Designation: B163 – 22

Standard Specification for Seamless Nickel and Nickel Alloy Condenser and Heat-Exchanger Tubes[1]

This standard is issued under the fixed designation B163; 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 (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification[2] covers seamless tubes of nickel and nickel alloys, as shown in Table 1, for use in condenser and heat-exchanger service.

1.2 This specification covers outside diameter and average wall, or outside diameter and minimum wall tube.

1.2.1 The sizes covered by this specification are 3 in. (76.2 mm) and under in outside diameter with minimum wall thicknesses of 0.148 in. (3.76 mm) and under, and with average wall thicknesses of 0.165 in. (4.19 mm) and under.

1.3 Tube shall be furnished in the alloys and conditions as shown in Table 2. For small diameter and light wall tube (converter sizes), see Appendix X2.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 The following safety hazards caveat pertains only to the test method portion, Section 12, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Safety Data Sheet (SDS) for this product/material as provided by the manufacturer, to establish appropriate safety, health, and environmental practices, and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

B829 Specification for General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube

B880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

E8/E8M Test Methods for Tension Testing of Metallic Materials

E18 Test Methods for Rockwell Hardness of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E76 Test Methods for Chemical Analysis of Nickel-Copper Alloys (Withdrawn 2003)[4]

E112 Test Methods for Determining Average Grain Size

E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

E1473 Test Methods for Chemical Analysis of Nickel, Cobalt and High-Temperature Alloys

2.2 *Federal Standards:*[5]

Fed. Std. No. 102 Preservation, Packaging and Packing Levels

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

Fed. Std. No. 182 Continuous Identification Marking of Nickel and Nickel-Base Alloys

2.3 *Military Standard:*[5]

MIL-STD-129 Marking for Shipment and Storage

[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.07 on Refined Nickel and Cobalt and Their Alloys.

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SB-163 in Section II of that Code.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] The last approved version of this historical standard is referenced on www.astm.org.

[5] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.

***A Summary of Changes section appears at the end of this standard**

TABLE 1 Chemical Requirements[A]

Element	Composition,%									
	N02200	N02201	N04400	N06025	N06045	N06600	N06601	N06603	N06686	N06690
Nickel	99.0 min[B]	99.0 min[B]	63.0 min[B]	remainder[B]	45.0 min[B]	72.0 min[B]	58.0–63.0	remainder[B]	remainder[B]	58.0 min[B]
Copper	0.25	0.25	28.0 – 34.0	0.1	0.3	0.5	1.0	0.5	...	0.5
Molybdenum	...	...	...	...	...	...	...	...	15.0 – 17.0	...
Iron	0.40	0.40	2.5	8.0 – 11.0	21.0 – 25.0	6.0 – 10.0	remainder[B]	8.0 – 11.0	5.0	7.0 – 11.0
Manganese	0.35	0.35	2.0	0.15	1.0	1.0	1.0	0.15	0.75	0.5
Carbon	0.15	0.02	0.3	0.15 – 0.25	0.05 – 0.12	0.15	0.10	0.20 – 0.40	0.010	0.05
Silicon	0.35	0.35	0.5	0.5	2.5 – 3.0	0.5	0.5	0.5	0.08	0.5
Sulfur	0.01	0.01	0.024	0.010	0.010	0.015	0.015	0.010	0.02	0.015
Chromium	...	...	...	24.0 – 26.0	26.0 – 29.0	14.0 – 17.0	21.0 – 25.0	24.0 – 26.0	19.0 – 23.0	27.0 – 31.0
Aluminum	...	...	...	1.8 – 2.4	...	...	1.0 – 1.7	2.4 – 3.0	...	...
Titanium	...	...	...	0.1 – 0.2	...	...	...	0.01 – 0.25	0.02 – 0.25	...
Phosphorus	...	...	...	0.020	0.020	...	...	0.02	0.04	...
Cerium	...	...	...	...	0.03 – 0.09	...	...	...	...	...
Zirconium	...	...	...	0.01 – 0.10	...	...	...	0.01 – 0.10	...	...
Yttrium	...	...	...	0.05 – 0.12	...	...	...	0.01 – 0.15	...	...
Boron	...	...	...	...	...	...	...	...	...	...
Cobalt	...	...	...	...	...	...	...	...	...	...
Niobium[C]	...	...	...	...	...	...	...	...	...	...
Tungsten	...	...	...	...	...	...	...	...	3.0 – 4.4	...
Nitrogen	...	...	...	...	...	...	...	...	...	...

