



Designation: **A904 – 14 A904 – 20**

# Standard Specification for 50 Nickel-50 Iron Powder Metallurgy Soft Magnetic Parts<sup>1</sup>

This standard is issued under the fixed designation A904; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 1. Scope

1.1 This specification covers the magnetic properties of 50 nickel-50 iron parts fabricated by powder metallurgy techniques and is intended for parts that require high magnetic permeability, high electrical resistivity, low coercive field strength, and low hysteresis loss. It differs from the wrought alloy specification (see Specification **A753**) because these parts are porous. A number of magnetic properties such as permeability are proportional to the sintered density.

1.2 This specification deals with powder metallurgy parts in the sintered or annealed condition. Should the sintered parts be subjected to any secondary operation that causes mechanical strain, such as machining or sizing, they should be resintered or annealed.

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

1.3.1 There are selected values presented in two units, both of which are in acceptable SI units. These are differentiated by the word “or,” as in “ $\mu\Omega$ -cm, or,  $\Omega$ -m.”

1.4 *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 ~~health~~ environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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:<sup>2</sup>

**A34/A34M** Practice for Sampling and Procurement Testing of Magnetic Materials [7-2e96810c917b/astm-a904-20](#)

**A340** Terminology of Symbols and Definitions Relating to Magnetic Testing

**A596/A596M** Test Method for Direct-Current Magnetic Properties of Materials Using the Ballistic Method and Ring Specimens

**A753** Specification for Wrought Nickel-Iron Soft Magnetic Alloys (UNS K94490, K94840, N14076, N14080)

**A773/A773M** Test Method for Direct Current Magnetic Properties of Low Coercivity Magnetic Materials Using Hysteresis-graphs

**B328** Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Metal Structural Parts and Oil-Impregnated Bearings (Withdrawn 2009)<sup>3</sup>

**B962** Test Methods for Density of Compacted or Sintered Powder Metallurgy (PM) Products Using Archimedes' Principle

**E1019** Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Inert Gas Fusion Techniques

## 3. Terminology

3.1 The terms and symbols used in this specification are defined in Terminology **A340**.

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto: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 for parts conforming to this specification shall include the following information.
- 4.1.1 Reference to this standard and year of issue/revision.
  - 4.1.2 Reference to an applicable part drawing.
  - 4.1.3 Quantity required.
  - 4.1.4 A critical cross section of the part shall be defined and so indicated on the applicable part drawing. The location of the critical section is by mutual agreement between the user and producer (see 6.2).
  - 4.1.5 Magnetic property requirements if they are other than stated in 7.5.
  - 4.1.6 Certification of chemical composition or magnetic property evaluation, or both (Sections 5 and 7).
  - 4.1.7 Marking and packaging requirements (Section 12).
  - 4.1.8 Exceptions to this specification or special requirements such as functional testing as mutually agreed upon by the producer and user.

#### 5. Chemical Composition

- 5.1 The chemical composition of the parts shall conform to the requirements prescribed in Table 1.
- 5.2 Determination of metallic constituents shall be by a method acceptable to both producer and user. Analysis of carbon, nitrogen, sulfur, and oxygen shall be done in accordance with Test Methods E1019.

#### 6. Sintered Density Requirements

6.1 ~~Magnetic and residual induction properties~~ of powder metallurgy parts strongly depend on density. The density of powder metallurgy parts is determined by the compressibility of the powder, the compacting pressure, and sintering practice (temperature, time, and atmosphere).

6.2 Parts produced in conformance with this specification shall have a minimum sintered density of ~~6.99 g/cm<sup>3</sup>~~ ~~6990 kg/m<sup>3</sup>~~ ~~or, 6.99 g/cm<sup>3</sup>~~ in the critical section of the part. The critical section shall be defined by agreement between the user and producer.

6.3 Sintered density shall be determined in accordance with Test Method ~~B328~~ (which has been replaced by Test Methods ~~B962~~).

