Standard Specification for
Seamless Carbon-Molybdenum Alloy-Steel Boiler and
Superheater Tubes

This standard is issued under the fixed designation A209/A209M; 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 (´) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers several grades of minimum-wall-thickness, seamless, carbon-molybdenum alloy-steel, boiler and superheater tubes.

1.2 This specification covers tubes ½ to 5 in. [12.7 to 127 mm] inclusive, in outside diameter and 0.035 to 0.500 in. [0.9 to 12.7 mm], inclusive, in minimum wall thickness.

1.3 An optional supplementary requirement is provided and, when desired, shall be so stated in the order.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. The inch-pound units shall apply unless the “M” designation of this specification is specified in the order.

2. Referenced Documents

2.1 ASTM Standards:
A1016/A1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

3. General Requirements

3.1 Product furnished under this specification shall conform to the requirements of Specification A1016/A1016M, includ-

4. Materials and Manufacture

4.1 Steelmaking Practice—The steel shall be killed.

4.2 The tubes shall be made by the seamless process and shall be either hot-finished or cold-finished, as specified.

4.3 Heat Treatment—Hot-finished tubes shall be heat treated at a temperature of 1200 °F [650 °C] or higher. Cold-finished tubes shall, after the final cold finishing, be heat treated at a temperature of 1200 °F [650 °C] or higher, or tubing may be furnished in the full-annealed, isothermal annealed, or normalized and tempered condition. If furnished in the normalized and tempered condition, the minimum tempering temperature shall be 1200 °F [650 °C].

5. Chemical Composition

5.1 The steel shall conform to the requirements given in Table 1.

5.2 Product Analysis

5.2.1 An analysis shall be made by the manufacturer of one billet or one tube from each heat. The chemical composition thus determined, shall conform to the requirements given in Table 1.

5.2.2 If the original test for product analysis fails, retests of two additional billets or tubes shall be made. Both retests for the elements in question shall meet the requirements of the specification; otherwise all remaining material in the heat or lot (See 7.1) shall be rejected or, at the option of the producer, each billet or tube may be individually tested for acceptance. Billets or tubes that do not meet the requirements of the specification shall be rejected.

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6. Mechanical Properties

6.1 Tensile Requirements

6.1.2 Table 3 gives the computed minimum elongation values for each ½-in. [0.8-mm] decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

\[ E = 48t + 15.00 \quad [E = 1.87t + 15.00] \quad (1) \]

where:

\[ E = \text{elongation in 2 in. [50 mm]}, \% \text{, and}, \]
\[ t = \text{actual thickness of specimen, in. [mm]}. \]

6.2 Hardness Requirements—The tubes shall have a hardness not exceeding the values given in Table 4.

6.3 Number of Tests

6.3.1 Tension Test—One tension test shall be made on a specimen for lots of not more than 50 tubes. Tension tests shall be made on specimens from two tubes for lots of more than 50 tubes (See 7.2).

6.3.2 Flattening Test—One flattening test shall be made on specimens from each end of one finished tube, not the one used for the flaring test, from each lot (See 7.1).

6.3.3 Flaring Test—One flaring test shall be made on specimens from each end of one finished tube, not the one used for the flattening test, from each lot (See 7.1).

6.3.4 Hardness Test—Brinell or Rockwell hardness tests shall be made on specimens from two tubes from each lot (See 7.2).

### Table 1 Chemical Composition Requirements

<table>
<thead>
<tr>
<th>Element</th>
<th>Grade T1</th>
<th>Composition, %</th>
<th>Grade T1a</th>
<th>Composition, %</th>
<th>Grade T1b</th>
<th>Composition, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>0.10–0.20</td>
<td>0.15–0.25</td>
<td>0.14 max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>0.30–0.80</td>
<td>0.30–0.80</td>
<td>0.30–0.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphorus, max</td>
<td>0.025</td>
<td>0.025</td>
<td>0.025</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfur, max</td>
<td>0.025</td>
<td>0.025</td>
<td>0.025</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silicon</td>
<td>0.10–0.50</td>
<td>0.10–0.50</td>
<td>0.10–0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.44–0.65</td>
<td>0.44–0.65</td>
<td>0.44–0.65</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 2 Tensile Requirements

<table>
<thead>
<tr>
<th>Tensile strength, min, ksi [MPa]</th>
<th>Grade T1</th>
<th>Grade T1a</th>
<th>Grade T1b</th>
</tr>
</thead>
<tbody>
<tr>
<td>55 [380]</td>
<td>53 [365]</td>
<td>60 [415]</td>
<td></td>
</tr>
</tbody>
</table>

For longitudinal strip tests the deduction shall be made for each ½-in. [0.8-mm] decrease in wall thickness below ½-in. [8 mm] from the basic minimum elongation of the following percentage:

When standard round 2-in. or 50-mm gage length or smaller proportionally sized specimen with the gage length equal to 4D (four times the diameter) is used:

<table>
<thead>
<tr>
<th>Size of Tube</th>
<th>Size of Lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 in. [50.8 mm] and over in outside diameter and 0.200 in. [5.1 mm] and over in wall thickness</td>
<td>not more than 50 tubes</td>
</tr>
<tr>
<td>2 in. [50.8 mm] and over in outside diameter and under 0.200 in. [5.1 mm] in wall thickness</td>
<td>not more than 75 tubes</td>
</tr>
<tr>
<td>Less than 2 in. [50.8 mm] but over 1 in. [25.4 mm] in outside diameter</td>
<td>not more than 75 tubes</td>
</tr>
<tr>
<td>1 in. [25.4 mm] or less in outside diameter</td>
<td>not more than 125 tubes</td>
</tr>
</tbody>
</table>
8. Forming Operations

8.1 Tubes when inserted in the boiler shall stand expanding and beading without showing cracks or flaws. Superheater tubes when properly manipulated shall stand all forging, welding, and bending operations necessary for application without developing defects.

9. Product Marking

9.1 In addition to the marking prescribed in Specification A1016/A1016M, the marking shall include whether the tube is hot-finished or cold-finished.

10. Keywords

10.1 boiler tubes; carbon-molybdenum; seamless steel tube; steel tube; superheater tubes

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirement shall apply only when specified by the purchaser in the inquiry, contract, or order.

S1. Surface Condition

S1.1 If pickling or shot blasting, or both, are required, this shall be specifically stated in the order. Details of this supplemental requirement shall be agreed upon between the manufacturer and the purchaser.