JACQUET

ALLOY 625 DATA SHEET

UNS N06625

GENERAL PROPERTIES

Alloy 625 (UNS designation N06625) is a nickel-chromium-molybdenum alloy possessing excellent resistance to oxidation and corrosion over a broad range of corrosive conditions, including aerospace and chemical process applications. The alloy has outstanding strength and toughness at temperatures ranging from cryogenic to elevated temperatures in the range of 2 000°F (1 093 °C). **Alloy 625** also has exceptional fatigue resistance.

Alloy 625 derives much of its strength from the addition of molybdenum and columbium. These elements also contribute to the alloy's outstanding corrosion resistance. The alloy resists a wide range of severely corrosive environments and is especially resistant to pitting and crevice corrosion. **Alloy 625** is used in chemical processing, aerospace and marine engineering, pollution-control equipment, and nuclear reactor applications.

The material possesses a high degree of formability and shows better weldability than many highly alloyed nickel-base alloys. The alloy is resistant to intergranular corrosion even in the welded condition.

Alloy 625 is produced by vacuum induction melting or by AOD refining. Consumable electrode remelting procedures may be used to further refine the material.

APPLICATIONS

- Chemical processing equipment handling mixed acids both oxidizing and reducing;
- Seawater applications;
- Aircraft ducting systems;
- Jet engine exhaust systems;
- Turbine shroud rings;
- Bellows and expansion joints;
- Aircraft exhaust liners and turbine seals;
- Nuclear water reaction components.

ALLOY 625

STANDARDS

Product form	Specifications		
	ASTM	ASME	AMS
Plate sheet and Strip	B443/B444/B446/ B564/B704/B705/ B751	SB443/SB444/ SB446/SB564/ Boiler Code Sections: I/III/VIII/IX	5581/5599/ 5666/5837
Seamless, Pipe and Tubing	B444	SB444	5581
Welded Tubing	B704/B705		
Rod, Bar and Forgings	B446	SB446	5665
Bar, Forgings and Rings			5666

CHEMICAL COMPOSITION

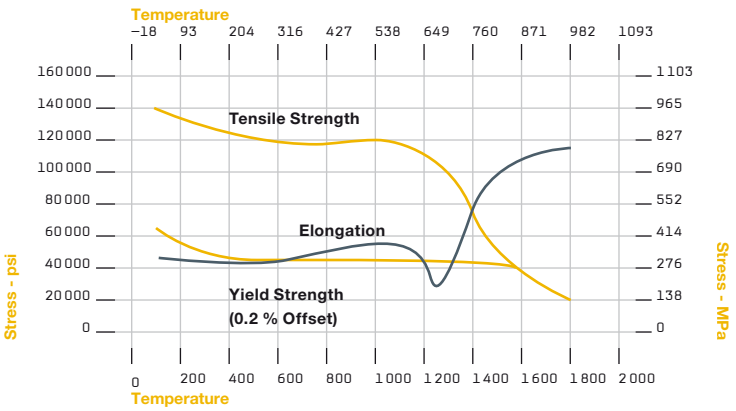
C	Mn	S	Si	Cr	Ni	Fe	Mo	Co + Ta	Ti	Al	P
0.05	0.30	0.003	0.25	20.00→23.00	**Balance**	4.00	9.00	3.50	0.30	0.30	0.015 **max**

MECHANICAL PROPERTIES

Typical room temperature short time tensile properties as a function of temperature.

	Yield Strength 0.2% Offset		Ultimate Tensile Strength		Elongation
Type & temperature of anneal	psi	MPa	psi	MPa	% to 2" (51 mm)
Annealed at 1920 °F (1065 °C)	63000	430	136000	940	51.5
Annealed at 2150 °F (1177 °C)	49500	340	115500	800	67

The short time elevated temperature tensile properties of Alloy 625 annealed at 1950 °F (1066 °C) are shown in the following graph



ALLOY 625

PHYSICAL PROPERTIES

Density	Magnetic Permeability	Specific Heat	Specific Gravity
0.305 **lb/in³**	75 **°F,** 200 **oersted** 1.0006	0.098 **Btu/lb-°F**	8.44
8.44 **g/cm³**		410 **J/kg-°K**	

