

HASTELLOY® G-35® alloy

Principal Features

A nickel alloy with exceptional resistance to “wet process” phosphoric acid

HASTELLOY® G-35® alloy (UNS N06035) was designed to resist “wet process” phosphoric acid (P_2O_5), which is used in the production of fertilizers. Tests in real-world solutions indicate that G-35 alloy is far superior to other metallic materials in this acid. It was also designed to resist localized attack in the presence of chlorides, since this can be a problem beneath deposits in evaporators used to concentrate “wet process” phosphoric acid. Furthermore, G-35 alloy is much less susceptible to chloride-induced stress corrosion cracking than the stainless steels and nickel-chromium-iron alloys traditionally used in “wet process” phosphoric acid.

As a result of its very high chromium content, G-35® alloy is extremely resistant to other oxidizing acids, such as nitric, and mixtures containing nitric acid. It possesses moderate resistance to reducing acids, as a result of its appreciable molybdenum content, and, unlike other nickel-chromium-molybdenum alloys, it is very resistant to “caustic de-alloying” in hot sodium hydroxide.

HASTELLOY® G-35® alloy is available in the form of plates, sheets, strips, billets, bars, wires, pipes, tubes, and covered electrodes. Applications include P_2O_5 evaporator tubes.

Nominal Composition

Weight %

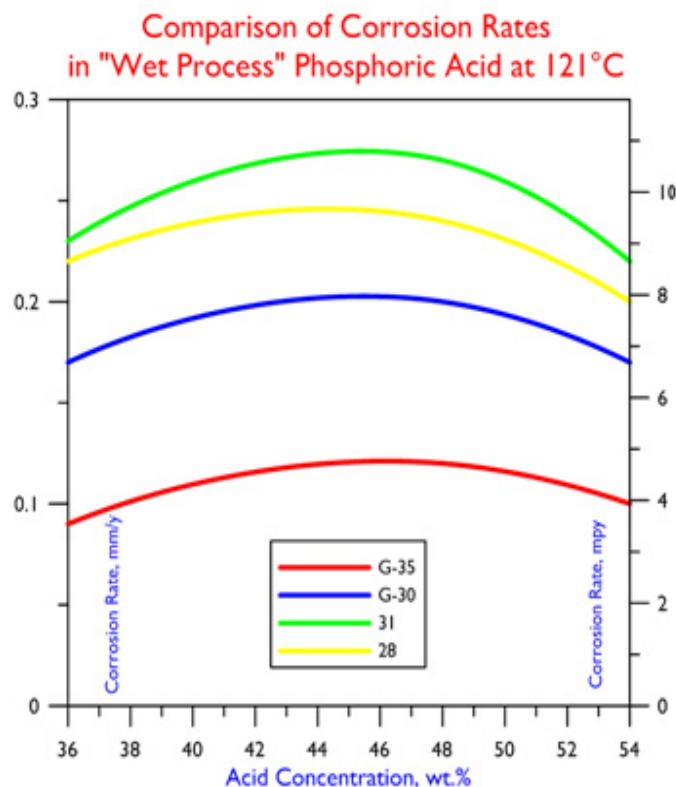
Nickel:	58 Balance
Cobalt:	1 max.
Chromium:	33.2
Molybdenum:	8.1
Tungsten:	0.6 max.
Iron:	2 max.
Manganese:	0.5 max.
Aluminum:	0.4 max.
Silicon:	0.6 max.
Carbon:	0.05 max.
Copper:	0.3 max.

Resistance to “Wet Process” Phosphoric Acid

“Wet process” phosphoric acid (P_2O_5), which is made by reacting phosphate rock with sulfuric acid, is one of the most important industrial chemicals, being the primary source of phosphorus for agrichemical fertilizers. As produced, it contains many impurities, and has a P_2O_5 concentration of only about 30%, because of the large amount of rinse water needed to separate it from the other main reaction product, calcium sulfate. Typical impurities include unreacted sulfuric acid, various metallic ions, fluoride ions, and chloride ions. The fluoride ions tend to form complexes with the metallic ions, and are therefore less of a problem than the chloride ions, which strongly influence electrochemical reactions between “wet process” phosphoric acid and metallic materials. Particulate matter (for example, silica particles) can also be present in “wet process” acid.

