HAYNES[®] 718 alloy

Principal Features

HAYNES[®] 718 alloy (UNS N07718) is an age-hardenable nickel-iron-chromium-niobium (columbium)-molybdenum-titanium-aluminum alloy designed to combine excellent strength with good fabrication characteristics in the annealed condition. While limited to applications below 1200°F (650°C), it is significantly stronger at these lower temperatures than materials such as Waspaloy alloy, R-41 alloy, or X-750 alloy. It is also much easier to weld than these alloys, and is less susceptible to the strain age cracking problems common for gamma prime strengthened materials. At temperatures greater than 1200°F (650°C), 718 alloy is being replaced by HAYNES[®] 282[®] alloy due to the superior strength of 282[®] alloy at those temperatures as well as its excellent fabricability.

HAYNES[®] 718 alloy is normally only used for component applications up to 1200°F (650°C); however, its oxidation resistance is comparable to that for other gamma-prime-strengthened superalloys.

Weight %				
Nickel:	52 Balance			
Cobalt:	1 max.			
Iron:	19			
Chromium:	18			
Columbium + Tantalum	5 5 5 5 5 5			
Molybdenum:	3			
Manganese:	0.35 max.			
Silicon:	0.35 max.			
Titanium: 🖉 🖉 🏑 🦯	0.9			
Aluminum:	0.5			
Carbon:	0.05			
Boron:	0.004			

Nominal Composition

Creep and Stress-Rupture Strengths

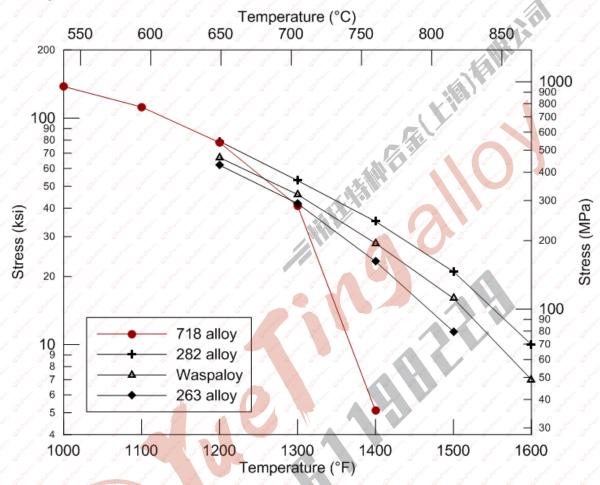
Temperature		Station Station Station S	Approxi	Approximate Initial Stress to Produce Specified Creep in					
		Creep	10h / /		/ / 100h / /		1,000h		
°F 🧳	°C	%	ksi	MPa	🖉 ksi 🧹	MPa	ksi	MPa	
harmann Stafmann Str	of the state of th	0.5	157	1083	146	1007	132	910	
1000	538	1/	160	1103	150	1034	138	952	
halingers alkalingers also		R	Contra Malanam - Malanam And	And Mallane - Jacoban Malan	165	1138	144	993	
testingen atestingen ate	and the france stationers	0.5	140	965	126	869	108	745	
1100 593	1	143	986	130	896	112	772		
	R	150	1034	134	924	115	793		
1200 649	0.5	121	834	101	696	75	517		
	1,	124	855	103	710	78	538		
	R	130	896	105	724	87	600		
	Start Start C	0.5	95	655	64	441	35	241	
1300	704	1 1 1	98	676	67	462	41	283	
Station Station State States 3	R	106	731	76	524	46	317		
1400 760	0.5	54	372	24	165	3.8	26		
	<u> </u>	60	414	28	193	-5.1	35		
	R	70 /	483	37	255	17	117		

HAYNES® 718 Sheet, Age-Hardened*

*Samples were age hardened by treating at 1325°F (718°C)/8h/FC to 1150°F (621°C)/8h/AC

Creep and Stress-Rupture Strengths Continued

Comparison of Stress to Produce 1% Creep in 1000 Hours in Sheet At temperatures below 1200°F (649°C), HAYNES[®] 718 alloy has creep strength that is superior to most other age-hardenable, wrought nickel-base superalloys. However, starting at temperatures around 1200°F (649°C) and higher, gamma-prime strengthened alloys such as HAYNES[®] 282[®] alloy, HAYNES[®] Waspaloy alloy, and HAYNES[®] 263 alloy provide higher strength.



