JACQUET

ALLOY 600 DATA SHEET

UNS N06600

GENERAL PROPERTIES

Alloy 600 (UNS designation N0660) is a nickel-chromium alloy designed for use in applications from cryogenic to elevated temperatures in the range of 2 000 °F (1 093 °C). **Alloy 600** is non-magnetic and readily weldable.

The alloy is used in a variety of corrosion resisting applications. The high nickel content of **Alloy 600** provides a level of resistance to reducing environments, while the chromium content of the material provides resistance to weaker oxidizing environments. The high nickel content of the material provides exceptional resistance to chloride-ion stress-corrosion cracking.

APPLICATIONS

- Chemical and food processing equipment;
- Paper mill and alkaline digesters;
- Heat exchangers;
- Heat treating muffles and retorts;
- High temperature furnace applications;
- Aircraft exhaust liners and turbine seals.

STANDARDS

Product form	Specifications			
	ASTM	ASME	AMS	Military
Plate sheet and Strip	B168	SB168	5540	MIL-N-23228/MIL-T-23227
Pipe and Tubing	B177/B516/B517	SB177/SB516/SB517	5580	
Condensed Tubing	B163	SB163		
Rod, Bar and Forgings	B166/B564	SB166/SB564	5565	MIL-N-23229
Wire	B166	SB166	5687	

CHEMICAL COMPOSITION (%)

C	Mn	S	Si	Cr	Ni + Co	Fe	Cu
0.50	0.25	0.002	0.20	15.5	Balance	8.00	0.10

ALLOY 600

MECHANICAL PROPERTIES

Room temperature mechanical properties of Alloy 600 are shown below. The material is in the annealed condition.

Yield Strength 0.2% offset		Ultimate Tensile Strength		Elongation
psi	MPa	psi	MPa	% to 2" (51 mm)
37000	255	93000	640	45

SHORT TIME ELEVATED TEMPERATURE TENSILE PROPERTIES

The following table illustrates the short time tensile properties of Alloy 601 at temperatures above room temperature. Low temperature properties are added for comparison.

Test temperature		Yield Strength 0.2% Offset		Ultimate Tensile Strength		Elongation
°F	°C	psi	MPa	psi	MPa	% in 2"
–110	–79	42400	292	106450	734	64
600	316	31000	213	90500	624	46
800	427	29500	203	88500	610	49
1000	538	28500	197	84000	579	47
1200	649	26500	183	65000	448	39
1400	760	17000	117	27500	190	46
1600	871	9000	62	15000	103	80
1800	982	4000	28	7500	52	118

PHYSICAL PROPERTIES

Density	Magnetic Permeability	Specific Heat		Specific Gravity
0.304 **lb/in**^{3}	< 1.02	32→212 **°F**	0.11 **Btu/lb-°F**	8.42
8.42 **g/cm**^{3}		0→100 **°C**	460 **J/kg-°K**	

LINEAR COEFFICIENT OF THERMAL EXPANSION

Average from		Linear coefficient of Thermal Expansion	
70°F (21°C)	to °F (°C)	10^{-6}/°F	10^{-6}/°C
200	93	6.9	12.4
400	204	7.3	13.1
600	316	7.6	13.7
800	427	7.9	14.2
1000	538	8.1	14.6
1200	649	8.4	15.1
1400	760	8.7	15.7

ALLOY 600

THERMAL CONDUCTIVITY

Temperature		Thermal Conductivity	
°F	°C	Btu-ft/h-ft²-°F	W/m-°K
70	21	8.6	14.8
200	93	8.9	15.4
400	204	9.9	17.1
600	316	10.8	18.7
800	427	11.9	20.6
1000	538	13.0	22.5

ELASTIC MODULUS, MODULUS OF RIGIDITY AND POISSON'S RATIO

Temperature		Elastic modulus (E)		Modulus of Rigidity (G)		Poisson's Ratio
°F	°C	psi	GPa	psi	GPa	μ
70	21	30	207	11	76	0.29

IMPACT RESISTANCE

Alloy 600 shows excellent toughness even at subzero temperatures. The following are typical results for standard size Charpy V-Notch impact specimens machined from plate.

Testing temperature		Charpy Impact Strength, ft-lb (Joules)					
°F	°C	Anneals		As Rolled		Cold Rolled	
–100	–73	180	244	180	244	–	
70	21	180	244	180	244	155	156
1000	538	160	217	160	217	–	

CREEP & STRESS RUPTURE PROPERTIES

Typical stress rupture properties of Alloy 600 are presented below in comparison to some other materials. The data indicate that Alloy 600 has modest load carrying ability in the temperature range in which creep and stress rupture are design criteria.

Temperature			Stress, psi (MPa) to produce rupture in		
°F	°C	Alloy	10hr	100 hr	1000 hr
1000	540	304	–	43000 (297)	34000 (234)
		600	74000 (510)	50000 (345)	34000 (234)
		A–286	100000 (690)	95000 (655)	88000 (607)
1200	650	304	–	23000 (159)	16000 (110)
		600	34000 (234)	23000 (159)	14500 (100)
		800	40000 (276)	32000 (221)	21000 (145)
1350	730	600	20000 (138)	13500 (93)	9200 (63)
		A–286	49000 (338)	35000 (241)	21000 (145)

ALLOY 600

CORROSION RESISTANCE

////The high nickel content of **Alloy 600** provides good resistance to moderate levels of reducing conditions. The nickel content of the alloy renders the alloy extremely resistant to chloride-ion stress-corrosion cracking. **Alloy 600** is one alloy used in solutions of magnesium chloride.

////Similarly, the chromium content of **Alloy 600** is an improvement over **Alloy 200** (commercially pure nickel). In strong oxidizing solutions, like hot, concentrated nitric acid, **Alloy 600** has poor resistance.

////**Alloy 600** is relatively unattacked by the majority of neutral and alkaline salt solutions. It is used in some caustic environments.
Alloy 600 resists steam and mixtures of steam, air, and carbon dioxide. The alloy has excellent oxidation resistance to about 2100 °F (1149 °C). The Nickel content of the alloy renders it subject to attack at elevated temperatures in sulfur-containing atmospheres, however.

HEAT TREATMENT

////**Alloy 600** is not hardenable by heat treatment. The alloy can only be strengthened by cold working. Annealing is conducted to soften the material after cold working operations. Softening begins at 1600 °F (871 °C). At temperatures of 1800 °F (982 °C) or higher, grain growth will occur rapidly. However, very short time at 1900 °F (1038 °C) may be used to soften the material without producing undue grain growth. Slow cooling or quenching produces approximately the same hardness in **Alloy 600.**

COLD FORMING

////**Alloy 600** exhibits the excellent cold forming characteristics normally associated with chromium-nickel stainless steels. The high nickel content prevents the austenite to martensite transformation which can occur when **Alloys 301** or **304** stainless steels are cold formed. The Alloy has a lower work hardening rate than **Alloys 301** or **304** and can be used in multiple draw forming operations where relatively large amounts of deformation occur between anneals..

////If a high temperature anneal is conducted on the **Alloy 600** to produce a relatively large grain size for elevated temperature properties, extensive forming produces a visibly undulated surface called “orange peel”. This surface characteristic is produced by the large grain size and is usually considered detrimental to the properties of the material.

WELDING

////**Alloy 600** can be joined by the standard resistance and fusion welding processes used for the stainless steels. A number of welding rods and wires are commercially available for joining **Alloy 600** to itself and other materials. Since the alloy forms a tightly adhering oxide, which can be removed only by grinding, inert gas shielding is desirable.