HAYNES® 263 alloy

Principal Features

Good High-Temperature Strength Up to 1650°F (900°C), Excellent Ductility, and Excellent Weldability

HAYNES® 263 alloy (UNS N07263) is an age-hardenable nickel-cobalt-chromium-molybdenum alloy designed specifically to combine good age-hardened strength properties with excellent fabrication characteristics in the annealed condition. HAYNES® 263 alloy exhibits excellent intermediate temperature tensile ductility, and is not normally subject to strain age cracking problems common for gamma prime strengthened alloys. Its strength at elevated temperature is not quite as high as materials such as HAYNES® 282® alloy, Waspaloy alloy, or R-41 alloy. However, it is much easier to form or weld than Waspaloy alloy and R-41 alloy. Because HAYNES® 282® alloy exhibits superior tensile, creep-rupture, and low cycle fatigue strength than HAYNES® 263 alloy and has significantly greater fabricability than Waspaloy and R-41 alloys, it is replacing HAYNES® 263 alloy in many applications.

HAYNES® 263 alloy is normally used for applications up to about 1650°F (900°C). Its oxidation resistance is comparable to that for other gamma-prime-strengthened superalloys.

Applications

HAYNES® 263 alloy combines properties which make it suitable for a variety of fabricated component applications in both aircraft turbine engine and industrial turbine applications. These include low-temperature combustors, transition liners, and some ring components.

Nominal Composition

Weight %

Nickel:	52 Balance
Cobalt:	20
Iron:	0.70 max.
Chromium:	20
Molybdenum:	6
Manganese:	0.40
Silicon:	0.20
Aluminum:	0.60 max.
Titanium:	2.40 max.
Carbon:	0.06
Boron:	0.005 max.
Zirconium:	0.04 max.
Aluminum + Titanium:	2.60

Creep and Stress Rupture Strength

HAYNES® 263 Alloy Sheet, Age-Hardened*

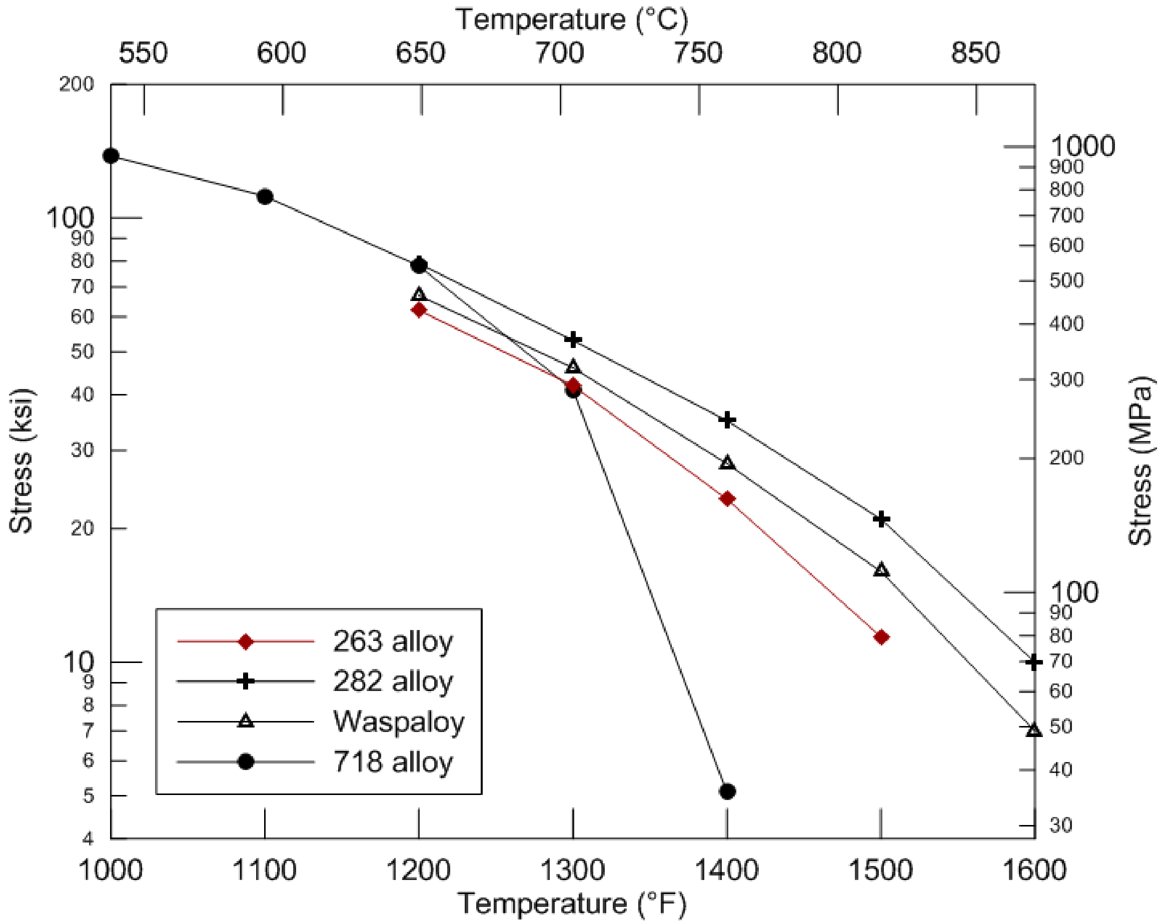
Temperature		Creep	Approximate Initial Stress to Produce Specified Creep in			
			100 h		1,000 h	
°F	°C	%	ksi	MPa	ksi	MPa
1200	649	1	75	517	58	400
		R	77	531	64	441
1300	704	1	54	372	41	283
		R	60	414	45	310
1400	760	1	37	255	25	172
		R	42	290	28	193
1500	816	1	22	152	12	83
		R	25	172	15	103
1600	871	1	11	76	6.0	41
		R	14	97	7.4	51
1700	927	1	5.7	39	3.0	21
		R	7.3	50	4.0	28

