Specification Sheet: Alloy 600 (UNS N06600)

A Nickel-Base Alloy with Resistance to a Variety of Corrosive Conditions

Alloy 600 (UNS Designation N06600) is a nickel-chromium alloy designed for use from cryogenic to elevated temperatures in the range of 2000ºF (1093ºC). 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 stress corrosion cracking.

Applications

- Chemical and food processing equipment
- Paper mill and alkaline digesters
- Heat exchangers
- Heat treating mufflers and retorts

Standards

ASTM .....B 168
ASME .....SB 168
AMS 5540
MIL MIL-N-23226
MIL-T-23227

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 stress corrosion cracking. Alloy 600 is one alloy used in solutions of magnesium chloride.

Similarly, the chromium content of Alloy 600 provides resistance to weak oxidizing environments. In this respect, 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 2100ºF (1149ºC). The nickel content of the alloy renders it subject to attack at elevated temperatures in sulfur containing atmospheres, however.

Chemical Analysis

Typical analysis (Weight %)

C	Mn	S	Si	Cr	Ni + Co	Fe	Cu
0.05	0.25	0.002	0.20	15.5	Balance	8.0	0.10

Mechanical Properties

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

0.2% Offset Yield Strength psi	(MPa)	Ultimate Tensile Strength psi	(MPa)	Elongation % to 2" (51 mm)
37,000	(255)	93,000	(640)	45

Short Time Elevated Temperature Tensile Properties

The following table illustrates the short time tensile properties of Alloy 600 at temperatures above room temperature. Low temperature properties are added for comparison.

Test Temperature °F	°C	0.2% Offset Yield Strength psi	(MPa)	Ultimate Tensile Strength psi	(MPa)	Elongation percent in 2" (1 mm)
-110	(-79)	42,400	(292)	106,450	(734)	64
600	(316)	31,000	(213)	90,500	(624)	46
800	(427)	29,500	(203)	88,500	(610)	49
1000	(538)	28,500	(197)	84,000	(579)	47
1200	(649)	26,500	(183)	65,000	(448)	39
1400	(760)	17,000	(117)	27,500	(190)	46
1600	(871)	9,000	(62)	15,000	(103)	80
1800	(982)	4,000	(28)	7,500	(52)	118

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 Temp. °F	(ºC)	Charpy Impact Strength, ft-lb (Joules) Annealed		As Hot Rolled		Cold Rolled	
-100	(-73)	180	(244)	180	(244)	—	
70	(21)	180	(244)	180	(244)	155	(156)
1000	(538)	160	(217)	160	(217)	—	

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.

SANDMEYER STEEL COMPANY
ONE SANDMEYER LANE • PHILADELPHIA, PA 19116-3598
800-523-3663 • FAX 215-677-1430 • www.SandmeyerSteel.com

Family Owned and Managed - Making Stainless Steel and Nickel Alloy Plate Products Since 1952

Alloy 600 03/04

Physical Properties

Density
0.304 lb/in³
8.42 g/cm³

Specific Gravity
8.42

Magnetic Permeability
<1.02

Specific Heat
32-212ºF (0-100ºC) 0.11 Btu/lb-ºF 460 Joules/kg-ºK

Linear Coefficient of Thermal Expansion

Average from 70ºF (21ºC) to ºF (ºC)		Linear Coefficient of Thermal Expansion 10⁻⁶/ºF	10⁻⁶/ºC
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

Thermal Conductivity

Temperature ºF	(ºC)	Thermal Conductivity Btu-ft/h-ft²-ºF	W/m-ºK
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 ºF	(ºC)	Elastic Modulus (E) Units of 10⁶ psi	GPa	Modulus of Rigidity (G) Units of 10⁶ psi	GPa	Poisson's Ratio (μ)
70	21	30	207	11	76	0.29

Creep and 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 ºF	(ºC)	Alloy	Stress, psi (MPa) to Produce Rupture in 10 hr		100 hr		1000 hr	
1000	(538)	304	—		43,000	(297)	34,000	(234)
		600	74,000	(510)	50,000	(345)	34,000	(234)
		A-286	100,000	(690)	95,000	(655)	88,000	(607)
1200	(649)	304	—		23,000	(159)	16,000	(110)
		600	34,000	(234)	23,000	(159)	14,500	(100)
		800	40,000	(276)	32,000	(221)	21,000	(145)
1350	(732)	600	20,000	(138)	13,500	(93)	9,200	(63)
		A-286	49,000	(338)	35,000	(241)	21,000	(145)

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 1600ºF (871ºC) and can be conducted to about 2100ºF (1149ºC). At temperatures of 1800ºF (982ºC) or higher, grain growth will occur rapidly. However, very short time at 1900ºF (1038ºC) may be used to soften the material without producing undue grain growth. Slow cooling or quenching produces approximately the same hardness in Alloy 600.

Processing

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 Types 301 or 304 stainless steels are cold formed. The alloy has a lower work hardening rate than Types 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.

NOTE

This technical data and information represents our best knowledge at the time of printing. However, it may be subject to some slight variations due to our ongoing research program on corrosion resistant grades.

We, therefore, suggest that information be verified at time of inquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here is only for the purpose of description and may only be considered as guarantees when our Company has given written formal approval.

SANDMEYER STEEL COMPANY