Technical Data Sheet

S240® Alloy

INTRODUCTION

S240 alloy (UNS S11900) is a martensitic precipitation-hardening stainless steel with tensile strength of 240 ksi (1,655 MPa), high fracture toughness, and good corrosion and stress corrosion cracking resistance. S240 alloy has strength and toughness properties that are comparable to other commercial steels in this class, but it also offers:

- Simple processing; can be thermal mechanically processed similarly to other precipitation-hardened stainless steels such as 13-8 and 15-5 alloys, and does not require “deep freeze” or cryogenic treatment to achieve the high tensile strength
- Improved corrosion and stress corrosion cracking resistance compared with other steels of similar strength
- Lower raw materials and processing costs (no cobalt; no complicated heat treatment)

Good transverse toughness properties are achieved by tight chemical composition control, low carbon content, and double vacuum melting. The alloy is produced by vacuum induction melting (VIM), followed by vacuum arc remelting (VAR).This melt practice ensures excellent macro- and micro-cleanliness, and tight compositional control. The strengthening mechanism (precipitation hardening in a martensitic matrix) makes it possible to achieve uniform strengthening in heavy sections. Strength and ductility levels can be tailored to the application by varying the aging temperature. S240 alloy is available as ingot, billet, block, round bar, rolled shapes and rectangles, rolled and drawn rod, and wire.

SPECIFICATIONS - AMS

• AMS 5929 - Bars and Forgings

PHYSICAL PROPERTIES

Melting Range:
2,560ºF to 2,680ºF (1,404ºC to 1,471ºC)

Density:
0.281 lb/in^3 (7.77 g/cm^3)

Elastic Modulus:
26.0 Msi (179.3 GPa)

HEAT TREATMENT

Solution treatment should be performed from 1,675ºF to 1,725ºF (913ºC to 941ºC) for 45 to 75 minutes at temperature followed by cooling to 32ºF (0ºC) and holding for at least four hours to ensure complete transformation to martensite. No “deep freeze” or cryogenic processing is required. Aging is normally carried out from 950ºF to 1,150ºF (510ºC to 621ºC), depending upon the desired final properties. Heat treatment is usually performed in air. Heat treatment of brazed components may be done in inert atmospheres. Reducing atmospheres should not be used because of the potential for nitrogen contamination.

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Hardness		
Solution Annealed	Solution Annealed & Aged to H950	Solution Annealed & Aged to H1000
R_c = 32-34	R_c = 48-50	R_c = 43-45

FORGEABILITY/ FORMABILITY

S240 alloy has good hot working characteristics which are comparable with other steels in this class. Forging can be performed at temperatures from 1,600°F to 2,200°F (871°C to 1204°C) with optimum properties achieved with forging at temperatures less than 2,000°F (1093°C). After forging, parts should be cooled to room temperature, then solution treated prior to aging. The alloy can be cold formed in annealed condition, utilizing conventional cold forming techniques.

MACHINABILITY

S240 alloy can be machined in both the annealed and hardened conditions. In the annealed condition, use machine speeds 20 to 30 percent lower than those used on 304 stainless steel.

WELDABILITY

S240 alloy is normally welded using inert gas tungsten arc techniques, although most other welding processes may be used. These include plasma arc, electron beam, gas metal arc, and shielded metal arc processes. Helium is the preferred shielding gas.

Nominal Composition														
	C	Mn	Si	P	S	Cr	Ni	Mo	Al	N	Ti	Cu	W	Fe
Wt. %, min.	-	-	-	-	-	11.00	9.25	0.75	0.7	-	0.20	0.5	0.5	Bal
Wt. %, max.	0.03	0.25	0.25	0.010	0.010	12.50	10.75	1.75	1.5	0.01	0.70	1.5	1.5	Bal

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Specific Heat, Thermal Conductivity, and Thermal Expansion

Temperature		Specific Heat	Thermal Conductivity	Coefficient Thermal Expansion
°F	°C	BTU/lb °F	BTU/hr ft °F	in/in °F
73	23	0.111	8.64	–
122	50	0.113	0.97	–
212	100	0.117	9.82	6.22
302	150	0.121	10.47	6.30
392	200	0.124	11.02	6.39
482	250	0.127	11.47	6.48
572	300	0.131	11.95	6.56
662	350	0.135	12.27	6.64
752	400	0.140	12.59	6.72
797	425	0.144	12.77	–
806	430	–	–	6.77

