ASTM B564-06a

Standard Specification for Nickel Alloy Forgings1

1. Scope* :-

1.1 This specification2 covers forgings of nickel alloy UNS N02200, Ni-Cu alloy UNS N04400, Ni-Cr-Fe alloys UNS N06600, UNS N06603, and UNS N06690, Ni-Cr-Mo-Nb alloy UNS N06625, Ni-Cr-Mo-Si alloy UNS N06219, low-carbon Ni-Mo-Cr alloys UNS N10276 and UNS N06022, Ni-Cr- Mo-W alloy UNS N06110, low-carbon Ni-Cr-Mo-W alloy UNS N06686, Ni-Fe-Cr-Mo-Cu alloy UNS N08825, Fe-Ni-Cr- Mo-N alloy UNS N08367, low-carbon Ni-Cr-Mo alloys UNS N06035, UNS N06058, and UNS N06059, low carbon Ni-Cr- Mo-Cu alloy UNS N06200, Ni-Mo-Cr-Fe alloy UNS N10242, Ni-Mo alloys UNS N10665 and UNS N10675, low-carbon Ni-Fe-Cr-Mo-Cu alloy UNS N08031, Ni-Cr-W-Mo alloy UNS N06230, Ni-Cr-Co-Mo alloy UNS N06617, Ni-Co-Cr-Si alloy UNS N12160, Ni-Fe-Cr alloys, Ni-Mo alloy UNS N10629, Ni-Cr-Fe-Al alloy UNS N06025, Ni-Cr-Fe-Si alloy UNS N06045, Low-Carbon Ni-Mo-Cr-Ta alloy UNS N06210, Ni- Mo-Cr-Fe alloy UNS N10624, and low-carbon Cr-Ni-Fe-N alloy UNS R20033*

1.1.1 The nickel-iron-chromium alloys are UNS N08120, UNS N08800, UNS N08810, and UNS N08811. Alloy UNS N08800 is normally employed in service temperatures up to and including 1100°F (593°C). Alloys UNS N08810, N08120, and UNS N08811 are normally employed in service tempera tures above 1100°F where resistance to creep and rupture is required, and are annealed to develop controlled grain size for optimum properties in this temperature range.

1.2 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.

1.3 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 Material Safety Data Sheet (MSDS) for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents :-

2.1 ASTM Standards:

B 880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

E 8 Test Methods for Tension Testing of Metallic Materials

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys4

E 112 Test Methods for Determining Average Grain Size

E 350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

E 1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys

2.2 Military Standards:

MIL-STD-129 Marking for Shipment and Storage MIL-STD-271 Nondestructive Testing Requirements for Metals

3. Ordering Information :-

3.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Examples of such requirements include, but are not limited to, the following:

3.1.1 Alloy (Table 1).

3.1.2 Condition (Table 2).

3.1.3 Quantity (mass or number of pieces).

3.1.4 Forging, sketch or drawing.

3.1.5 Certification—State if certification or a report of test results is required (14.1).

3.1.6 Samples for Product (Check) Analysis—Whether samples for product (check) analysis should be furnished (see 4.2).

3.1.7 Purchaser Inspection—If the purchaser wishes to witness tests or inspection of material at the place of manufacture, the purchase order must so state indicating which tests or inspections are to be witnessed (12.1).

TABLE 1 Chemical Requirements

Elem-ents	Nickel-Copper Alloy UNS N04400	Nickel-Chro-mium-Iron Alloy UNS N06600	Nickel-Chro-mium-Iron Alloy UNS N06690	Nickel-Iron Chro-mium Alloy UNS N08120	Nickel-Iron-Chro-mium Alloy UNS N08800	Nickel-Iron-Chro-mium Alloy UNS N08810	Nickel-Chro-mium-Iron-Alum-inum Alloy UNS N06603	Nickel-Chro-mium-Iron-Alum-inum Alloy UNS N06025	Nickel-Chro-mium-Iron-Silicon Alloy UNS N06045	Low-Carbon Nickel-molyb-denum-Chro-mium-Tantalum Alloy UNS N06210
Ni	63.0[A] min	72.0[A] min	58.0 min[A]	35.0-39.0	30.0-35.0	30.0-35.0	balance[A]	Balance	45 min	remainder[A]
Cu	28.0-34.0	0.5 max	0.5 max	0.50 max	0.75 max	0.75 max	0.5 max	0.10 max	0.3 max	...
I	2.5 max	6.0-10.0	7.0-11.0	Rema-inder	39.5 min[A]	39.5 min[A]	8.0-11.0	8.0-11.0	21.0-25.0	1.0 max