Tensile Properties

N Hall Hall Hall	tool tool tool tool	onone Bata	, i lato	with the the the	the the test the test
Test Temperature			they they they they		Elongation
°C	ksi	MPa	ksi	MPa	%
RT	200.5	1382	167.8	1157	20.6
427	173.1	1193	149	1027	22.6
538	170.2	1173	145.9	1006	21.8
649	162.5	1120	139.9	965	25.1
760	117.3	809	104.9	723	12.1
871	42.2 🧹	291	34.3	236	68 🗸 🗸
982	14.1 🗸	97	9.6	66 🧹	129.9
	rature °C RT 427 538 649 760 871	stUltimateratureStre°CksiRT200.5427173.1538170.2649162.5760117.387142.2	StUltimate Tensile Streugth°CksiMPaRT200.51382427173.11193538170.21173649162.51120760117.380987142.2291	St Ultimate Tensile 0.2 rature Strength Yield S °C ksi MPa ksi RT 200.5 1382 167.8 427 173.1 1193 149 538 170.2 1173 145.9 649 162.5 1120 139.9 760 117.3 809 104.9 871 42.2 291 34.3	ratureStrengthYield Strength°CksiMPaksiMPaRT200.51382167.81157427173.111931491027538170.21173145.91006649162.51120139.9965760117.3809104.972387142.229134.3236

Tensile Data, Plate

Mill Annealed + 1325°F/8h/Furnace Cool to 1150°F/8h/Air Cool Total time: 18 hours

RT= Room Temperature

	Test Temperature		Ultimate Tensile Strength		0.2% Yield Strength	
°F	°C	ksi	MPa	ksi	MPa	%
RT	RT	203.6	1404	174.7	1205	18.4
800	427	176.2	1215	155.4	1071	21.3
1000	538	172.3	1188	150.2	1036	20.7
1200	649	164.1	1131	144.3	995	16.3
1400	760	114.8	792	103.8	716	6.9
1600	871	<mark>39</mark> .9	275	34	234	81.8
1800	982	13.7	94	9.7	67	175.6

Tensile Data Sheet

Mill Annealed + 1325°F/8h/Furnace Cool to 1150°F/8h/Air Cool Total time: 18 hours

Physical Property	Briti	sh Units	Metric Units		
Density	/ / RT / /	0.297 lb/in. ³	RT 🖉	8.23 g/cm. ³	
Melting Range	2300-2435°F	an State State State State State State	1260-1335°C	an alterna alterna and alterna al	
and change change change change change change	/ / RT / /	47.5 µohm.in	RT	121 µohm.cm	
	🧹 200°F 🗸 💡	48.0 µohm.in	100°C 🧹 🖉	122 µohm.cm	
	400°F	49.4 µohm.in	200°C	125 µohm.cm	
	600°F	50.3 µohm.in	300°C	127 µohm.cm	
	800°F	50.7 µohm.in	400°C	129 µohm.cm	
Electrical	1000°F	51.6 µohm.in	500°C	130 µohm.cm	
Resistivity	1200°F	52.0 µohm.in	600°C	132 µohm.cm	
	1400°F	52.2 µohm.in	700°C	132 µohm.cm	
	1600°F	52.1 µohm.in	800°C	132 µohm.cm	
	1800°F	52.4 µohm.in	900°C	133 µohm.cm	
n den den den den den den den neke solet solet solet solet so			1000°C	133 µohm.cm	
fan 3an 3an 3an 3an 3an 3an 3an 3an	RT	79 Btu.in/h.ft ² .°F	RT	11.4 W/m-°C	
	200°F	87 Btu.in/h.ft ² .°F	100°C	12.6 W/m-°C	
	400°F	100 Btu.in/h.ft ² .°F	200°C	14.3 W/m-°C	
	600°F	112 Btu.in/h.ft ² .°F	300°C	15.9 W/m-°C	
The system of th	800°F	124 Btu.in/h.ft ² .°F	400°C	17.5 W/m-°C	
Thermal Conductivity	1000°F	136 Btu.in/h.ft ² .°F	500°C	19.0 W/m-°C	
Conductivity	1200°F	148 Btu.in/h.ft ² .°F	600°C 🗸	20.6 W/m-°C	
	1400°F	161 Btu.in/h.ft ² .°F	700°C 🧹 🖉	22.2 W/m-°C	
	1600°F	173 Btu.in/h.ft ² .°F	800°C	23.8 W/m-°C	
	1800°F	186 Btu.in/h.ft ² .°F	900°C	254.4 W/m-°0	
And Statement Statement Statement Statement Statement		and the second	1000°C	27.1 W/m-°C	
Real States States States States States	70-200°F	7.1 µin/in-°F	25-100°C	12.8 µm/m-°0	
and a set and a set of	70-400°F	7.5 µin/in-°F	25-200°C	13.5 µm/m-°0	
the state of the state of the	70-600°F	7.7 µin/in-°F	25-300°C	13.8 µm/m-°0	
	70-800°F	7.9 µin/in-°F	25-400°C	14.1 µm/m-°0	
lean Coefficient of hermal Expansion	<mark>70-</mark> 1000°F	8.0 µin/in-°F	25-500°C	14.3 µm/m-°0	
	70-1200°F	8.4 µin/in-°F	25-600°C	14.8 µm/m-°0	
	70-1400°F	8.9 µin/in-°F	25-700°C	15.5 µm/m-°0	
T ST ST ST ST ST ST ST ST	70-1600°F	9.4 µin/in-°F	25-800°C	16.3 µm/m-°0	
and the start start start start and	Jan Jan Jan Ja	1 3 ⁴⁴ 3 ⁴⁴ 3 ⁴⁴ 3 ⁴⁴ 3 ⁴	25-900°C	17.2 µm/m-°C	

