ATI 718 Plus® *Alloy*

Technical Data Sheet

GENERAL

ATI 718Plus® Alloy[1] is a precipitation hardened nickel-base superalloy that exhibits a combination of superior high temperature properties and good fabricability. This alloy is designed to have the high temperature capability and thermal stability of Waspaloy* alloy while retaining the processing characteristics of 718 alloy [2,3]. It is produced by double vacuum melting (VIM/VAR) or triple melting (VIM/ESR/VAR), depending on the application. The VIM/VAR process ensures excellent micro-cleanliness and tight compositional control. Triple melting further minimizes macrosegregation, increases microcleanliness, and is preferred for premium quality jet engine rotating components. 718Plus alloy provides a nominal 100 F° (55 C°) operating temperature advantage over 718 alloy and has higher strength, superior formability, better wear resistance, and resistance to weld cracking advantages over Waspaloy and other, higher temperature nickel-base alloys[4]. Since 718Plus alloy has a lower intrinsic raw material cost than Waspaloy alloy, and also has improved hot workability with resulting higher material yield, lower finished part costs can be achieved. 718Plus alloy is available in all product forms including: ingot, billet, forged round and rectangular bar, hot-rolled shapes and rectangles, round bar, rod, wire, plate, sheet, strip, and castings.

SPECIFICATIONS

- AMS 5441, Nickel Alloy, Bars, Forgings, Rings, Precipitation-Hardenable
- AMS 5442, Nickel Alloy, Bars, Forgings, Rings, Solution and Precipitation Heat Treated
- AMS 5964, Nickel Alloy, Corrosion and Heat-Resistant,Welding Wire

HEAT TREATMENT

Billet is typically supplied in the as-forged condition; bar products are provided in the solution treated or solution treated and aged condition. The heat treatment practice is modified from the standard 718 practice due to different aging kinetics. For optimum tensile and creep-rupture properties: solution treat at 1,750 °F to 1,800 °F (954 °C to 982 °C) for 1 hour and cool at a rate equivalent to air cool or faster. Age at 1,450 °F (788 °C) for 2-8 hours, furnace cool at 100 F° (38 C°) per hour to 1,200 °F (649 °C), hold 8 hours, and air cool.

A pre-solution treatment at 1,500 °F to 1,600 °F (816 °C to 871 °C), for 8 hours minimum followed by air cooling to room temperature prior to solution treating has been shown to improve tensile and stress-rupture properties in some forged products. ATI 718Plus alloy can be direct aged (DA) after rapid cool-down from low temperature forging. DA material has improved strength and stress rupture life over standard solution heat treated material.

Detailed discussions of the important relationships between processing, structure, and heat treatment are included in the articles referenced below, or from the ATI 718Plus alloy website [5]: http://www.allvac.com/allvac/718plus/

PHYSICAL PROPERTIES

Melting Range: 2,300-2,450 °F (1,260-1,343 °C)
Density: 0.298 lbs/cu. in.; 8.25 gm /cc

HARDNESS

Hardness, like tensile properties, is a function of the precipitation or aging cycle. As-solution heat treated hardness is approximately 20-30 HRC. In the fully aged condition, hardness is 38-45 HRC.

FORGEABILITY

ATI 718Plus alloy exhibits good hot working characteristics. In the initial stages of forging, temperatures as high as 2,050 °F (1,121 °C) can be used. Finish forging is usually performed with starting temperatures of 1,800 °F – 1,900 °F (982 °C - 1,038 °C) depending on finished part requirements. A reduction of 25% minimum from the final heating, together with a low finishing temperature, (1650 °F to 1800°F; 899°C to 982 °C) is required to obtain the small amount of grain boundary delta phase necessary for optimum mechanical properties. Forging flow stresses are higher than for 718 alloy, but cracking tendency is significantly less than that of Waspaloy alloy. Hot dies are definitely recommended and care should be taken to avoid cold corners.

MACHINABILITY

ATI 718Plus alloy is readily machinable in both the solution treated and age-hardened conditions. Machinability testing has shown that the machinability is similar to 718 alloy.