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Mn	2.0 max	1.0 max	0.5 max	1.5	1.5 max	1.5 max	0.15 max	0.15	1.0	0.5 max
C	0.3 max	0.15 max	0.05 max	0 .02-0.10	0.10 max	0.05-0.10	0.20-0.40	0.15-0.25	0.05-0.12	0.015 max
Si	0.5 max	0.5 max	0.5 max	1.0	1.0 max	1.0 max	0.5 max	0.5	2.5-3.0	0.08 max
S, max	0.024	0.015	0.015	0.03	0.015	0.015	0.010	0.01	0.010	0.02
Cr	...	14.0-17.0	27.0-31.0	23.0-27.0	19.0-23.0	19.0-23.0	24.0-26.0	24.0-26.0	26.0-29.0	18.0-20.0
Al	....	...	...	0.40 max	0.15-0.60	0.15-0.60	2.4-3.0	1.8-2.4	...	...
Ti	...	...	...	0.20 max	0.15-0.60	0.15-0.60	0.01-0.25	0.1-0.2	...	...
Cb (Nb) + Ta	...	...	...	0.4-0.9	...	...	...	...	...	...
Mo	...	....	...	2.50 max	...	...	...	...	...	18.0-20.0
P	...	...	...	0.040 max	...	...	0.02 max	0.02 max	0.02 max	0.02 max
W	...	...	...	2.50 max	...	...	...	...	...	...
Co, max	...	...	...	3.0	...	...	...	...	...	1.0
V, max	...	...	...	...	...	...	...	...	...	0.35
N	...	...	...	0.15-0.30	...	...	...	...	...	...
B	...	...	...	0.010 max	...	...	...	...	...	...
La	...	...	...	...	...	...	...	...	...	...
Al + Ti	...	...	...	...	...	...	...	...	...	...
Ni + Mo	...	...	...	...	...	...	...	...	...	...
Cb (Nb), max	...	...	...	...	...	...	...	...	...	...
Ta	...	...	...	...	...	...	...	...	...	1.5-2.2
Zr, max	...	...	...	...	...	...	0.01-0.10	0.01-0.10	...	...
Ce	...	...	...	...	...	...	...	...	0.03-0.09	...
Y	...	...	...	...	...	...	0.01-0.15	0.05-0.12	...	...

Elem-ents	Nickel- Iron Chro-mium Alloy UNS N08811	Nickel-Chro-mium-molyb-denum-Colum-bium Alloy	Nickel-Chro-mium-molyb-denum-Tung-sten	Nickel-Iron-Chro-mium molyb-denum-	Low-Carbon Nickel-molyb-denum-Chro-	Low-Carbon Nickel-molyb-denum-Chro-	Iron-Nickel-Chro-mium-molyb-denum-	Low-Carbon Nickel-Chro-mium-molyb-	Low-Carbon Nickel-Chro-mium-molyb-denum-Alloy UNS

