SPECIFICATION FOR SEAMLESS CARBON-MOLYBDENUM ALLOY-STEEL BOILER AND SUPERHEATER TUBES

SA-209/SA-209M

Identical with ASTM Specification A 209/A 209M-95)

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 Document

2.1 *ASTM Standard:*

A 450/A 450M Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes

3. Ordering Information

3.1 Orders for material under this specification shall include the following as required, to describe the desired material adequately:

3.1.1 Quantity (feet, metres, or number of lengths),

3.1.2 Names of material (seamless tubes),

3.1.3 Grade (Table 1),

3.1.4 Manufacture (hot-finish or cold-finished),

3.1.5 Size (outside diameter and minimum wall thickness),

3.1.6 Length (Specific or random),

3.1.7 Test reported required (see Certification Section of Specification A 450/A450M),

3.1.8 Specification designation, and

3.1.9 Special requirements and any supplementary requirements selected.

4. General Requirements

4.1 Material furnished under this specification should conform to the applicable requirements of the current edition of Specification A 450/A 450M, unless otherwise provided herein.

5. Manufacture

5.1 *Steelmaking Practice* — The steel shall be killed.

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

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6. Heat Treatment

6.1 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].

7. Chemical Composition

7.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 1.

8. Product Analysis

8.1 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 requirement specified.

8.2 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 (Note 1) shall be rejected or, at the option of the producer, each billet or tube may be individually tested for acceptance. Billets or tubes which do not meet the requirements of the specification shall be rejected.

NOTE 1 — For flattening and flaring requirements, the term *lot* applies to all tubes prior to cutting of the same nominal size and wall thickness which are produced from the same heat of steel. When final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and from the same heat which are heat treated in the same furnace charge. When the final heat treatment is in a continuous furnace, the number of tubes of the same size and from the same heat in a lot shall be determined from the size of the tubes as prescribed in Table 2.

NOTE 2 — For tension and hardness test requirements, the term *lot* applies to all tubes prior to cutting, of the same nominal diameter and wall thickness which are produced from the same heat of steel. When final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and the same heat which are heat treated in the same furnace charge. When the final heat treatment is in a continuous furnace, a lot shall include all tubes of the same size and heat, heat treated in the same furnace at the same temperature, time at heat, and furnace speed.

9. Tensile Requirements

9.1 The material shall conform to the requirements as to tensile properties prescribed in Table 3.

9.2 Table 4 gives the computed minimum elongation values for each $\frac{1}{32}$ in. [8.0 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:

$$E = 48t + 15.00 \; [E = 1.87t + 15.00] \qquad (1)$$

where:

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

10. Hardness Requirements

10.1 The tubes shall have a hardness not exceeding the values in Table 5.

11. Mechanical Tests Required

11.1 *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 (Note 2).

11.2 *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 (Note 1).

11.3 *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 (Note 1).

11.4 *Hardness Test* — Brinell or Rockwell hardness tests shall be made on specimens from two tubes from each lot (Note 2).

11.5 *Hydrostatic Test* — Each tube shall be subjected to the hydrostatic test, or, instead of this test a nondestructive electric test may be used when specified by the purchaser.

12. Forming Operations

12.1 Tubes when inserted in the boiler shall stand expanding and beading without showing cracks or flaws. Superheater tubes when properly manipulated shall stand

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all forging, welding and bending operations necessary for application without developing defects.

13. Product Marking

13.1 In addition to the marking prescribed in Specification A 450/A 450M, the marking shall include whether the tube is hot-finished or cold-finished.

14. Keywords

14.1 boiler tubes; carbon; seamless steel tube; steel tube; superheater tubes

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TABLE 1
CHEMICAL REQUIREMENTS

Element	Composition, %		
	Grade T1	Grade T1a	Grade T1b
Carbon	0.10–0.20	0.15–0.25	0.14 max
Manganese	0.30–0.80	0.30–0.80	0.30–0.80
Phosphorus, max	0.025	0.025	0.025
Sulfur, max	0.025	0.025	0.025
Silicon	0.10–0.50	0.10–0.50	0.10–0.50
Molybdenum	0.44–0.65	0.44–0.65	0.44–0.65

TABLE 2
NUMBER OF TUBES IN A LOT HEAT TREATED BY THE CONTINUOUS PROCESS

Size of Tube	Size of Lot
2 in. [50.8 mm] and over in outside diameter and 0.200 in. [5.1 mm] and over in wall thickness	not more than 50 tubes
2 in. [50.8 mm] and over in outside diameter and under 0.200 in. [5.1 mm] in wall thickness	not more than 75 tubes
Less than 2 in. [50.8 mm] but over 1 in. [25.4 mm] in outside diameter	not more than 75 tubes
1 in. [25.4 mm] or less in outside diameter	not more than 125 tubes

TABLE 3
TENSILE REQUIREMENTS

	Grade T1	Grade T1b	Grade T1a
Tensile strength, min, ksi [MPa]	55 [380]	53 [365]	60 [415]
Yield strength, min, ksi [MPa]	30 [205]	28 [195]	32 [220]
Elongation in 2 in. or 50 mm, min, %	30	30	30
For longitudinal strip tests a deduction shall be made for each $^{1}/_{32}$ in. [0.8 mm] decrease in wall thickness below $^{5}/_{16}$ in. [8 mm] from the basic minimum elongation of the following percentage	1.50[A]	1.50[A]	1.50[A]
When standard round 2 in. or 50 mm gage length or smaller proportionally sized specimen with the gage length equal to 4*D* (four times the diameter) is used	22	22	22

[A] Table 4 gives the computed minimum values.

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TABLE 4
COMPUTED MINIMUM VALUES

Wall Thickness		Elongation in 2 in. or mm, min, %[A]
in.	mm	
5/16 (0.312)	8	30
9/32 (0.281)	7.2	29
1/4 (0.250)	6.4	27
7/32 (0.219)	5.6	26
3/16 (0.188)	4.8	24
5/32 (0.156)	4	22
1/8 (0.125)	3.2	21
3/32 (0.094)	2.4	20
1/16 (0.062)	1.6	18

[A] Calculated elongation requirements shall be rounded to the nearest whole number.

TABLE 5
HARDNESS REQUIREMENTS

	Brinell Hardness Number (Tubes 0.200 in. [5.1 mm] and over in Wall Thickness)	Rockwell Hardness Number (Tubes less than 0.200 in. [5.1 mm] in Wall Thickness)
Grade T1	146	B80
Grade T1a	153	B81
Grade T1b	137	B77

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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.

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