



Designation: A1126 – 23

Standard Specification for Magnetic Pure Iron¹

This standard is issued under the fixed designation A1126; 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 specification covers the requirements for mill-cast and wrought magnetic pure iron containing no more than 0.0060 % carbon and a typical total iron content of 99.9 %. The magnetic characteristics exhibited by magnetic pure iron are made possible by the absence of alloying elements during production.

1.2 This specification also covers magnetic pure iron supplied in a form and condition which allows for subsequent heat treatment to achieve desired magnetic characteristics.

1.3 Magnetic pure iron may be supplied in forms including hot-rolled strip, sheet, plate, bar, billet, and slab; cold-rolled strip and sheet; mill-cast slab and bloom; forgings; and drawn wire and rod.

1.4 This specification does not cover cast parts or iron powders capable of being processed into magnetic components. Please refer to the following ASTM standards for information regarding powdered metal materials and magnetic components: Specifications [A811](#), [A839](#), and [A904](#).

1.5 This specification does not cover material that contains constituent elements sufficient to increase the carbon content above 0.0060 % or to decrease the iron content below 99.9 %. Refer to Specification [A848](#) for properties of low carbon magnetic iron.

1.6 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to customary (cgs-emu and inch-pound) units which are provided for information only and are not considered standard.

1.6.1 There are selected values presented in two units, both of which are acceptable SI units. These are differentiated by the word “or,” as in “g/cm³, or, (kg/m³).”

1.7 Acceptance values may be generated by an independent party. This specification accepts reports from producers or intermediate suppliers.

1.8 *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.*

1.9 *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

[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](#)

[A596/A596M Test Method for Direct-Current Magnetic Properties of Materials Using the Point by Point \(Ballistic\) Method and Ring Specimens](#)

[A773/A773M Test Method for Direct Current Magnetic Properties of Low Coercivity Magnetic Materials Using Hysteresigraphs](#)

[A811 Specification for Soft Magnetic Iron Parts Fabricated by Powder Metallurgy Techniques](#)

[A839 Specification for Iron-Phosphorus Powder Metallurgy Parts for Soft Magnetic Applications](#)

[A848 Specification for Low-Carbon Magnetic Iron](#)

[A904 Specification for 50 Nickel-50 Iron Powder Metallurgy Soft Magnetic Parts](#)

3. Terminology

3.1 The terms and symbols used in this specification, unless otherwise noted, are defined in Terminology [A340](#).

¹ This specification is under the jurisdiction of ASTM Committee [A06](#) on Magnetic Properties and is the direct responsibility of Subcommittee [A06.02](#) on Material Specifications.

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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.

4. Ordering Information

4.1 Orders to this specification shall include as much of the following information as is required to describe the desired material:

- 4.1.1 ASTM specification number;
- 4.1.2 *Dimensions and Tolerances*—Dimensional tolerances are to be mutually agreed upon between the user and the producer or supplier;
- 4.1.3 Quantity (weight or number of pieces);
- 4.1.4 Form and condition;
- 4.1.5 Magnetic property requirements if they are other than stated herein;
- 4.1.6 Certification of chemical analysis or magnetic property evaluation, or both;
- 4.1.7 Marking and packaging;
- 4.1.8 *End Use*—Whenever possible, the user should specify subsequent processing such as machining, blanking, forging, or deep drawing to shape. This information will help the supplier provide the most suitable product for the user’s fabrication practice; and
- 4.1.9 Exceptions to this specification or special requirements.

5. Chemical Composition

5.1 Magnetic pure iron supplied to this specification shall conform to the chemical composition requirements shown in [Table 1](#).

5.1.1 By agreement between user and producer or supplier, analysis may be required, and limits established for elements not specified in the table of chemical composition.

6. Form and Condition

6.1 Magnetic pure iron is capable of being produced in a wide variety of forms and conditions for fabrication into magnetic components. The desired form and condition should be discussed with the supplier to assure receiving a product suitable for the intended purpose. Available forms and conditions may include:

- 6.1.1 *Hot-Rolled Product*—Hot-rolled; hot-rolled and acid cleaned; hot-rolled, annealed, and acid cleaned; hot-rolled and mechanically cleaned.
- 6.1.2 *Cold-Rolled Product*—Cold-rolled; cold-rolled and annealed; cold-rolled and mechanically cleaned; cold-drawn; cold-drawn and annealed.
- 6.1.3 *Billet and Bar*—Hot or cold worked, may have surface conditioned by grinding.

6.1.4 *Forgings*.

7. Magnetic Property Requirements

7.1 *Density*—The density for test purposes is 7.86 g/cm³, or, (7860 kg/m³).

7.2 *Test Specimen*—The test specimen size and shape shall conform to Practice [A34/A34M](#). Shapes such as ring laminations, solid rings, Epstein specimens, or straight lengths having a uniform cross section are preferred. If, however, it is impossible to prepare a preferred test specimen shape from the as-manufactured product, specimen shape and size shall be mutually agreed upon by the user and producer or supplier.

