ECHX (UNS N06002) NICKEL BASE ALLOY

ECHX is a nickel base, austenitic, solid solution strengthened alloy. Additions of chromium, molybdenum, cobalt, tungsten, and a small amount of boron provide excellent strength at high temperatures. The oxidation resistance of ECHX is outstanding at temperatures up to 2200°F. ECHX has good resistance to thermal shock and to furnace atmospheres such as carburizing, carbonitriding, reducing, dissociated ammonia, hydrogen, and many fuel gasses.

CHEMICAL COMPOSITION (Nominal Analysis, weight percent)

Carbon	**0.05 / 0.15**	**Nickel**	**Balance**
Manganese *(max)*	**1.00**	**Copper** *(max)*	**0.50**
Phosphorus *(max)*	**0.040**	**Cobalt**	**0.50 / 2.50**
Sulfur *(max)*	**0.030**	**Titanium** *(max)*	**0.15**
Silicon *(max)*	**1.00**	**Molybdenum**	**8.00 / 10.00**
Chromium	**20.50 / 23.00**	**Tungsten**	**0.20 / 1.00**
Aluminum *(max)*	**0.50**	**Boron** *(max)*	**0.010**
Iron	**17.00 / 20.00**		

TYPICAL APPLICATIONS

Aerospace

- Combustion chambers, liners for gas turbines and jet engines, tail pipes, turbine blades, afterburner components, nozzle vanes, shrouds, rings, hot-air ducting.

Thermal Processing

- Equipment for heat treating muffles, retorts, baskets, boxes and trays, furnace fixtures, shrouds, hearth plates, chains, rolls, hangers, frames, burner components, mufflers, tubes.

Specifications: ASTM B572, AMS 5754, NACE MR0175

Forms: ingot, billet, bar, rod, and coil rod

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PHYSICAL PROPERTIES

Melting Temperature:	2380°F to 247°C (1260°C to 1355°C)
Density:	0.297 lb./in.^{3} (8.23 gm/cm^3)
Specific Heat:	(@ 70°F) 0.104 Btu/lb./°F
Magnetic Permeability:	(H=200 Oersteds) < 1.002
Electrical Resistivity:	(@ 77°F) 45.6 microhm-in.

Thermal Conductivity

Temperature		
°F	°C	Btu/ft^2/ft./hr./°F
600	316	8.3
1000	538	11.3
1500	816	11.8

Coefficient of Thermal Expansion

°F	°C	in./in./°F
79 to 200	26 to 93	7.7 x 10^{-6}
70 to 1000	21 to 538	8.4 x 10^{-6}
70 to 1800	21 to 982	9.2 x 10^{-6}

Modulus of Elasticity (E)

Temperature °F	10^{6}psi
70	29
1000	24
1800	18.3

MECHANICAL PROPERTIES

Tensile Properties and Stress Rupture Properties: *Annealed*

Specification	UTS (ksi) (min)	.2% YS (ksi) (min)	%EL (min) 2" (50.8 mm) or 4D
ASTM B572	95 (660 MPa)	35 (240 MPa)	35
AMS 5754	-	-	-
Stress Rupture Temperature	**Load**	**Time (min)**	**%EL (min)**
1500°F	15.0 ksi	24 hr.	10

HEAT TREATMENT

ECHX does not harden by heat treatment. Annealing is accomplished by heating to 2150°F and holding 1 hour per inch of thickness then water quenching. Carbide precipitation will occur in the temperature range of 1200°F - 1950°F.

WORKABILITY

The recommended hot working temperature range is between 1800°F - 2150°F. Neutral or slightly oxidizing atmospheres are recommended. ECHX can be readily cold formed in the annealed condition by practices such as drawing, hydro-forming, spinning, bending, roll forming, and cold heading.

CORROSION & OXIDATION RESISTANCE

ECHX exhibits the best oxidation resistance of the commercially available nickel base super alloys. This alloy forms a tight, thin oxide layer which does not spall off during intermediate heating and cooling. The overall corrosion resistance of ECHX is good. Tests in boiling 65% nitric acid for one 48 hour test period showed typical penetration rate of 0.013 inches per year for 2150°F annealed bar.

WELDING

ECHX can be welded using conventional methods such as gas tungsten arc (GTAW), gas metal arc (GMAW), shielded metal arc (SMAW), and resistance welding methods. When highest corrosion resistance is desired, it may be necessary to solution anneal after welding.

MACHINING

ECHX can be machined using conventional techniques and equipment similar to those used for 300 series stainless steel. It is much slower to machine than stainless steels and exhibits the same gumminess. High work hardening characteristics require ridged machine set-ups and sharp tools.

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Plate Products

2-2019