# ASTM B164 / ASME SB164

## SPECIFICATION FOR NICKEL-COPPER ALLOY ROD, BAR, AND WIRE

This specification covers nickel-copper alloys UNS N04400 and N04405 in the form of hot-worked and coldworked rod and bar.

**A. Chemical Composition :-**

The material shall conform to the composition limits specified in Table 1.

**Table 1**

| Element | UNS N04400 | UNS N04405 |
|---|---|---|
| Nickel[A] | 63.0 min | 63.0 min |
| Copper | 28.0 min, 34.0 max | 28.0 min, 34.0 max |
| Iron | 2.5 max | 2.5 max |
| Manganese | 2.0 max | 2.0 max |
| Carbon | 0.3 max | 0.3 max |
| Silicon | 0.5 max | 0.5 max |
| Sulfur | 0.024 max | 0.025 min,0.060 max |

[A] *Element shall be determined arithmetically by difference.*

**B. Mechanical Properties :-**

The material shall conform to the mechanical properties specified in Table 2 for rod or bar, or in Table 3 for wire.

**Table 2**

| Condition and Diameter or Distance Between Parallel Surfaces, in.(mm) | Tensile Strength min, psi(MPa) | Yield Strength (0.2% offset) min., psi(MPa) | Elongation in 2 in. or 50 mm (or 4D), min, % | Rockwell Hardness (or equivalent) |
|---|---|---|---|---|
| UNS N04400 | | | | |
| Cold-worked (as worked): | | | | |
| Rounds under 1⁄2 (12.7) | 110000 (760) | 85000 (585) | 8[A] | . . . |
| Squares, hexagons, and rectangles under 1⁄2 (12.7) | 85000 (585) | 55000 (380) | 10[A] | . . . |
| Cold-worked (stress-relieved): | | | | |
| Rounds under 1⁄2 (12.7) | 84000 (580) | 50000 (345) | 10[A] | . . . |
| Rounds, 1⁄2 to 3 (1⁄2) (12.7 to 88.9), incl | 87000 (600) | 60000 (415) | 20 | . . . |
| Rounds, over 3(1⁄2) to 4 (88.9 to 101.6), incl | 84000 (580) | 55000 (380) | 20 | . . . |
| Squares, hexagons and rectangles, 2 (50.8) and under | 84000 (580) | 50000 (345) | 20[A,B] | . . . |
| Squares, hexagons and rectangles, over 2 (50.8) to 3(1⁄8) (79.4), incl | 80000 (552) | 50000 (345) | 20 | . . . |
| H ot-worked (as worked or stress-relieved): | | | | |
| Rounds, squares, and rectangles up to 12 (305), incl, and hexagons 2(1⁄8) (54) and under | 80000 (552) | 40000 (276) | 30[C] | . . . |
| Rounds, squares, and rectangles over 12 (305) to 14 (356), incl | 75000 (517) | 40000 (276) | 30 | . . . |
| Hexagons over 2(1⁄8) (54) to 4 (102), incl | 75000 (517) | 30000 (207) | 25 | . . . |
| Rings and disks | . . . | . . . | . . . | B 75 to B 95 |

| | | | | |
|---|---|---|---|---|
| Hot-worked (annealed) or cold-worked (annealed) : | | | | |
| Rod and bar, all sizes | 70000 (480) | 25000 (170) | 35 | . . . |
| Rings and disks | . . . | ... | ... | B 60 to B 75 |
| Forging quality:[D] | | | | |
| all sizes | . . . | . . . | ... | . . . |
| UNS N04405 | | | | |
| Cold-worked (as worked or stress-relieved) : | | | | |
| Rounds, under 1⁄2 (12.7) | 85000 (585) | 50000 (345) | 8[A] | . . . |
| Rounds, 1⁄2 (12.7) to 3 (76.2), incl | 85000 (585) | 50000 (345) | 15 | . . . |
| Rounds, over 3 (76.2) to 4 (101.6), incl | 80000 (552) | 50000 (345) | 15 | . . . |
| Hexagons and squares 2 (50.8) and under | 85000 (585) | 50000 (345) | 15[A,B] | . . . |
| Hexagons and squares over 2 (50.8) to 3(1⁄8) (79.4), incl | 80000 (552) | 45000 (310) | 15 | . . . |
| Hot-worked (as hot-worked or stress-relieved): | | | | |
| Rounds 3 (76.2) and less | 75000 (517) | 35000 (241) | 30 | . . . |
| Hexagons and squares, 2(1⁄8) (54) and less | 75000 (517) | 35000 (241) | 30 | . . . |
| Hexagons and squares, over 2(1⁄8) (54) to 4 (101.6), incl | 70000 (480) | 30000 (207) | 25 | . . . |
| Hot-worked (annealed) or cold-worked (annealed): | | | | |
| Rod and Bar, All sizes | 70000 (480) | 25000 (170) | 35 | . . . |

[A] *Not applicable to diameters or cross sections under 3⁄32 in. (2.4 mm).*
[B] *For sections under 1⁄2 in. (12.7 mm), the elongation shall be 10% min.*
[C] *For hot-worked flats 5⁄16 in. (7.9 mm) and under in thickness the elongation shall be 20% min.*
[D] *Forging quality is furnished to chemical requirements and surface inspection only. No tensile properties are required.*

