

Alloy C-22

UNS N06022

Alloy C-22 (UNS N06022) is the most versatile Ni-Cr-Mo alloy available today. This alloy has improved corrosion resistance than Alloy C-276 and Alloy 625. C-22 offers resistance to pitting, stress-corrosion cracking and crevice corrosion.

Specification

NiWire's production follows:

ASTM B 366 (welding fittings), B 564 (forgings), B 574 (rod), B 575 (plate, sheet, and strip), B 619 (welded pipe), B 622 (seamless tubing), B 626 (welded tubing)

ASME SB-366, SB-564, SB-574, SB-575, SB-619, SB-622, SB-626

Chemical Composition

Nominal composition: 22 Cr; 13 Mo; 3 Fe; 3 W; 2.5 max Co; 0.5 max Mn; 0.35 max V; 0.08 max Si; 0.01 max C; bal Ni

Applications

Typical uses: Some of the areas of use for Alloy C-22 are acetic acid/acetic anhydride production, cellophane manufacturing, chlorination systems, complex acid mixtures, electro galvanizing rolls, expansion bellows, flue gas scrubber systems, hydrogen fluoride scrubber systems, geothermal wells, incineration scrubber systems, nuclear fuel reprocessing, pesticide production, phosphoric acid production, pickling systems, plate heat exchangers, selective leaching systems, sulfur dioxide cooling towers, sulfonation systems, tubular heat exchangers, and weld overlays for valves.

Physical Properties

Density: 8.69 g/cm³ (0.314 lb/in.³)

Melting range: 1357 to 1399 °C (2475–2550 °F)

Coefficient of thermal expansion: 12.4 μm/m · K at 24 to 93 °C (6.9 μin./in · °F at 75–200 °F)

Thermal conductivity: 10.1 W/m · K at 48 °C (70 Btu · in./ft² · h · °F), 11.1 W/m · K at 100 °C (77 Btu · in./ft² · h · °F), and 13.4 W/m · K at 200 °C (93 Btu · in./ft² · h · °F at 392 °F)

Specific heat: 414 J/kg · K at 52 °C (0.099 Btu/lb · °F at 126 °F) and 423 J/kg · K at 100 °C (0.101 Btu/lb · °F at 212 °F)

Electrical resistivity: 1.14 μΩ · m (44.8 μΩ · in.) at room temperature

Mechanical Properties

Hardness: Sheet: 93 HRB; plate: 95 HRB

Elastic modulus: For plate, solution treated at 1120 °C (2050 °F) and rapidly quenched: 206 GPa (29.9 × 10⁶ psi) at room temperatures, 190 GPa (27.6 × 10⁶ psi) at 315 °C (600 °F), and 177 GPa (26.6 × 10⁶ psi) at 540 °C (1000 °F)

Impact strength: For plate, solution treated at 1120 °C (2050 °F) and rapidly quenched: 353 J (260 ft · lbf) at room temperature, and 351 J (259 ft · lbf) at –195 °C (–320 °F)

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Typical tensile properties of solution heat treated Alloy C-22

Test temperature °C (°F)	Ultimate tensile strength		Yield strength at 0.2% offset		Elongation in 50mm(2 in.),%
	MPa	ksi	MPa	ksi	
Sheet, 0.71 to 3.2mm(0.028 to 0.125 in.) thick					
Room temperature	800	116	407	59	57
93 (200)	758	110	372	54	58
204 (400)	703	102	303	44	57
316 (600)	676	98	290	42	62
427(800)	655	95	283	41	67
538 (1000)	627	91	276	40	61
649 (1200)	586	85	248	36	65
760 (1400)	524	76	241	35	63
Plate, 6.4 to 19mm thick					
Room temperature	786	114	372	54	62
93 (200)	738	107	338	49	65
204 (400)	676	98	283	41	66
316 (600)	655	95	248	36	68
427 (800)	634	92	241	35	68
538 (1000)	607	88	234	34	67
649 (1200)	572	83	221	32	69
760 (1400)	524	76	214	31	68
Bar, 13 to 50mm dia					
Room temperature	765	111	359	52	70
93 (200)	724	105	310	45	73
204 (400)	662	96	262	38	74
316 (600)	634	92	234	34	79
427 (800)	614	89	214	31	79
538 (1000)	579	84	200	29	80
649 (1200)	552	80	193	28	80
760 (1400)	496	72	200	29	77