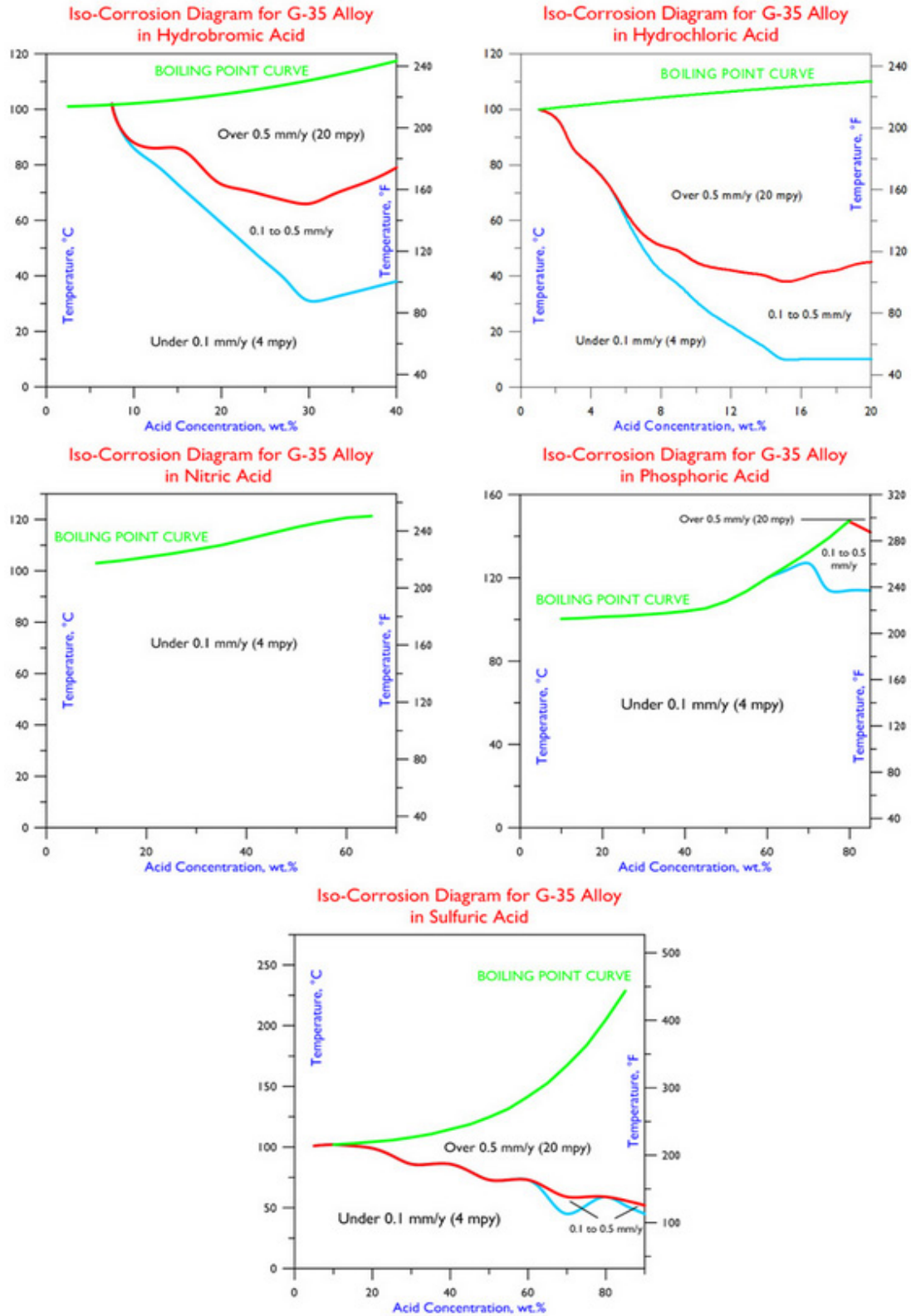
The main use of metallic materials is in the concentration process, where the “wet process” acid is taken through a series of evaporation steps, involving metallic tubing. Typically, the P_2O_5 concentration is raised to 54% during this process. The concentration effect upon the corrosivity of the acid is somewhat offset by the fact that the impurity levels drop as the concentration increases.

The following chart, comparing G-35[®] alloy with competitive materials, is based on tests in three concentrations (36, 48, and 54%) of “wet process” phosphoric acid (supplied by a producer in Florida, USA) at 121°C (250°F).



Iso-Corrosion Diagrams

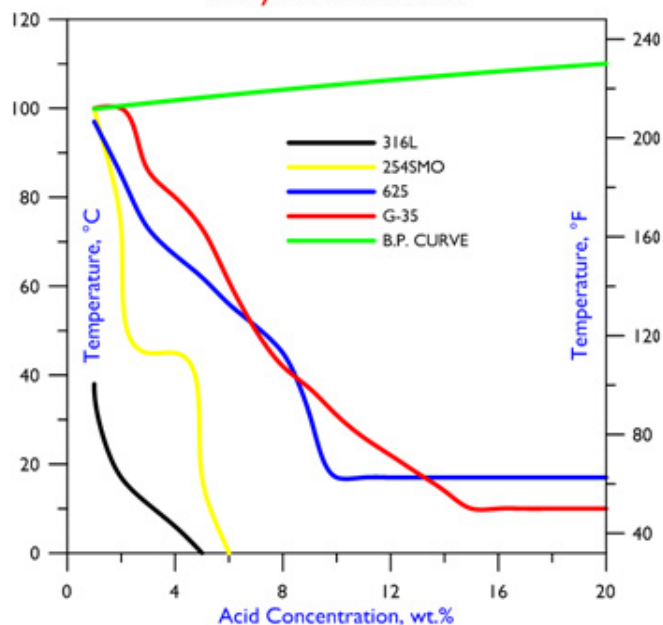
Each of these iso-corrosion diagrams was constructed using numerous corrosion rate values, generated at different acid concentrations and temperatures. The blue line represents those combinations of acid concentration and temperature at which a corrosion rate of 0.1 mm/y (4 mils per year) is expected, 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.



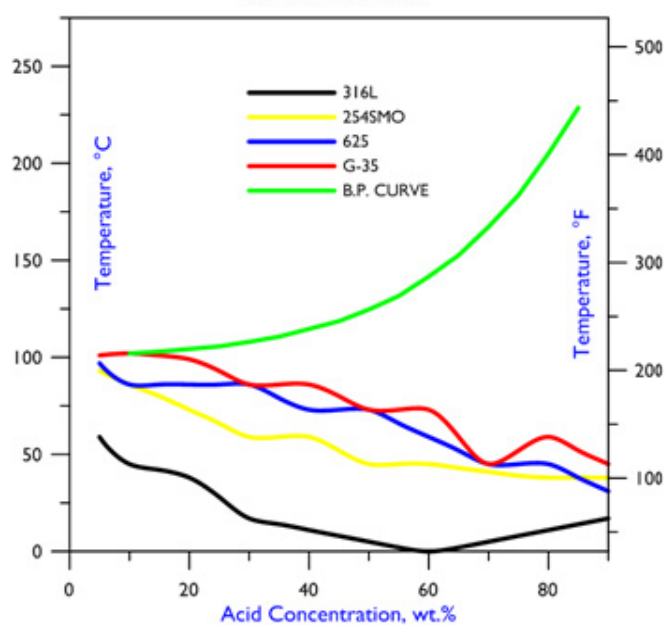
Comparative 0.1 mm/y Line Plots

To compare the performance of HASTELLOY® G-35® alloy with that of other materials, it is useful to plot the 0.1 mm/y lines. In the following graphs, the lines for G-35® alloy are compared with those of 625 alloy, 254SMO alloy, and 316L stainless steel, in hydrochloric and sulfuric acids. Note that the lines for G-35® alloy are close to those for 625 alloy. The hydrochloric acid concentration limit of 20% is the azeotrope, above which corrosion tests are less reliable.

