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Standard Test Method for Lamination Factor of Magnetic Materials[1]

This standard is issued under the fixed designation A 719/A 719M; 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 measurement of the lamination factor (Note 1) of a specimen composed of strips cut from magnetic material.

NOTE 1—Lamination factor is also termed space factor or stacking factor.

1.2 This test method shall be used in conjunction with Practice A 34/A 34M.

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

1.4 *This standard does not purport to address the safety concerns 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]

A 34/A 34M Practice for Sampling and Procurement Testing of Magnetic Materials

3. Summary of Test Method

3.1 The laminated test specimen is subjected to pressure in a compression device and the resulting volume is then determined from the measured specimen height, width, and length. An equivalent solid volume is calculated from the specimen mass and the true density of the specimen material. The ratio of the calculated (equivalent solid) volume to the measured volume is the lamination factor.

4. Significance and Use

4.1 Lamination factor, *S*, indicates the deficiency of effective steel volume which is due to the presence of oxides, roughness, insulating coatings, and other conditions affecting the steel surface.

5. Apparatus

5.1 *Testing Machine*—A compression testing machine or other compression device capable of exerting the specified pressure.

5.2 *Metal Plates*—Two flat, smooth, rigid metal plates with square edges and ends are required. They shall be of sufficient stiffness to distribute the pressure uniformly over the surface of the sample. Each plate shall be 8.46 in. [215 mm] long and have a minimum width of 1.97 in. [50 mm] so that the area of strips under pressure when testing 1.18-in. [30-mm] wide specimens will be 10 in.^{2} [6450 mm^2].

5.2.1 Extensions can be added to the plates to allow the use of micrometers or outside calipers instead of inside calipers for determining plate separation. Precautions must be taken to ensure that, within the limits of accuracy of the measurements, no significant deflection of these extensions result from the test pressure.

5.3 *Length-Measuring Tools*—Calipers or other devices of adequate accuracy for measurement of plate separation.

6. Sampling

6.1 Test strips shall be selected as representative of the surface condition. Core loss test specimens (Epstein test specimens) are normally used for this purpose.

6.2 In routine testing, where the core loss specimens are too small to conform to the number of strips requirement of Table 1, sufficient specimens may be combined to provide an adequate test specimen. The combined specimens must be of the same thickness and material, have similar surfaces, and be representative of the surface condition of the test lot.

6.3 When a referee test becomes necessary, the test specimen must be composed of strips taken from one lot of steel. It must be representative of the surface condition, thickness, and

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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.

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TABLE 1 Number of Strips in Lamination Factor Test Specimens

Electrical Sheet Gage Number[A]	Thickness		Number of Strips per Test Specimen
	in.	[mm]	
16	0.0625	1.59	24
17	0.0560	1.42	24
18	0.0500	1.27	30
19	0.0453	1.15	30
20	0.0375	0.95	40
21	0.0340	0.86	40
22	0.0310	0.79	50
23	0.0280	0.71	50
24	0.0250	0.64	60
25	0.0220	0.55	60
26	0.0185	0.47	80
27	0.0170	0.43	80
28	0.0155	0.39	80
29	0.0140	0.35	100
30	0.0125	0.32	100
31	0.0100	0.25	100

[A] Note—For the sake of convenience for the users of this test method, the electrical sheet gage numbers are listed for the nominal thickness values listed above.

other variables. The shearing burrs should be removed and the strips wiped free of loose particles.

7. Test Specimen

7.1 The test specimens shall consist of the number of strips prescribed in Table 1.

7.2 Each strip shall have a minimum length of 9.84 in. [250 mm] and a width of 1.18 in. [30 mm]. See Practice A 34/A 34M.

7.3 Length and width dimensions should be known to at least 0.25 % and preferably to 0.1 %.

8. Procedure

8.1 Determine the mass of the test specimen by weighing.

8.2 Stack the strips evenly and place them symmetrically between the two flat plates in the compression testing machine.

8.3 Apply pressure so it is distributed uniformly across the test specimen.

8.4 The recommended standard minimum test pressure shall be 50 psi [345 kPa]. Other pressures, depending on the application, may be agreed upon between the seller and the purchaser.

8.5 If more than one test pressure is used, apply the pressures in ascending order.

8.6 Calculate the average separation of the backing plates, or stack height, at the required pressure from measurements of the plates separation.

8.6.1 When using a compression testing machine make four measurements of the separation, one at each corner of the backing plates.

8.6.2 When using a compression device designed specifically for determining this factor only two measurements, taken on the longitudinal axis of the strips at each end of the plates, are required.

9. Calculation

9.1 *Customary Units*:

9.1.1 Calculate the percentage lamination factor as follows:

$$S = [m/(2.54\ wl\delta\ h')] \times 100 \quad (1)$$

where:

S = lamination factor, %;
m = mass of test specimen, g;
w = width of test specimen, cm;
l = length of test specimen, cm;
δ = density of the specimen material; g/cm^3, (see Practice A 34/A 34M); and
h' = measured average separation of the plate faces or stack height, in.

9.2 *SI Units*:

9.2.1 Calculate the percentage lamination factor as follows:

$$S = [m/(wl\delta h')] \times 100 \quad (2)$$

where:

S = lamination factor, %;
m = mass of test specimen, g;
w = width of specimen, mm;
l = length of specimen, mm;
δ = density of specimen material, kg/m^3; and
h' = measured stack height, mm.

10. Precision and Bias

10.1 *Precision*—The precision of the procedure in this test method for measuring the lamination factor of magnetic materials is being determined.

10.2 *Bias*—Since there is no accepted reference material for determining the bias for the procedure in this test method for measuring lamination factor, bias has not been determined.

11. Keywords

11.1 lamination factor; space factor; stacking factor

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