Alloy B-2

NiWire Industries
www.niwire.com

UNS N10665

Alloy B-2 (UNS N10665) is a nickel-molybdenum alloy with low iron and low carbon compared with Alloy B. Alloy B-2 exhibits superior resistance to hydrochloric acid, aluminum chloride catalysts and other strongly reducing chemicals.

Specification

NiWire's production follows:
ASTM B 333 (plate, sheet, and strip), B 335 (rod), B 366 (welding fittings), B 619 (welded pipe), B 622 (seamless pipe and tube), B 626 (welded tubes)

Chemical Composition

Composition limits: 26 to 30 Mo; 2.00 max Fe; 1.00 max Co; 1.00 max Cr; 1.00 max Mn; 0.10 max Si; 0.040 max P; 0.030 max S; 0.02 max C; bal Ni

Applications

Typical uses: Suitable for most chemical process applications in the as-welded condition. Well suited for equipment handling hydrochloric acid in all concentrations and temperatures. Resistant to hydrogen chloride gas and sulfuric, acetic, and phosphoric acids. Principal high-temperature uses are those in which a low coefficient of thermal expansion is required.
Precautions in use: Exposure to temperatures of 540 to 815 °C (1000–1500 °F) should be avoided because of a reduction in the ductility of the alloy. In oxidizing gases such as air, Alloy B-2 can be used at temperatures up to 540 °C (1000 °F). In reducing gases or in vacuum, the alloy can be used from 815 °C (1500 °F) to substantially higher temperatures. Ferric or cupric salts might develop when hydrochloric acid comes in contact with iron or copper, so Alloy B-2 should not be used with copper or iron piping in a system containing hydrochloric acid.

Physical Properties

Density: 9.22 g/cm3 (0.333 lb/in.3) at 22 °C (72 °F)

Coefficient of thermal expansion (linear) & Specific heat:

Temperature		Coefficient	
°C	°F	µm/m · K	µin./in. · °F
20–93	68–200	10.3	5.7
20–204	68–400	10.8	6.0
20–316	68–600	11.2	6.2
20–427	68–800	11.5	6.4
20–538	68–1000	11.7	6.5

Temperature		Specific heat	
°C	°F	J/kg · K	Btu/lb · °F
0	32	373	0.089
200	390	406	0.097
400	750	431	0.103
600	1100	456	0.109

Thermal conductivity:

Temperature		Conductivity	
°C	°F	W/m · K	Btu/ft · h · °F
0	32	11.1	6.4
100	232	12.2	7.1
200	390	13.4	7.75
300	570	14.6	8.5
400	750	16.0	9.25
500	930	17.3	10.0
600	1100	18.7	10.8

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UNS N10665

Mechanical Properties

Average tensile properties for Alloy B-2:

Temperature		Tensile strength		0.2%yield strength		Elongation in 50mm(2 in.),%	Rockwell hardness
°C	°F	MPa	ksi	MPa	ksi		
Sheet, 1.3 to 3 mm(0.05–0.12 in.) thick(a)							
RT	RT	965	140	525	76	53	22 HRC
204	400	885	128	450	65	50	...
316	600	860	125	425	62	49	...
427	800	860	125	415	60	51	...
Sheet and plate, 2.5 to 9 mm(0.10–0.35 in.) thick(a)							
RT	RT	895	130	415	60	61	95 HRB
204	400	850	123	350	51	59	...
316	600	820	119	325	47	60	...
427	800	805	117	310	45	60	...
Plate, 9 to 50 mm(0.36–2 in.) thick(a)							
RT	RT	905	131	405	59	61	94 HRB
204	400	870	126	360	52	60	...
316	600	840	122	340	49	60	...
427	800	820	119	315	46	61	...

RT, room temperature. (a) Solution treated at 1065 °C (1950 °F) and rapidly quenched

Average dynamic modulus of elasticity of Alloy B-2:

Form	Condition	Test temperature		Dynamic modulus of elasticity	
		°C	°F	GPa	10^6 psi
Plate, 13 mm(1 2 in.) thick	Heat treated at: 1065 °C (1950 °F), rapid quenched	RT	RT	217	31.4
		315	600	202	29.3
		425	800	196	28.4
		540	1000	189	27.4

Chemical Properties

General corrosion behavior: Superior resistance to hydrochloric acid, aluminum chloride catalysts, and other strongly reducing chemicals. Alloy B-2 has excellent resistance to pitting, stress-corrosion cracking, and to knife-line and heat-affected zone attack. It resists the formation of grain-boundary carbide precipitates in the weld heat-affected zone, thus making it suitable for most chemical process applications in the as-welded condition. Limited tests indicate that the corrosion resistance of Alloy B-2 in boiling 20% hydrochloric acid is not affected by cold reductions up to 50%. As stated earlier, contact with ferric or cupric salts can cause rapid and premature corrosion failure.

Alloy B-2

UNS N10665

Average corrosion rates of Alloy B-2 in boiling acids:

Media	Concentration, wt%	Average corrosion rate	
		mm/yr	mils/yr
Acetic acid	10	<0.02	0.5
	30	0.01	0.4
	50	0.01	0.4
	70	<0.01	0.3
	99 (glacial)	<0.01	0.3
Formic acid	10	<0.01	0.3
	20	<0.02	0.6
	30	<0.02	0.7
	40	<0.02	0.7
	60	<0.02	0.5
	89	<0.02	0.5
Hydrochloric acid	1	0.02	0.8
	2	0.08	3
	5	0.13	5
	10	0.18	7
	15	0.28	11
	20	0.38	15
	20	0.51(a)	20(a)
Phosphoric acid (chemically pure)	10	0.05	2
	30	0.08	3
	50	0.15	6
	85	0.63	25
Sulfuric acid	2	<0.02	0.5
	5	0.08	3
	10	0.05	2
	20	<0.02	0.7
	30	<0.02	0.7
	40	<0.03	0.9
	50	0.03	1
	50	0.05(a)	2(a)
	50	0.03(b)	1(b)
	60	0.05(b)	2(b)
	70	0.23(b)	9(b)

Determined in laboratory tests of 120 h duration. It is recommended that samples be tested under actual plant conditions. All test specimens were heat treated at 1065 °C (1950 °F), water quenched unless otherwise noted. (a) As gas-tungsten arc welded. (b) Aged 48 h at 540 °C (1000 °F)