HASTELLOY® C-276 alloy

Principal Features

50 years of proven performance in a wide range of aggressive chemicals

HASTELLOY® C-276 alloy (UNS N10276) was the first wrought, nickel-chromium-molybdenum material to alleviate concerns over welding (by virtue of extremely low carbon and silicon contents). As such, it was widely accepted in the chemical process and associated industries, and now has a 50-year-old track record of proven performance in a vast number of corrosive chemicals.

Like other nickel alloys, it is ductile, easy to form and weld, and possesses exceptional resistance to stress corrosion cracking in chloride-bearing solutions (a form of degradation to which the austenitic stainless steels are prone). With its high chromium and molybdenum contents, it is able to withstand both oxidizing and non-oxidizing acids, and exhibits outstanding resistance to pitting and crevice attack in the presence of chlorides and other halides. Furthermore, it is very resistant to sulfide stress cracking and stress corrosion cracking in sour, oilfield environments.

HASTELLOY® C-276 alloy is available in the form of plates, sheets, strips, billets, bars, wires, pipes, tubes, and covered electrodes. Typical chemical process industry (CPI) applications include reactors, heat exchangers, and columns.

Nominal Composition

Weight %

Nickel:	57 Balance
Cobalt:	2.5 max.
Chromium:	16
Molybdenum:	16
Iron:	5
Tungsten:	4
Manganese:	1 max.
Vanadium:	0.35 max.
Silicon:	0.08 max.
Carbon:	0.01 max.
Copper:	0.5 max.

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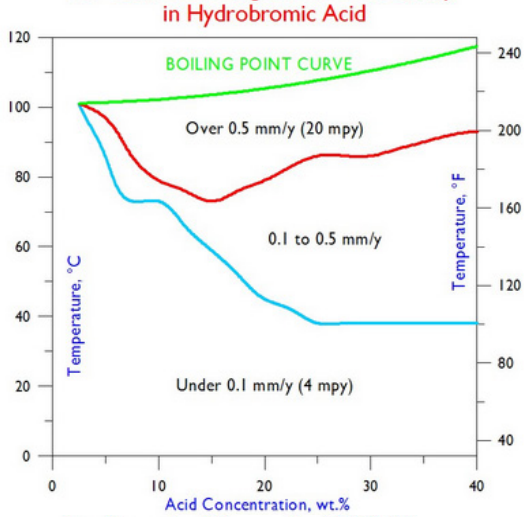
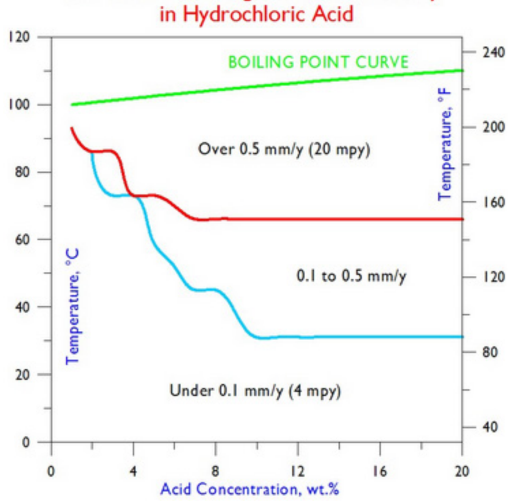
Iso-Corrosion Diagrams

Each of these iso-corrosion diagrams was constructed using numerous corrosion rate values, generated at different acid concentrations and temperatures. The blue line represents those combinations of acid concentration and temperature at which a corrosion rate of 0.1 mm/y (4 mils per year) is expected, based on laboratory tests in reagent grade acids. Below the line, rates under 0.1 mm/y are expected. Similarly, the red line indicates the combinations of acid concentration and temperature at which a corrosion rate of 0.5 mm/y (20 mils per year) is expected. Above the line, rates over 0.5 mm/y are expected. Between the blue and red lines, corrosion rates are expected to fall between 0.1 and 0.5 mm/y.

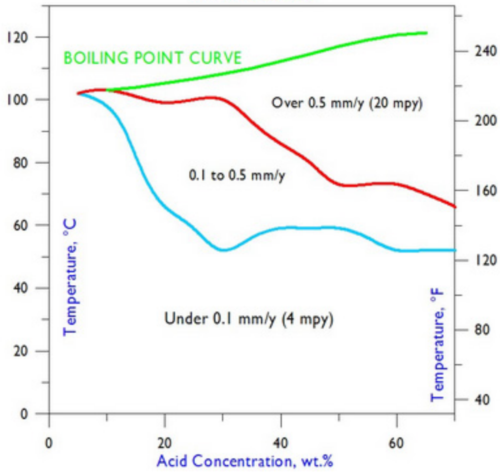
Iso-Corrosion Diagram for C-276 Alloy in Hydrobromic Acid



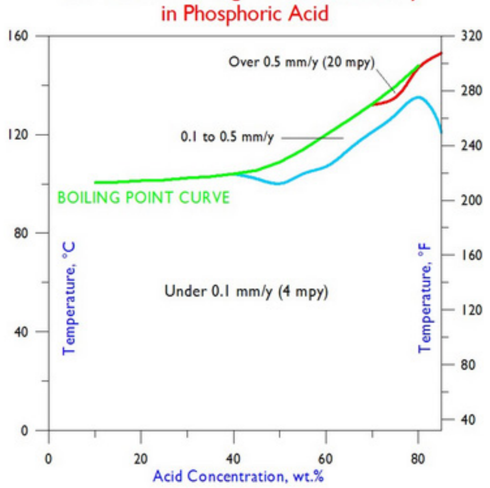
Iso-Corrosion Diagram for C-276 Alloy in Hydrochloric Acid



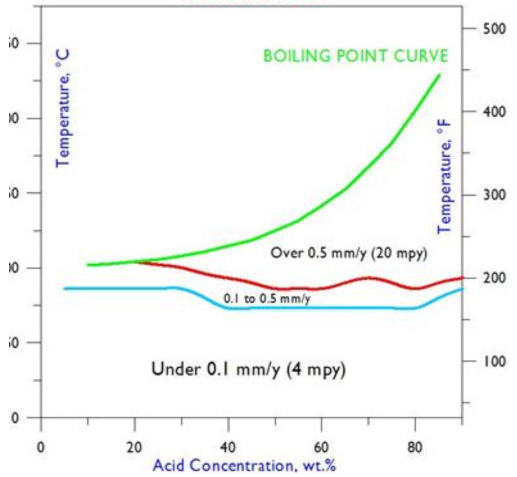
Iso-Corrosion Diagram for C-276 Alloy in Nitric Acid