Comparison of 0.1 mm/y Lines
in Hydrochloric Acid



Comparison of 0.1 mm/y Lines
in Sulfuric Acid



Selected Corrosion Data

Hydrobromic Acid

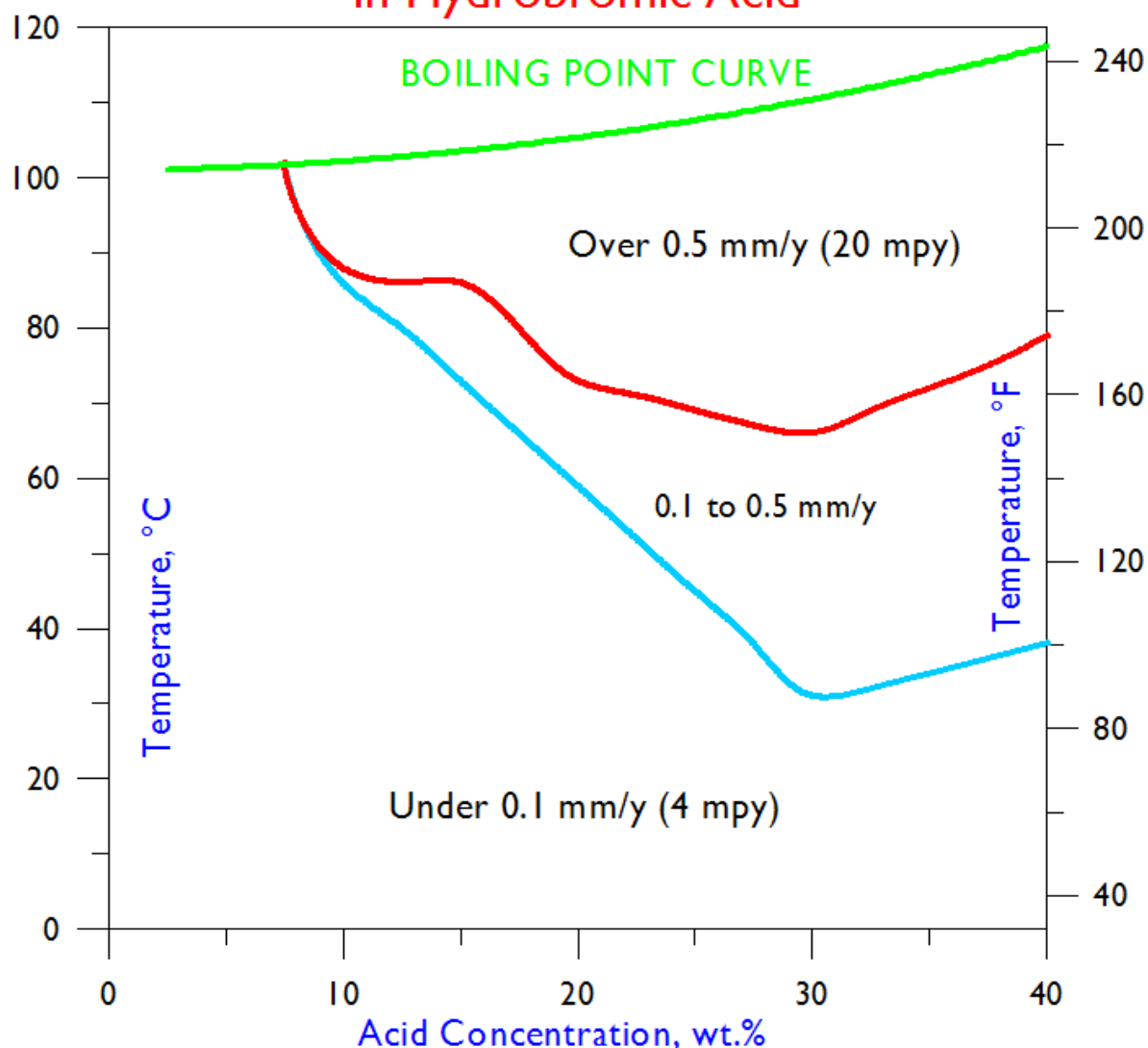
Conc. Wt.%	50°F	75°F	100°F	125°F	150°F	175°F	200°F	225°F	Boiling
	10°C	24°C	38°C	52°C	66°C	79°C	93°C	107°C	
2.5	-	-	-	-	<0.01	-	<0.01	-	<0.01
5	-	-	-	-	<0.01	-	<0.01	-	<0.01
7.5	-	-	-	-	<0.01	-	<0.01	-	0.02
10	-	-	-	-	<0.01	<0.01	1.12	-	-
15	-	-	-	-	<0.01	0.41	1.89	-	-
20	-	-	-	<0.01	0.44	1.12	-	-	-
25	-	-	-	-	-	-	-	-	-
30	-	0.01	0.14	0.26	0.46	0.84	-	-	-
40	-	-	0.1	0.17	0.31	0.48	-	-	-

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 Job 17-04.

All tests were performed in reagent grade acids under laboratory conditions; field tests are encouraged prior to industrial use.