Physical Properties

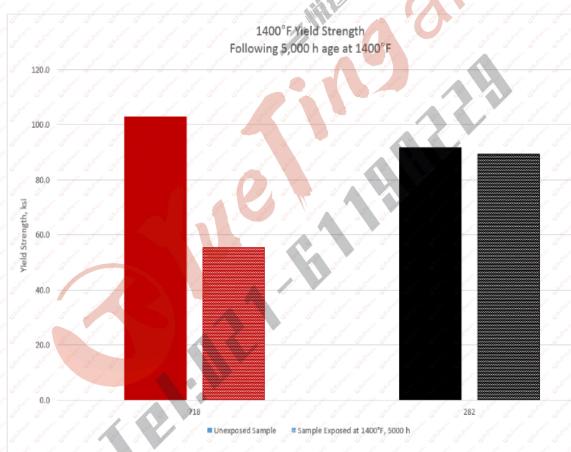
RT= Room Temperature

Physical Properties Continued

Physical Property	Briti	ish Units	Metric Units	
and and a start and a start and a start and	RT	29.0 x 10 ⁶ psi	RT	200 GPa
States States States States States States	200°F	28.4 x 10 ⁶ psi	100°C	195 GPa
States States States States States States States	🧹 400°F 🧹	27.6 x 10 ⁶ psi	200°C	191 GPa
Statute Statute Statute Statute Statute Statute Statute	600°F	26.7 x 10 ⁶ psi	300°C	/ 185 GPa
Dynamic Modulus	800°F	25.8 x 10 ⁶ psi	400°C	179 GPa
of Elasticity	/1000°F	24.8 x 10 ⁶ psi	500°C	173 GPa
Starten Starten Starten Starten Starten Starten Starten	1200°F	23.7 x 10 ⁶ psi	600°C	167 GPa
and and all all all all all all all all all al	1400°F	22.3 x 10 ⁶ psi	700°C	159 GPa
and a second and a second as a second as	1600°F	20.2 x 10 ⁶ psi	3°008	149 GPa
a a a a a a a a a a a a a a a a a a a	1800°F	17.4 x 10 ⁶ psi	900°C	134 GPa

RT= Room Temperature

Thermal Stability



718 data from G.E. Korth, Mechanical properties test data of Alloy 718 for liquid metal fast breeder reactor applications, EGG-2229, January 1, 1983.

Fabrication

HAYNES[®] 718 alloy has very good forming and welding characteristics. It may be hotworked at temperatures in the range of about 1700-2100°F (925-1150°C) provided the entire piece is soaked for a time sufficient to bring it uniformly to temperature. Initial breakdown is normally performed at the higher end of the range, while finishing is usually done at the lower temperatures to afford grain refinement.