THERMAL PROPERTIES

Temperature		Linear Coefficient of Thermal Expansion (a) (Units of 10^{-6})		Thermal Conductivity	
°F	°C	/°F	/°C	Btu-in/ft²-hr-°F	W/m-°K
−250	−157	–	–	4.2	7.3
−200	−129	–	–	4.3	7.4
−100	−73	–	–	4.8	8.3
0	−18	–	–	5.3	9.2
70	21	–	–	5.7	9.9
100	38	–	–	5.8	10.0
200	93	7.1	12.8	6.3	10.7
400	204	7.3	13.1	7.3	12.6
600	316	7.4	13.3	8.2	14.2
800	427	7.6	13.7	9.1	15.7
1000	538	7.8	14.0	10.1	17.5
1200	649	8.2	14.8	11.0	19.0
1400	760	8.5	15.3	12.0	20.8
1600	871	8.8	15.8	13.2	22.8
1700	927	9.0	16.2	–	–
1800	982	–	–	14.6	25.3

MODULUS DATA

Temperature				Elastic Modulus		Poisson's ratio
°F	°C	^{6} psi	GPa	10^{6} psi	GPa	μ
70	21	11.4	79	29.8	205	0.308
200	93	11.2	77	29.2	200	0.310
400	204	10.8	75	28.4	195	0.312
600	316	10.5	72	27.5	190	0.313
800	427	10.1	70	26.6	185	0.312
1000	538	9.7	67	25.6	175	0.321
1200	649	9.2	63	24.4	170	0.328
1400	760	8.7	60	23.1	160	0.329
1600	871	8.2	57	–	–	–

IMPACT RESISTANCE

Alloy 625 maintains high impact resistance at low temperatures as shown below.

Temperature			Charpy V-Notch Impact Strength	
°F	°C	Orientation	ft/lb	J
85	30	Longitudinal	49	66
85	30	Transverse	49	66
−110	−79	Longitudinal	44	60
−110	−79	Transverse	41.5	56
−320	−196	Longitudinal	35	47
−320	−196	Transverse	35	47

Impact properties may be expected to decrease with extended service in the 1 200→1 600 °F (649→871 °C) range.

CORROSION & OXIDATION RESISTANCE

The high level of chromium and molybdenium in **Alloy 625** provides a high level of pitting and crevice corrosion resistance to chloride contaminated media, such as seawater, neutral salts and brines.

////TYPICAL DATA IN CHLORIDE SOLUTIONS

Crevice test in 10 % Ferric Chloride	T316 Stainless steel	Alloy 625
Onset Temperature for Attack in ASTM Procedure G-48	< 32 °F	104–113 °F (40–50 °C)

////PANEL EXPOSURES IN SEA WATER

Panel Location Onset Temperature	T316 Stainless Steel	Alloy 625
Flowing Seawater	**Crevice Attack** 1 month	**No Attack** 18 months
Tidal Zone	**Crevice Attack** 1 month	**No Attack** 18 months
Partial Mud Burial	**Crevice Attack** 1 month	**No Attack** 18 months

The alloy is resistant to a variety of corrosive media from highly oxidizing to moderately reducing. Tests in geothermal brines indicate that **Alloy 625** is highly resistant to hot geothermal fluids comparable to titanium grade 2. Tests in simulated flue gas desulfurization environments show that **Alloy 625** is highly resistant to the environment in comparison to alloys such as **T316** stainless steel and comparable to **Alloy C276**.

////BOILING ORGANIC ACID SOLUTIONS

Alloy	45 % Formic	10 % Oxalic	88 % Formic	99 % Acetic
Alloy 625	5.0 (0.13)	6.0 (0.15)	9.0 (0.23)	4.0 (0.01)
T316	11 (0.28)	40 (1.02)	9.0 (0.23)	2.0 (0.05)

////DILUTE REDUCING ACIDS - BOILING SOLUTIONS

Alloy	1 % Sulfuric	5 % Sulfuric	10 % Sulfuric	1 % Hydrochloric
Alloy 625	2.2 (0.06)	8.9 (0.23)	25.3 (0.64)	36.3 (0.92)
T316	25.8 (0.65)	107 (2.72)	344 (8.73)	200 (5)