Iso-Corrosion Diagram for G-35 Alloy in Hydrobromic Acid



Selected Corrosion Data Continued

Hydrochloric Acid

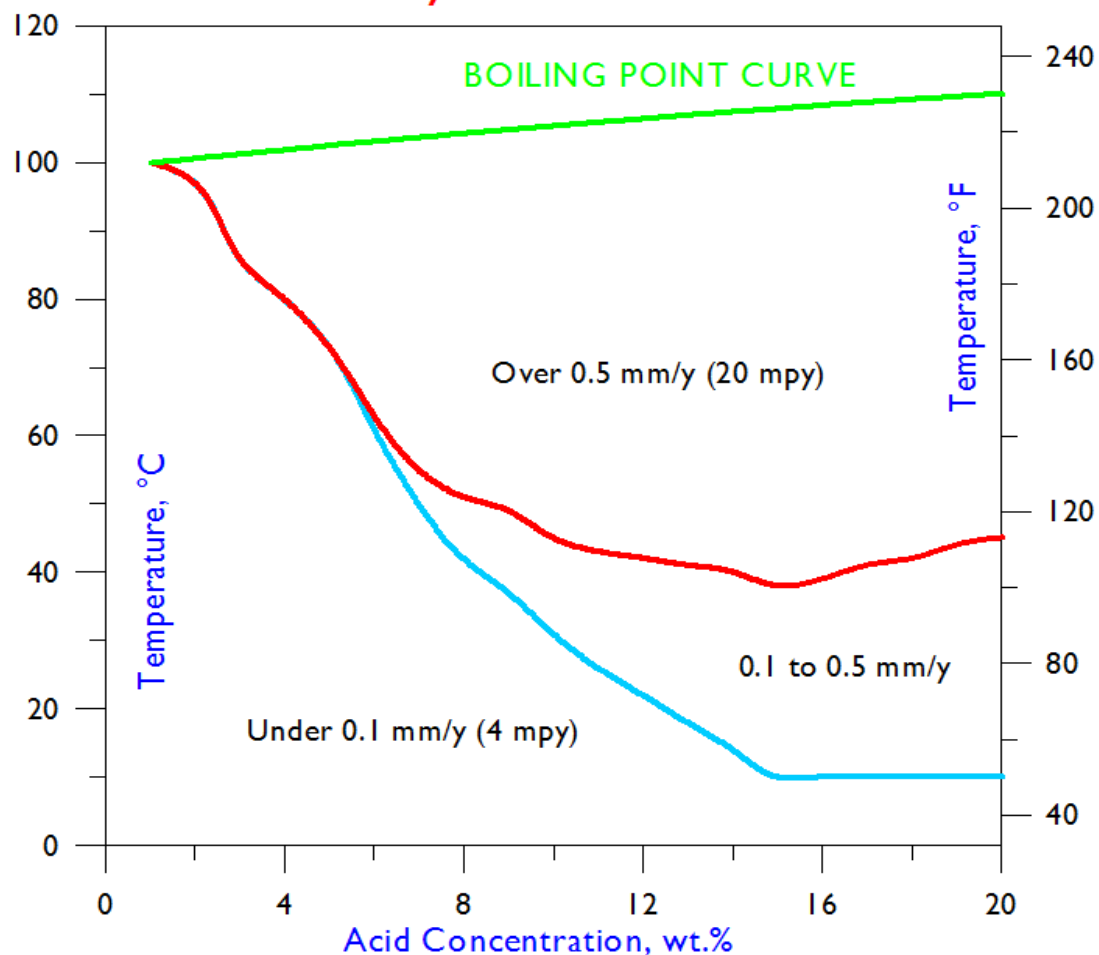
Conc. Wt.%	50°F	75°F	100°F	125°F	150°F	175°F	200°F	225°F	Boiling
	10°C	24°C	38°C	52°C	66°C	79°C	93°C	107°C	
1	-	-	-	-	-	-	-	-	0.05
1.5	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	<0.01	-	0.05
2.5	-	-	-	<0.01	<0.01	<0.01	17.83	-	-
3	-	-	-	-	<0.01	<0.01	-	-	-
3.5	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-
4.5	-	-	-	-	-	-	-	-	-
5	-	-	<0.01	-	<0.01	1.23	17.08	-	-
7.5	-	-	<0.01	0.47	0.97	-	-	-	-
10	-	<0.01	0.17	1.49	-	-	-	-	-
15	0.09	0.19	0.52	-	-	-	-	-	-
20	0.08	0.15	0.42	-	-	-	-	-	-

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 Job 44-02.

All tests were performed in reagent grade acids under laboratory conditions; field tests are encouraged prior to industrial use.