#### 7. Magnetic Property Requirements

7.1 Because of the nature of powder metallurgy parts production, magnetic testing of each lot is not required by this specification. Nevertheless, it is strongly recommended that the user require the producer to conduct periodic magnetic evaluations and to certify such results. Such magnetic property evaluations shall be conducted in the manner described below.

7.2 When requested, each lot of parts should be sintered with at least one and preferably three ring test specimens that comply with the geometric requirements listed in Practice A34/A34M. The ring specimen(s) shall be produced from the same mixed lot of powder used to produce the parts.

7.3 The magnetic properties shall be determined in accordance with Test Methods ~~Method~~ ~~A596/A596M~~ or ~~A773/A773M~~.

7.4 For the purpose of this specification, only the coercive field strength determined from a maximum applied magnetic field strength of ~~15 Oe (1200 A/m)~~ 1200 A/m (15 Oe) needs to be determined. Other magnetic properties may be specified by mutual agreement between the user and producer.

7.5 *Coercive Field Strength Requirements*—Parts supplied to this specification shall exhibit a maximum coercive field strength of ~~0.4 Oe (32 A/m)~~ 32 A/m (0.4 Oe).

**TABLE 1 Chemical Composition Requirements  
(in Weight Percent)**

Element	%
Nickel	46–51
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Carbon	0.02 max
Oxygen	0.10 max
Nitrogen	0.01 max
Others <sup>A</sup>	0.5 max
Iron <sup>B</sup>	balance

<sup>A</sup> Others refers to trace elements that are to be regarded as incidental and not deliberate additions.

<sup>B</sup> Iron is the balance by difference. Quantitative analysis of this element is not required.

7.6 Since magnetic properties are strongly affected by process conditions, refer to the appendixes for typical values and explanatory notes.

## 8. Workmanship, Finish, and Appearance

- 8.1 The parts shall be uniform in composition and uniform in density within critical sections.
- 8.2 If parts are sectioned or fractured, there shall be no readily recognizable defects.

## 9. Sampling

- 9.1 A lot shall consist of parts of the same form and dimensions, produced from a single mixed powder batch and from an unchanged process, without discontinuity in production, and submitted for inspection at one time.
- 9.2 The user and producer shall agree upon the number of specimens for testing.

## 10. Rejection and Rehearing

- 10.1 Parts that fail to conform to the requirements of this specification shall be rejected. Rejection should be reported to the producer promptly and in writing. In case of dissatisfaction with the results of the test, the producer may make claim for a rehearing.
- 10.2 The disposition of rejected parts shall be subject to agreement between the user and producer.

## 11. Certification

- 11.1 When specified in the purchase order or contract, the user shall be furnished certification that samples representing each lot have either been tested or inspected as directed in this specification and the requirements have been met.
- 11.2 When specified in the purchase order or contract, a report of the test results shall include:
  - 11.2.1 Chemical composition,
  - 11.2.2 Part density in the critical section,
  - 11.2.3 Magnetic test results, if required by user, and
  - 11.2.4 The results of any other tests stipulated in the purchase order or contract.

## 12. Packaging and Package Marking

- 12.1 Packaging shall be subject to agreement between the user and producer.
- 12.2 Parts furnished under this specification shall be in a container identified by the name or symbol of the parts producer.

## 13. Keywords

- 13.1 50 Ni-50 Fe; coercive field strength; powder metallurgy

## APPENDIXES

### (Nonmandatory Information)

#### X1. TYPICAL MAGNETIC PROPERTIES

X1.1 Typical dc magnetic properties, based on interlaboratory studies, are listed in **Table X1.1**. These results were obtained using a sintering practice of ~~2300°F (1260°C)~~ 1260 °C (2300 °F) in dry hydrogen or in vacuum. The influence of sintered density is shown. The data provided are for information only and are not requirements in this specification.

X1.2 Maximum flux density, residual ~~induction~~ flux density, and coercive field strength are measured from a maximum applied magnetic field strength of ~~15 Oe (1200 A/m)~~ 1200 A/m (15 Oe).