Designation: A799/A799M – 10 (Reapproved 2020)

Standard Practice for Steel Castings, Stainless, Instrument Calibration, for Estimating Ferrite Content[1]

This standard is issued under the fixed designation A799/A799M; 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 practice covers the procedure for calibration of instruments to be used for estimating the ferrite content of the microstructure of cast stainless steels by magnetic response or measurement of permeability. This procedure covers both primary and secondary instruments.

1.1.1 A primary instrument is one that has been calibrated using National Institute of Standards and Technology-Standard Reference Material (NIST-SRM) thickness coating standards. It is a laboratory tool to be used with test specimens. Some primary instruments may be used to directly measure the ferrite content of castings.

1.1.2 A secondary instrument is one that has been calibrated by the use of secondary standards that have been measured by a calibrated primary instrument. Secondary instruments are to be used to directly measure the ferrite content of castings.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. 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 the standard.

1.2.1 Within the text, the SI units are shown in brackets.

1.3 *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.*

1.4 *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]

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

B499 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals

E562 Test Method for Determining Volume Fraction by Systematic Manual Point Count

2.2 *NIST Standard:*

NIST-SRM Coating Thickness Standards

NOTE 1—The specific coating thickness standards previously referenced in this practice are no longer available. Similar ones are now available from NIST.

3. Terminology

3.1 *Definitions*—The definitions in Terminology A941 are applicable to this standard.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *ferrite, n*—the body-centered cubic microconstituent in stainless steel.

3.2.2 *ferrite percentage, n*—a value designating the ferrite content of stainless steels.

3.2.2.1 *Discussion*—The Steel Founders' Society of America (SFSA) has assigned ferrite percentages to the series of NIST coating thickness standards.[3] This assignment was based on the magnetic attraction for a standard magnet by the coating standards when compared with the magnetic attraction of the same magnet by a series of cast stainless steels whose ferrite content had been determined by an accurate metallographic point count. A similar assignment based on magnetic permeability was also established. Algebraic equations have now been derived from a plot of the thickness of these standards and the assigned ferrite percentages. By the use of

[1] This practice is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.18 on Castings.

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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.

[3] Aubrey, L. S., Weiser, P. F., Pollard, W. J., and Schoefer, E. A., "Ferrite Measurement and Control in Cast Duplex Stainless Steels," *Stainless Steel Castings, ASTM STP 756*, ASTM International, 1982, p 126.

these equations, any primary instrument will have its calibration traceable to the SFSA's instruments or any other calibrated instrument and thus afford comparable reproducible ferrite percentages. It also allows traceability to NIST.

3.2.3 *secondary standards, n*—a piece of cast stainless steel whose ferrite percentage has been determined by a calibrated primary instrument.

3.2.3.1 *Discussion*—Secondary statements are used to calibrate secondary instruments (see Calibration of Secondary Instruments).

4. Significance and Use

4.1 The amount of ferrite present in an austenitic stainless steel has been shown to influence the strength, toughness, and corrosion resistance of this type of cast alloy. The amount of ferrite present tends to correlate well with the magnetic permeability of the steel. The methods described in this standard cover calibration practice for estimating ferrite by the magnetic permeability of the steel. The practice is inexpensive to use over large areas of the cast part and is nondestructive.

4.2 This practice has been used for research, alloy development, quality control, and manufacturing control.

4.2.1 Many instruments are available having different designs and different principles of operation. When the probe is placed on the material being investigated, a closed magnetic circuit is formed allowing measurement of the magnetic permeability. When calibrated with standards having known ferrite content, this permeability indicates the ferrite content of the material being analyzed. The estimated ferrite content is read from a calibrated dial or from a digital readout dial. Follow the manufacturer's instructions for proper calibration of the instrument.

4.3 Since this practice measures magnetic attraction and not ferrite directly, it is subject to all of the variables that affect magnetic permeability, such as the shape, size, orientation, and composition of the ferrite phase. These in turn are affected by thermal history. Ferrite measurements by magnetic methods have also been found to be affected by the surface finish of the material being analyzed.

4.4 Magnetic methods should not be used for arbitration of conflicts on ferrite content except when agreed upon between manufacturer and purchaser.

5. Apparatus

5.1 One primary instrument that uses magnetic attraction consists of a spring-loaded balance arm from which a rod-shaped magnet is suspended.[4] The opposite end of the balance arm from the magnet has counterweights that balance most but not all of the weight of the magnet.

5.1.1 When this instrument is used, the spring load is relaxed sufficiently to allow the magnet to make contact with the material being tested.

5.1.2 The spring is then wound until the force of the coiled spring overcomes the magnetic attraction of the magnet for the material being tested, causing the magnet to break contact and the lever arm to rise.

5.1.3 The amount of force that the coiled spring has developed is determined from a marked dial securely attached to the shaft that is used to coil or uncoil the spring.

5.1.3.1 A weighted No. 2 magnet (catalog number J5-0664W) is used with this instrument.

5.2 When using a Feritscope,[5] follow the manufacturer's instructions for calibration. When traceability is required, confirm the calibration using the appropriate NIST standards.

5.2.1 Newer versions of this instrument have a single-point probe, while older versions have a two-point probe as the sensing device. When this probe is placed on the material being investigated, a closed magnetic circuit is formed and energized by a low-frequency magnetic field. The voltage induced in the probe coil by this field is a measure of the permeability. When calibrated with standards having known ferrite content, this permeability indicates the ferrite content of the material being analyzed. The estimated ferrite content is read from a calibrated dial or from a digital readout dial.

5.3 One secondary instrument consists of a balance arm that has a rod-shaped magnet attached to one end.[6] The opposite end is counterweighted to balance the magnet.

5.3.1 This arm with its magnet and counterweight is enclosed in a transparent box. The top face of this container has a threaded hole directly over the magnet. Marked inserts that have metal plates on their bottom faces are screwed into this hole. These plates have different strengths of attraction for the magnet.

5.3.2 In use, the bottom end of the magnet is touched to the material being investigated. The other end of the magnet is in contact with the metal plate on the bottom of the insert. The container is then raised. If the material being measured has a greater attraction for the magnet than does the plate on the bottom of the insert, the magnet will be pulled away from the insert. If not, the magnet will pull away from the material being measured. The inserts are changed and the test repeated until the inserts that are just weaker and just stronger than the material being investigated are found.

5.3.3 The results of a measurement with this instrument are reported as less than A and greater than B.

5.4 *NIST-SRM Coating Thickness Standards*—These are mild steel plates that are covered by an electroplated copper layer which in turn is covered by a flash coat of chromium. The thickness of the copper coat varies from standard to standard and is certified by NIST. The strength of the magnetic attraction of each standard varies with the thickness of the coating. These are primary standards for calibration.

5.5 Other instruments such as the Elcometer[7] may be used.

[4] Magne Gage, produced by Magne Gage Sales and Service Co., Inc., 629 Packer Street, Avoca, PA 18641; http://www.magne-gage.com.

[5] Feritscope, produced by Fischer Technology, Inc., 750 Marshall Phelps Road, Windsor, CT 06095; http://www.fischer-technology.com.

[6] Severn Gage, Severn Engineering Co., Old Stage Business Park, 555 Old Stage Road, Suite 1-A, Auburn, AL 36830; http://www.severnengineering.com.

[7] Elcometer, Elcometer Instruments Ltd., Edge Lane, Manchester, UK M43 6BU; http://www.elcometer.com.