Iso-Corrosion Diagram for G-35 Alloy in Hydrochloric Acid



Selected Corrosion Data Continued

Nitric Acid

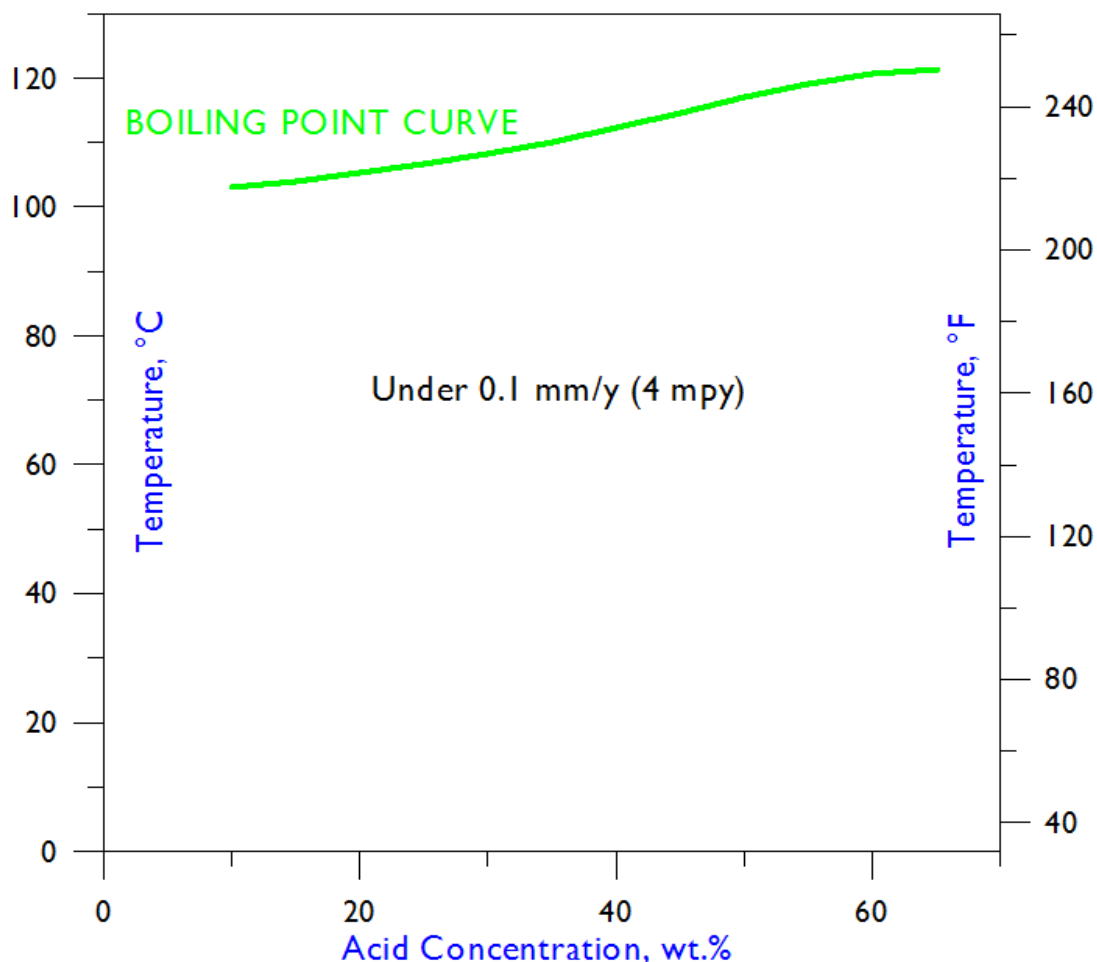
Conc. Wt.%	50°F	75°F	100°F	125°F	150°F	175°F	200°F	225°F	Boiling
	10°C	24°C	38°C	52°C	66°C	79°C	93°C	107°C	
10	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	<0.01
30	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	0.01
50	-	-	-	-	-	-	-	-	0.03
60	-	-	-	-	-	-	-	-	0.06
65	-	-	-	-	-	-	-	-	0.07
70	-	-	-	-	-	-	-	-	0.1

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 Job 6-03.

All tests were performed in reagent grade acids under laboratory conditions; field tests are encouraged prior to industrial use.

Iso-Corrosion Diagram for G-35 Alloy in Nitric Acid



Selected Corrosion Data Continued

Phosphoric Acid

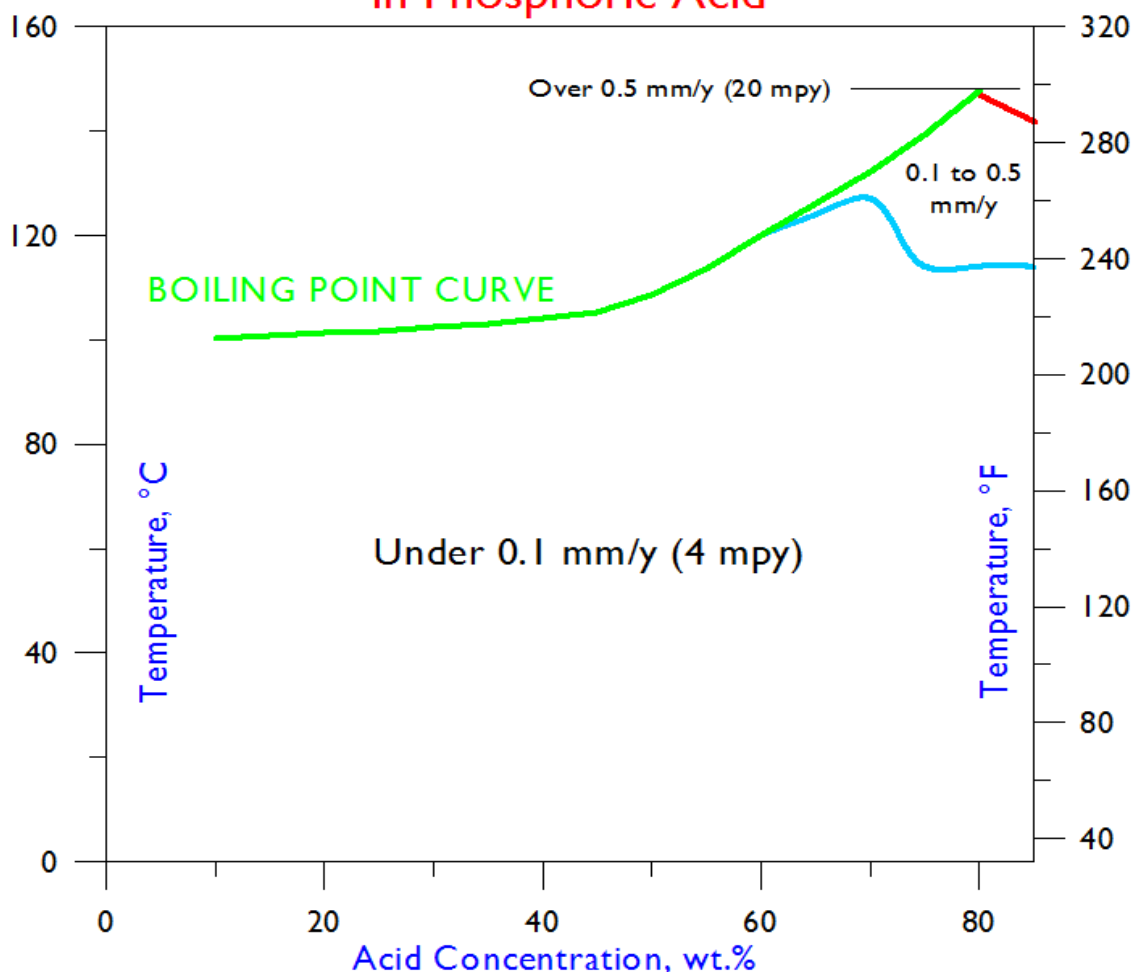
Conc. Wt.%	125°F	150°F	175°F	200°F	225°F	250°F	275°F	300°F	Boiling
	52°C	66°C	79°C	93°C	107°C	121°C	135°C	149°C	
50	-	-	-	-	-	-	-	-	0.01
60	-	-	-	-	-	-	-	-	0.01
65	-	-	-	-	-	-	-	-	0.17
70	-	-	-	-	0.01	0.09	-	-	0.11
75	-	-	-	-	-	0.12	-	-	0.3
80	-	-	-	-	0.07	0.12	0.37	-	0.42
85	-	-	-	-	0.07	0.14	0.31	0.71	0.99