ATI Allvac
2020 Ashcraft Ave., P.O. Box 5030
Monroe NC 28110-5030 USA
704-289-4511
www.allvac.com

WELDABILITY

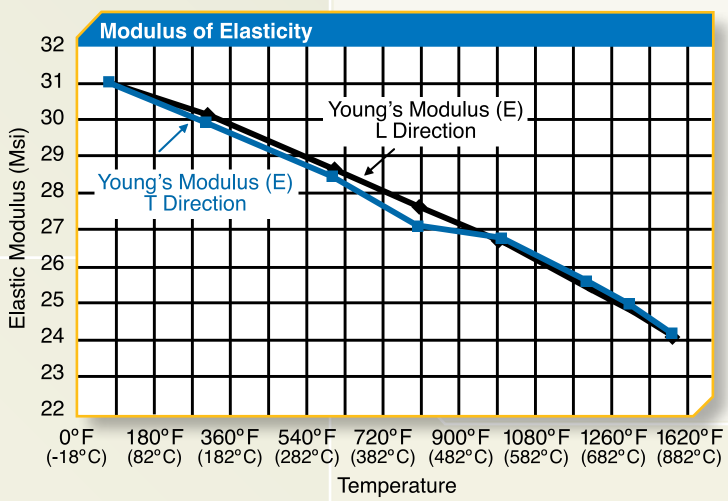
Satisfactory welds can be produced in both the solution treated and fully-aged conditions using inert gas-shielded arc, plasma arc, electron beam, and resistance welding techniques. The welding performance has been shown to be similar to 718 alloy and superior to Waspaloy alloy. Because of its sluggish aging response, ATI 718Plus alloy can be welded without hardening during the heating and cooling cycles, and the aged alloy can be repair welded several times without cracking.

SPECIAL PRECAUTIONS

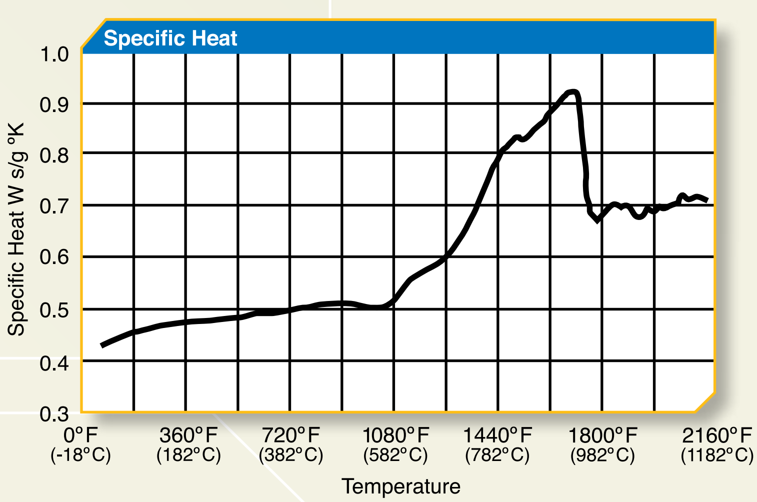
All lubricants or coolants, particularly sulfur-bearing fluids, should be removed prior to heat treating and welding.

Chemical Composition

	C	Mn	Si	P	S	Cr	Ni	Mo	Nb	Ti	Al	Co	Fe	W	B
% w/w, min.	0.01	-	-	0.004-	-	17.00	BAL	2.50	5.20	0.50	1.20	8.00	8.00	0.008	0.003
% w/w, max.	0.05	0.35	0.035	0.020	0.025	21.00	BAL	3.10	5.80	1.00	1.70	10.00	10.00	1.40	0.008

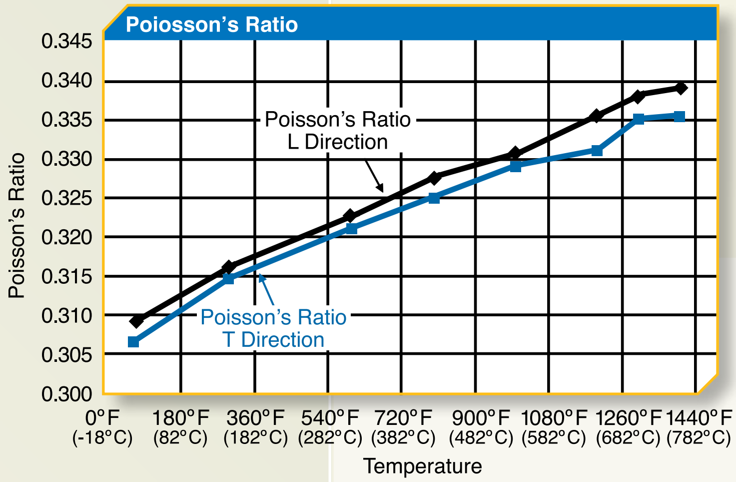


Dynamic Elastic Properties Measured According to ASTM E 1876. Heat B53F-1, Forged Billet per AMS 5442. Values shown are the averge of two measurements, one measurement from each of two replicate samples from the same piece of billet.