**Table 3[A]**

| Alloy Condition and Size, in. (mm) | Tensile Strength, psi (MPa) | | Wrapping Test |
|---|---|---|---|
| | Min | Max | |
| UNS N04400 and N04405: | | | |
| Annealed, all sizes | 70000 (483) | 85000 (586) | All wire shall wrap around a rod of the |
| No.0 temper, under 1⁄2 (12.7) | 80000 (552) | 95000 (655) | same diameter as the wire without |
| No. 1 temper, under 1⁄2 (12.7) | 90000 (621) | 110000 (758) | cracking |
| UNS N04400: | | | |
| Regular temper, under 1⁄2 (12.7) | 110000 (758) | 140000 (965) | All wire up to0.2294 in. (5.84 mm) |
| Regular temper, 1⁄2 (12.7) and over Spring temper | 90000 (621) | 130000 (896) | inclusive, shall wrap around a rod of the same diameter as the wire without |
| 0.028 (0.71) and less | 165000 (1138) | ... | cracking. wire over0.2294 in. |
| Over0.028 (0.71) to0.057 (1.45), incl | 160000 (1103) | ... | (5.84 mm) diameter shall wrap around |
| Over0.057 (1.45) to0.114 (2.90), incl | 150000 (1034) | . . . | a rod of twice the wire diameter |
| Over0.114 (2.90) to0.312 (7.92), incl | 140000 (965) | ... | without cracking. |
| Over0.312 (7.92) to0.375 (9.53), incl | 135000 (931) | . . . | . . . |
| Over0.375 (9.53) to0.500 (12.7), incl | 130000 (896) | . . . | . . . |
| Over0.500 (12.7) to0.563 (14.3), incl | 120000 (827) | ... | . . . |

[A] Properties are not applicable to wire after straightening and cutting.

**C. Length :-**

The permissible variations in length of cold-worked and hot-worked rod and bar shall be as prescribed in Table 4.

**Table 4**

| | |
|---|---|
| Random mill lengths: | |
| Hot-worked | 6 to 24 ft (1.83 to 7.31 m) long with not more than 25 weight % between 6 and 9 ft (1.83 and 2.74 m)[A] |
| Cold-worked | 6 to 20 ft (1.83 to 6.1 m) long with not more than 25 weight % between 6 and 10 ft (1.83 and 3.05 m). |
| Multiple lengths | Furnished in multiples of a specified unit length, within the length limits indicated above. For each multiple, an allowance of 1⁄4 in. (6.4 mm) will be made for cutting, unless otherwise specified. At the manufacturer's option, individual specified unit lengths may be furnished. |
| Nominal lengths | Specified nominal lengths having a range of not less than 2 ft (610 mm) with no short lengths allowed[B] |
| Cut lengths | A specified length to which all rods and bars will be cut with a permissible variation of plus 1⁄8 in. (3.2 mm), minus0 for sizes 8 in. (203 mm) and less in diameter or distance between parallel surfaces. For larger sizes, the permissible variation shall be +1⁄4 in. (6.4 mm), −0. |

[A] *For hot-worked sections weighing over 25 lb/ft (37 kg/m) and for smooth forged products, al l sections, short lengths down to 2 ft (610 mm) may be furnished.*

[B] *For col d-worked rods and bars under 1/2 in. (12.7 mm) in diameter or di stance between parallel surfaces ordered to nominal or stock lengths with a 2-ft (610-mm) range, at least 93% of such material shall be within the range specified; the balance may be in shorter lengths but in no case shall lengths less than 4 ft (1220 mm) be furnished*.

**D. Mechanical Tests :-**

1. Chemical Analysis.
2. Tension.
3. Wrapping.
4. Hardness.

**E. Test Methods :-**

The chemical composition, mechanical, and other properties of the material as enumerated in this specification shall be determined, in case of disagreement, in accordance with the following methods:

| Test | ASTM Designation |
|---|---|
| Chemical Analysis | E 76, E 1473 |
| Tension | E 8 |
| Rockwell Hardness | E 18 |
| Hardness Conversion | E 140 |
| Rounding Procedure | E 29 |

**F. Supplementary Requirements :-**

1. Chemical Composition :-

   The material shall conform to the composition limits specified in Table 1 except as specified in Table 5A or Table 5B.

**Table 5A**

| Element | UNS N04400 |
|---|---|
| Carbon | 0.2 max. |
| Sulfur | 0.015 max. |
| Aluminum | 0.5 max. |
| Lead | 0.006 max. |
| Tin | 0.006 max. |
| Zinc | 0.02 max. |
| Phosphorus | 0.02 max. |

**Table 5B**

| Element | UNS N04405 |
|---|---|
| Aluminum | 0.5 max. |
| Lead | 0.006 max. |
| Tin | 0.006 max. |
| Zinc | 0.02 max. |
| Phosphorus | 0.02 max. |

2. Non-destructive Tests :-
    i. Ultrasonic Tests:
        a. Shear wave test.
        b. Longitudinal wave test.
    ii. Liquid Penetrant Inspection

## Related Keywords

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