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 5-03 and 30-04.

All tests were performed in reagent grade acids under laboratory conditions; field tests are encouraged prior to industrial use.

Iso-Corrosion Diagram for G-35 Alloy in Phosphoric Acid



Selected Corrosion Data Continued

Sulfuric Acid

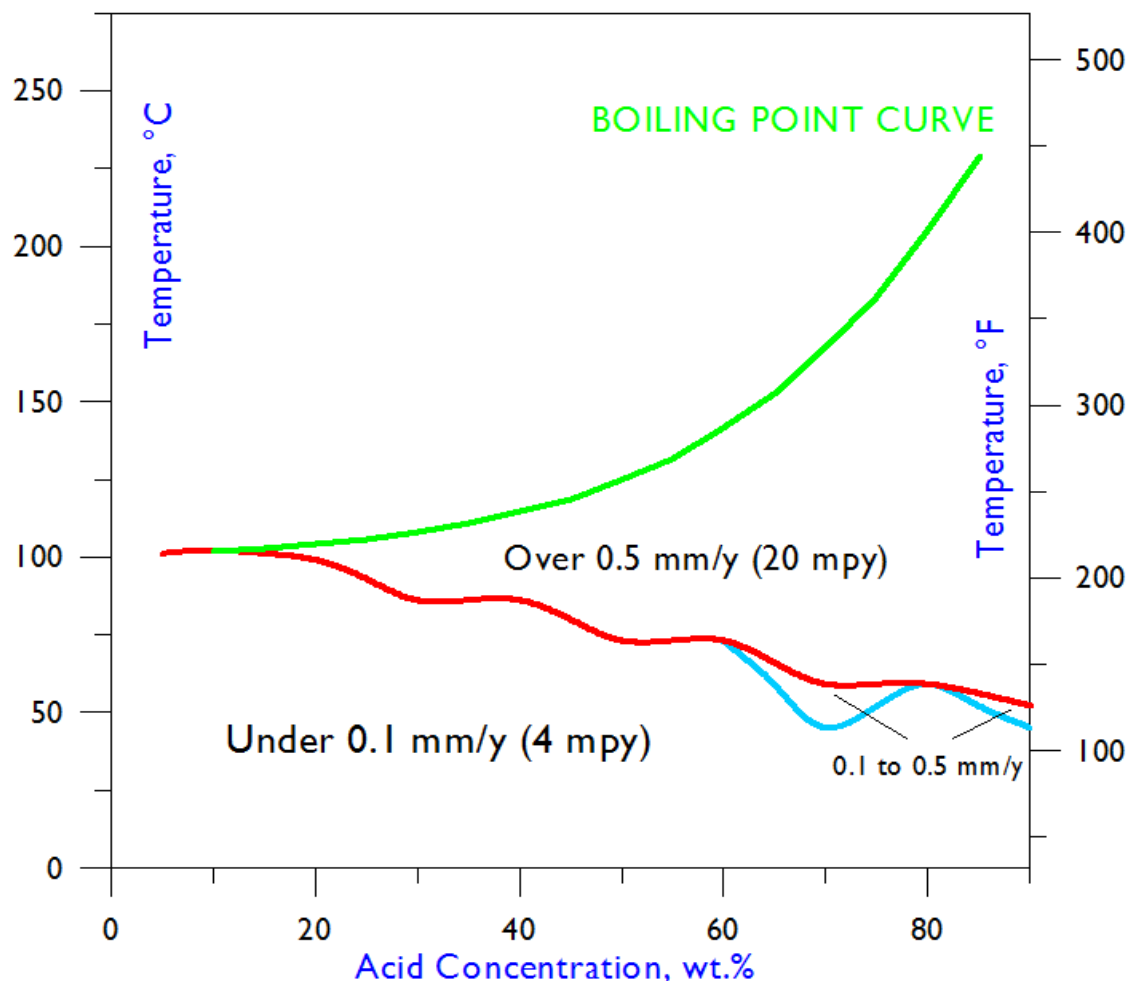
Conc. Wt.%	75°F	100°F	125°F	150°F	175°F	200°F	225°F	250°F	275°F	300°F	350°F	Boiling
	24°C	38°C	52°C	66°C	79°C	93°C	107°C	121°C	135°C	149°C	177°C	
1	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	0.07
10	-	-	-	-	-	<0.01	-	-	-	-	-	0.11
20	-	-	-	-	-	0.01	-	-	-	-	-	0.59
30	-	-	-	-	<0.01	2.62	-	-	-	-	-	-
40	-	-	-	<0.01	<0.01	5.41	-	-	-	-	-	-
50	-	-	-	<0.01	2.30	-	-	-	-	-	-	-
60	-	-	-	<0.01	2.45	-	-	-	-	-	-	-
70	-	<0.01	0.32	1.62	-	-	-	-	-	-	-	-
80	-	<0.01	<0.01	2.54	-	-	-	-	-	-	-	-
90	-	<0.01	0.54	3.12	-	-	-	-	-	-	-	-
96	-	<0.01	0.50	2.84	-	-	-	-	-	-	-	-

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 Job 45-02.