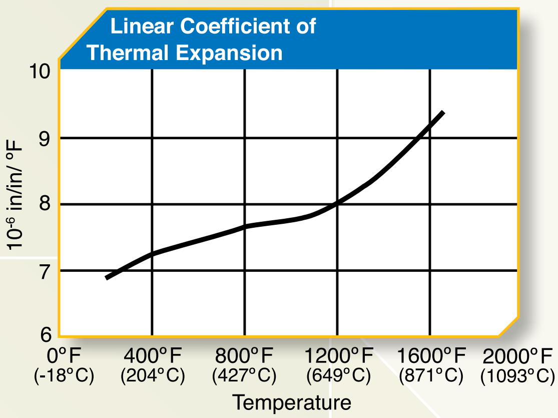


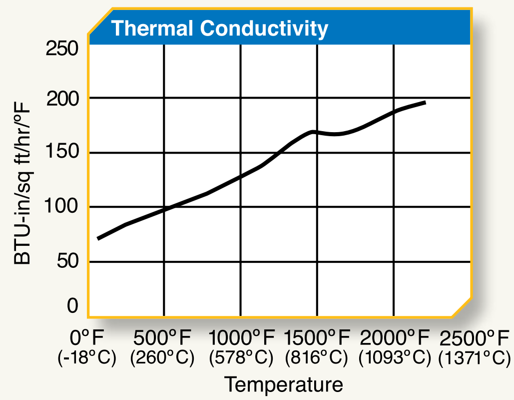
Wrought 718Plus in solution and aged condition. Specific heat (C_P) measured according to ASTM E1269. Thermophysical Properties Research Laboratory, Inc. Rpt. No. 2786, December 12, 2000.

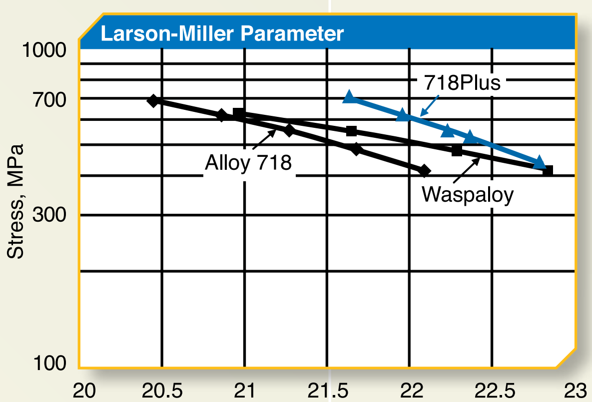
ATI Allvac
2020 Ashcraft Ave., P.O. Box 5030
Monroe NC 28110-5030 USA
704-289-4511
www.allvac.com



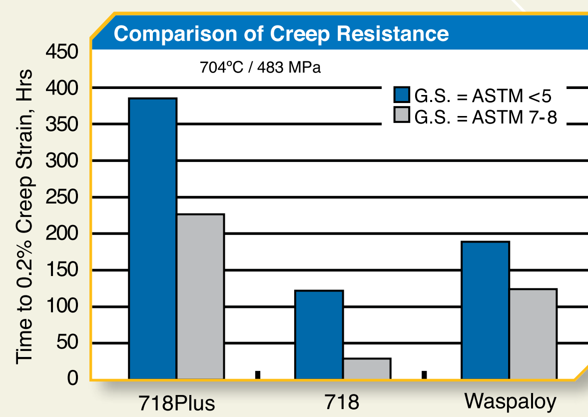
Dynamic Elastic Properties Measured According to ASTM E 1876. Heat B53F-1, Forged Billet per AMS 5442. Values shown are the averge of two measurements, one measurement from each of two replicate samples from the same piece of billet.