Iso-Corrosion Diagram for C-276 Alloy in Phosphoric Acid

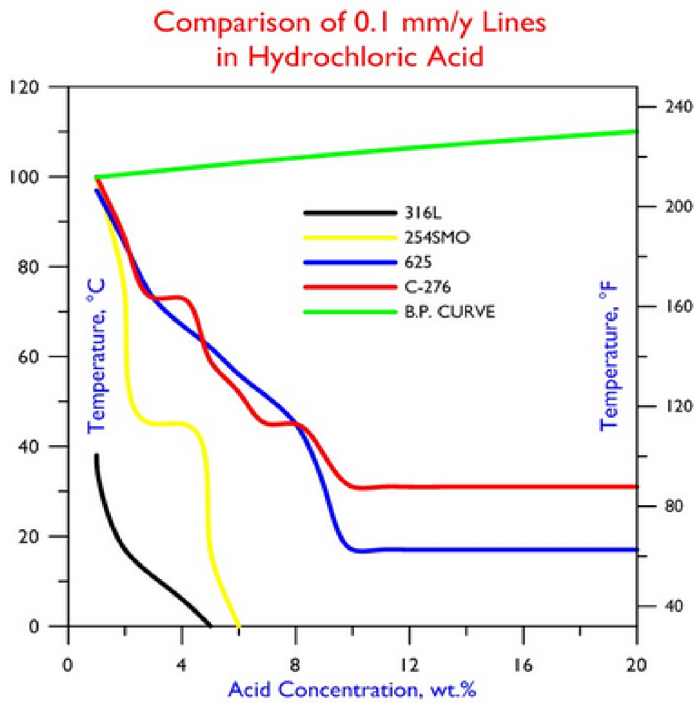


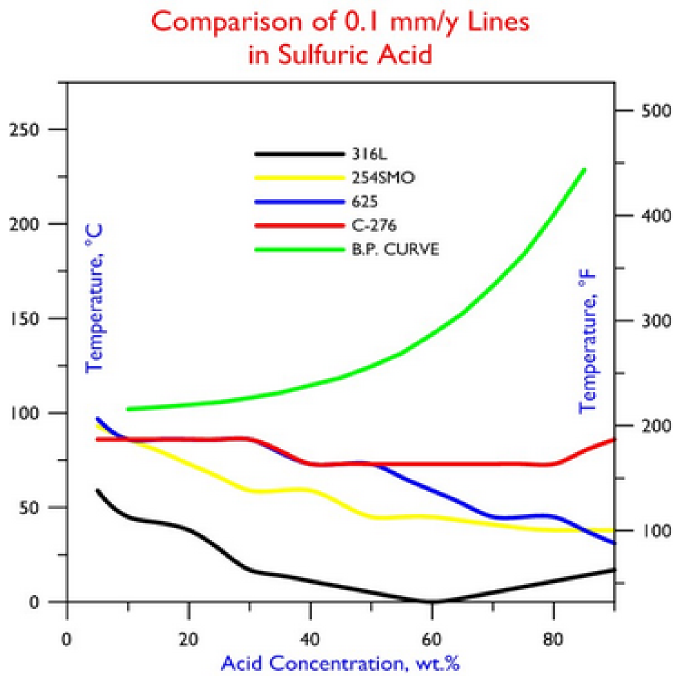
Iso-Corrosion Diagram for C-276 Alloy in Sulfuric Acid



Comparative Plots

To compare the performance of HASTELLOY® C-276 alloy with that of other materials, it is useful to plot the 0.1 mm/y lines. In the following graphs, the lines for C-276 alloy are compared with those of two popular, austenitic stainless steels (316L and 254SMO), and a lower-molybdenum nickel alloy (625), in hydrochloric and sulfuric acids. At hydrochloric acid concentrations above about 5%, C-276 alloy provides a quantum improvement over the stainless steels, and offers much greater resistance to higher concentrations of both acids than alloy 625. The concentration limit of 20% hydrochloric acid is the azeotrope, beyond which high temperature corrosion tests are less reliable.