*Samples were age hardened by treating at 1472°F (850°C)/8h/AC

Creep and Stress Rupture Strength Continued

Comparison of Stress to Produce 1% Creep in 1000 Hours in Sheet

At temperatures of 1200°F (649°C) and above, HAYNES® 263 alloy has creep strength less than those of two other gamma-prime strengthened alloys, HAYNES® 282® alloy and HAYNES® Waspaloy alloy. At temperatures greater than 1300°F (704°C), HAYNES® 263 has a creep strength far superior to that of HAYNES® 718 alloy.



Thermal Stability

Condition	Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		4D Elongation
	°F	°C	ksi	MPa	ksi	MPa	%
Solution Annealed	RT	RT	58	400	120.1	828	53.3
Age Hardened*	RT	RT	93.1	642	154.2	1063	36.9
	1200	649	78.2	539	132.3	912	38.6
	1400	760	79.2	546	100	689	29.5
	1500	816	69.3	478	77.9	537	36.9
	1600	871	42.2	291	49.4	341	61.2
Age Hardened* + 1200°F/8000h	RT	RT	113.3	781	176.8	1219	28.7
	1200	649	96.7**	667**	149.2**	1029**	31.3**
Age Hardened* + 1400°F/8000h	RT	RT	83.3	574	151.3	1043	24.8
	1400	760	60.9	420	83.7	577	36.4
Age Hardened* + 1500°F/8000h	RT	RT	77.5	534	132.8	916	23
	1500	816	42	290	58.6	404	37
Age Hardened* + 1600°F/8000h	RT	RT	54.9	379	115.7	798	37.8
	1600	871	38.4	265	25.5	176	49.1

* Samples were age hardened by treating at 1472°F for 8 hours and air cooling.
** Limited data

Tensile Properties

Cold-Rolled Sheet, Solution Treated and Aged

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		Elongation
°F	°C	ksi	MPa	ksi	MPa	%
RT	RT	89.2	615	151.0	1041	35.8
400*	204*	82.3*	567*	139.6*	963*	40.9*
800*	427*	80.4*	554*	126.7*	874*	39.6*
1000	537	76.4	527	124.8	860	42.1
1200	649	75.2	518	130.7	901	36.9
1400	760	76.0	524	100.9	696	26.6
1500*	816*	68.2*	470*	77.3*	533*	35.2*
1600	871	43	296	50.5	348	58.1
1700	927	17.0	117	25.0	172	105.2
1800	982	12.3	85	17.9	123	95.1
2000	1093	5.5	38	9.0	62	103.6

* Limited data
Mill Annealed +1472°F/8h/Air Cool

Cold-Rolled Plate, Solution Treated and Aged

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		Elongation
°F	°C	ksi	MPa	ksi	MPa	%
RT	RT	84.7	584	147.7	1018	30.4
400*	204*	74.5*	514*	139.6*	963*	34.2*
800*	427*	70.9*	489*	126.8*	874*	41.2*
1000	537	74.3	512	122.6	845	42.5
1200	649	71.8	495	125.8	867	32.7
1400	760	72.5	500	101.9	703	19.9
1500*	816*	64.1*	442*	81.8*	564*	22.8*
1600	871	45.2	312	53.2	367	47.5
1800	982	12.5	86	18.8	130	101.6
2000	1093	6	41	9.1	63	114.8

