Designation: A342/A342M – 26

Standard Test Methods for Permeability of Weakly Magnetic Materials[1]

This standard is issued under the fixed designation A342/A342M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These test methods cover four procedures for determination of the permeability [relative permeability][2] of materials having a relative permeability not exceeding 6.0.

1.2 The test methods covered are as follows:

1.2.1 *Test Method 1—Fluxmetric Method* is suitable for materials with relative permeabilities between 1.0 and 4.0. This method permits the user to select the magnetic field strength at which the permeability is to be measured.

1.2.2 *Test Method 2—Permeability of Paramagnetic Materials* has been eliminated as an acceptable method of test.

1.2.3 *Test Method 3—Low Mu Permeability Indicator* is suitable for measuring the permeability of a material as "less than" or "greater than" that of calibrated standard inserts with relative permeabilities between 1.01 and 6.0, as designated for use in a Low-Mu Permeability Indicator.[3] In this method, a small volume of specimen is subjected to a local magnetic field that varies in magnitude and direction, so it is not possible to specify the magnetic field strength at which the measurement is made.

1.2.4 *Test Method 4—Flux Distortion* is suitable for materials with relative permeabilities between 1.0 and 2.0. In this method, a small volume of specimen is subjected to a local magnetic field that varies in magnitude and direction, so it is not possible to specify the magnetic field strength at which the measurement is made.[4]

1.2.5 *Test Method 5—Vibrating Sample Magnetometry* is suitable for materials with relative permeabilities between 1.0 and 4.0. This test method permits the user to select the magnetic field strength at which the permeability is to be measured.

1.3 Materials typically tested by these methods such as austenitic stainless steels may be weakly ferromagnetic. That is, the magnetic permeability is dependent on the magnetic field strength. As a consequence, the results obtained using the different methods may not closely agree with each other. When using Methods 1 and 5, it is imperative to specify the magnetic field strength or range of magnetic field strengths at which the permeabilities have been determined.

1.4 The values and equations stated in customary (cgs-emu and inch-pound) or SI units are to be regarded separately as standard. Within this standard, SI units are shown in brackets except for the sections concerning calculations where there are separate sections for the respective unit systems. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with this standard.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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.*

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[1] These test methods are under the jurisdiction of ASTM Committee A06 on Magnetic Properties and are the direct responsibility of Subcommittee A06.01 on Test Methods.

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[2] Test Methods 1 and 5 actually measure magnetic susceptibility. The permeability (μ) [relative permeability (μ_r)] is related to the susceptibility (κ) by the equations:

$$\mu = 1 + 4\pi\kappa \text{ (cgs-emu)}$$
$$\mu_r = 1 + \kappa \text{ (SI)}$$

The term permeability has been retained in these test methods because of its widespread commercial and technological usage.

[3] The sole source of supply of the apparatus known to the committee at this time is Low-Mu Permeability Indicator, manufactured by Severn Engineering Instruments LLC, 1203 Crestside Drive, Suite 120 Coppell, TX, 75019, http://www.severnengineering.com. (Indicators can be returned for recalibration.) If the user of this test method is aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[4] The sole source of supply of the apparatus known to the Committee at this time is the Magnetoscop manufactured by INSTITUT DR. POERSTER GmbH & Co. KG. in Laisen 70, 72766, Reutlingen, Germany. (Probes can be returned for calibration.) If the user of this test method is aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

2. Referenced Documents

2.1 *ASTM Standards:*[5]

A34/A34M Practice for Sampling and Procurement Testing of Magnetic Materials

A340 Terminology of Symbols and Definitions Relating to Magnetic Testing

A341/A341M Test Method for Direct Current Magnetic Properties of Soft Magnetic Materials Using D-C Permeameters and the Point by Point (Ballistic) Test Methods

3. Terminology

3.1 The definitions of terms, symbols, and conversion factors relating to magnetic testing, used in this test method, are found in Terminology A340.