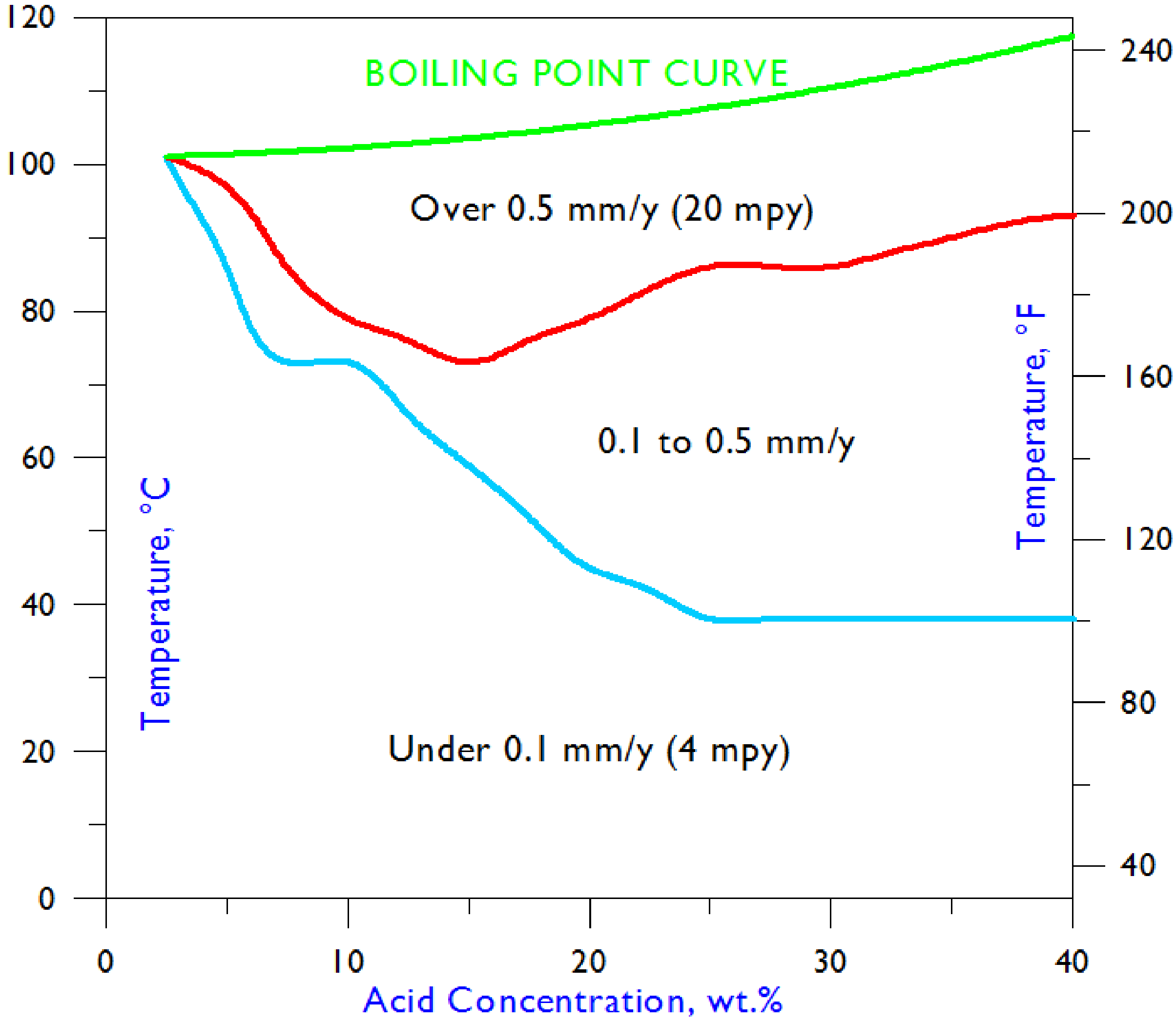
Selected Corrosion Data

Hydrobromic Acid

Conc. Wt.%	50°F 10°C	75°F 24°C	100°F 38°C	125°F 52°C	150°F 66°C	175°F 79°C	200°F 93°C	225°F 107°C	Boiling
2.5	-	-	-	-	-	-	-	-	0.13
5	-	-	-	-	-	0.01	0.15	-	0.78
7.5	-	-	-	-	0.01	0.14	0.73	-	-
10	-	-	-	-	0.02	0.51	0.89	-	-
15	-	-	-	0.01	0.34	0.57	-	-	-
20	-	-	<0.01	0.25	0.37	0.51	-	-	-
25	-	-	0.11	0.2	0.29	0.45	0.75	-	-
30	-	-	0.12	0.2	0.28	0.44	0.75	-	-
40	-	-	0.08	0.13	0.21	0.3	0.53	-	-

All corrosion rates are in millimeters per year (mm/y); to convert to mils (thousandths of an inch) per year, divide by 0.0254.
Data are from Corrosion Laboratory Jobs 15-02, 27-02, and 37-02.
All tests were performed in reagent grade acids under laboratory conditions; field tests are encouraged prior to industrial use.

Iso-Corrosion Diagram for C-276 Alloy in Hydrobromic Acid



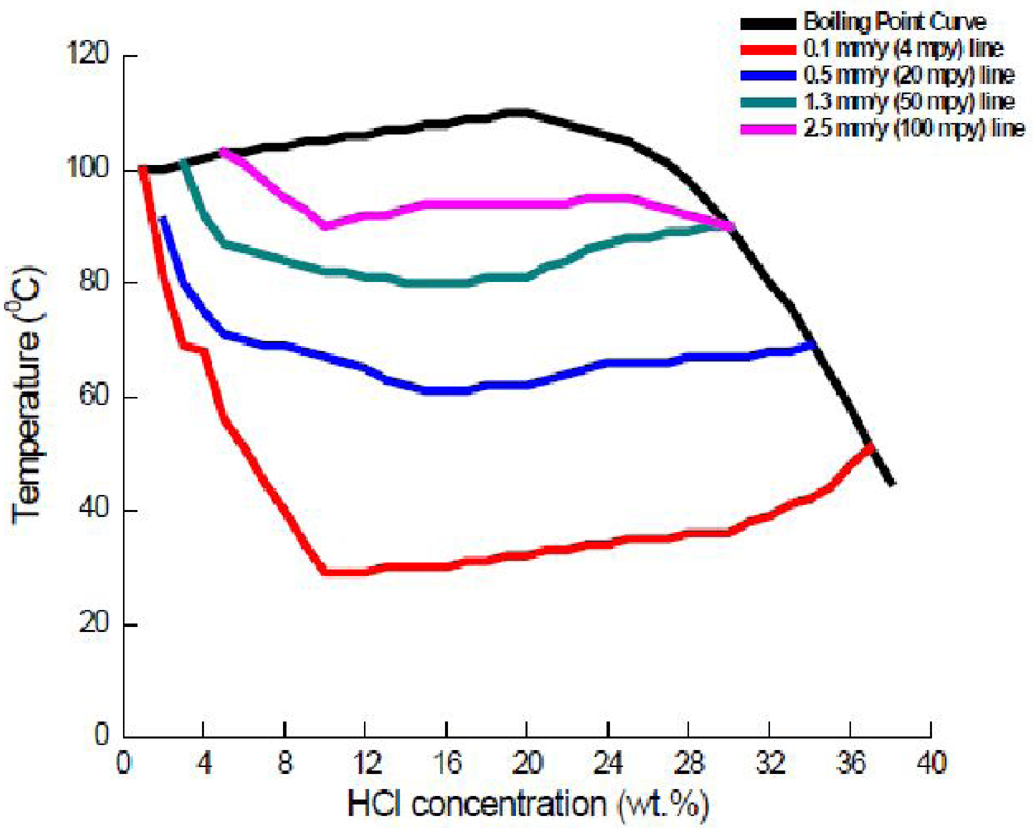
Selected Corrosion Data Continued

Hydrochloric Acid

Conc. Wt.%	50°F 10°C	75°F 24°C	100°F 38°C	125°F 52°C	150°F 66°C	175°F 79°C	200°F 93°C	225°F 107°C	Boiling
1	-	-	-	-	-	-	-	-	0.33
1.5	-	-	-	-	-	-	-	-	0.70
2	-	-	-	-	0.01	0.02	0.57	-	1.26
2.5	-	-	-	-	-	0.03	0.89	-	1.86
3	-	-	-	-	0.01	0.42	1.18	-	2.34
3.5	-	-	-	-	-	0.57	1.26	-	2.43
4	-	-	-	-	0.02	0.67	1.37	-	2.92
4.5	-	-	-	-	0.37	0.68	1.72	-	3.34
5	-	-	-	0.02	0.31	0.75	1.25	-	3.63
7.5	-	-	0.03	0.31	0.53	0.94	-	-	-
10	-	-	0.17	0.32	0.46	1.18	-	-	-
15	-	-	0.19	0.33	0.54	1.21	-	-	-
20	-	-	0.14	0.29	0.55	1.10	-	-	-

All corrosion rates are in millimeters per year (mm/y); to convert to mils (thousandths of an inch) per year, divide by 0.0254.
Data are from Corrosion Laboratory Jobs 8-95, 11-95, 18-95, 36-95, 3-96, 9-96, 16-96, and 25-96.
All tests were performed in reagent grade acids under laboratory conditions; field tests are encouraged prior to industrial use.