* Limited data
Mill Annealed +1472°F/8h/Air Cool

Aged Hardness

Age Hardened Room Temperature Hardness

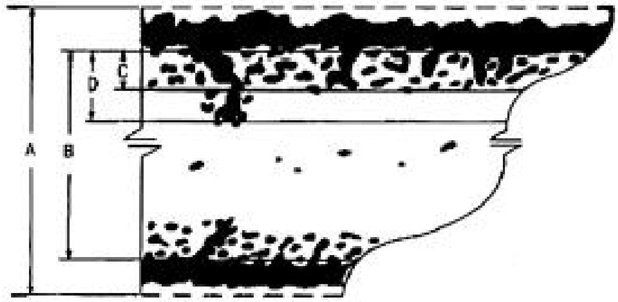
Form	Hardness
Sheet	26 HRC
Plate	27 HRC

Mill Annealed +1472°F/8h/Air Cool
HRC = Hardness Rockwell "C"

Oxidation Resistance

Static Oxidation Testing

Environment: Flowing Air
Test Duration: 1,008 h
Number of Cycles: 6
Cycle Length: 168 h
Temperatures: 1600, 1700, 1800°F (871, 927, 982°C)
Metal Loss = (A-B)/2
Average Internal Penetration = C
Maximum Internal Penetration = D
Average Metal Affected = Metal Loss + Average Internal Penetration
Maximum Metal Affected = Metal Loss + Maximum Internal Penetration



Comparative Oxidation Resistance in Flowing Air, 1008 Hours

	1600°F (871°C)				1700°F (927°C)				1800°F (982°C)			
	Metal Loss, mils (µm)		Avg. Met. Aff. mils, (µm)		Metal Loss, mils (µm)		Avg. Met. Aff. mils, (µm)		Metal Loss, mils (µm)		Avg. Met. Aff. mils, (µm)	
Alloy	**mils**	**µm**	**mils**	**µm**	**mils**	**µm**	**mils**	**µm**	**mils**	**µm**	**mils**	**µm**
263	**0.1**	**3**	**0.4**	**10**	**0.2**	**5**	**0.7**	**18**	**0.9**	**23**	**5.0**	**127**
282®	0.2	5	0.6	15	0.1	3	1.1	28	0.2	5	1.8	46
R-41	0.2	5	0.8	20	0.2	5	1.5	38	0.2	5	2.9	74
Waspaloy	0.3	8	1.4	36	0.3	8	3.4	86	0.7	18	5.0	127

Dynamic Oxidation Testing (Burner Rig)

Burner rig oxidation tests were conducted by exposing, in a rotating holder, samples 0.375 inch x 2.5 inches x thickness (9.5mm x 64mm x thickness) to the products of combustion of fuel oil (2 parts No. 1 and 1 part No. 2), burned at an air to fuel ratio of about 50:1. The gas velocity was about 0.3 mach. Samples were automatically removed from the gas stream every 30 minutes and fan cooled to less than 500°F (260°C) and then reinserted into the flame tunnel.

	1600°F (871°C), 1000 hours, 30 minute cycles				1800°F (982°C), 1000 hours, 30 minute cycles			
	Metal Loss, mils (µm)		Avg. Met. Aff. mils, (µm)		Metal Loss, mils (µm)		Avg. Met. Aff. mils, (µm)	
Alloy	**mils**	**µm**	**mils**	**µm**	**mils**	**µm**	**mils**	**µm**
263	**1.4**	**36**	**4.0**	**102**	**12.5**	**318**	**16.1**	**409**
282®	1.8	46	4.2	107	8.0	203	13.0	330
Waspaloy	1.9	48	4.3	109	9.5	241	13.6	345
R-41	1.2	30	4.4	112	5.8	147	12.1	307