Average Mechanical Properties*

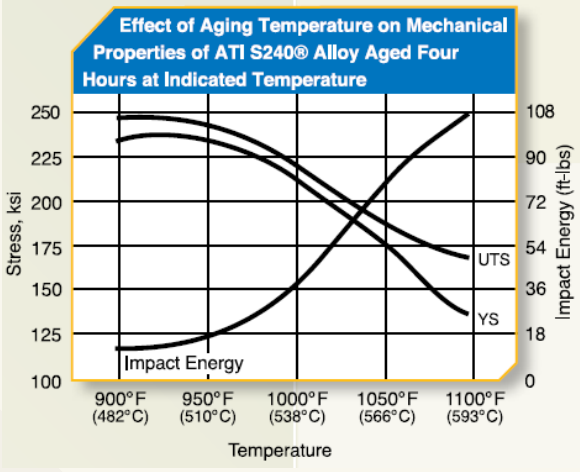
	H950		H1000	
	n	average	n	average
UTS	140	243	132	225
Yield Stress (ksi)	139	231	132	215
Elongation (%)	140	12	132	14
Reduction in Area (%)	140	46	132	56
Fracture Toughness (ksi $in^{1/2}$)	20	79	21	101

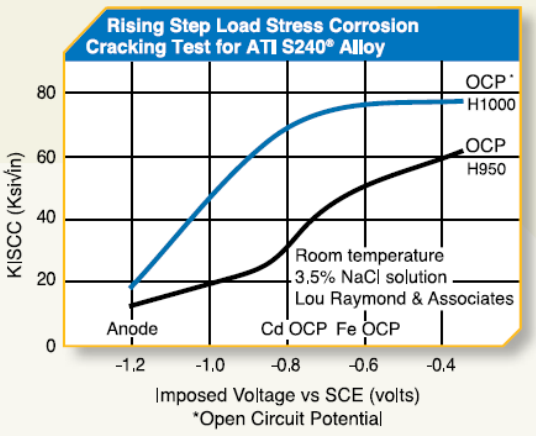
* All tests done at room temperature

Corrosion Data

	ATI S240 ALLOY Solution Annealed & Aged to H1000	AL 15-5™ ALLOY Solution Annealed & Aged to H1025
Corrosion Rate[1]	0.0085 μ/yr	0.0085 μ/yr
Pitting potential[2]	136 V vs E_{ref}	31 V vs E_{ref}
PRE[3]	17.9	15.5

ASTM D1141 synthetic seawater at room temperature
[1] ASTM G59-97
[2] ASTM G5-94
[3] PRE = %CR + 3.3 (%Mo) + 16 (%N)





