Technical Data Sheet

ATI 840™

Stainless Steel: Austenitic

GENERAL CHARACTERISTICS

ATI 840™ alloy is a titanium- and aluminum-bearing austenitic stainless steel offering elevated-temperature scaling resistance superior to conventional chromium-nickel stainless steels, such as Type 304. The oxidation resistance of ATI 840 alloy compares favorably with higher alloyed grades up to 1900ºF (1038ºC), making it a good candidate alloy for use in sheathing for electric heating elements, automotive emission control systems, and other applications where resistance to elevated temperature degradation is important.

CHEMICAL COMPOSITION

The chemical composition of ATI 840 stainless steel is indicated in the table below.

Element	Weight Percent
Carbon	0.08 max
Manganese	1.00 max
Phosphorus	0.03 max
Sulfur	0.015 max
Silicon	1.00 max
Chromium	18.0 – 22.0
Nickel	18.0 – 22.0
Titanium	0.60 max
Aluminum	0.60 max
Copper	0.75 max
Iron	Balance

CORROSION RESISTANCE

Various tests have indicated that ATI 840 alloy possesses corrosion resistance similar to that of Types 309 and 310. ATI 840 alloy has displayed immunity to salt spray but does not resist stress corrosion cracking as well as Type 332.

OXIDATION RESISTANCE

ATI 840 stainless steel contains sufficient chromium to form and maintain a protective chromium oxide scale at elevated temperatures. This, combined with the relatively high level of nickel, results in an alloy with superior oxidation resistance when compared to the standard 18–8 grades of stainless steel.

The oxidation data summarized in the following table is representative of ATI 840 stainless steel. Specimens prepared from

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standard mill-finish production material were degreased, cleaned and dried prior to exposure. Specimens were placed in inert ceramic crucibles and exposed in still laboratory air for 100 hours at temperature in a continuous oxidation test. All data reflects the average results from a minimum of two different test specimens.

Test Temperature °F (°C)		Yield Strength, 0.2% Offset psi (MPa)		Tensile Strength psi (MPa)		Percent Elongation in 2" (51 mm)
68	(20)	37,650	(260)	72,750	(502)	45.6
200	(93)	32,300	(223)	62,750	(433)	38.0
400	(204)	31,550	(218)	59,500	(410)	30.0
600	(316)	28,100	(194)	57,250	(395)	27.8
800	(427)	24,850	(171)	51,150	(353)	31.8
1000	(538)	22,200	(153)	42,550	(293)	29.0
1200	(649)	18,000	(124)	37,650	(260)	29.3
1400	(760)	12,650	(87)	21,150	(146)	35.8
1600	(871)	7,150	(49)	10,700	(74)	39.5

In general, total weight gains greater than 10 mg/cm^2 indicate that additional exposures at these temperatures would lead to rapid failures. However, it can be difficult to evaluate the actual oxidation behavior of any alloy in service relying on laboratory data alone. Since oxidation rates are greatly affected by the conditions of actual exposure, the data presented in this publication can only serve as approximate guidelines.

APPLICATIONS

ATI 840 alloy is a common sheathing material for electrical resistance heating elements. It is suitable for this application due to its combination of formability, weldability, corrosion resistance, and oxidation resistance. The alloy composition results in the formation of a cosmetically desirable dark oxide layer during annealing in a gas-fired furnace. This oxide layer is retained during service due to the alloy's elevated chromium and nickel contents. The excellent environmental resistance of this alloy makes it suitable for other applications as well. For example, ATI 840 stainless has sufficient chromium and nickel to resist the corrosive environment present in automotive exhaust systems.

PHYSICAL PROPERTIES

Modulus of elasticity 29–30 x 10^6 psi (200 GPa)

Density 0.286 lb/in^3 (7.92 g/cm^3)

Thermal Conductivity

Temperature Range		Btu/ft^2/hr/°F/ft	W/m-K
°C	°F		
68-132	20-56	90.0	12.9
68-204	20-96	93.6	13.5
68-333	20-167	104.4	15.0
68-465	20-241	114.0	16.3
68-590	20-310	122.4	17.6
68-726	20-385	133.2	19.2
68-848	20-453	145.2	20.9
68-972	20-522	156.0	22.4
68-1001	20-594	168.0	24.1
68-1198	20-648	181.2	26.0

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Electrical Resistivity

Temperature Range		microhm-cm
°C	°F	
132	56	89.1
204	96	91.6
333	167	95.9
465	241	99.8
590	310	103.3
726	385	106.6
848	453	109.4
972	522	112.1
1001	594	114.6
1198	648	116.2