All tests were performed in reagent grade acids under laboratory conditions; field tests are encouraged prior to industrial use.

Iso-Corrosion Diagram for G-35 Alloy in Sulfuric Acid



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

Chemical	Concentration	100°F	125°F	150°F	175°F	200°F	Boiling
	wt.%	38°C	52°C	66°C	79°C	93°C	
Acetic Acid	99	-	-	-	-	-	<0.01
Chromic Acid	10	-	-	0.15	-	-	-
	20	-	-	0.85	-	-	-
Formic Acid	88	-	-	-	-	-	0.07
Hydrobromic Acid	2.5	-	-	<0.01	-	<0.01	<0.01
	5	-	-	<0.01	-	<0.01	<0.01
	7.5	-	-	<0.01	-	<0.01	0.02
	10	-	-	<0.01	<0.01	1.12	-
	15	-	-	<0.01	0.42	1.89	-
	20	-	<0.01	0.44	1.12	-	-
	30	0.14	0.26	0.46	0.84	-	-
	40	0.1	0.17	0.31	0.48	-	-
Hydrochloric Acid	1	-	-	-	-	-	0.05
	2	-	-	-	-	<0.01	0.05
	2.5	-	<0.01	<0.01	<0.01	17.83	-
	3	-	-	<0.01	<0.01	-	-
	5	<0.01	-	<0.01	1.23	-	-
	7.5	<0.01	0.47	0.97	-	-	-
	10	0.17	1.49	-	-	-	-
	15	0.52	-	-	-	-	-
Nitric Acid	20	-	-	-	-	-	<0.01
	40	-	-	-	-	-	0.01
	50	-	-	-	-	-	0.03
	60	-	-	-	-	-	0.06
	65	-	-	-	-	-	0.07
	70	-	-	-	-	-	0.1
Phosphoric Acid	50	-	-	-	-	-	0.01
	60	-	-	-	-	-	0.01
	70	-	-	-	-	-	0.11
	75	-	-	-	-	-	0.3
	80	-	-	-	-	-	0.42
Sulfuric Acid	10	-	-	-	-	<0.01	0.11
	20	-	-	-	-	0.01	0.59
	30	-	-	-	<0.01	2.62	-
	40	-	-	<0.01	<0.01	-	-
	50	-	-	<0.01	2.3	-	-
	60	-	-	<0.01	2.45	-	-
	70	<0.01	0.32	1.62	-	-	-
	80	<0.01	<0.01	2.54	-	-	-
	90	<0.01	0.54	3.12	-	-	-
96	<0.01	0.5	2.84	-	-	-	

Resistance to Pitting and Crevice Corrosion

HASTELLOY® G-35® alloy exhibits good resistance to chloride-induced pitting and crevice attack, forms of corrosion to which some of 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.

Alloy	Critical Pitting Temperature in Acidified 6% FeCl ₃		Critical Crevice Temperature in Acidified 6% FeCl ₃	
	°F	°C	°F	°C
315L	59	15	32	0
254SMO	40	60	86	30
28	113	45	64	17.5
31	163	72.5	109	42.5
G-30®	154	67.5	100	37.5
G-35®	203	95	133	45
625	212	100	104	40

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, G-35® alloy is 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
28	36 h
31	36 h
G-30®	168 h
G-35®	No Cracking in 1,008 h
625	No Cracking in 1,008 h

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. Interestingly, the resistance of all-weld-metal samples of G-35[®] alloy to key, inorganic acids is close to that of the wrought, base metal, and even exceeds it in concentrated sulfuric acid.

Chemical	Concentration wt.%	Temperature		Corrosion Rate			
		°F	°C	Weld Metal		Wrought Base Metal	
				mpy	mm/y	mpy	mm/y
H ₂ SO ₄	30	150	66	<0.4	<0.01	0.4	0.01
H ₂ SO ₄	50	150	66	<0.4	<0.01	<0.4	<0.01
H ₂ SO ₄	70	150	66	56.3	1.43	63.8	1.62
H ₂ SO ₄	90	150	66	66.5	1.69	122.8	3.12
HCl	5	100	38	<0.4	<0.01	<0.4	<0.01
HCl	10	100	38	9.4	0.24	6.7	0.17
HCl	15	100	38	22	0.56	20.5	0.52
HCl	20	100	38	17.7	0.45	16.5	0.42
HNO ₃	70	Boiling		4.7	0.12	3.9	0.1