Iso-Corrosion Diagram for C-276 Alloy in Hydrochloric Acid



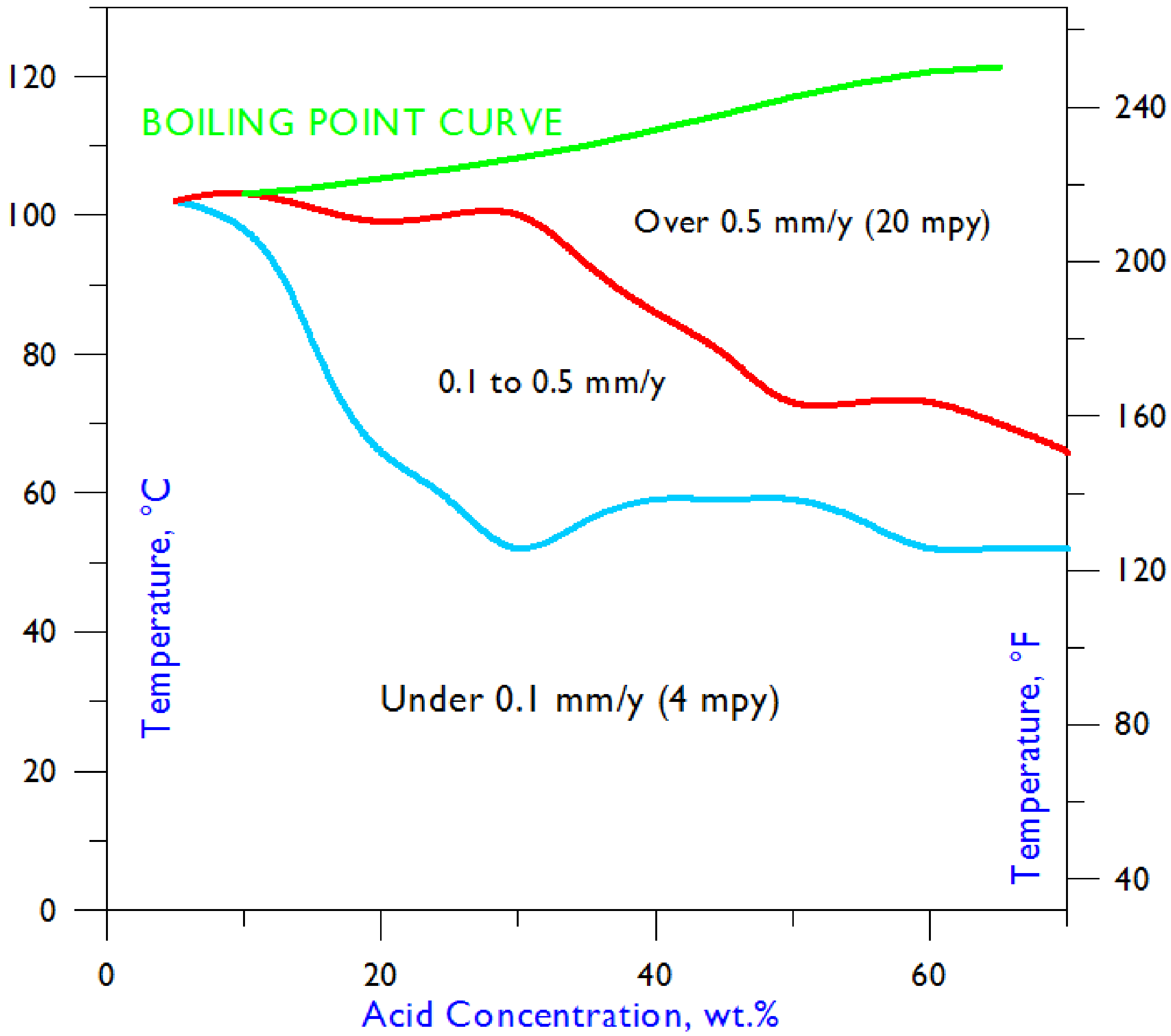
Selected Corrosion Data Continued

Nitric Acid

Conc. Wt.%	50°F 10°C	75°F 24°C	100°F 38°C	125°F 52°C	150°F 66°C	175°F 79°C	200°F 93°C	225°F 107°C	Boiling
10	-	-	0.01	-	0.03	-	0.06	-	0.26
20	-	-	-	-	0.09	-	0.16	-	0.66
30	-	-	0.02	-	0.14	0.17	0.41	-	1.52
40	-	-	-	0.05	0.20	0.38	0.88	-	4.42
50	-	-	0.04	0.07	0.30	0.65	1.51	-	-
60	-	-	0.06	0.10	0.42	0.82	2.03	-	18.42
65	-	-	-	-	0.41	-	2.53	-	22.12
70	-	-	0.06	-	0.46	1.12	2.62	-	-

All corrosion rates are in millimeters per year (mm/y); to convert to mils (thousandths of an inch) per year, divide by 0.0254.
Data are from Corrosion Laboratory Jobs 1-74 and 19-97.
All tests were performed in reagent grade acids under laboratory conditions; field tests are encouraged prior to industrial use.

