



Designation: B 581 – 97

## Standard Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Rod<sup>1</sup>

This standard is issued under the fixed designation B 581; 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.

### 1. Scope

1.1 This specification<sup>2</sup> covers rod of Ni-Cr-Fe-Mo-Cu alloys (UNS N06007, N06975, N06985, N06030, and N08031)\* as shown in Tables 1-3, for use in general corrosive service.

1.2 The following products are covered under this specification:

1.2.1 Rods  $\frac{5}{16}$  to  $\frac{3}{4}$  in. (7.94 to 19.05 mm) excl in diameter, hot- or cold-finished, solution annealed and pickled or mechanically descaled.

1.2.2 Rods  $\frac{3}{4}$  to  $3\frac{1}{2}$  in. (19.05 to 88.9 mm) incl in diameter, hot- or cold-finished, solution annealed, ground or turned.

1.3 The values stated in inch-pound units are to be regarded as the standard.

### 2. Referenced Documents

2.1 *ASTM Standards:*

E 8 Test Methods for Tension Testing of Metallic Materials<sup>3</sup>

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>4</sup>

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition<sup>5</sup>

E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys<sup>5</sup>

### 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *rod*—material of round solid section furnished in straight lengths.

### 4. Ordering Information

4.1 Orders for material under this specification shall include the following information:

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B-2 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SB-581 in Section II of that Code.

\* New designation established in accordance with ASTM E527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 03.05.

4.1.1 *Alloy*—Table 1.

4.1.2 *Dimensions*—Nominal diameter and length. The shortest useable multiple length shall be specified (Table 4).

4.1.3 *Certification*—State if certification or a report of test results is required (Section 16).

4.1.4 *Purchaser Inspection*—State which tests or inspections are to be witnessed (Section 14).

4.1.5 *Samples for Product (Check) Analysis*—State whether samples shall be furnished (10.2.2).

### 5. Chemical Composition

5.1 *Heat Analysis*—The material shall conform to the composition limits specified in Table 1.

5.2 *Product (Check) Analysis*—If a product (check) analysis is made by the purchaser, the material shall conform to the requirements specified in Table 1 subject to the permissible tolerances in Table 2.

### 6. Mechanical and Other Requirements

6.1 The material shall conform to the requirements of Table 3.

### 7. Straightness

7.1 The maximum curvature (depth of cord) shall not exceed 0.050 in. multiplied by the length in feet (0.04 mm multiplied by the length in centimetres).

### 8. Permissible Variations in Dimensions

8.1 *Diameter*—The permissible variations from the specified diameter and out-of-roundness shall be as prescribed in Table 4.

8.2 *Machining Allowances*—When the surfaces of finished material are to be machined, the following allowances are suggested for normal machining operations:

8.2.1 *As-Finished Rounds (Annealed and Descaled)*—For diameters of  $\frac{5}{16}$  to  $1\frac{1}{16}$  in. (7.94 to 17.46 mm) incl, an allowance of  $\frac{1}{16}$  in. (1.59 mm) on the diameter should be made for finish machining.

8.3 *Length*—The permissible variations in length of finished rods shall be as prescribed in Table 5. Unless otherwise specified, random mill lengths shall be furnished. Rods ordered to random or nominal lengths shall be furnished with either cropped or saw-cut ends; material ordered to cut lengths shall be furnished with square saw-cut or machined ends. Where



**TABLE 1 Chemical Requirements**

| Element              | Composition Limits, %  |                        |                        |                        |                        |
|----------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
|                      | Alloy N06007           | Alloy N06975           | Alloy N06985           | Alloy N06030           | Alloy N08031           |
| Nickel               | remainder <sup>A</sup> | 47.0–52.0              | remainder <sup>A</sup> | remainder <sup>A</sup> | 30.0–32.0              |
| Chromium             | 21.0–23.5              | 23.0–26.0              | 21.0–23.5              | 28.0–31.5              | 26.0–28.0              |
| Iron                 | 18.0–21.0              | remainder <sup>A</sup> | 18.0–21.0              | 13.0–17.0              | remainder <sup>A</sup> |
| Molybdenum           | 5.5–7.5                | 5.0–7.0                | 6.0–8.0                | 4.0–6.0                | 30–7.0                 |
| Copper               | 1.5–2.5                | 0.70–1.20              | 1.5–2.5                | 1.0–2.4                | 1.0–1.4                |
| Manganese            | 1.0–2.0                | 1.0 max                | 1.0 max                | 1.5 max                | 2.0 max                |
| Cobalt, max          | 2.5                    | ...                    | 5.0 max                | 5.0 max                | ...                    |
| Carbon, max          | 0.05                   | 0.03                   | 0.015 max              | 0.03 max               | 0.015                  |
| Tungsten             | 1.0 max                | ...                    | 1.5 max                | 1.5–4.0                | ...                    |
| Silicon, max         | 1.0                    | 1.0                    | 1.0 max                | 0.8 max                | 0.3                    |
| Phosphorus, max      | 0.04                   | 0.03                   | 0.04 max               | 0.04 max               | 0.020                  |
| Sulfur, max          | 0.03                   | 0.03                   | 0.03 max               | 0.02 max               | 0.010                  |
| Columbium + tantalum | 1.75–2.50              | ...                    | 0.50 max               | 0.30–1.50              | ...                    |
| Titanium             | ...                    | 0.7–1.5                | ...                    | ...                    | ...                    |
| Nitrogen             | 0.15–0.25              | ...                    | ...                    | ...                    | ...                    |

<sup>A</sup>See 13.1.1.

