Society of Automotive Engineers, Inc.
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AEROSPACE MATERIAL SPECIFICATION

AMS 2315A
Superseding AMS 2315
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DETERMINATION OF FREE FERRITE CONTENT

1. SCOPE: This specification covers two methods for determining the percentage of free ferrite in steels and other iron alloys in which control of free ferrite is required to ensure that specified mechanical properties after heat treatment will be met.

2. APPLICABLE DOCUMENTS: None.

3. TECHNICAL REQUIREMENTS:

3.1 Specimen Preparation:

3.1.1 Heat Qualification: Sampling shall be in accordance with 4.3.1. Samples shall be converted into test specimens in accordance with 3.1.3.

3.1.2 Product Qualification: Product from a heat not qualified based on sampling as in 4.3.1 shall be sampled in accordance with 4.3.2. Samples shall be converted into test specimens in accordance with 3.1.3.

3.1.3 Machining: Specimens of sufficient size to provide approximately 0.5 sq in. (650 mm^2) area for examination shall be cut from the product as in 3.1.3.1, 3.1.3.2, or 3.1.3.3, as applicable. Each specimen shall be marked in such a manner that its orientation with respect to the direction of rolling, drawing, or extruding is easily identifiable.

3.1.3.1 Round, Hexagonal, or Square Product: Specimens shall be selected from an area midway between the edge and the center of the sample.

3.1.3.2 Rectangular Product: Specimens shall be selected from an area midway between the longitudinal edge and the center of the sample.

3.1.3.3 Tubing and Other Hollow Shapes: Specimens shall be selected from samples which include the full wall thickness of the product.

3.1.4 Heat Treatment: Specimens shall be austenitized at the normal recommended temperature for the grade of steel being examined and adequately quenched. The quenched specimens shall be tempered at a sufficiently high temperature to develop good metallographic contrast. Solution and precipitation hardenable steels shall be solution and precipitation heat treated to develop good metallographic contrast.

3.1.5 Polishing: After heat treatment as in 3.1.4, the face of each specimen perpendicular to the direction of rolling shall be ground and polished, using standard metallographic polishing techniques, to produce a surface suitable for microscopic examination.

3.1.6 Etching: The polished surface of each specimen shall be suitably etched to reveal ferrite.

3.2 Procedure: The percentage of free ferrite in each specimen shall be determined by the occupied squares method of 3.2.1 or by the point counting method of 3.2.2. When a dispute occurs between purchaser and vendor over the percent of free ferrite, the percentage determined as in 3.2.2 shall govern.

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3.2.1 Occupied Squares Method: Project an image of each specimen at 250X magnification on a ground-glass screen under tinted illumination or make a representative photomicrograph of each specimen. Superimpose on the image or the photomicrograph a transparent overlay grid containing small squares within a large square at a ratio of 100 to 1, such as large squares 10 mm on a side divided into small squares 1 mm on a side. Count the number of small squares occupied by free ferrite in each of at least 15 large squares. Partially occupied small squares shall be added into the sum of fully occupied squares on the basis of an estimate of portions of squares using multiples of not closer than 1/4. Partially occupied squares with less than 1/8 ferrite shall be disregarded.

3.2.1.1 Calculation: Calculate the average number "n" of occupied small squares per large square (sum of occupied small squares divided by number of large squares used). Convert the number "n" to volume percentage of free ferrite "N", correcting for variations in particle shape as follows: $N = 1.16n$. Applying a standard deviation "d" with a value of 0.08 n, the final value of percentage of free ferrite in the specimen becomes: $N \pm d = 1.16n \pm 0.08n$.

3.2.2 Point Count Method: Project an image of each specimen on a ground-glass screen which has been ruled off into 500-grid points, such as a grid having points 1/4 in. (6 mm) apart. Select a magnification which yields approximately one intercept for each free ferrite phase. For each specimen, count the number of free ferrite intercepts and tangents for 20 fields selected so that areas representative of the entire surface being examined are included. Count each ferrite phase as 1 and each intercept tangent to a ferrite phase as 1/2.

3.2.2.1 Calculation: Calculate the percentage of free ferrite from the equation:

$$N = \frac{n}{10,000} \times 100$$

where,

N = Percent free ferrite
n = Sum total of ferrite phase intercepts and tangents
10,000 = Total intercepts

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests: Tests in accordance with all applicable requirements of this specification are classified as acceptance tests and shall be performed to represent each lot.

4.2.1 Heat Qualification: Tests in accordance with 4.3.1 to determine conformance to "heat qualification" requirements, if acceptable, need be conducted only once per heat.

4.2.1.1 Heats which have been qualified as semi-finished product shall be considered qualified for finished product.

4.2.2 Product Qualification: Tests in accordance with requirements of this specification on product not "heat qualified" shall be conducted on product from each lot.

4.3 Sampling: The sampling procedure described in 4.3.1 shall be performed by the producer for heat qualification. No further sampling by the producer shall be required from a heat which meets the requirements of the applicable material specification. Sampling procedure on the product shall be as described in 4.3.2.