Coefficient of Linear Thermal Expansion

Test Temperature Range		Mean Coefficients	
°F	°C	in/in•°F	m/m•°C
68-122	20-50	9.34×10^{-6}	16.8×10^{-6}
68-212	20-100	9.47×10^{-6}	17.0×10^{-6}
68-302	20-150	9.59×10^{-6}	17.3×10^{-6}
68-392	20-200	9.71×10^{-6}	17.5×10^{-6}
68-482	20-250	9.81×10^{-6}	17.7×10^{-6}
68-572	20-300	9.92×10^{-6}	17.9×10^{-6}
68-662	20-350	10.10×10^{-6}	18.2×10^{-6}
68-752	20-400	10.17×10^{-6}	18.3×10^{-6}
68-842	20-450	10.21×10^{-6}	18.4×10^{-6}
68-932	20-500	10.30×10^{-6}	18.5×10^{-6}
68-1022	20-550	10.43×10^{-6}	18.8×10^{-6}
68-1112	20-600	10.55×10^{-6}	19.0×10^{-6}
68-1202	20-650	10.61×10^{-6}	19.1×10^{-6}
68-1292	20-700	10.68×10^{-6}	19.2×10^{-6}

MECHANICAL PROPERTIES

Nominal Room Temperature Mechanical Properties

Yield strength,0.2% offset	35,000 psi (241 MPa)
Ultimate tensile strength	83,000 psi (572 MPa)
Elongationin 2" gauge length	40%
Hardness (Rb)	70

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Elevated Temperature Tensile Properties

Short time elevated temperature tensile test data is presented in the table below.

Test Temperature °F (°C)		Yield Strength, 0.2% Offset psi (MPa)		Tensile Strength psi (MPa)		Percent Elongation in 2" (51 mm)
1000	(538)	25,000	(172)	68,000	(469)	25
1400	(760)	23,000	(159)	43,000	(297)	21
1600	(871)	18,000	(124)	26,000	(179)	36
1800	(982)	9,100	(63)	15,000	(103)	56
1900	(1038)	8,500	(59)	12,000	(83)	43

FATIGUE STRENGTH

The fatigue strength or endurance limit is the maximum stress below which failure is unlikely to occur after 10 million cycles in an ambient environment. The fatigue strength for austenitic stainless steels, as a group, is typically about 35 percent of the tensile strength. Substantial variability in fatigue strength is generally noted in service as extrinsic variables have a significant influence. For example, a finer surface finish tends to increase the fatigue strength, while a corrosive service environment will tend to decrease fatigue strength.

HEAT TREATMENT AND FABRICATION

The austenitic stainless steels, including ATI 840 alloy, are routinely fabricated into a variety of shapes, ranging from simple to complex. These alloys can be formed on equipment essentially the same as is used for carbon steel. The excellent ductility of the austenitic grades allows them to be formed by bending, stretching, deep drawing, and spinning. However, because of their greater strength and tendency to work harden, the power requirements for forming the austenitic stainless is considerably greater than those for carbon steels.

Austenitic stainless steels are generally provided in the mill annealed condition ready for use. Their tendency to work harden results in an increase in strength, with a subsequent reduction in ductility, during deformation at or near room temperature. Heat treatment may be needed after fabrication to remove the effects of cold work. ATI 840 alloy cannot be hardened by heat treatment.

The austenitic grades are considered the most weldable of all the stainless steels. They are routinely joined by all fusion and resistance welding processes. For ATI 840 alloy, as with all stainless steels, inert gas processes must be used. Autogenous (TIG) welding is most common. If the situation dictates the use of filler metals, ATI 840 alloy should also be amenable to welding with standard consumables. It is suggested that Type 82 (AWS ERNiCr-3) and Type A (AWS EniCrFe-2) filler metals be evaluated for such applications. Scale or slag that forms from welding processes should be removed with a stainless steel wire brush. Normal carbon steel wire brushes will leave carbon steel particles in the surface which will eventually produce surface rusting and discoloration. For more severe applications, welded areas should be treated with a descaling solution such as a mixture of nitric and hydrofluoric acids and these should be subsequently washed off.

Two important considerations for weld joints in the austenitic stainless steels are (a) avoidance of solidification cracking and (b) preservation of corrosion resistance in the weld and the surrounding heat affected zone. The occurrence of solidification cracking can be minimized by proper weld practice. Avoidance of contamination during welding is also critical, as trace amounts of elements such as copper can cause severe cracking.

Exposure of the austenitic stainless steels to temperatures in the 800°F to 1500°F (427°C to 816°C) range may cause precipitation of chromium carbides along grain boundaries. Such steels are “sensitized” and subject to intergranular corrosion when exposed to aggressive environments. The carbon content of ATI 840 alloy may allow sensitization to occur from thermal conditions experienced by autogenous welds and heat-affected zones of welds. Annealing may then be needed to dissolve the carbides and restore corrosion resistance. Solution annealing of ATI 840 alloy should be performed in the 1900º–2150ºF (1038º–1177ºC) range, followed by an air or water quench, depending on section thickness. Cooling should be rapid through the sensitization range to avoid re-precipitation of chromium carbides at the grain boundaries.

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