

ASTM B168 / ASME SB168

SPECIFICATION FOR NICKEL-CHROMIUM-IRON ALLOYS (UNS N06600, N06601, N06603, N06690, N06693, N06025, AND N06045) AND NICKEL-CHROMIUMCOBALT- MOLYBDENUM ALLOY (UNS N06617) PLATE, SHEET, AND STRIP

This specification covers rolled nickel-chromium-iron alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, and N06045) and nickel-chromium-cobalt- molybdenum alloy (UNS N06617) plate, sheet, and strip.

A. Chemical Composition :-

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

Table 1

Element	Alloy N06600	Alloy N06601	Alloy N06617	Alloy N06690	Alloy N06693	Alloy N06025	Alloy N06045	Alloy N06603
Nickel	72.0 min.	58.0–63.0	44.5 min.	58.0 min.	remainder ^A	remainder ^A	45.0 min.	remainder ^A
Chromium	14.0–17.0	21.0–25.0	20.0–24.0	27.0–31.0	27.0–31.0	24.0–26.0	26.0–29.0	24.0–26.0
Cobalt	...	...	10.0–15.0	...	...	...	...	...
Molybdenum	...	...	8.0–10.0	...	...	...	...	...
Niobium	...	...	...	...	0.5–2.5	...	...	...
Iron	6.0–10.0	remainder ^A	3.0 max.	7.0–11.0	2.5–6.0	8.0–11.0	21.0–25.0	8.0–11.0
Manganese	1.0 max.	1.0 max.	1.0 max.	0.5 max.	1.0 max.	0.15 max.	1.0 max.	0.15 max.
Aluminum	...	1.0–1.7	0.8–1.5	...	2.5–4.0	1.8–2.4	...	2.4–3.0
Carbon	0.15 max.	0.10 max.	0.05–0.15	0.05 max.	0.15 max.	0.15–0.25	0.05–0.12	0.20–0.40
Copper	0.5 max.	1.0 max.	0.5 max.	0.5 max.	0.5 max.	0.1 max.	0.3 max.	0.50 max.
Silicon	0.5 max.	0.5 max.	1.0 max.	0.5 max.	0.5 max.	0.5 max.	2.5–3.0	0.50 max.
Sulfur	0.015 max.	0.015 max.	0.015 max.	0.015 max.	0.01 max.	0.010 max.	0.010 max.	0.010 max.
Titanium	...	...	0.6 max.	...	1.0 max.	0.1–0.2	...	0.01–0.25
Phosphorus	...	...	...	...	...	0.020 max.	0.020 max.	0.020 max.
Zirconium	...	...	...	...	...	0.01–0.10	...	0.01–0.10
Yttrium	...	...	...	...	...	0.05–0.12	...	0.01–0.15
Boron	...	...	0.006 max.	...	...	...	...	...
Nitrogen	...	...	...	...	...	...	...	...
Cerium	...	...	...	...	...	...	0.03–0.09	...

^A Element shall be determined arithmetically by difference.

B. Mechanical Properties and Other Requirements :-

- Mechanical Properties —The material shall conform to the mechanical properties prescribed in Table 2.

Table 2

Condition (Temper)	Tensile Strength, Min., psi (MPa)	Yield Strength ^A (0.2% Offset), Min., psi (MPa)	Elongation in 2 in. or 50 mm (or 4D), Min., %	Rockwell Hardness ^{B,C}
Hot-Rolled Plate				
UNSN06600:				
Annealed	80000 (550)	35000 (240)	30	...
As-rolled ^{D,E}	85000 (586)	35000 (240)	30	...

UNSN06601:				
Annealed	80000 (550)	30000 (205)	30	...
UNSN06603:				
Annealed	94000 (650)	43000 (300)	25	...
UNSN06617:				
Annealed ^H	95000 (655)	35000 (240)	35	...
UNSN06690:				
Annealed	85000 (586)	35000 (240)	30	...
As-rolled ^{D,E}	85000 (586)	35000 (240)	30	...
Annealed ^F	75000 (514)	30000 (206)	30	...
UNSN06693:				
Annealed	100000 (690)	50000 (345)	30	...
UNSN06025:				
Annealed	98000 (680)	39000 (270)	30	...
UNSN06045:				
Annealed	90000 (620)	35000 (240)	35	...
Hot-Rolled Sheet				
UNSN06600:				
Annealed	80000 (550)	35000 (240)	30	...
UNSN06601:				
Annealed	80000 (550)	30000 (205)	30	...
UNSN06603:				
Annealed	94000 (650)	43000 (300)	25	...
UNSN06617:				
Annealed ^H	95000 (655)	35000 (240)	30	...
UNSN06690:				
Annealed	85000 (586)	35000 (240)	30	...
UNSN06693:				
Annealed	100000 (690)	50000 (345)	30	...
UNSN06025:				
Annealed	98000 (680)	39000 (270)	30	...
UNSN06045:				
Annealed	90000 (620)	35000 (240)	35	...
Cold-Rolled Plate				
UNSN06603:				
Annealed	94000 (650)	43000 (300)	25	...
UNSN06025:				
Annealed	98000 (680)	39000 (270)	30	...
UNSN06045:				
Annealed	90000 (620)	35000 (240)	35	...
Cold-Rolled Sheet				
UNSN06600:				
Annealed	80000 (550) ^G	35000 (240)	30 ^G	...
Hard	125000 (860) ^G	90000 (620)	2 ^G	...
UNSN06601:				
Annealed	80000 (550) ^G	30000 (205)	30 ^G	...
UNSN06603:				
Annealed	94000 (650)	43000 (300)	25 ^G	...

