SPECIFICATION FOR SEAMLESS COLD-DRAWN INTERMEDIATE ALLOY-STEEL HEAT-EXCHANGER AND CONDENSER TUBES

SA-199/SA-199M

(Identical with ASTM Specification A 199/A 199M-92)

1. Scope

1.1 This specification covers several grades of minimum-wall-thickness, chromium-molybdenum and chromium-molybdenum-silicon, seamless, cold-drawn, intermediate alloy steel tubes for heat exchangers, condensers, and similar heat transfer apparatus.

1.2 The tubing sizes usually furnished to this specification are $\frac{1}{8}$ to 3 in. [3.2 to 76.2 mm] in outside diameter. Tubing having other dimensions may be furnished provided such tubes comply with all other requirements of this specification.

1.3 Mechanical property requirements do not apply to tubing smaller than $\frac{1}{8}$ in. [3.2 mm] in inside diameter or 0.015 in. [0.4 mm] in thickness.

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. General Requirements

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

4. Ordering Information

4.1 Orders for material under this specification should include the following, as required, to describe the desired material adequately.

4.1.1 Quantity (feet, metres, or number of lengths).

4.1.2 Name of material (seamless tubes),

4.1.3 Grade (Table 1),

4.1.4 Manufacture (cold drawn),

4.1.5 Size (outside diameter and minimum wall thickness),

4.1.6 Length (specific or random),

4.1.7 Chemical composition (heat or product),

4.1.8 Test report required (see Certification Section of Specification A 450/A 450M),

4.1.9 Optional requirements (of 12.5),

4.1.10 Specification designation, and

4.1.11 Special requirements.

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5. Manufacture

5.1 Tubes shall be made by the seamless process and shall be cold drawn.

6. Heat Treatment

6.1 After the final cold-draw pass, Grade T-11 tubes shall be heat treated at 1200°F [650°C] or higher and all other grades except T91 shall be heat treated at 1250°F [675°C] or higher. For Grade T91, the tubes shall be normalized from the temperature range of 1900–2000°F [1040–1095°C] and tempered at 1305°F (730°C) minimum.

7. Surface Condition

7.1 The tubes shall be free of scale. A slight amount of oxidation will not be considered as scale.

8. Chemical Composition

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

9. Product Analysis

9.1 An analysis shall be made of one billet or tube from each heat. The chemical composition thus determined shall conform to the requirements specified.

9.2 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 that 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 that 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 3.

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 that 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.

10. Tensile Requirements

10.1 The material shall conform to the requirements as to tensile properties prescribed in Table 2.

11. Hardness Requirements

11.1 The tubes fabricated from Grades T3b, T4, T5, T11, T21, and T22 shall have a hardness number not exceeding 85 HRB. For tubes fabricated from Grade T9, the maximum hardness shall be 89 HRB and for Grade T91 the maximum hardness shall be 98 HRB.

12. Mechanical Tests Required

12.1 *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).

12.2 *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).

12.3 *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).

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

12.5 *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.

13. Product Marking

13.1 In addition to the marking prescribed in Specification A 450/A 450M, the marking shall include the name and order number of the purchaser.

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TABLE 1
CHEMICAL REQUIREMENTS

	Composition, %							
Grade	Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon	Chromium	Molybdenum	Others
T4	0.05 min–0.15 max	0.30–0.60	0.025	0.025	0.50–1.00	2.15–2.85	0.44–0.65	. . .
T5	0.15 max	0.30–0.60	0.025	0.025	0.50 max	4.00–6.00	0.45–0.65	. . .
T9	0.15 max	0.30–0.60	0.025	0.025	0.25–1.00	8.00–10.00	0.90–1.10	. . .
T11	0.05 min–0.15 max	0.30–0.60	0.025	0.025	0.50–1.00	1.00–1.50	0.44–0.65	. . .
T21	0.05 min–0.15 max	0.30–0.60	0.025	0.025	0.50 max	2.65–3.35	0.80–1.06	. . .
T22	0.05 min–0.15 max	0.30–0.60	0.025	0.025	0.50 max	1.90–2.60	0.87–1.13	. . .
T91	0.08–0.12	0.30–0.60	0.020	0.010	0.20–0.50	8.00–9.50	0.85–1.05	Ni 0.40 max; V 0.18–0.25; Cb 0.06–0.10; N 0.03–0.07; Al 0.04 max

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TABLE 2
TENSILE REQUIREMENTS

	All Grades Except T91	Grade T91
Tensile strength, min., ksi [MPa]	60 [415]	85 [585]
Yield strength, min., ksi [MPa]	25 [170]	60 [415]
Elongation in 2 in., or 50 mm, min., %	30	20
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 points	1.50[1]	1.00[1]
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	

NOTES:
(1) The following table gives the computed minimum values.
(2) Calculated elongation requirements shall be rounded to the nearest whole number.

Wall Thickness, in. [mm]	Elongation in 2 in.,	or 50 mm, min., %[2]
$^{5}/_{16}$ (0.312) [8]	30	20
$^{9}/_{32}$ (0.281) [7.2]	28	19
$^{1}/_{4}$ (0.250) [6.4]	27	18
$^{7}/_{32}$ (0.219) [5.6]	26	17
$^{3}/_{16}$ (0.188) [4.8]	24	16
$^{5}/_{32}$ (0.156) [4]	23	15
$^{1}/_{8}$ (0.125) [3.2]	21	14
$^{3}/_{32}$ (0.094) [2.4]	20	13
$^{1}/_{16}$ (0.062) [1.6]	18	12
0.062 to 0.035 [1.6 to 0.9], excl	17	12
0.035 to 0.022 [0.9 to 0.6], excl	16	11
0.022 to 0.015 [0.6 to 0.4], incl	16	11

GENERAL NOTE: The above table gives the computed minimum elongation values for each $^{1}/_{32}$ 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:

For all Grades except T91: $E = 48t + 15.00$
[$E = 1.87t + 15.00$]
For Grade T91: $E = 32t + 10.00$

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

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TABLE 3
NUMBER OF TUBES IN A LOT HEAT
TREATED BY THE CONTINUOUS PROCESS

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

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