////MISCELLANEOUS ENVIRONMENTS

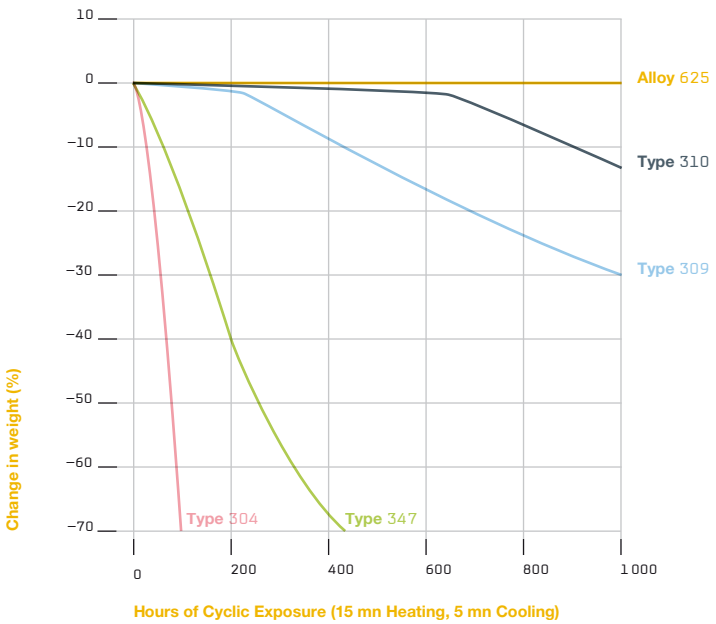
Environment	Alloy 625	T316
20 % Phosphoric Acid	0.36 (<0.01)	6.96 (0.18)
10 % Sulfamic Acid	4.80 (0.12)	63.6 (1.61)
10 % Sodium Bisulfate	3.96 (0.10)	41.6 (1.06)

////CHLORIDE STRESS CORROSION CRACKING RESISTANCE

Test	Alloy 625	T316	Alloy 20
42 % Magnesium Chloride	No Crack 1 000 hrs	Crack < 24 hrs	Crack < 100 hrs
26 % Sodium Chloride	No Crack 1 000 hrs	Crack 600 hrs	No Crack 1 000 hrs

////OXIDATION RESISTANCE

Alloy 625 has excellent oxidation and scaling resistance at temperatures up to 2 000 °F (1 093 °C). It is superior to many other high temperature alloys under cyclic heating and cooling conditions. The following graph compares the weight loss of several stainless steel alloys to **Alloy 625** under cyclic oxidation at 1 800 °F.



ALLOY 625

FORMABILITY

////**Alloy 625** is capable of being formed in the same manner as standard austenitic stainless steels. However, as the material is considerably stronger than conventional austenitic stainless steels, higher loads are required to cause the material to deform. During cold working, the material work hardens more rapidly than austenitic stainless steels. The combination of high initial strength and work hardening rate may necessitate the need for intermediate anneals if the cold deformation is extensive.

////EFFECT OF COLD REDUCTION ON PROPERTIES OF PLATE ANNEALED AT 2150 °F (1177 °C)

Cold Reduction (%)	Hardness Rockwell (C)	Yield Strength (0.2 % Offset) psi	Yield Strength (0.2 % Offset) MPa	Tensile Strength psi	Tensile Strength MPa	Elongation (%)	Reduction of Area (%)
0	88Rb	49500	341	115500	796	67.0	60.4
5	94Rb	77500	534	121000	834	58.0	58.1
10	25	102500	707	130000	896	47.5	54.6
15	32	112500	776	137000	945	39.0	51.9
20	34	125000	862	143000	986	31.5	50.0
30	36	152000	1048	165000	1137	17.0	49.3
40	39	167000	1151	179500	1238	12.5	41.9
50	40	177000	1220	189500	1307	8.5	38.0
60	44	180000	1245	205000	1413	6.5	32.7
70	45	201000	1386	219000	1510	5.0	25.4

ELECTRICAL RESISTIVITY

Temperature °F	Temperature °C	Electrical resistivity microhm-cm
70	21	128.9
100	38	129.6
200	93	131.9
400	204	133.9
600	316	134.9
800	427	135.9
1000	538	137.9
1200	649	137.9
1400	760	136.9
1600	871	135.9
1800	982	134.9
2000	1093	133.9

HEAT TREATMENT

////**Alloy 625** is furnished with one heat treatment for optimum properties up to 1200 °F (649 °C) and another for optimum properties above 1200 °F (649 °C). The standard anneal at a minimum of 1600 °F (871°C) is used for service temperatures up to 1200 °F (649 °C). When optimum high temperature creep and rupture properties are required, as for service above 1200°F (649°C), a solution anneal at 2000 °F (1093 °C) minimum is sometimes specified to further enhance resistance to sensitization.

ALLOY 625

WELDING

////**Alloy 625** can be readily welded by conventional processes used for austenitic stainless steel, including fusion and resistance methods. The material should be in the mill annealed condition and thoroughly descaled and cleaned before welding. Preheating is not required and pos-weld treatment is not needed to maintain or restore corrosion resistance.