Physical Properties

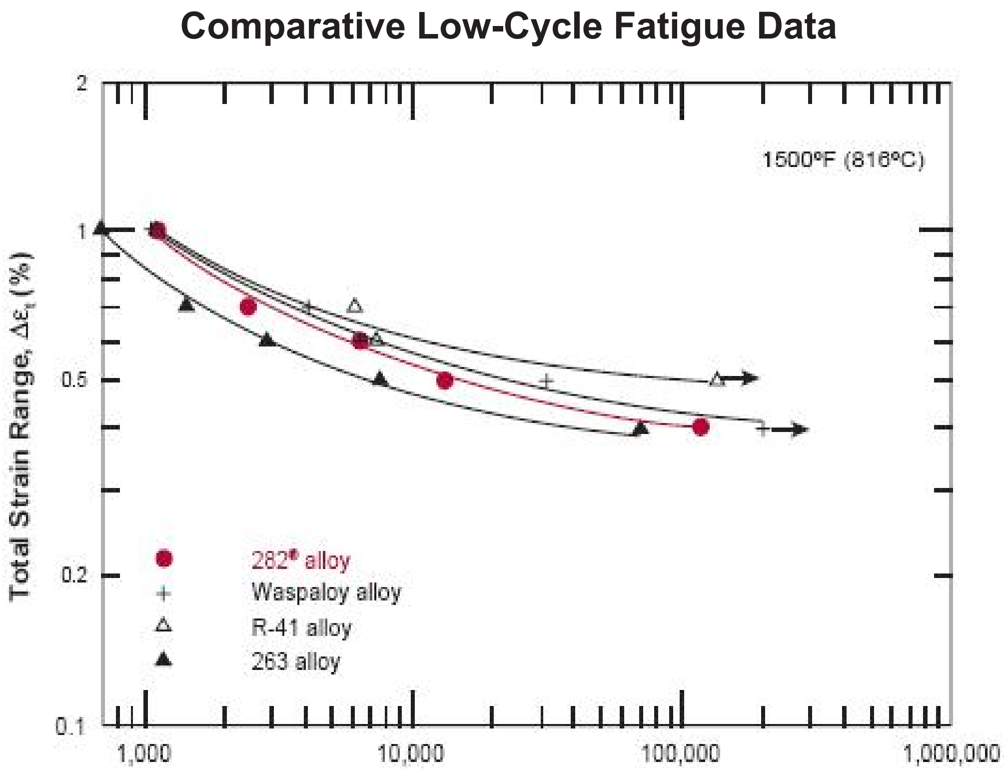
Physical Property	British Units		Metric Units	
Density	RT	0.302 lb/in³	RT	8.36 g/cm³
Melting Range	2370-2470°F	-	1300-1355°C	-
Electrical Resistivity	RT	45.3 µohm-in	RT	115 µohm-cm
	200°F	45.8 µohm-in	100°C	116 µohm-cm
	400°F	46.5 µohm-in	200°C	118 µohm-cm
	600°F	47.5 µohm-in	300°C	120 µohm-cm
	800°F	48.2 µohm-in	400°C	122 µohm-cm
	1000°F	49.1 µohm-in	500°C	124 µohm-cm
	1200°F	49.6 µohm-in	600°C	126 µohm-cm
	1400°F	49.4 µohm-in	700°C	126 µohm-cm
	1600°F	48.9 µohm-in	800°C	125 µohm-cm
	1800°F	48.9 µohm-in	900°C	124 µohm-cm
	-	-	1000°C	124 µohm-cm
Thermal Conductivity	RT	81 Btu-in/ft²-hr-°F	RT	11.7 W/m-°C
	200°F	89 Btu-in/ft²-hr-°F	100°C	13.0 W/m-°C
	400°F	103 Btu-in/ft²-hr-°F	200°C	14.7 W/m-°C
	600°F	115 Btu-in/ft²-hr-°F	300°C	16.3 W/m-°C
	800°F	128 Btu-in/ft²-hr-°F	400°C	18.0 W/m-°C
	1000°F	141 Btu-in/ft²-hr-°F	500°C	19.7 W/m-°C
	1200°F	154 Btu-in/ft²-hr-°F	600°C	21.4 W/m-°C
	1400°F	167 Btu-in/ft²-hr-°F	700°C	23.0 W/m-°C
	1600°F	182 Btu-in/ft²-hr-°F	800°C	24.7 W/m-°C
	1800°F	195 Btu-in/ft²-hr-°F	900°C	26.8 W/m-°C
	-	-	1000°C	28.5 W/m-°C
Mean Coefficient of Thermal Expansion	70-200°F	6.2 µin/in-°F	25-100°C	11.1 µm/m- °C
	70-400°F	6.7 µin/in-°F	25-200°C	12.1 µm/m- °C
	70-600°F	7.1 µin/in-°F	25-300°C	12.7 µm/m- °C
	70-800°F	7.2 µin/in-°F	25-400°C	12.8 µm/m- °C
	70-1000°F	7.6 µin/in-°F	25-500°C	13.6 µm/m- °C
	70-1200°F	7.9 µin/in-°F	25-600°C	13.9 µm/m- °C
	70-1400°F	8.3 µin/in-°F	25-700°C	14.7 µm/m- °C
	70-1600°F	9.0 µin/in-°F	25-800°C	15.4 µm/m- °C
	70-1800°F	9.9 µin/in-°F	25-900°C	17.0 µm/m- °C
	-	-	25-1000°C	18.1 µm/m- °C

