Self-Lubricated Rubbing Contact Using a Thrust Washer Testing Machine
D3704 Test Method for Wear Preventive Properties of Lubricating Greases Using the (Falex) Block on Ring Test Machine in Oscillating Motion
D4170 Test Method for Fretting Wear Protection by Lubricating Greases
D4172 Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)
F732 Test Method for Wear Testing of Polymeric Materials Used in Total Joint Prostheses
G32 Test Method for Cavitation Erosion Using Vibratory Apparatus
G40 Terminology Relating to Wear and Erosion
G56 Test Method for Abrasiveness of Ink-Impregnated Fabric Printer Ribbons and Other Web Materials
G65 Test Method for Measuring Abrasion Using the Dry Sand/Rubber Wheel Apparatus
G73 Test Method for Liquid Impingement Erosion Using Rotating Apparatus
G75 Test Method for Determination of Slurry Abrasivity (Miller Number) and Slurry Abrasion Response of Materials (SAR Number)
G76 Test Method for Conducting Erosion Tests by Solid Particle Impingement Using Gas Jets
G77 Test Method for Ranking Resistance of Materials to Sliding Wear Using Block-on-Ring Wear Test
G81 Test Method for Jaw Crusher Gouging Abrasion Test
G83 Test Method for Wear Testing with a Crossed-Cylinder Apparatus (Withdrawn 2005)[3]
G98 Test Method for Galling Resistance of Materials
G99 Test Method for Wear Testing with a Pin-on-Disk Apparatus
G105 Test Method for Conducting Wet Sand/Rubber Wheel Abrasion Tests
G117 Guide for Calculating and Reporting Measures of Precision Using Data from Interlaboratory Wear or Erosion Tests (Withdrawn 2016)[3]
G118 Guide for Recommended Format of Wear Test Data Suitable for Databases (Withdrawn 2016)[3]
G119 Guide for Determining Synergism Between Wear and Corrosion
G132 Test Method for Pin Abrasion Testing
G133 Test Method for Linearly Reciprocating Ball-on-Flat Sliding Wear
G134 Test Method for Erosion of Solid Materials by Cavitating Liquid Jet
G137 Test Method for Ranking Resistance of Plastic Materials to Sliding Wear Using a Block-On-Ring Configuration
G163 Guide for Digital Data Acquisition in Wear and Friction Measurements (Withdrawn 2016)[3]
G171 Test Method for Scratch Hardness of Materials Using a Diamond Stylus
G174 Test Method for Measuring Abrasion Resistance of Materials by Abrasive Loop Contact

[1] This guide is under the jurisdiction of ASTM Committee G02 on Wear and Erosion and is the direct responsibility of Subcommittee G02.91 on Terminology.

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

G176 Test Method for Ranking Resistance of Plastics to Sliding Wear Using Block-on-Ring Wear Test—Cumulative Wear Method
G181 Test Method for Conducting Friction Tests of Piston Ring and Cylinder Liner Materials Under Lubricated Conditions

3. Terminology

3.1 *Definitions:*

3.1.1 See Terminology G40 for terms used in this guide.

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *wear test*—any test for the determination of wear characteristics of materials.

4. Summary of Guide

4.1 This guide describes the generic elements that need to be considered in the selection and development of a wear test for it to be relevant to an application. General recommendations and considerations regarding these elements and their significance in the process of selecting and developing a wear test are provided. Variability to be expected with a well-controlled test is discussed as well as the correlation with an application.

4.2 This guide describes a general methodology for the implementation of a wear test. This methodology comprises the elements of simulation, acceleration, apparatus design, specimen preparation, test protocol, measurement, and documentation of results.

5. Significance and Use

5.1 The guidance and methodology provided by this guide is applicable for any wear situation and is not limited to material or lubrication. This guide is intended to provide general information and guidance regarding the selection and development of a wear test and does not provide specifics about any one wear test or intended application. In general the variability and correlation that is obtained with any wear test is determined by the degree to which the various elements of the wear test methodology described in this guide are followed.

6. Elements of Method

6.1 Wear behavior is a complex phenomenon, involving two or more bodies, one or more materials, and dependent on a wide range of factors, such as motion, loading, and environment. A material can wear by different mechanisms in different situations and different materials can wear by different mechanisms in the same wear situation. Wear of one surface or body can also be influenced by the wear of the other contacting body. As a result, wear behavior, or simply wear, is best viewed as a system property not a material property. The group of elements that affect wear behavior is referred to as a tribosystem.

6.2 Because of this complex nature of wear, the primary element involved in the selection of a wear test for an application is the simulation of the tribosystem of the application in the wear test. Another element of the methodology for selecting a wear test is acceleration of wear results, which is related to the consideration of simulation. Apparatus design, specimen preparation, test protocol, and measurement are additional elements of this methodology. In addition to their relationships with the need for simulation, these further elements are important in obtaining acceptable repeatability of test results.

6.3 Documentation of the result of a wear test is also an element of this methodology, and this is important for assessment and interpretation of the data obtained, as well as for the reporting of such data.

6.4 *Simulation:*

6.4.1 Simulation ensures that the behavior experienced in the test is the same as in the application. Given the complexity of wear and the current incomplete understanding of wear and its phenomena, test development is subject to trial and error and is dependent on the capability of the developer. Ideally, the test would exactly duplicate a wear situation. However, this generally is neither practical nor possible. Some differences will have to be accepted. While this is the case, any difference between the test and the intended application should be evaluated carefully to obtain relevant and useful wear data for the application.

6.4.2 The literature, prior data, and results of auxiliary or preliminary tests are useful in assessing the possible effects of differences.

6.4.3 The engineer concerned with reliability and life generally requires precise simulation. However, the material developer interested in a convenient test to rank the wear resistance of materials usually requires only that the test simulates the general area of application.

6.4.4 Contact conditions, primarily, the motion, contact stress, wear agent, lubrication, and environment, generally need to be representative of the application for adequate simulation.

6.4.5 Wear test simulation does not require that an application be replicated to provide valid data, provided the essential elements of a wear situation are replicated. For example, a sliding wear test is used to evaluate the wear resistance of material used for print elements in mechanical printers. In this application, the apparent key element is impact. Print element wear, however, is caused by sliding abrasive action that occurs during impact, which is simulated in a sliding test (see Test Method G56). As another example, the configuration of the dry-sand rubber wheel test (see Test Method G65), useful in ranking material wear situations involving dry abrasion, is not typical of some situations to which the test is applied. In the test, a rotating rubber wheel presses and rubs sand across the face of a specimen. A typical use of this test is to select materials for farm tools operating in sandy soils, where dry abrasion often dominates the wear situation.

6.4.6 *Wear Scar Morphology and Debris*—Although general knowledge and experience can aid in assessing the differences between test and application, correlations in wear behavior between test and application should also be studied. The most helpful correlation in developing a test is comparison of the worn surface and wear debris produced in the test to