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		UNS N06625	Alloy UNS N06110	Copper Alloy UNS N08825	mium-Alloy UNS N10276	mium-Alloy UNS N06022	Nitrogen Alloy UNS N08367	denum-Alloy UNS N06059	N06058
Ni	30.-35.0	58.0 min[A]	51.0 min[A]	38.0-46.0	Rema-inder[A]	Rema-inder[A]	23.50-25.50	balance[A]	balance
Cu	0.75 max	...	0.50 max	1.5-3.0	...	...	0.75 max	0.50 max	0.50 max
I	39.5 min[A]	5.0 max	1.0 max	22.0 min[A]	4.0-7.0	2.0-6.0	Rema-inder[A]	1.5 max	1.5 max
Mn	1.5 max	0.5 max	1.0 max	1.0 max	1.0 max	0.50 max	2.00 max	0.5 max	0.50 max
C	0.06-0.10	0.10 max	0.15 max	0.05 max	0.010 max	0.015 max	0.030 max	0.010 max	0.010 max
Si	1.0 max	0.5 max	1.0 max	0.5 max	0.08 max	0.08 max	1.00 max	0.10 max	0.10 max
S, max	0.015	0.015	0.015	0.03	0.03	0.02	0.030	0.010	0.010
Cr	19.0-23.0	20.0-23.0	28.0-33.0	19.5-23.5	14.5-16.5	20.0-22.5	20.0-22.0	22.0-24.0	20.0-23.0
Al	0.15-0.60	0.4 max	1.0 max	0.2 max	...	...	...	0.1-0.4	0.40 max
Ti	0.15-0.60	0.4 max	1.0 max	0.6-1.2	...	...	...	...	...
Cb (Nb) + Ta	...	3.15-4.15	1.0 max	...	...	...	...	...	...
Mo	...	8.0-10.0	9.0-12.0	2.5-3.5	15.0-17.0	12.5-14.5	6.00-7.00	15.0-16.5	19.0-21.0
P	...	0.015 max	0.50 max	...	0.04 max	0.02 max	0.040 max	0.015 max	0.015 max
W	...	...	1.0-4.0	...	3.0-4.5	2.5-3.5	...	...	0.3 max
Co, max	...	...	...	...	2.5 max	2.5 max	...	0.3 max	0.3 max
V, max	...	...	...	...	0.35	0.35	...	...	...
N	...	...	...	...	...	...	0.18-0.25	...	0.02-0.15
B	...	...	...	...	...	...	...	...	...
La	...	...	...	...	...	...	....	...	...
Al + Ti	0.85-1.20	...	...	...	...	...	...	...	...
Ni + Mo	...	...	...	...	...	...	...	...	...
Cb (Nb), max	...	...	...	...	...	...	...	...	...
Ta	...	...	...	...	...	...	...	...	...
Zr, max	...	...	...	...	...	...	...	...	...
Ce	...	...	...	...	...	...	...	...	...
Y	...	...	...	...	...	...	...	...	...

Elem-ents	Low-Carbon Nickel-Chro-mium-molyb-denum-	Low-Carbon Nickel-Chro-mium-molyb-denum-	Nickel-Chro-mium-molyb-denum-	Low-Carbon Nickel-Iron Chro-mium-	Nickel-Chro-mium-Tungsten molyb-denum-	Nickel-Chro-mium-Cobalt molyb-denum-	Nickel Molyb-denum Alloy UNS	Nickel Molyb-denum Alloy UNS

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	Alloy UNS N06035	Copper Alloy UNS N06200	Silicon Alloy UNS N06219	molyb-denum-Copper Alloy UNS N08031	Alloy UNS N06230	Alloy UNS N06617	N10629	N10665
Ni	remainder[A]	remainder[A]	balance[B]	30.0-32.0	remainder[A]	44.5 min	balance	remainder[A]
Cu	0.30 max	1.3-1.9	0.50 max	1.0-1.4	...	0.5 max	0.5 max	...
I	2.00 max	3.0 max	2.0-4.0	balance[B]	3.0 max	3.0 max	1.0-6.0	2.0 max
Mn	0.50 max	0.50 max	0.50 max	2.0 max	0.30-1.00	1.0 max	1.5	1.0 max
C	0.050 max	0.010 max	0.05 max	0.015 max	0.05-0.15	0.05-0.15	0.010 max	0.02 max
Si	0.60 max	0.08 max	0.70-1.10	0.3 max	0.25-0.75	1.0 max	0.05	0.10 max
S, max	0.015	0.010	0.010	0.010	0.015	0.015	0.01	0.03
Cr	32.25-34.25	22.0-24.0	18.0-22.0	26.0-28.0	20.0-24.0	20.0-24.0	0.5-1.5	1.0 max
Al	0.40 max	0.50 max	0.50 max	...	0.50 max	0.8-1.5	0.1-0.5	...
Ti	...	...	0.50 max	...	...	0.6 max	...	...
Cb (Nb) + Ta	...	...	...	...	...	...	...	...
Mo	7.60-9.00	15.0-17.0	7.0-9.0	6.0-7.0	1.0-3.0	8.0-10.0	26.0-30.0	26.0-30.0
P	0.030 max	0.025 max	0.020 max	0.020 max	0.030 max	...	0.04 max	0.04 max
W	0.60 max	...	...	...	13.0-15.0	...	...	...
Co, max	1.00 max	2.0 max	1.0 max	...	5.0 max	10.0 min-15.0 max	2.5	1.00 max
V, max	0.20	...	...	...	...	...	...	...
N	...	...	...	0.15-0.25	...	...	...	...
B	...	...	...	...	0.015 max	0.006 max	...	...
La	...	...	...	...	0.005-0.050	...	...	...
Al + Ti	...	...	...	...	...	...	...	...
Ni + Mo	...	...	...	...	...	...	...	...
Cb (Nb), max	...	...	...	...	...	...	...	...
Ta	...	...	...	...	...	...	...	...
Zr, max	...	...	...	...	...	...	...	..
Ce	...	...	...	...	...	...	...	...
Y	...	...	...	...	...	...	...	...