Physical Properties

Physical Property	British Units		Metric Units	
Density	RT	0.297 lb/in ³	RT	8.22 g/cm ³
Electrical Resistivity	RT	46.5 μohm.in	RT	1.18 μohm.m
	200°F	46.8 μohm.in	100°C	1.19 μohm.m
	400°F	47.4 μohm.in	200°C	1.20 μohm.m
	600°F	47.7 μohm.in	300°C	1.21 μohm.m
	800°F	48.2 μohm.in	400°C	1.22 μohm.m
	1000°F	49.0 μohm.in	500°C	1.24 μohm.m
	1200°F	49.4 μohm.in	600°C	1.25 μohm.m
Thermal Conductivity	RT	70 Btu.in/h.ft ² .°F	RT	10 W/m.°C
	200°F	82 Btu.in/h.ft ² .°F	100°C	12 W/m.°C
	400°F	98 Btu.in/h.ft ² .°F	200°C	14 W/m.°C
	600°F	113 Btu.in/h.ft ² .°F	300°C	16 W/m.°C
	800°F	127 Btu.in/h.ft ² .°F	400°C	18 W/m.°C
	1000°F	143 Btu.in/h.ft ² .°F	500°C	19 W/m.°C
	-	-	600°C	23 W/m.°C
Mean Coefficient of Thermal Expansion	77-200°F	6.8 μin/in.°F	21-100°C	12.3 μm/m.°C
	77-400°F	7.0 μin/in.°F	21-200°C	12.6 μm/m.°C
	77-600°F	7.4 μin/in.°F	21-300°C	13.2 μm/m.°C
	77-800°F	7.5 μin/in.°F	21-400°C	13.4 μm/m.°C
	77-1000°F	7.7 μin/in.°F	21-500°C	13.6 μm/m.°C
	-	-	21-600°C	14.1 μm/m.°C
Thermal Diffusivity	RT	0.11 ft ² /h	RT	0.028 cm ² /s
	200°F	0.12 ft ² /h	100°C	0.031 cm ² /s
	400°F	0.13 ft ² /h	200°C	0.034 cm ² /s
	600°F	0.15 ft ² /h	300°C	0.038 cm ² /s
	800°F	0.17 ft ² /h	400°C	0.042 cm ² /s
	1000°F	0.18 ft ² /h	500°C	0.045 cm ² /s
	-	-	600°C	0.048 cm ² /s
Specific Heat	RT	0.11 Btu/lb.°F	RT	450 J/kg.°C
	200°F	0.11 Btu/lb.°F	100°C	470 J/kg.°C
	400°F	0.12 Btu/lb.°F	200°C	490 J/kg.°C
	600°F	0.12 Btu/lb.°F	300°C	510 J/kg.°C
	800°F	0.13 Btu/lb.°F	400°C	530 J/kg.°C
	1000°F	0.13 Btu/lb.°F	500°C	530 J/kg.°C
	-	-	600°C	600 J/kg.°C
Dynamic Modulus of Elasticity	RT	29.6 x 10 ⁶ psi	RT	204 GPa
	600°F	27.4 x 10 ⁶ psi	300°C	190 GPa
	800°F	26.5 x 10 ⁶ psi	400°C	184 GPa
	1000°F	25.7 x 10 ⁶ psi	500°C	179 GPa
	1200°F	24.7 x 10 ⁶ psi	600°C	174 GPa
Melting Range	2430-2482°F	-	1332-1361°C	-

Impact Strength

Plate Thickness		Test Temperature		Impact Strength*	
in	mm	°F	°C	ft.lbf	J
0.75	19.1	RT	RT	>264	>358

*Charpy V-Notch Samples

Tensile Strength & Elongation

Form	Thickness/ Bar Diameter		Test Temperature		0.2% Offset Yield Strength		Ultimate Tensile Strength		Elongation
	in	mm	°F	°C	ksi	MPa	ksi	MPa	%
Sheet	0.125	3.2	RT	RT	50	345	107	738	60
Sheet	0.125	3.2	200	93	43	296	101	696	63
Sheet	0.125	3.2	400	204	36	248	93	641	64
Sheet	0.125	3.2	600	316	31	214	89	614	70
Sheet	0.125	3.2	800	427	30	207	86	593	74
Sheet	0.125	3.2	1000	538	27	186	80	552	68
Sheet	0.125	3.2	1200	649	26	179	75	517	68
Plate	0.5	12.7	RT	RT	46	317	100	689	72
Plate	0.5	12.7	200	93	41	283	97	669	74
Plate	0.5	12.7	400	204	33	228	88	607	75
Plate	0.5	12.7	600	316	29	200	82	565	71
Plate	0.5	12.7	800	427	30	207	78	538	77
Plate	0.5	12.7	1000	538	26	179	72	496	75
Plate	0.5	12.7	1200	649	24	165	68	469	74
Bar	1	25.4	RT	RT	46	317	103	710	66
Bar	1	25.4	200	93	41	283	98	676	70
Bar	1	25.4	400	204	35	241	89	614	71
Bar	1	25.4	600	316	30	207	84	579	71
Bar	1	25.4	800	427	31	214	81	558	73
Bar	1	25.4	1000	538	28	193	75	517	72
Bar	1	25.4	1200	649	23	159	69	476	71

RT= Room Temperature

Welding & Fabrication

HASTELLOY® G-35® 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 our “Welding and Fabrication” brochure.

Wrought products of HASTELLOY® G-35® 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® G-35® 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® G-35® alloy are given in our “Welding and Fabrication” brochure.

HASTELLOY® G-35® 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 1204°C (2200°F) and the recommended finish temperature is 954°C (1750°F). Moderate reductions and frequent re-heating provide the best results, as described in our “Welding and Fabrication” brochure. This reference also provides guidelines for cold forming, spinning, drop hammering, punching, and shearing of the HASTELLOY® alloys. G-35® alloy is stiffer than most austenitic stainless steels, and more energy is required during cold forming. Also, G-35® 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® G-35® 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® G-35® alloy (N06035)	
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-22) F= 43
Bare Welding Rods & Wire	SFA 5.14/ A 5.14 (ERNiCrMo-22) F= 43
Seamless Pipe & Tube	SB 622/B 622 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	No. 2.4643 NiCr33Mo8
TÜV	-
Others	NACE MR0175 ISO 15156 ASME Code Case No. 2484

Codes

HASTELLOY® G-35® alloy				
UNS		N06035		
ASME	Section I	-		
	Section III	Class 1	-	
		Class 2	-	
		Class 3	-	
	Section VIII	Div. 1	800°F (427°C) ¹	
		Div. 2	-	
	Section XII	-		
	B16.5	800°F (427°C) ²		
	B16.34	800°F (427°C) ²		
	B31.1	-		
B31.3	800°F (427°C) ¹			
VdTÜV (doc #)		-		

¹Approved material forms: Plate, Sheet, Bar, Forgings, fittings, welded pipe/tube, seamless pipe/tube

²Approved material forms: Plate, Bar, Forgings, seamless pipe/tube

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