RT= Room Temperature

Physical Properties Continued

Physical Property	British Units		Metric Units	
Dynamic Modulus of Elasticity	RT	32.1 x 10^6 psi	RT	221 GPa
	200°F	31.7 x 10^6 psi	100°C	219 GPa
	400°F	30.7 x 10^6 psi	200°C	212 GPa
	600°F	29.6 x 10^6 psi	300°C	205 GPa
	800°F	28.5 x 10^6 psi	400°C	198 GPa
	1000°F	27.5 x 10^6 psi	500°C	192 GPa
	1200°F	26.2 x 10^6 psi	600°C	185 GPa
	1400°F	24.8 x 10^6 psi	700°C	176 GPa
	1600°F	22.9 x 10^6 psi	800°C	166 GPa
	1800°F	21.1 x 10^6 psi	900°C	154 GPa
	-	-	1000°C	143 GPa

Low Cycle Fatigue



1500°F (816°C), Fully Reversed, R = -1, Waveform = Triangle, Frequency = 0.33Hz, Material: 0.125"(3.2 mm) Sheet*

Fabrication and Welding

Fabrication

HAYNES® 263 alloy has excellent forming and welding characteristics. The hot working temperature range for the alloy is approximately 1750 to 2150°F (955- 1175°C). The alloy has excellent ductility in the annealed condition, and thus may also be formed by cold working. Intermediate annealing in the temperature range from 1900 to 2000°F (1040 to 1100°C) may be needed for complex component forming operations. All hot- or cold-worked parts should be annealed and rapidly cooled in order to restore the best balance of properties.

Welding

For welding HAYNES® 263 alloy, please review the General Welding and Joining Guidelines. In addition to those guidelines, there are some additional considerations when welding 263 alloy.

HAYNES® 263 alloy is a precipitation-strengthened alloy and requires a postweld heat treatment (PWHT) to develop suitable properties. Postweld heat treatment for 263 alloy consists of two parts: a solution anneal, which is followed by a suitable aging treatment. Details can be found here. During PWHT, the gamma-prime phase (Ni3Al,Ti) precipitates and the alloy undergoes a slight volumetric contraction. This makes it susceptible to strain-age cracking, which typically occurs upon heating to the solution annealing temperature. To inhibit strain-age cracking, the heating rate to the solution annealing temperature should be as fast as possible, within the capability of the furnace being used.

Filler metal of matching composition is suggested for welding 263 alloy to itself. For filler metal suggestions for welding 263 alloy to other alloys, please refer to the Haynes Welding SmartGuide, or contact Haynes International for further guidance.

Tensile Properties of Solution Annealed 263 at Room Temperature

	Ultimate Tensile Strength		Yield Strength		Elongation
	ksi	MPa	ksi	MPa	%
Sheet	116.9	806	49.1	339	57.5
Plate	115.6	797	47.7	329	59.3

Solution Annealed Room Temperature Hardness

Form	Hardness	Typical ASTM Grain Size
Sheet	98 HRB	5 - 7.5
Plate	31 HRC	4 - 6

All samples tested in solution-annealed condition

Heat Treatment

Wrought HAYNES® 263 alloy is furnished in the solution heat-treated condition unless otherwise specified. The alloy is normally solution heat-treated in the range of 1900 - 2150°F (1038 - 1177°C) and rapidly cooled or water quenched for optimal properties. Following solution heat treatment, the alloy is age-hardened at 1475°F (802°C) for eight hours, and air-cooled.

Specifications

Specifications

HAYNES® 263 alloy (N07263)	
Sheet, Plate & Strip	AMS 5872
Billet, Rod & Bar	AMS 5886
Coated Electrodes	-
Bare Welding Rods & Wire	AMS 5966
Seamless Pipe & Tube	-
Welded Pipe & Tube	-
Fittings	-
Forgings	AMS 5886
DIN	-
Others	-