Elem-ents	Nickel-molyb-denum- Alloy UNS N10675	Nickel- molyb-denum- Chro-mium- Iron Alloy UNS N10242	Low-Carbon Nickel-Chro-mium- molyb-denum-Tungsten Alloy UNS N06686	Nickel-Cobalt Chro-mium-Silicon Alloy UNS N12160	Nickel-Alloy UNS N02200	Nickel-molyb-denum-Chro-mium-Iron Alloy UNS N10624	Chromium-Nickel-Iron-Nitrogen Alloy UNS R20033

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Ni	65.0 min	remainder[A]	remainder	remainder[A]	99.0[A] min	remainder[A]	30.0-33.0
Cu	0.20 max	...	...	...	0.25 max	0.5 max	0.30-1.20
I	1.0-3.0	2.0 max	5.0 max	3.5 max	0.40 max	5.0-8.0	balance[A]
Mn	3.0 max	0.80 max	0.75 max	1.5 max	0.35 max	1.0 max	2.0
C	0.01 max	0.03	0.010 max	0.15 max	0.15 max	0.01 max	0.015 max
Si	0.10 max	0.80 max	0.08 max	2.4-3.0	0.35 max	0.10 max	0.50
S, max	0.010	0.015	0.02	0.015	0.01	0.01 max	0.01
Cr	1.0-3.0	7.0-9.0	19.0-23.0	26.0-30.0	...	6.0-10.0	31.0-35.0
Al	0.50 max	0.50 max	...	...	...	0.5 max	...
Ti	0.20 max	...	0.02-0.25	0.20-0.80	...	...	...
Cb (Nb) + Ta	...	...	...	...	...	...	...
Mo	27.0-32.0	24.0-26.0	15.0-17.0	1.0 max	...	21.0-25.0	0.50-2.0
P	0.030 max	0.030 max	0.04 max	0.030 max	...	0.025 max	0.02 max
W	3.0 max	...	3.0-4.4	1.0 max	...	...	...
Co, max	3.0 max†	1.00 max	...	27.0-33.0†	...	1.0 max	...
V, max	0.20	...	...	...	...	...	...
N	...	...	...	...	...	...	0.35-0.60
B	...	0.006 max	...	...	...	...	...
La	...	...	...	...	...	...	...
Al + Ti	...	...	...	...	...	...	...
Ni + Mo	94.0-98.0	...	...	...	...	...	...
Cb (Nb), max	0.20	...	...	1.0	...	...	...
Ta	0.20 max	...	...	...	...	...	...
Zr, max	0.10	...	...	...	...	...	...
Ce	...	...	...	...	...	...	...
Y	...	...	...	...	...	...	...

TABLE 2 Mechanical Property Requirements[A]

Material Condition	Maximum Section Thickness, in.(mm)	Tensile Strength, min, ksi(MPa)	Yield Strength, 0.2% Offset, min, ksi (MPa)	Elongation in 2 in. Or 4D, min, %
Nickel alloy UNS N02200, Annealed		55 (380)	15 (105)	40
Nickel-copper alloy UNS N04400, annealed		70 (483)	25 (172)	35