7.3 *Heat Treatment*—When testing of heat-treated specimens is requested by the user, the following method shall be used: in a reducing atmosphere, inert atmosphere, or vacuum, temperature shall be held at 845 °C (1553 °F) for up to two hours and cooled at a rate from 55 °C to 100 °C per hour (131 °F to 212 °F per hour) to 500 °C (932 °F), and cooled at any rate thereafter. Use of a heat treatment method other than the method described above shall be subject to agreement between the supplier or producer and user. While the magnetic properties of magnetic pure iron are often sufficient as produced, certain desired magnetic properties require heat treatment to achieve. See [Appendix X2](#) for a discussion of heat treatment.

7.4 *Test Method*—Magnetic testing shall be conducted in accordance with Test Methods [A341/A341M](#), [A596/A596M](#), or [A773/A773M](#). Under this specification, magnetic polarization and relative maximum permeability shall be measured when reporting of magnetic characteristics is required by the user.

7.5 *Requirements*—Magnetic polarization (J) and relative maximum permeability (μm) shall meet the requirements in [Table 2](#).

8. Rejection and Rehearing

8.1 Material that fails to conform to the requirements of this specification may be rejected by the user. The rejection shall be reported to the supplier or producer promptly and in writing. The rejected material shall be set aside, adequately protected and correctly identified. The disposition of rejected parts shall be subject to agreement between the supplier or producer and user.

8.2 The supplier or producer may make a claim for rehearing. In this event, the user shall make samples that are representative of the rejected material available to the supplier or producer for evaluation.

TABLE 1 Chemical Composition Requirements (Weight Percent As Cast)

Carbon, max	0.006
Manganese, max	0.055
Phosphorus, max	0.006
Sulfur, max	0.004
Nitrogen, max	0.006
Copper, max	0.030
Cobalt, max	0.003
Silicon, max	0.010
Aluminum, max	0.005
Titanium, max	0.005
Iron	Balance

TABLE 2 Magnetic Property Requirements

	Unannealed	Annealed
Magnetic Polarization, min ^A	2.0 T	2.0 T
Relative Maximum Permeability, min ^B	1750	11 000

^A Magnetic polarization tested at a magnetic field strength of 25 000 A/m (314 Oe).

^B Relative maximum permeability tested at any necessary magnetic field strength.

9. Certification

9.1 When specified in the purchase order or contract, the user shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

10. Packaging and Marking

10.1 Packaging shall be subject to agreement between the supplier or producer and user.

10.2 Material furnished under this specification shall be identified by the name or symbol of the supplier, by unique identification number, and material size. Each heat supplied on a given order must be identified separately.

11. Keywords

11.1 coercive field strength; magnetic field strength; magnetic flux density; magnetic polarization; magnetic pure iron; relative maximum permeability; 99.9 % iron

APPENDIXES

(Nonmandatory Information)

X1. TYPICAL PROPERTIES

X1.1 Typical physical and mechanical properties are shown in [Table X1.1](#).

NOTE X1.1—All values are typical of hot-rolled magnetic pure iron in the as-rolled condition.

X1.2 Typical magnetic properties are shown in [Table X1.2](#).

NOTE X1.2—All values are typical of hot-rolled magnetic pure iron tested in accordance with Test Method [A773/A773M](#).

TABLE X1.1 Typical Physical and Mechanical Properties

Specific Gravity (20 °C)	7.86
Specific Resistance (20 °C)	0.11 $\mu\Omega\cdot\text{m}$
Linear Thermal Expansion Coefficient (0 °C to 100 °C)	$12 \times 10^{-6}/^\circ\text{C}$
Hardness, max	60 HB to 90 HB
Yield Strength (0.2 % Offset)	130 MPa to 180 MPa
Tensile Strength	240 MPa to 275 MPa
% Elongation (L = 5d)	40 to 60

TABLE X1.2 Typical Magnetic Properties

	Unannealed	Annealed
Coercive Field Strength ^A	50 A/m to 150 A/m (0.628 Oe to 1.88 Oe)	15 A/m to 50 A/m (0.188 Oe to 0.628 Oe)
Relative Maximum Permeability	1750 to 8000	11 000 to 20 000

^A Coercive field strength measured from a magnetic polarization of 1.5 T to allow for better resolution.

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<https://standards.iteh.ai/catalog/standards/astm-a1126-23> **X2. HEAT TREATMENT OF MAGNETIC PURE IRON** 59608e7/astm-a1126-23

X2.1 In many instances, parts fabricated from magnetic pure iron exhibit sufficient magnetic properties without subsequent heat treatment.

X2.2 In cases where manufacturing techniques induce significant stress in fabricated parts, it is beneficial to use a heat treatment method with a temperature greater than 900 °C (1652 °F).

X2.3 Small amounts of carbon can be detrimental to the magnetic characteristics of magnetic pure iron. Caution should be used to mitigate contamination by carbon-bearing materials in the furnace.