[A] Maximum unless range or minimum is given. Where ellipses (...) appear in this table, there is no requirement and analysis for the element need not be determined or reported.
[B] Element shall be determined arithmetically by difference.
[C] Columbium and niobium are interchangeable names for the same element and both names are acceptable for use in B02.07 specifications.

TABLE 1 Chemical Requirements[A] *(continued)*

Element	Composition, %									
	N06696	N06699	N06845	N08120	N08800	N08801	N08810	N08811	N08825	N08935
Nickel	remainder[B]	remainder[B]	44.0 – 50.0	35.0 – 39.0	30.0 – 35.0	30.0 – 34.0	30.0 – 35.0	30.0 – 35.0	38.0 – 46.0	34.0 – 36.0
Copper	1.5 – 3.0	0.50	2.0 – 4.0	0.50	0.75	0.50	0.75	0.75	1.5 – 3.0	0.4
Molybdenum	1.0 – 3.0	...	5.0 – 7.0	2.50	...	...	...	...	2.5 – 3.5	6.1 – 7.1
Iron	2.0 – 6.0	2.5	remainder[B]	remainder[B]	39.5 min[B]	39.5 min[B]	39.5 min[B]	39.5 min[B]	22.0 min[B]	remainder[B]
Manganese	1.0	0.50	0.5	1.5	1.5	1.50	1.5	1.5	1.0	1.2
Carbon	0.15	0.005 – 0.10	0.05	0.02 – 0.10	0.10	0.10	0.05 – 0.10	0.06 – 0.10	0.05	0.030
Silicon	1.0 – 2.5	0.50	0.5	1.0	1.0	1.00	1.0	1.0	0.5	0.5
Sulfur	0.010	0.01	0.010	0.03	0.015	0.015	0.015	0.015	0.03	0.020
Chromium	28.0 – 32.0	26.0 – 30.0	20.0 – 25.0	23.0 – 27.0	19.0 – 23.0	19.0 – 22.0	19.0 – 23.0	19.0 – 23.0	19.5 – 23.5	26.0 – 28.0
Aluminum	...	1.9 – 3.0	...	0.40	0.15 – 0.60	...	0.15 – 0.60	0.25 – 0.60[D]	0.2	...
Titanium	1.0	0.60	...	0.20	0.15 – 0.60	0.75 – 1.5	0.15 – 0.60	0.25 – 0.60[D]	0.6 – 1.2	...
Phosphorus	...	0.02	...	0.04	0.045	...	0.045	0.045	...	0.030
Cerium	...	...	...	...	...	...	...	...	...	...
Zirconium	...	0.10	...	...	...	...	...	...	...	...
Yttrium	...	...	...	...	...	...	...	...	...	...
Boron	...	0.008	...	0.010	...	...	...	...	...	...
Cobalt	...	...	...	3.0	...	...	...	...	...	...
Niobium[C]	...	0.50	...	0.4 – 0.9	...	...	...	...	...	...
Tungsten	...	...	2.0 – 5.0	2.50	...	...	...	...	...	...
Nitrogen	...	0.05	...	0.13 – 0.30	...	...	...	...	...	0.25 – 0.36

[A] Maximum unless range or minimum is given. Where ellipses (...) appear in this table, there is no requirement and analysis for the element need not be determined or reported.
[B] Element shall be determined arithmetically by difference.
[C] Columbium and niobium are interchangeable names for the same element and both names are acceptable for use in B02.07 specifications.
[D] Alloy UNS N08811: Al + Ti = 0.85 – 1.20.