Nickel-chromium-iron alloy UNS N06600, annealed		80 (552)	35 (241)	30
UNS N06690, annealed Low-carbon nickel-chromium Molybdenum		85 (586)	35 (241)	30
Alloy UNS N06035, solution Annealed		85 (586)	35 (241)	30
Alloy UNS N06058, solution Annealed		110 (760)	52 (360)	40
Alloy UNS N06059, solution Annealed		100 (690)	45 (310)	45
Low carbon nickel-chromium molybdenum-copper alloy UNS N06200, solution Annealed		100 (690)	45 (310)	45
Nickel-iron-chromium alloys: UNS N08120), solution Annealed		90 (621)	40 (276)	30
Annealed (alloy UNS N08800)		75 (517)	30 (207)	30
Annealed (alloys UNS N08810 and UNS N08811)		65 (448)	25 (172)	30
Nickel-chromium-molybdenum-columbium alloy UNS N06625, annealed		120 (827) 110 (758)	60 (414) 50 (345)	30 25
Nickel-chromium-molybdenum-tungsten alloy UNS N06110, annealed		95 (655) 90 (621)	45 (310) 40 (276)	60 50
Nickel-iron-chromium-molybdenum-copper alloy		85 (586)	65 (241)	30

UNS N08825, annealed				
Low carbon nickel-chromium-molybdenum alloy UNS N10276, solution Annealed		100 (690)	41 (283)	40
Low-carbon nickel-chromium-molybdenum alloy UNS N06022, solution annealed		100 (690)	45 (310)	45
Iron-nickel-chromium-molybdenum-nitrogen alloy UNS N08367, solution annealed		95 (655)	45 (310)	30
Low-carbon nickel-iron-chromium-molybdenum-copper-alloy UNS N08031, solution annealed		94 (650)	40 (276)	40
Nickel-chromium-tungsten-molybdenum alloy UNS N06230, solution annealed[c]		110 (758)	45 (310)	40
Nickel-chromium-cobalt-molybdenum alloy UNS N06617, annealed		95 (655)	35 (241)	35
Nickel-molybdenum alloy UNS N10665, solution annealed		110 (760)	51 (350)	40
Nickel-molybdenum		110 (760)	51 (350)	40

alloy UNS N10675, solution Annealed				
Nickel-molybdenum-chromium-iron alloy UNS N10242, annealed		105 (725)	45 (310)	40
Low-carbon nickel-chro mium-molybdenum-tung sten alloy UNS N06686, solution annealed		100 (690)	45 (310)	45
Nickel-cobalt-chromium -silicon alloy UNS N12160, solution annealed		90 (620)	35 (240)	40
Low-carbon chromium- nickel-iron-nitrogen alloy UNS R20033, solution Annealed		109 (750)	55 (380)	40
Nickel-molybdenum alloy UNS N10629, solution annealed		110 (760)	51 (350)	40
Nickel-chromium-iron- aluminum alloy UNS N06025, solution annealed		98 (680) 84 (580)	39 (270) 39 (270)	30 15
Nickel-chromium-iron- aluminum alloy UNS N06603, annealed		94 (650)	43 (300)	25
Nickel-chromium-iron-silicon alloy UNS N06045, solution annealed		90 (620)	35 (240)	35
Nickel-molybdenum-		104 (720)	46 (320)	40

chromium-iron alloy UNS N10624, annealed				
Low-carbon nicke-molybdenum-chromium-tantalum alloy UNS N06210, solution annealed		100 (690)	45 (310)	45
Nickel-chromium-molybdenum-silicon alloy UNS N06219, solution annealed		96 (660)	39 (270)	50

4. Chemical Composition :-

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

4.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in accordance with Specification B 880.

5. Mechanical Properties and Other Requirements :-

5.1 Mechanical Properties—The material shall conform to the mechanical properties specified in Table 2.

5.2 Grain Size—Annealed alloys (UNS N08810, N08120, and UNS N08811) shall conform to an average grain size of ASTM No. 5 or coarser.

6. Dimensions and Permissible Variations

7. Workmanship, Finish, and Appearance

8. Sampling

9. Number of Tests

10. Specimen Preparation

11. Test Methods

12. Inspection

13. Rejection and Rehearing

14. Certification :-

14.1 When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser stating that material has been manufactured, tested, and inspected in accordance with this specification, and that the test results on representative samples meet specification requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

15. Product Marking

16. Keywords :-

16.1 nickel alloy forgings

SUPPLEMENTARY REQUIREMENTS :-

S1. Referenced Documents

S2. Chemical Composition

S3 Mechanical Properties

S4. Number of Tests

S5. Nondestructive Tests

S6. Quality Assurance

S7. Identification Marking

S8. Preparation for Delivery