Iso-Corrosion Diagram for C-276 Alloy in Nitric Acid



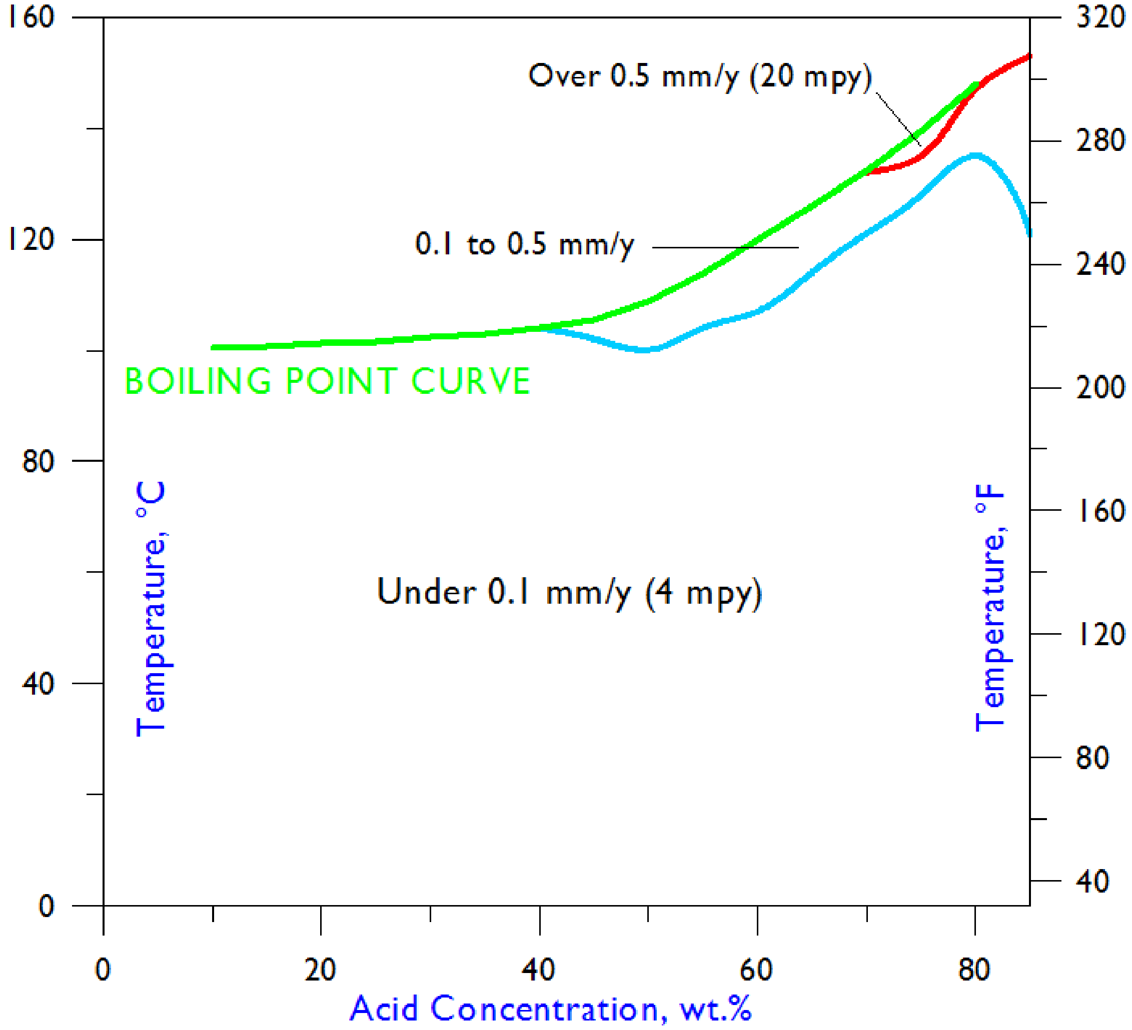
Selected Corrosion Data Continued

Phosphoric Acid

Conc. Wt.%	125°F 52°C	150°F 66°C	175°F 79°C	200°F 93°C	225°F 107°C	250°F 121°C	275°F 135°C	300°F 149°C	Boiling
50	-	-	0.01	0.02	-	-	-	-	0.18
60	-	-	0.01	0.02	0.08	-	-	-	0.28
70	-	-	0.01	0.02	0.08	0.08	-	-	0.13
75	-	-	-	-	-	-	-	-	1.29
80	-	-	0.01	0.02	-	0.09	0.12	-	0.31
85	-	-	-	-	-	0.09	0.17	0.29	1.68

All corrosion rates are in millimeters per year (mm/y); to convert to mils (thousandths of an inch) per year, divide by 0.0254.
Data are from Corrosion Laboratory Jobs 19-95 and 64-96.
All tests were performed in reagent grade acids under laboratory conditions; field tests are encouraged prior to industrial use.