TEST METHOD 1, FLUXMETRIC METHOD

4. Significance and Use of Test Method 1

4.1 This test method is suitable for specification acceptance, design purposes, service evaluation, regulatory statutes, manufacturing control, and research and development.

4.2 Because of the restrictions on the specimen shape and size, this test method is most often used to evaluate semifinished product before fabrication of parts.

5. Apparatus

5.1 *Power Supply*—A source of dc current for the electrical circuit shown in Fig. 1. Electronic power supplies are preferable although the use of storage batteries is permitted.

5.2 *Test Fixture*—A test fixture consisting of a magnetizing solenoid with a pair of test coils, one for measuring B in the specimen and one for measuring air flux, plus a variable resistor for precisely canceling the air flux, and a fluxmeter and associated circuitry conforming to the following requirements:

5.2.1 *Magnetizing Solenoid, C_1,* having a minimum length of 30 cm [300 mm] and a ratio of length to equivalent diameter of four or more. The magnetizing winding shall be uniformly wound and be capable of producing a uniform field of at least 300 Oe [24 kA/m] over the length of the test specimen for a short time (approximately 10 s) without overheating.

5.2.2 *Test Coil, B_1,* used for measuring magnetic flux density, shall have a cross-sectional area not greater than ten times that of the test specimen. The test coil should have sufficient turns (>1000) to provide adequate resolution and should be no longer than 20 % of the test specimen length.

5.2.3 *Compensating Coil, B'_1,* of the same length, cross-sectional area, and number of turns as coil B_1 and connected to it in series opposition.

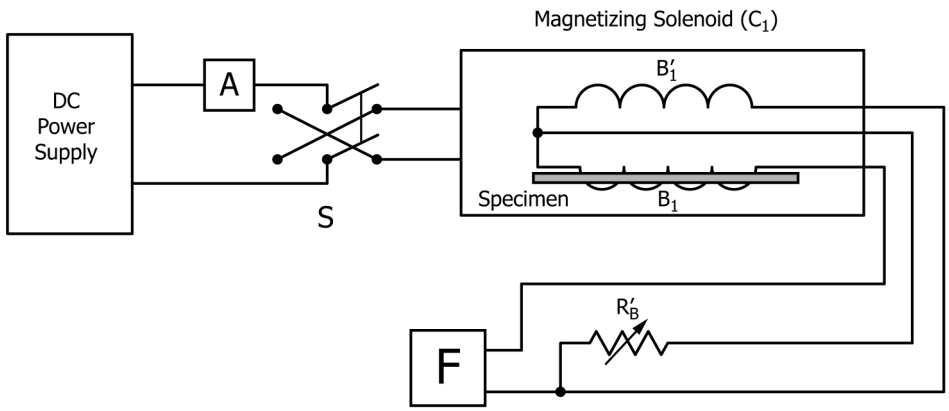
5.2.4 *Air Flux Compensating Resistor, R'_B*—This resistor is used in conjunction with coil B'_1 of Fig. 1 to adjust for exact compensation for the air flux enclosed by coil B_1 in order that the intrinsic flux density may be measured directly.

5.2.5 *Electronic Fluxmeter, F*—used to measure magnetic flux density. Alternatively, the magnetizing fixture may be connected to a dc hysteresigraph. The combined resistance of the two test coils and the air flux compensating resistor form part of the input resistance of the fluxmeter. The fluxmeter shall be appropriately adjusted to compensate.

6. Test Specimens

6.1 The test specimens shall consist of straight bars, rods, wires, or strips of uniform cross section. Multiple pieces of the same test lot may be used to increase the specimen cross-sectional area when needed. The cross-sectional area shall be

[5] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



S - Current Reversing Switch
A - Ammeter and Current Range Network
F - Electronic Fluxmeter
C_1 - Magnetizing Solenoid
B_1 - Test Coil
B'_1 - Compensating Coil
R'_B - Air Flux Compensating Resistor

FIG. 1 Circuit Diagram for Method No. 1