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Standard Test Methods for Permeability of Feebly~~~~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 ~~three~~four procedures for determination of the permeability [relative permeability][2] of materials having a permeability not exceeding ~~4.0.~~6.0.

1.2 The test methods covered are as follows:

1.2.1 *Test Method ~~1~~ 1—Fluxmetric Method* is suitable for materials with 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~~ 2—~~ is suitable for measuring the permeability of paramagnetic materials~~Permeability of Paramagnetic Materials* ~~having a permeability less than 1.05.~~has been eliminated as an acceptable method of test.

1.2.3 *Test Method ~~3~~ 3—Low Mu Permeability Indicator* is ~~a~~ suitable ~~means of~~ for measuring the permeability of a material as "less than" or "greater than" that of calibrated standard inserts with permeability 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 permeability 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 permeability 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 and health practices and determine the applicability of regulatory limitations prior to use.*

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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 ~~2~~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 Co., Inc., 555 Stage Rd., Suite 1A, Auburn, AL 36830, http://www.severnengineering.com. (Indicators can be returned for recalibration.) If you are 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 you are aware of alternate 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

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

TEST METHOD ~~NO.~~ 1, FLUXMETRIC METHOD

3. Significance and Use of Test Method 1

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

3.2 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.

4. Apparatus

4.1 *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.

4.2 *Test Fixture*—A test fixture consisting of a magnetizing solenoid with a ~~set~~pair of test ~~coils mounted midway between the ends of the solenoid for measuring magnetic induction and an air flux balancing resistor, fluxmeter, and~~ 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:

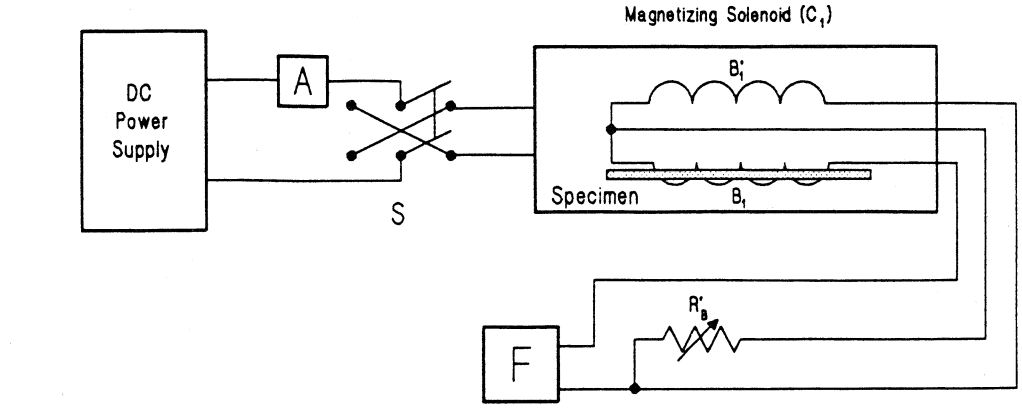
4.2.1 *Magnetizing Solenoid, C_1,* having a minimum length of 30 cm [300 mm] and a ratio of length to equivalent diameter of four or more. The magnetizing winding shall be uniformly wound and be capable of producing a uniform field of at least 300 Oe [24 kA/m] over the length of the test specimen for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

4.2.2 *Test Coil, B_1,* used for measuring ~~induction,~~ 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.

4.2.3 *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.

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

[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.



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