Decarburization in Hardened and Tempered Threaded Fasteners—SAE J121a

SAE Recommended Practice
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DECARBURIZATION IN HARDENED AND TEMPERED THREADED FASTENERS—SAE J121a

SAE Recommended Practice

Report of Iron and Steel Technical Committee approved September 1969 and last revised July 1976.

1. Scope—This recommended practice covers methods for measuring, classifying, and specifying decarburization in the threaded section of hardened and tempered steel bolts, screws, studs, and similar parts. It is not intended to cover products which are specifically carburized to achieve special properties.

2. Definitions—According to SAE J419, "decarburization" is the loss of carbon at the surface of commercial ferrous materials which have been heated to facilitate fabrication or heated to modify mechanical properties. SAE J419 defines also "complete decarburization," "partial decarburization," and "effective decarburization," as related to unhardened steels. This standard extends these definitions, as follows, to cover more specifically hardened and tempered steel bolts, screws, studs, and similar products.

2.1 Partial Decarburization—Decarburization with loss of carbon sufficient to cause a lighter shade of tempered martensite than that of the immediately adjacent base metal, when examined metallographically by the method outlined in paragraph 4.1, but insufficient carbon loss to show clearly defined ferrite grains. (The hardness traverse method, outlined in paragraph 4.2, is the referee method for determining that partial decarburization is not present at a point below that shown in Fig. 1 for each classification.)

2.2 Gross Decarburization—Decarburization with sufficient carbon loss to show only clearly defined ferrite grains under metallographic examination by the method outlined in paragraph 4.1. This is sometimes called "Complete Decarburization."

2.3 Carbon Restoration—A process of restoring surface carbon loss by heat treating in an atmosphere furnace of properly controlled carbon potential. (This process is generally required to produce products having decarburization as defined herein.)

2.4 Carburization—A darker shade of tempered martensite than that of the immediately adjacent base metal, when examined metallographically by the method outlined in paragraph 4.1, and harder by at least 30 points (Knoop or Vickers DPH) than the hardness at root diameter when checked by the method outlined in paragraph 4.2. (The limits established by this standard exclude this condition.)

2.5 Base Metal Hardness—For purposes of this report, hardness at root diameter on a line bisecting the included angle of the thread (Position 1 in Fig. 2) is considered "base metal hardness."

3. Classes of Decarburization—This report establishes two classes of decarburization for inch series threaded products and three classes for SI (metric) series threaded products. Each class is characterized by dimensional limits for decarburized zone, gross decarburized zone, and/or base carbon zone (as applied to longitudinal sections through the thread axis). Decarburization limits applicable to the more commonly used ISO Modified Threads (mm) and Unified Threads (inch) are shown in Fig. 1. Limits applicable to other threaded products are as follows:

For Class 1/2H ——— N = .50H; G = 0.015 mm (0.0006 in) max
For Class 2/3H ——— N = .67H; G = 0.015 mm (0.0006 in) max
For Class 3/4H ——— N = .75H; G = 0.015 mm (0.0006 in) max

NOTE: This recommended practice recognizes that the surface may vary in carbon content from the base metal carbon content, and stipulates that this variation shall be either "partial decarburization" or "gross decarburization" or a "carbon restored surface" to the extent allowed in Fig. 1 for the different classes. "Carburization" is not permitted in the surface zone.

4. Methods for Measuring Decarburization—Two methods for measuring decarburization are provided. the microscopic method is intended primarily for routine inspection purposes. The hardness method is intended primarily for referee purposes. In the case of gross decarburization, however, only the microscopic method is applicable.

4.1 Microscopic Method[1]:

4.1.1 SPECIMENS—Use longitudinal sections taken through the thread axis of the bolt, screw, or stud, after all heat treating operations have been performed on the product.

4.1.2 PREPARATION

(a) Mount specimen for grinding and polishing. Protection from rounding the surface to be examined is essential. The specimen should be mounted in a clamp or in a plastic mount, the latter being the preferred method.

(b) After mounting, grind and polish the surface in accordance with good metallographic practice.

(c) Etching in a 3% nital (concentrated nitric acid) or picral (saturated picric acid) is usually suitable for showing changes in microstructure caused by decarburization.

4.1.3 MEASUREMENT—Unless otherwise agreed on between purchaser and producer, examine at 100X magnification. Compare with Fig. 1 and definitions in paragraphs 2.1, 2.2, and 2.3.

If the microscope is of a type with a ground glass screen, the extent of decarburization can be measured directly with a scale. If an eye-piece is used for measurement, it should be an appropriate type containing a cross hair or a scale.

4.2 Hardness Method[2]

4.2.1 Prepare specimens as outlined in paragraphs 4.1.1 and 4.1.2.

4.2.2 Determine hardness at three positions, as shown in Fig. 2, using a Knoop indenter with a 500 g load or Vickers DPH with 300 g load.

4.2.3 Interpret hardness readings as follows:

(a) A decrease of more than 30 hardness points from Position 1 to Position 2 indicates that the part does not conform to the classification specified.

(b) An increase of more than 30 points between Position 1 and Position 3 is regarded as "carburization," and indicates that part does not conform to the classification specified.

NOTE: Careful differentiation must be made between an increase in hardness caused by carburization or by cold working the surface (such as from thread rolling).

[1] Same as outlined in SAE J419, except "Specimen."

[2] Hardness Method applicable only for threads with pitches 1.25 mm and larger, and for all sizes of threaded products having base metal hardness Rockwell C40 and higher and surface hardness Rockwell 30N 60 and higher.

The ϕ symbol is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.