



Standard Test Method for Magnetic Properties of High-Coercivity Permanent Magnet Materials Using Hysteresisgraphs¹

This standard is issued under the fixed designation A977/A977M; 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 how to determine the magnetic characteristics of magnetically hard materials (permanent magnets), particularly their initial magnetization, demagnetization, and recoil curves, and such quantities as the residual induction, coercive field strength, knee field, energy product, and recoil permeability. This test method is suitable for all materials processed into bulk magnets by any common fabrication technique (casting, sintering, rolling, molding, and so forth), but not for thin films or for magnets that are very small or of unusual shape. Uniformity of composition, structure, and properties throughout the magnet volume is necessary to obtain repeatable results. Particular attention is paid to the problems posed by modern materials combining very high coercivity with high saturation induction, such as the rare-earth magnets, for which older test methods (see Test Method [A341/A341M](#)) are unsuitable. An applicable international standard is IEC Publication 60404-5.

1.2 The magnetic system (circuit) in a device or machine generally comprises flux-conducting and nonmagnetic structural members with air gaps in addition to the permanent magnet. The system behavior depends on properties and geometry of all these components and on the operating temperature. This test method describes only how to measure the properties of the permanent magnet material. The basic test method incorporates the magnetic specimen in a magnetic circuit with a closed flux path. Test methods using ring samples or frames composed entirely of the magnetic material to be characterized, as commonly used for magnetically soft materials, are not applicable to permanent magnets.

1.3 This test method shall be used in conjunction with Practice [A34/A34M](#).

1.4 The values and equations stated in customary (cgs-emu or inch-pound) or SI units are to be regarded separately as standard. Within this test method, 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 test method.

1.5 The names and symbols of magnetic quantities used in this test method, summarized in [Table 1](#), are those generally accepted by the industry.

1.6 This test method is useful for magnet materials having H_{ci} values between about 100 Oe and 35 kOe [8 kA/m and 2.8 MA/m], and B_r values in the approximate range from 500 G to 20 kG [50 mT to 2 T]. High-coercivity rare-earth magnet test specimens may require much higher magnetizing fields than iron-core electromagnets can produce. Such samples must be premagnetized externally and transferred into the measuring yoke. Typical values of the magnetizing fields, H_{mag} , required for saturating magnet materials are shown in [Table A2.1](#).

1.7 *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

- [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 Materials Using D-C Permeameters and the Ballistic Test Methods](#)
- [E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods](#)

¹ This test method is under the jurisdiction of ASTM Committee [A06](#) on Magnetic Properties and is the direct responsibility of Subcommittee [A06.01](#) on Test Methods.

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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.