UNSN06617:				
Annealed ^H	95000 (655) ^G	35000 (240)	25 ^G	...
UNSN06690:				
Annealed	85000 (586) ^G	35000 (240)	30 ^G	...
Hard	125000 (860) ^G	90000 (620)	2 ^G	...
UNSN06693:				
Annealed	100000 (690)	50000 (345)	30	...
UNSN06025:				
Annealed	98000 (680)	39000 (270)	30	...
UNSN06045:				
Annealed	90000 (620)	35000 (240)	35	...
Cold-Rolled Strip				
UNSN06600:				
Annealed	80000 (550) ^G	35000 (240)	30 ^G	...
Skin-hard	...	...	...	B85 to B88
Quarter-hard	...	...	...	B88 to B94
Half-hard	...	...	...	B93 to B98
Three-quarter-hard	...	...	...	B97 to C25
Hard	125000 (860) ^G	90000 (620)	2 ^G	...
Spring	...	...	...	C 30 min.
UNSN06601:				
Annealed	80000 (550) ^G	30000 (205)	30 ^G	...
UNSN06603:				
Annealed	94000 (650)	43000 (300)	25 ^G	...
UNSN06617:				
Annealed ^H	95000 (655) ^G	35000 (240)	30 ^G	...
UNSN06690:				
Annealed	85000 (586) ^G	35000 (240)	30 ^G	...
Skin-hard	...	...	...	B85 to B88
Quarter-hard	...	...	...	B88 to B94
Half-hard	...	...	...	B93 to B98
Three-quarter-hard	...	...	...	B97 to C25
Hard	125000 (860) ^G	90000 (620)	2 ^G	...
Spring	...	...	...	C 30 min.
UNSN06693:				
Annealed	100000 (586)	50000 (345)	30	...
UNSN06025:				
Annealed	98000 (680)	39000 (270)	30	...
UNSN06045:				
Annealed	90000 (620)	35000 (240)	35	...

^A Yield strength requirements do not apply to material under 0.020 in. (0.51 mm) in thickness.

^B For Rockwell or equivalent hardness conversions, see Hardness Conversion Tables E 140.

^C Caution should be served in using the Rockwell test on thin material, as the results may be affected by specimen thickness. For thicknesses under 0.050 in. (1.3 mm), the use of the Rockwell superficial or the Vickers hardness test is suggested.

^D As-rolled plate may be given a stress relieving heat treatment subsequent to final rolling.

^E As-rolled plate specified “suitable for hot forming” shall be furnished from heats of known good hot-malleability characteristics. There are no applicable tensile or hardness requirements for such material.

^F Annealed at 1850°F (1010°C) minimum.

^G Not applicable for thickness under 0.010 in. (0.25 mm).

^H Solution anneal is done at 2100°F–2250°F and quenched in water or rapidly cooled by other means.

2. Deep Drawing and Spinning Quality Sheet and Strip — The material shall conform to the grain size and hardness requirements as prescribed in Table 3.

Table 3

Thickness, in. (mm)	Calculated Diameter of Average Grain Section, Max., in. Section, Max., in. (mm)	Corresponding ASTM Micro Grain Size No.	Rockwell B ^{A,B} Hardness, Max.
Sheet [56 in. (1.42 m) Wide and Under]			
0.050 (1.3) and less	0.0030 (0.075)	4.5	86
Over 0.050 to 0.250 (1.3 to 6.4), incl.	0.0043 (0.110)	3.5	86
Strip [12 in. (305 mm) Wide and Under] ^C			
0.005 ^D to 0.010 (0.13 to 0.25), incl.	0.0009 (0.022)	8 ^E	88 ^E
Over 0.010 to 0.125 (0.25 to 3.2), incl.	0.0030 (0.075)	4.5	86

^A For Rockwell or equivalent hardness conversions, see Hardness Conversion Tables E 140.

^B Caution should be observed in using the Rockwell test on thin material, as the results may be affected by specimen thickness. For thicknesses under 0.050 in. (1.3 mm), the use of the Rockwell superficial or the Vickers hardness test is suggested.

^C Sheet requirements (above) apply to strip thicknesses over 0.125 in. (3.2 mm), and for all thicknesses of strip over 12 in. (305 mm) in width.

^D For ductility evaluations for strip under 0.005 in. (0.13 mm) in thickness, the springback test, such as described in Test Method

^F 155, is often used and the manufacturer should be consulted.

^E Accurate grain size and hardness determinations are difficult to make on strip under 0.005 in. (0.13 mm) in thickness and are not recommended.

3. The mechanical properties of Table 3 do not apply to deep drawing and spinning quality sheet and strip.

C. 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 38A, E 1473
Tension	E 8
Brinell hardness	E 10
Rockwell hardness	E 18
Hardness conversion	E 140
Grain size	E 112
Rounding procedure	E 29
Spring-back	F 155

^A Methods E 38 are to be used only for elements not covered by Test Methods E 1473.

Related Keywords

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