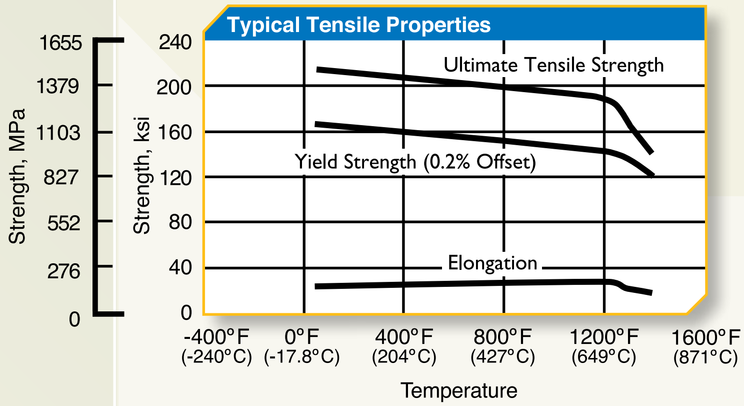


Larson-Miller Plot of Stress Rupture Life of Alloy 718Plus Alloy in Comparison with Alloy 718 and Waspaloy. Larson-Miller Parameter = (ºC + 273ºC) (20 + Log t_f).



Comparison of Creep Resistance of ATI 718Plus Alloy with Alloy 718 and Waspaloy (Samples from 150-200 mm Round Production Billets).

ATI Allvac
2020 Ashcraft Ave., P.O. Box 5030
Monroe NC 28110-5030 USA
704-289-4511
www.allvac.com



1. W.D. Cao, "Nickel-Base Alloy", U.S. Patent 6,730,264 B2, 04 May 2004.
2. R.L. Kennedy, W.D. Cao, T.D. Bayha and R. Jeniski, "Developments in Wrought Nb Containing Superalloys (718 + 100 F°)," published in the Proceedings of the International Symposium on Niobium for High Temperature Applications, 01-03 December 2003, Araxá, MG, Brazil.
3. W.D. Cao and R.L. Kennedy, "Role of Chemistry in 718 Type Alloys - Allvac® 718 Plus™ Development," Superalloy 2004, Seven Springs Conference, Seven Springs, PA,TMS, 2004.
4. W.D. Cao and R.L. Kennedy, "New Developments in Wrought 718-Type Superalloys," Acta Metallurgica Sinica, Vol.17, No.6, 2004.
5. OtherTechnical References
   - "Fatigue Crack Propagation Behaviors of New Developed Allvac® 718Plus® Superalloy" (TMS, 2004)
   - "Allvac® 718Plus®, Superalloy For The Next Forty Years" (TMS, 2005)
   - "Structure and Property Comparison of Allvac® 718Plus® Alloy and Waspaloy Forgings" (TMS, 2005)
   - "Solidification and Solid State Phase Transformation of Allvac® 718Plus® Alloy" (TMS, 2005)
   - "Structure Stability Study on a Newly Developed Nickel-Base Superalloy, Allvac® 718Plus®" (TMS, 2005)
   - "TTT Diagram of a Newly Developed Nickel-Base Superalloy, Allvac® 718Plus®" (TMS, 2005)
   - "Evaluation of Allvac® 718Plus® Alloy in the Cold Worked and Heat Treated Condition" (TMS, 2005)
   - "Application of Direct Aging to Allvac® 718Plus® for Improved Performance" (TMS, 2005)
   - "Investment Casting of Allvac® 718Plus® Alloy" (TMS, 2005)
   - "Effect of Thermal-Mechanical Treatment on the Fatigue Crack Propagation Behavior of Newly Developed Allvac® 718 Plus® Alloy" (TMS, 2005)
   - "Properties and Microstructure of Allvac® 718Plus® Alloy Rolled Sheet" (TMS, 2005)
   - "HAZ Microfissuring in EB Welded Allvac® 718Plus® Alloy" (TMS, 2005)
   - "Metals Affordability Initiative: Application of Allvac Alloy 718Plus® for Aircraft Engine Static Structural Components", (TMS 2005)

ATI Allvac
2020 Ashcraft Ave., P.O. Box 5030
Monroe NC 28110-5030 USA
704-289-4511
www.allvac.com