Iso-Corrosion Diagram for C-276 Alloy in Phosphoric Acid



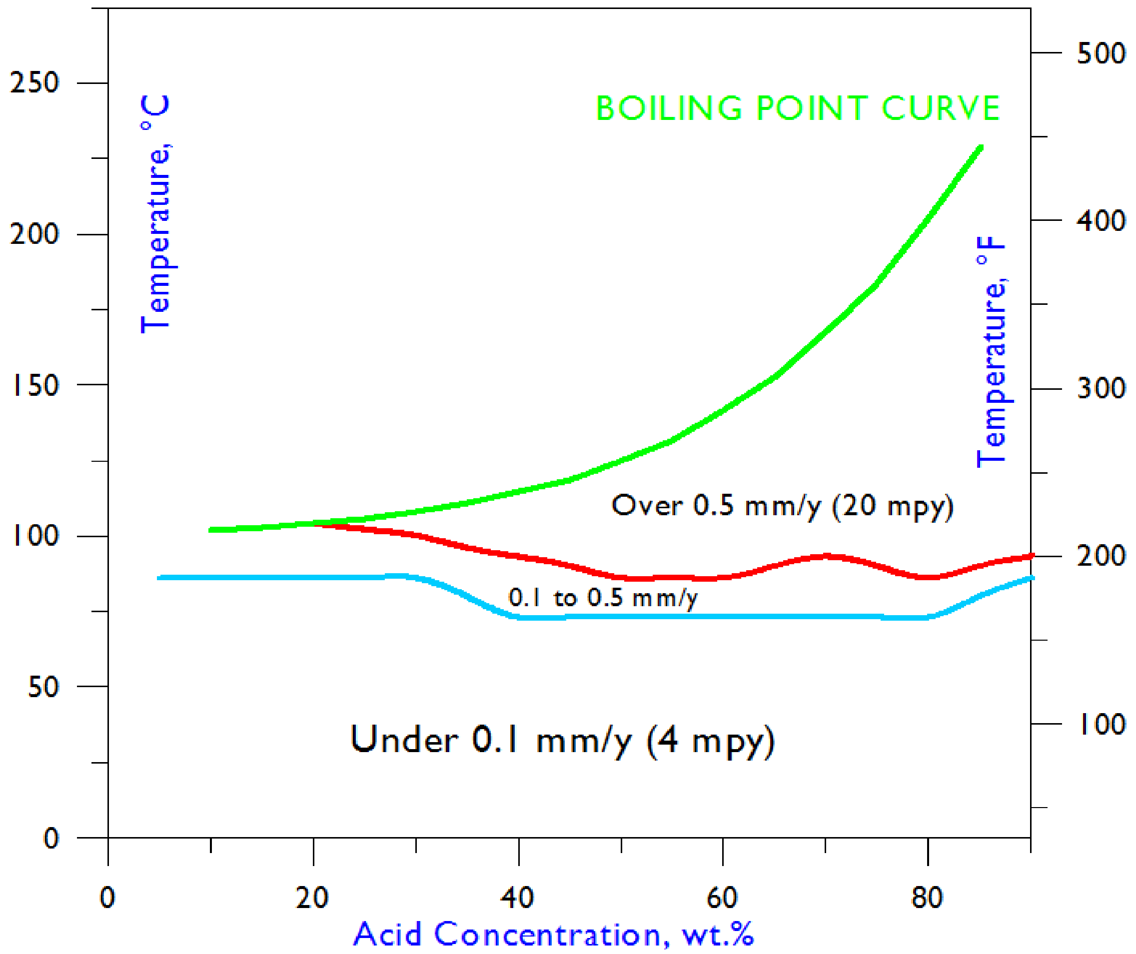
Selected Corrosion Data Continued

Sulfuric Acid

Conc. Wt.%	75°F 24°C	100°F 38°C	125°F 52°C	150°F 66°C	175°F 79°C	200°F 93°C	225°F 107°C	250°F 121°C	275°F 135°C	300°F 149°C	350°F 177°C	Boiling
1	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	0.03	0.14	-	-	-	-	-	0.18
20	-	-	-	-	0.05	0.4	-	-	-	-	-	0.49
30	-	-	-	-	0.06	0.42	-	-	-	-	-	0.83
40	-	-	-	-	0.19	0.48	1.02	-	-	-	-	1.87
50	-	-	-	0.02	0.26	0.62	1.13	2.33	-	-	-	3.64
60	-	-	-	0.02	0.3	0.67	1.03	2.87	-	-	-	13.08
70	-	-	-	0.05	0.16	0.5	1.06	13.68	-	-	-	-
80	-	-	-	0.04	0.14	0.6	2.73	5.66	-	-	-	-
90	-	-	-	0.03	0.05	0.46	1.64	4.79	-	-	-	-
96	-	-	-	-	0.04	0.18	0.95	-	-	-	-	-

All corrosion rates are in millimeters per year (mm/y); to convert to mils (thousandths of an inch) per year, divide by 0.0254.
Data are from Corrosion Laboratory Jobs 8-95, 11-95, 18-95, 43-95, 9-96, 15-96, and 20-96.
All tests were performed in reagent grade acids under laboratory conditions; field tests are encouraged prior to industrial use.

Iso-Corrosion Diagram for C-276 Alloy in Sulfuric Acid



Selected Corrosion Data (Reagent Grade Solutions, mm/y)

Chemical	Concentration wt.%	100°F 38°C	125°F 52°C	150°F 66°C	175°F 79°C	200°F 93°C	Boiling
Acetic Acid	99	-	-	-	-	-	<0.01
Chromic Acid	10	-	-	0.13	-	-	-
	20	-	-	0.53	-	-	-
Formic Acid	88	-	-	-	-	-	0.04
Hydrobromic Acid	2.5	-	-	-	-	-	0.13
	5	-	-	-	-	-	0.78
	7.5	-	-	0.01	0.14	-	-
	10	-	-	0.02	0.51	-	-
	15	-	0.01	0.34	0.57	-	-
	20	<0.01	0.25	0.37	0.51	-	-
	25	0.11	0.2	0.29	0.45	-	-
	30	0.12	0.2	0.28	0.44	-	-
	40	0.08	0.13	0.21	0.3	-	-
Hydrochloric Acid	1	-	-	-	-	-	0.33
	1.5	-	-	-	-	-	0.7
	2	-	-	0.01	0.02	-	-
	2.5	-	-	-	0.03	-	-
	3	-	-	0.01	0.42	-	-
	3.5	-	-	-	0.57	-	-
	4	-	-	0.02	0.67	-	-
	4.5	-	-	0.37	0.68	-	-
	5	-	0.02	0.31	0.75	-	-
	7.5	0.03	0.31	0.53	0.94	-	-
	10	0.17	0.32	0.46	1.18	-	-
	15	0.19	0.33	0.54	1.21	-	-
	20	0.14	0.29	0.55	1.1	-	-
Hydrofluoric Acid*	5	-	0.34	-	-	-	-
	10	-	0.41	-	-	-	-
	20	-	0.48	-	-	-	-
Nitric Acid	10	-	-	0.03	-	0.06	0.26
	20	-	-	0.09	-	0.16	0.66
	30	-	-	0.14	0.17	0.41	-
	40	-	-	0.2	0.38	0.88	-
	50	-	-	0.3	0.65	1.51	-
	60	-	-	0.42	0.82	2.03	-
	65	-	-	0.41	-	2.53	-
	70	-	-	0.46	-	2.62	-

*Hydrofluoric acid can also induce internal attack of nickel alloys; these values represent only external attack.

Selected Corrosion Data (Reagent Grade Solutions, mm/y)

Chemical	Concentration wt. %	100°F 38°C	125°F 52°C	150°F 66°C	175°F 79°C	200°F 93°C	Boiling
Phosphoric Acid	50	-	-	-	0.01	0.02	-
	60	-	-	-	0.01	0.02	-
	70	-	-	-	0.01	0.02	-
	75	-	-	-	-	-	-
	80	-	-	-	0.01	0.02	-
	85	-	-	-	-	-	-
Sulfuric Acid	10	-	-	-	0.03	0.14	0.18
	20	-	-	-	0.05	0.4	0.49
	30	-	-	-	0.06	0.42	0.83
	40	-	-	-	0.19	0.48	-
	50	-	-	0.02	0.26	0.62	-
	60	-	-	0.02	0.3	0.67	-
	70	-	-	0.05	0.16	0.5	-
	80	-	-	0.04	0.14	0.6	-
	90	-	-	0.03	0.05	0.46	-
	96	-	-	-	0.04	0.18	-

Resistance to Pitting and Crevice Corrosion

HASTELLOY® C-276 alloy exhibits high resistance to chloride-induced pitting and crevice attack, forms of corrosion to which the austenitic stainless steels are particularly prone. To assess the resistance of alloys to pitting and crevice attack, it is customary to measure their Critical Pitting Temperatures and Critical Crevice Temperatures in acidified 6 wt.% ferric chloride, in accordance with the procedures defined in ASTM Standard G 48. These values represent the lowest temperatures at which pitting and crevice attack are encountered in this solution, within 72 hours. For comparison, the values for 316L, 254SMO, 625, and C-276 alloys are as follows:

Alloy	Critical Pitting Temperature in Acidified 6% $FeCl_3$		Critical Crevice Temperature in Acidified 6% $FeCl_3$	
	°F	°C	°F	°C
316L	59	15	32	0
254SMO	140	60	86	30
625	212	100	104	40
C-276	**>302**	**>150**	**131**	**55**

Other chloride-bearing environments, notably Green Death (11.5% H_2SO_4 + 1.2% HCl + 1% $FeCl_3$ + 1% $CuCl_2$) and Yellow Death (4% NaCl + 0.1% $Fe_2(SO_4)_3$ + 0.021M HCl), have been used to compare the resistance of various alloys to pitting and crevice attack (using tests of 24 hours duration). In Green Death, the lowest temperature at which pitting has been observed in C-276 alloy is the boiling point. In Yellow Death, C-276 alloy has not exhibited pitting, even at the maximum test temperature (150°C).The Critical Crevice Temperature of C-276 alloy in Yellow Death is 60°C.