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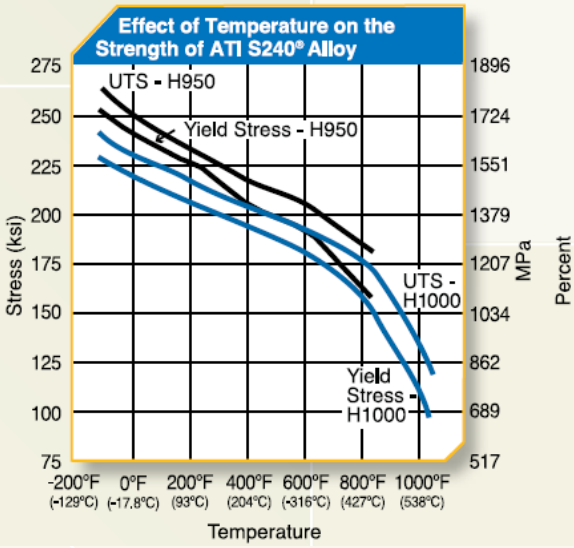
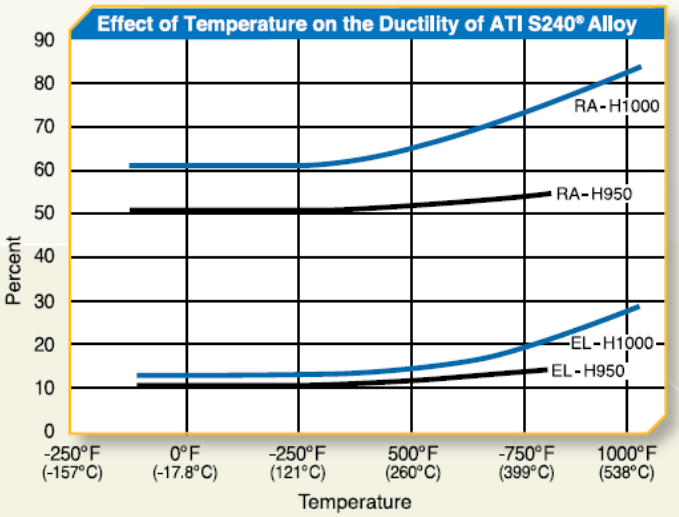
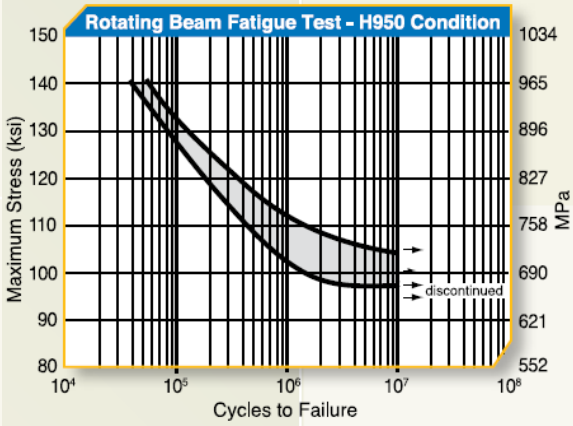
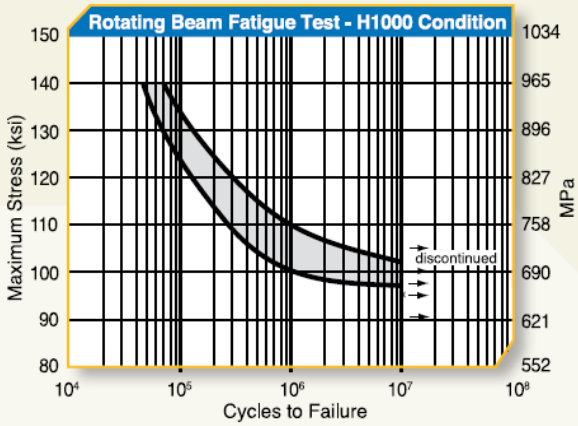






H950 Solution Heat Treated and Aged Condition
Rotating Beam Fatigue
Room temperature
R = -1
Frequency 150 Hz sinusoidal waveform



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Mechanical Properties of ATI S240® Alloy at Sub-Zero Temperature (4" Round Forged Bar)

Test Temperature	Tensile Testing Results				Charpy Impact Energy	Fracture Toughness
	UTS Ksi (MPa)	YS Ksi (MPa)	EL %	RA %	Ft/lbs (joules)	Ksi.in$^{1/2}$ (MPa m$^{1/2}$)
H950						
68° F (20° C)	245 (1689)	232 (1600)	14	51	18 (24.4)	84 (92.3)
-40° F (-40° C)	254 (1751)	239 (1648)	11	52	8 (10.8)	58 (63.7)
-65° F (-54° C)	257 (1772)	243 (1675)	11	50	6 (8.1)	53 (58.2)
-110° F (-79° C)	265 (1827)	251 (1731)	11	50	4 (5.4)	46 (50.5)
H1000						
68° F (20° C)	224 (1544)	215 (1482)	15	62	28 (38)	98 (107.7)
-40° F (-40° C)	233 (1606)	221 (1524)	14	60	14 (19)	77 (84.6)
-65° F (-54° C)	235 (1620)	223 (1538)	14	59	12 (16.3)	76 (83.5)
-110° F (-79° C)	240 (1655)	228 (1572)	14	57	8 (10.8)	64 (70.3)

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