ATI 418 SPL™

Stainless Steel

(UNS S41800)

GENERAL PROPERTIES

ATI 418 SPL™ alloy (Greek Ascoloy) is a corrosion and heat resistant stainless steel similar in many respects to Type 410 but exhibiting improved high temperature properties. ATI 418 SPL alloy is a modification of former AISI Type 418; the only difference is that nickel has been added to prevent the formation of delta ferrite. Up to 1100°F, its stress rupture strength is equal or superior to the austenitic stainless steels. It can be hardened to Rc 45 typical when quenched from 1750°F or Rc 50 typical when quenched from 1850°F.

ATI 418 SPL alloy is readily forgeable and has fair machinability and cold formability in the annealed condition.

ATI 418 SPL alloy can be welded by any of the commonly used processes; but since it is air hardening, welded sections should be annealed or tempered for maximum ductility.

ATI 418 SPL alloy is commercially available as sheet, strip and plate and is produced to the AMS 5508 specification.

TYPICAL ANALYSIS

Element	Percent
Carbon	0.15-0.20
Manganese	0.50 max
Silicon	0.50 max
Chromium	12.00-14.00
Nickel	1.80-2.20
Molybdenum	0.50 max
Tungsten	2.50-3.50

RESISTANCE TO CORROSION

The corrosion resistance of ATI 418 SPL alloy is about the same as Type 410 and the Blue Sheet on this grade should be consulted for information on resistance to specific media. ATI 418 SPL alloy is less susceptible than Type 410 to hydrogen embrittlement and stress corrosion.

RESISTANCE TO OXIDATION

ATI 418 SPL alloy resists oxidation up to 1400°F and may be used in continuous service at 1100°F. As the rate of oxidation is greatly affected by the atmosphere present and by the operating conditions, no actual data can be presented which will apply to all service conditions.

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APPLICATIONS

ATI 418 SPL alloy is used for stream and gas turbine parts, jet engines and high pressure steam valves. It is suggested for service in the 750-1100°F range where good strength and oxidation resistance are desired.

PHYSICAL PROPERTIES

Density, lb per cu in. 0.284 (g/cm^3 7.86)
Specific Gravity 7.86

Linear Coefficient of Expansion

Temperature Range		Coefficients	
°C	°F	cm/cm/°C	in./ in./°F
20-100	68-212	9.5 X 10^{-6}	5.3 X 10^{-6}
20-300	68-572	10.4 X 10^{-6}	5.8 X 10^{-6}
20-500	68-932	11.2 X 10^{-6}	6.2 X 10^{-6}
20- 787	68-1450	12.0 X 10^{-6}	6.7 X 10^{-6}

Specific Heat

°C	°F	Cal/gm/°C	Btu/lb/°F
0-100	32-212	.11	0.11

Electrical Resistivity

Temperature		Microhm-cm	Microhm-in.
°C	°F		
20	68	61.7	24.3

MECHANICAL PROPERTIES

Room Temperature Properties

Annealed

Yield Strength, 0.2% offset, psi	85,000-120,00
Tensile Strength, psi	115,000-150,000
Elongation in 2 in., %	18-22
Hardness, Rockwell C	23-33

Heat Treated

Within the standard analysis range, a wide range of mechanical properties is obtainable by hardening and tempering. Hardnesses ranging from Rc 25 to Rc 50 are possible with corresponding tensile strengths.

The following table shows the effect of tempering temperature on the room temperature mechanical properties for material with the composition shown below.

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C	Mn	P	S	Si	Cr	Ni	Mo	W
0.178	0.39	0.024	0.012	0.16	13.28	2.04	0.08	2.86

Heat Treatment: 1750°F. – 1/2 hr - oil quench. temper 4 hrs - air cool.

Tempering Temp. °F	Yield Strength 0.02% Offset, psi	Yield Strength 0.2% Offset, psi	Tensile Strength psi	Elong. in 2 in. %	Red. of Area %	Hardness, R_C
900	161 800	195 100	218 000	17.0	51.5	45
1000	147 900	164 000	177 900	17.5	57.2	38
1100	126 600	134 600	150 800	20.0	60.3	32
1200	102 100	115 400	141 200	20.5	61.1	27.5
1300	82 500	106 300	134 800	21.0	62.8	27.0

ELEVATED TEMPERATURE PROPERTIES

Tensile

The following data were obtained on material hardened at 1750°F, oil quenched and tempered 2 hours at 1200°F; hardness Rc 28:

Test Temperature °F	Tensile Strength psi	Elong. in 2 in. %	Red. of Area %
Room	140 000	20	58
900	105 000	17	61
1000	89 000	20	71
1100	70 000	25	82
1200	53 000	30	87

Stress Rupture

The following data were obtained on material hardened at 1800°F, oil quenched and tempered for 1 1/2 hours at 1250°F; hardness Rc 26:

Test Temperature °F	Rupture Strength, psi	
	100 hr	1000 hr
900	56 000	50 000
1000	43 000	37 000
1100	33 000	23 000
1200	19 000	12 000

Hardness

Annealed

Brinell	240-311
Rockwell C	23-33

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Hardened

Brinell	255-477
Rockwell C	25-50

Impact Strength

Annealed
Izod 50-90 ft-lb (68-122 Joules)

Hardened (1750°F oil quenched and tempered 4 hours as indicated)

Tempering Temperature °F	Izod Impact ft-lb (J)	Hardness Rc
none	16 (22)	47
975	26 (35)	37
1050	49 (66)	35
1125	58 (79)	33
1200	65 (88)	28

Fatigue Strength

(material hardened to 34-37 Rc)

Test Temperature °F	
Room	Approx. 50% of ultimate tensile strength at room temp.
800	Approx. 55% of ultimate tensile strength at 800°F.
1000	Approx. 55% of ultimate tensile strength at 1000°F.

Modulus of Elasticity

Approximately 29 x 10^6 psi (200 GPa)

HEAT TREATMENT

Forging Temperature

Initial	2000-2100°F
Final	1600-1700°F

Annealing Temperature

Because of the sluggish transformation characteristics of ATI 418 SPL alloy, a full anneal is impractical. For maximum softness, the material should be heated to 1215-1255°F and held for 6 hours at temperature followed by air cooling.

If a somewhat higher hardness is not objectionable, a simpler annealing treatment is to heat the material to 1300-1350°F followed by air cooling. This treatment will result in a hardness between 277 and 311 Brinell, depending upon composition.

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Response to Heat Treatment

ATI 418 SPL alloy may be fully hardened by oil quenching from 1750-1900°F for heavy sections and air cooling from the same range for thin sections. The as quenched hardness will vary with composition, particularly the carbon content. Various tempering treatments may be utilized to obtain the desired combination of hardness, tensile strength and ductility.

Structure

In the annealed condition, ATI 418 SPL alloy consists of ferrite and carbides; and in the hardened condition, its structure is martensitic.

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