Resistance to Stress Corrosion Cracking

One of the chief attributes of the nickel alloys is their resistance to chloride-induced stress corrosion cracking. A common solution for assessing the resistance of materials to this extremely destructive form of attack is boiling 45% magnesium chloride (ASTM Standard G 36), typically with stressed U-bend samples. As is evident from the following results, the two nickel alloys, C-276 and 625, are much more resistant to this form of attack than the comparative, austenitic stainless steels. The tests were stopped after 1,008 hours (six weeks).

Alloy	Time to Cracking
316L	2 h
254SMO	24 h
625	No Cracking in 1,008 h
C-276	**No Cracking in 1,008 h**

Resistance to Seawater Crevice Corrosion

Seawater is probably the most common aqueous salt solution. Not only is it encountered in marine transportation and offshore oil rigs, but it is also used as a coolant in coastal facilities. Listed are data generated as part of a U.S. Navy study at the LaQue Laboratories in Wrightsville Beach, North Carolina (and published by D.M. Aylor et al, Paper No. 329, CORROSION 99, NACE International, 1999). Crevice tests were performed in both still (quiescent) and flowing seawater, at 29°C, plus or minus 3°C. Two samples (A & B) of each alloy were tested in still water for 180 days, and likewise in flowing water. Each sample contained two possible crevice sites.

	Quiescent		Flowing	
Alloy	No. of Sites Attacked	Maximum Depth of Attack, mm	No. of Sites Attacked	Maximum Depth of Attack, mm
316L	A:2, B:2	A:1.33, B:2.27	A:2, B:2	A:0.48, B:0.15
254SMO	A:2, B:2	A:0.76, B:1.73	A:2, B:2	A:0.01, B:<0.01
625	A:1, B:2	A:0.18, B:0.04	A:2, B:2	A:<0.01, B:<0.01
C-276	**A:1, B:1**	**A:0.10, B:0.13**	**A:0, B:0**	**A:0, B:0**

Corrosion Resistance of Welds

To assess the resistance of welds to corrosion, Haynes International has chosen to test all-weld-metal samples, taken from the quadrants of cruciform assemblies, created using multiple gas metal arc (MIG) weld passes. Predictably, the inhomogeneous nature of weld microstructures leads to higher corrosion rates (than with homogeneous, wrought products). Nevertheless, HASTELLOY® C-276 alloy exhibits excellent resistance to the key, inorganic acids, even in welded form, as shown in the following table:

	Concentration	**Temperature**		**Corrosion Rate**			
				Weld Metal		**Wrought Base Metal**	
Chemical	**wt.%**	**°F**	**°C**	**mpy**	**mm/y**	**mpy**	**mm/y**
H_2SO_4	30	150	66	1.2	0.03	<0.1	<0.01
H_2SO_4	50	150	66	1.2	0.03	0.8	0.02
H_2SO_4	70	150	66	5.1	0.13	2	0.05
H_2SO_4	90	150	66	4.3	0.11	1.2	0.03
HCl	10	100	38	8.7	0.22	6.7	0.17
HCl	15	100	38	7.9	0.2	7.5	0.19
HCl	20	100	38	6.3	0.16	5.5	0.14

Physical Properties

Physical Property	British Units		Metric Units	
Density	RT	0.321 lb/in^3	RT	8.89 g/cm^3
Electrical Resistivity	RT	48.4 µohm.in	RT	1.23 µohm.m
	200°F	48.7 µohm.in	100°C	1.24 µohm.m
	400°F	49.0 µohm.in	200°C	1.25 µohm.m
	600°F	49.5 µohm.in	300°C	1.26 µohm.m
	800°F	49.8 µohm.in	400°C	1.26 µohm.m
	1000°F	50.6 µohm.in	500°C	1.28 µohm.m
	-	-	600°C	1.30 µohm.m
Thermal Conductivity	100°F	71 Btu.in/h.ft^2.°F	50°C	10.5 W/m.°C
	200°F	77 Btu.in/h.ft^2.°F	100°C	11.2 W/m.°C
	400°F	90 Btu.in/h.ft^2.°F	200°C	12.9 W/m.°C
	600°F	104 Btu.in/h.ft^2.°F	300°C	14.7 W/m.°C
	800°F	117 Btu.in/h.ft^2.°F	400°C	16.5 W/m.°C
	1000°F	132 Btu.in/h.ft^2.°F	500°C	18.3 W/m.°C
Mean Coefficient of Thermal Expansion	75-200°F	6.2 µin/in.°F	24-100°C	11.2 µm/m.°C
	75-400°F	6.7 µin/in.°F	24-200°C	12.0 µm/m.°C
	77-600°F	7.1 µin/in.°F	24-300°C	12.7 µm/m.°C
	77-800°F	7.3 µin/in.°F	24-400°C	13.1 µm/m.°C
	77-1000°F	7.4 µin/in.°F	24-500°C	13.3 µm/m.°C
	77-1100°F	7.8 µin/in.°F	24-600°C	13.8 µm/m.°C
Magnetic Permeability	200 oersted	1.0002	15.9 kA/m	1.0002
Specific Heat	RT	0.102 Btu/lb.°F	RT	427 J/kg.°C
Dynamic Modulus of Elasticity	RT	29.8 x 10^6 psi	RT	205 GPa
	400°F	28.3 x 10^6 psi	200°C	195 GPa
	600°F	27.3 x 10^6 psi	300°C	189 GPa
	800°F	26.4 x 10^6 psi	400°C	183 GPa
	1000°F	25.5 x 10^6 psi	500°C	178 GPa
Melting Range	2415-2500°F	-	1323-1371°C	-
Poisson's Ratio	-	-	RT	0.31

RT= Room Temperature

Impact Strength

Type of Test	Test Temperature	Form	Thickness		Impact Strength	
			in	mm	ft.lbf	J
Charpy V-Notch	RT	Plate	0.394	10	348	472
Charpy V-Notch	RT	Plate	0.472	12	351	476

*RT= Room Temperature

Tensile Strength and Elongation

Form	Test Temperature		Thickness		0.2%Offset Yield Strength		Ultimate Tensile Strength		Elongation
	°F	°C	in	mm	ksi	MPa	ksi	MPa	%
Sheet	RT	RT	0.078	2	51.6	356	114.9	792	61
Sheet	400	204	0.078	2	42	290	100.6	694	59
Sheet	600	316	0.078	2	35.9	248	98.8	681	68
Sheet	800	427	0.078	2	32.7	225	94.3	650	67
Sheet	400	204	0.094	2.4	39.9	275	101	696	58
Sheet	600	316	0.094	2.4	33.5	231	97.6	673	64
Sheet	800	427	0.094	2.4	29.7	205	93.5	645	64
Sheet[1]	400	204	0.063-0.187	1.6-4.7	42.1	290	100.8	695	56
Sheet[2]	600	316	0.063-0.187	1.6-4.7	37.7	260	97	669	64
Sheet[2]	800	427	0.063-0.187	1.6-4.7	34.8	240	95	655	65
Sheet[2]	1000	538	0.063-0.187	1.6-4.7	33.8	233	88.9	613	60
Plate[3]	400	204	0.188-1.0	4.8-25.4	38.2	263	98.9	682	61
Plate[3]	600	316	0.188-1.0	4.8-25.4	34.1	235	94.3	650	66
Plate[3]	800	427	0.188-1.0	4.8-25.4	32.7	225	91.5	631	60
Plate[3]	1000	538	0.188-1.0	4.8-25.4	32.8	226	87.2	601	59
Plate	RT	RT	1	25.4	52.9	365	113.9	785	59
Plate	600	316	1	25.4	36.2	250	96.3	664	63
Plate	800	427	1	25.4	30.5	210	94.8	654	61