**TABLE 2 Product (Check) Analysis Tolerances**

|                      | Tolerances Over max or Under min, Limit, % |                                 |              |                                 |              |
|----------------------|--------------------------------------------|---------------------------------|--------------|---------------------------------|--------------|
|                      | Alloy N06007                               | Alloy N06975                    | Alloy N06985 | Alloy N06030                    | Alloy N08031 |
| Nickel               | ...                                        | 0.35                            | ...          | ...                             | 0.30         |
| Chromium             | 0.25                                       | 0.25 under min<br>0.30 over max | 0.25         | 0.30                            | 0.30         |
| Iron                 | 0.30                                       | ...                             | 0.30         | 0.15 under min<br>0.30 over max | 0.30         |
| Molybdenum           | 0.15                                       | 0.10 under min<br>0.15 over max | 0.15         | 0.10 under min<br>0.15 over max | 0.15         |
| Copper               | 0.04                                       | 0.04                            | 0.04         | 0.04                            | 0.04         |
| Manganese            | 0.03 under min<br>0.04 over max            | 0.03                            | 0.03         | 0.04                            | 0.04         |
| Cobalt               | 0.05                                       | ...                             | 0.05         | 0.05                            | ...          |
| Carbon               | 0.01                                       | 0.005                           | 0.005        | 0.01                            | 0.005        |
| Tungsten             | 0.04                                       | ...                             | 0.10         | 0.10 under min<br>0.15 over max | ...          |
| Silicon              | 0.05                                       | 0.05                            | 0.05         | 0.05                            | 0.03         |
| Phosphorus           | 0.005                                      | 0.005                           | 0.005        | 0.005                           | 0.005        |
| Sulfur               | 0.005                                      | 0.005                           | 0.005        | 0.003                           | 0.003        |
| Columbium + tantalum | 0.10                                       | ...                             | 0.05         | 0.05                            | ...          |
| Titanium             | ...                                        | 0.04 under min<br>0.05 over max | ...          | ...                             | ...          |
| Nitrogen             | ...                                        | ...                             | ...          | ...                             | 0.01         |

**TABLE 3 Mechanical Property Requirements**

| Alloy  | Specified Diameter, in. (mm)            | Tensile Strength min, psi (MPa) | Yield Strength (0.2 % Offset), min, psi (MPa) | Elongation in 2 in. or 50.8 mm or 4D <sup>A</sup> min |
|--------|-----------------------------------------|---------------------------------|-----------------------------------------------|-------------------------------------------------------|
| N06007 | 5/16 to 3/4 (7.94 to 19.05), incl       | 90 000 (621)                    | 35 000 (241)                                  | 35                                                    |
|        | Over 3/4 to 3 1/2 (19.05 to 88.9), incl | 85 000 (586)                    | 30 000 (207)                                  | 30                                                    |
| N06975 | 5/16 to 3/2 (7.94 to 88.9), incl        | 85 000 (586)                    | 32 000 (221)                                  | 40                                                    |
| N06985 | 5/16 to 3/4 (7.9 to 19.05), incl        | 90 000 (621)                    | 35 000 (241)                                  | 45                                                    |
|        | Over 3/4 to 3 1/2 (19.05 to 88.9), incl | 85 000 (586)                    | 30 000 (207)                                  | 35                                                    |
| N06030 | ...                                     | 85 000 (586)                    | 35 000 (241)                                  | 30                                                    |
| N08031 | All sizes                               | 94 000 (648)                    | 40 000 (276)                                  | 40                                                    |

<sup>A</sup>D refers to the diameter of the tension specimen.

rods are ordered in multiple lengths, a 1/4-in. (6.35-mm) length addition shall be allowed for each uncut multiple length.

8.4 *Weight*—For calculation of mass or weight, the following densities shall be used:

| Alloy  | lb/in. <sup>3</sup> | Density | g/cm <sup>3</sup> |
|--------|---------------------|---------|-------------------|
| N06007 | 0.300               |         | 8.31              |
| N06975 | 0.295               |         | 8.17              |
| N06985 | 0.300               |         | 8.31              |
| N06030 | 0.297               |         | 8.22              |
| N08031 | 0.293               |         | 8.10              |