Chemical Properties

General corrosion behavior: Alloy C-22 has outstanding resistance to pitting, crevice corrosion, and stress-corrosion cracking. It has excellent resistance to oxidizing aqueous media including wet chlorine and mixtures containing nitric acid or oxidizing acids with chloride ions. Alloy C-22 also offers optimum resistance to environments where reducing and oxidizing conditions are encountered in process streams. Because of this versatility, it can be used where upset conditions are likely to occur or in multipurpose plants.

Resistance to specific corroding agents: Comparative corrosion data for Alloy C-22, C-276, C-4, and 625 are given in the following table.

Corrosion rates of Alloy C-22 in various corrosive media compared with other corrosion resistant alloys:

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Media	Concentration, wt%	Test temperature, °C (°F)	Average corrosion rate mils/yr(a)			
			Alloy C-22	Alloy C-276	Alloy C-4	Alloy 625
Acetic acid	99	Boiling	Nil	<1	Nil	<1
Ferric chloride	10	Boiling	1	2	140	7325
Formic acid	88	Boiling	<1	1	2	9
Hydrochloric acid	1	Boiling	3	13	25	1
	2	Boiling	61	51	82	557
	2.5	Boiling	141	85	44	605
	10	Boiling	400	288	228	642
Hydrochloric acid + 42 g/L Fe ₂ (SO ₄) ₃	1	93 (200)	2	41	...	238
	5	66 (150)	2	5	3	2
Hydrochloric acid + 2% HF	5	70 (158)	59	26	34	123
Hydrofluoric acid	2	70 (158)	9	9	17	20
P ₂ O ₅ (commercial grade)	38	85 (185)	2	9	...	1
	52	116 (240)	11	33	...	12
P ₂ O ₅ + 2000 ppm Cl	38	85 (185)	1	12	...	2
P ₂ O ₅ + 0.5% HF	38	85 (185)	7	45	...	9
Nitric acid	10	Boiling	<1	7	7	<1
	65	Boiling	134	888	217	21
Nitric acid + 6% HF	5	60 (140)	67	207	204	73
Nitric acid + 25% H ₂ SO ₄ + 4% NaCl	5	Boiling	12	64	97	713
Nitric acid + 1% HCl	5	Boiling	<1	8	11	1
Nitric acid + 2.5% HCl	5	Boiling	2	21	26	<1
Nitric acid + 15.8% HCl	8.8	52 (126)	4	33	114	>10,000
Sulfuric Acid	2	66 (150)	Nil	<1	Nil	Nil
	5	Boiling	9	12	16	16
	10	Boiling	12	19	25	37
	20	66 (150)	<1	<1	<1	<1
	20	Boiling	33	39	36	91
	30	Boiling	64	55	73	227
	40	66 (150)	<1	1	9	1
	50	38 (100)	<1	Nil	<1	1
	60	38 (100)	<1	<1	1	<1
	70	38 (100)	Nil	Nil	2	<1
80	38 (100)	Nil	<1	<1	<1	
Sulfuric acid + 0.1% HCl	5	Boiling	26	33	49	151
Sulfuric acid + 0.5% HCl	5	Boiling	61	49	91	434
Sulfuric acid + 1% HCl	10	70 (158)	<1	11	24	121
Sulfuric acid + 2% HF	10	Boiling	29	22	26	55
Sulfuric acid + 200 ppm Cl-	25	70 (158)	11	12	37	110
Sulfuric acid + 1.2% HCl + 1% FeCl ₃ + 1% CuCl ₂	11.5	Boiling	3	42	837	1815
Sulfuric acid + 1.2% HCl + 1% FeCl ₃ + 1% CuCl ₂ (ASTMG28B)	23	Boiling	8	55	2155	2721
Sulfuric acid + 42 g/L Fe ₂ (SO ₄) ₃ (ASTMG28A)	50	Boiling	40	250	143	23

(a) To convert mils/yr to mm/yr, divide by 40.