As a consequence of its good ductility, 718 alloy is also readily formed by cold-working. All hot- or cold-worked parts should normally be annealed at 1700 to 1850°F (925 to 1010°C) and cooled by air cool or faster rate before aging in order to develop the best balance of properties.

Ultimate T		sile Strength	Yield Strength		Elongation
Form	ksi	MPa	ksi	MPa	%
Sheet	126.3	871	60.7	419	46.7
Plate	124.3	857	57.3	395	49

Tensile Properties of Solution-annealed 718 at Room Temperature

% Cold-work	Average Hardness HRB/ C
0	92.4 HRB
10	27.2 HRC
20	33.6 HRC
30	36.9 HRC
5 5 5 5 5 5 5 5 40 5 5 5 5 5 5 5 5 5 5 5	38.3 HRC
d d d d d s50° d d d d d	39.2 HRC

Cold-work Hardness

HRB= Hardness Rockwell "B"

HRC= Hardness Rockwell "C"

Hardness and Grain Size

Form	Hardness, HRB	Typical ASTM Grain Size
Sheet	94	6-8
Plate	93	5-8

All samples tested in solution-annealed condition

Welding

HAYNES[®] 718 alloy is readily welded by Gas Tungsten Arc Welding (GTAW), Gas Metal Arc Welding (GMAW), Shielded Metal Arc Welding (SMAW), Electron Beam (EB) and resistance welding techniques. Its welding characteristics are similar to those for HASTEL-LOY[®] X alloy. Submerged Arc Welding (SAW) and oxyacetylene are not recommended as these processes are characterized by high heat input to the base metal and slow cooling of the weld. These factors can increase weld restraint and promote cracking.

Base Metal Preparation

The welding surface and adjacent regions should be thoroughly cleaned with an appropriate solvent prior to any welding operation. All greases, oils, cutting oils, crayon marks, machining solutions, corrosion products, paint, scale, dye penetrant solutions, and other foreign matter should be completely removed.

Filler Metal Selection

HAYNES[®] 718 alloy should be joined using matching filler metal (AWS A5.14 ERNiFeCr-2, AMS5832). For welding 718 alloy to other alloys, HASTELLOY[®] S (AMS 5838) or W (AWS A5.14 ERNiMo-3, AMS 5786) filler wires are suggested. Please see the "Welding and Fabrication" brochure or the Haynes Welding SmartGuide for more information.

Preheating and Interpass Temperatures

Preheat is not required. Preheat is generally specified as room temperature (typical shop conditions). Interpass temperature should be maintained below 200°F (93°C). Auxiliary cooling methods may be used between weld passes, as needed, providing that such methods do not introduce contaminants. For further information, please refer to the "Welding and Joining" brochure.

Post-Weld Heat-treatment

HAYNES[®] 718 alloy is normally used in the fully-aged condition. Following forming and welding, a full solution anneal prior to aging is often employed in order to develop the best joint and overall fabrication properties. The best practice is dependent upon the specific condition of the fabrication prior to aging. Contact Haynes International, Inc. for further information.

Nominal Welding Parameters

Details for GTAW, GMAW and SMAW welding are given in the "Welding and Fabrication" brochure. Nominal welding parameters are provided as a guide for performing typical operations and are based upon welding conditions used in our laboratories.

Specifications and Codes

Spec	ifications			
	S[®] 718 alloy 07718)			
Sheet, Plate & Strip	AMS 5596 AMS 5597			
Billet, Rod & Bar	AMS 5662 AMS 5663 AMS 5664 SB 637/B 637			
Coated Electrodes	the state of state of state of state			
Bare Welding Rods & Wire	A 5.14 (ERNiFeCr-2) AMS 5832			
Seamless Pipe & Tube	AMS 5589 AMS 5590 B 983			
Welded Pipe & Tube				
Fittings	States and the states of the s			
Forgings	AMS 5662 AMS 5663 AMS 5664 SB 637/B 637			
	17742 No. 2.4668 NiCr19Fe19NbMo3			
Others	ASME Code Case No. 1993- Case No. 2221-1 NACE MR0175 ISO 15156			
Cod	es			
HAYNES® (N07	718 alloy			
MMPDS 6.3.5				

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