1: Average of 25 tests
2: Average of 34-36 tests
3: Average of 9-11 tests
RT= Room Temperature

Hardness

Form	Hardness, HRBW	Typical ASTM Grain Size
Sheet	88	3.5 - 6
Plate	88	1 - 5
Bar	86	1 - 5

All samples tested in solution-annealed condition.
HRBW = Hardness Rockwell “B”, Tungsten Indentor.

Welding and Fabrication

HASTELLOY® C-276 alloy is very amenable to the Gas Metal Arc (GMA/MIG), Gas Tungsten Arc (GTA/TIG), and Shielded Metal Arc (SMA/Stick) welding processes. Matching filler metals (i.e. solid wires and coated electrodes) are available for these processes, and welding guidelines are given in the “Welding and Fabrication” brochure.

Wrought products of HASTELLOY® C-276 alloy are supplied in the Mill Annealed (MA) condition, unless otherwise specified. This solution annealing procedure has been designed to optimize the alloy’s corrosion resistance and ductility. Following all hot forming operations, the material should be re-annealed, to restore optimum properties. The alloy should also be re-annealed after any cold forming operations that result in an outer fiber elongation of 7% or more. The annealing temperature for HASTELLOY® C-276 alloy is 1121°C (2050°F), and water quenching is advised (rapid air cooling is feasible with structures thinner than 10 mm (0.375 in). A hold time at the annealing temperature of 10 to 30 minutes is recommended, depending on the thickness of the structure (thicker structures need the full 30 minutes). More details concerning the heat treatment of HASTELLOY® C-276 alloy are given in our “Welding and Fabrication” brochure.

HASTELLOY® C-276 alloy can be hot forged, hot rolled, hot upset, hot extruded, and hot formed. However, it is more sensitive to strain and strain rates than the austenitic stainless steels, and the hot working temperature range is quite narrow. For example, the recommended start temperature for hot forging is 1232°C (2250°F) and the recommended finish temperature is 954°C (1750°F). Moderate reductions and frequent re-heating provide the best results, as described in “Welding and Fabrication” brochure. This reference also provides guidelines for cold forming, spinning, drop hammering, punching, and shearing. The alloy is stiffer than most austenitic stainless steels, and more energy is required during cold forming. Also, HASTELLOY® C-276 alloy work hardens more readily than most austenitic stainless steels, and may require several stages of cold work, with intermediate anneals.

While cold work does not usually affect the resistance of HASTELLOY® C-276 alloy to general corrosion, and to chloride-induced pitting and crevice attack, it can affect resistance to stress corrosion cracking. For optimum corrosion performance, therefore, the re-annealing of cold worked parts (following an outer fiber elongation of 7% or more) is important.

Specifications & Codes

Specifications

HASTELLOY® C-276 alloy (N10276, W10276)	
Sheet, Plate & Strip	SB 575/B 575 P= 43
Billet, Rod & Bar	SB 574/B 574 B 472 P= 43
Coated Electrodes	SFA 5.11/ A 5.11 (ENiCrMo-4) DIN 2.4887 (EL-NiMo15Cr15W) F= 43
Bare Welding Rods & Wire	SFA 5.14/ A 5.14 (ERNiCrMo-4) DIN 2.4886 (SG-NiMo16Cr16W) F= 43
Seamless Pipe & Tube	SB 622/B 622 B 983 P= 43
Welded Pipe & Tube	SB 619/B 619 SB 626/B 626 P= 43
Fittings	SB 366/B 366 SB 462/B 462 P= 43
Forgings	SB 564/B 564 SB 462/B 462 P= 43
DIN	17744 No. 2.4819 NiMo16Cr15W
TÜV	Werkstoffblatt 400 Kennblatt 320 Kennblatt 319
Others	NACE MR0175 ISO 15156

Codes

<table>
<tr><th colspan="4">HASTELLOY® C-276 alloy
(N10276, W10276)</th></tr>
<tr><td rowspan="12">ASME</td><td>Section I</td><td colspan="2">1000°F (538°C)[1]
Code Case 1924
1000°F (538°C)</td></tr>
<tr><td rowspan="3">Section III</td><td>Class 1</td><td>-</td></tr>
<tr><td>Class 2</td><td>800°F (427°C)[2]</td></tr>
<tr><td>Class 3</td><td>800°F (427°C)[2]</td></tr>
<tr><td rowspan="2">Section VIII</td><td>Div. 1</td><td>1250°F (677°C)[3]</td></tr>
<tr><td>Div. 2</td><td>1250°F (677°C)[3]</td></tr>
<tr><td>Section XII</td><td colspan="2">650°F (343°C)[3]</td></tr>
<tr><td>B16.5</td><td colspan="2">1250°F (677°C)[4]</td></tr>
<tr><td>B16.34</td><td colspan="2">1250°F (677°C)[5]</td></tr>
<tr><td>B31.1</td><td colspan="2">1000°F (538°C)[6]</td></tr>
<tr><td>B31.3</td><td colspan="2">1250°F (677°C)[7]</td></tr>
<tr><td>VdTÜV (doc #)</td><td colspan="3">844°F (450°C)[8],
#400</td></tr>
</table>

[1]Approved material forms: Plate, Sheet, Bar, fittings, welded pipe/tube, seamless pipe/tube
[2]Approved material forms: Plate, Sheet, Bar, welded pipe/tube, seamless pipe/tube
[3]Approved material forms: Plate, Sheet, Bar, Forgings, fittings, welded pipe/tube, seamless pipe/tube
[4]Approved material forms: Plate, Forgings, fittings, Bolting
[5]Approved material forms: Plate, Bar, Forgings, seamless pipe/tube, Bolting
[6]Approved material forms: Plate, Sheet, fittings, welded pipe/tube, seamless pipe/tube
[7]Approved material forms: Plate, Sheet, Forgings, fittings, welded pipe/tube, seamless pipe/tube
[8]Approved material forms: Plate, Sheet, Bar, Forgings

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