Specification Sheet: 17-4PH (UNS S17400)

A 17Cr-4Ni-3Cu Precipitation Hardening Martensitic Stainless Steel

Alloy 17-4PH is a precipitation hardening martensitic stainless steel with Cu and Nb/Cb additions. The grade combines high strength, hardness (up to 572°F / 300°C), and corrosion resistance.

Mechanical properties can be optimized with heat treatment. Very high yield strength up to 1100-1300 MPa (160-190 ksi) can be achieved.

The grade should not be used at temperatures above 572°F (300°C) or at very low temperatures. It has adequate resistance to atmospheric corrosion or in diluted acids or salts where its corrosion resistance is equivalent to grade 304 or 430.

Applications

- Offshore (foils, helicopter deck platforms, etc.)
- Food industry
- Pulp and paper industry
- Aerospace (turbine blades, etc.)
- Mechanical components
- Nuclear waste casks

Standards

ASTM .....A693 grade 630 (AMS 5604B) UNS S17400

EURONORM ...1.4542 X5CrNiCuNb 16-4

AFNOR.....Z5 CNU 17-4PH

DIN 1.4542

Corrosion Resistance

Alloy 17-4PH withstands corrosive attacks better than any of the standard hardenable stainless steels and is comparable to type 304 in most media.

If there are potential risks of stress corrosion cracking, the higher aging temperatures then must be selected over 1022°F (550°C), preferably 1094°F (590°C).

1022°F-550°C is the optimum tempering temperature in chloride media.

1094°F-590°C is the optimum tempering temperature in H2S media.

The alloy is subject to crevice or pitting attack if exposed to stagnant seawater for any length of time.

It is corrosion resistant in some chemical, petroleum, paper, dairy, and food processing industries (equivalent to 304L grade).

Chemical Analysis

Typical values (Weight %)

C	Cr	Ni	Cu	Nb/Cb	Mn
0.04	16.5	4.5	3.3	0.3	0.7
PREN (%cr+3.3%Mo+16%N)≥ 17					

Mechanical Properties

Room temperature properties (longitudinal direction)

Guaranteed values (ASTM A693 hot rolled plates); thickness from 3/16” up to 3”.

Heat treatment	YS 0.2% N/mm		UTS N/mm		YS 0.2% ksi		UTS ksi		El%	
	Min.	Typ.	Min.	Typ.	Min.	Typ.	Min.	Typ.	Min.	Typ.
A	1070	1207	1170	1310	155	175	170	190	8	14
B	790	931	965	1034	115	135	140	150	10	17

A: hardening 925°F (496°C) - 4 hours - air cooling
B: hardening 1100°F (593°C) - 4 hours - air cooling
2 examples of heat treatments that may be applied.
For specific requests, please contact us.

Elevated temperature properties

Minimum guaranteed values following EN 10088 hot rolled plates.
The EN guaranteed values are valid for a thickness from 3/16" up to 3".

Temperature °F Temperature °C		212 100	302 150	392 200	482 250	572 300
YS 0.2%	N/mm_	730	710	690	670	650
	ksi	106	103	100	97	95

Heat treatment : hardening 1094°F (590°C) - 4 hours - air cooling
1 example of heat treatments that may be applied.
For specific requests, please consult us.

Minimum guaranteed room temperature impact values

Minimum guaranteed values following ASTM A693 hot rolled plates.
The ASTM guaranteed values are valid for a thickness from 3/16" up to 3".

Heat treatment	KV transverse	
	J	ft.lbf
Hardening 1100° F (593° C) - 4 hours - air cooling	20	15

Minimum guaranteed room temperature hardness values

Minimum guaranteed values following ASTM A693 hot rolled plates.
The ASTM guaranteed values are valid for a thickness from 3/16" up to 3".

Heat treatment	Hardness	
	Rockwell	Brinell
Hardening 925° F (496° C) - 4 hours - air cooling	C38	375
Hardening 1100° F (593° C) - 4 hours - air cooling	C29	293

For specific requests, please consult us.

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Physical Properties

Density: 7800 kg/m3 (.28 lbs/in3)
The following physical properties have been obtained after hardening 896°F (480°C) – 1 hour - air cooling

Interval Temperature °C	Thermal expansion $\alpha x10^{-6}°C^{-1}$	°F	°C	Thermal conductivity $(w.m^{-1}.K^{-1})$	Young modulus (GPa)
0-100	10.8	68	20	14	197
0-200	11	212	100	16	193
0-300	11.3	392	200	18.5	186
0-400	11.6	572	300	20	180
0-500	12	752	400	22	175
		932	500	23	170

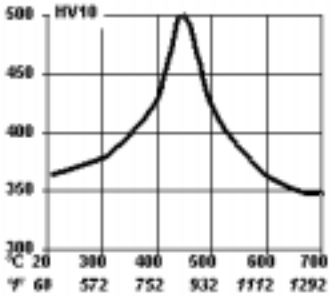
Room temperature properties:
Resistivity : 80 µ*.cm
Specific heat : 460 $J.kg^{-1}.K^{-1}$
Tension modulus : 77 GPa
The alloy is magnetic.

Heat Treatment

Martensitic transformation
Indicative values
Ms : 266°F (130°C)
Mf : 86°F (30°C)

Solution annealing
1925°F+ /-50°F (1050°C +/-25°C) – 30 min up to 1 hour
Air cooling / oil quenching below 76°F (25°C)

Aging / Tempering
The highest mechanical properties are obtained with the following heat treatment: 896°F (480°C) – 1 hour – air cooling.
Higher ductilities are obtained when using higher aging temperatures up to 1148°F (620°C).



Hardness/Temperature tempered for 4 hours after austenitizing at 1904°F (1040°C) for 30 min quenched 100°C/sec (212°F/sec)

Processing

Hot forming

Hot forming should be carried out in a temperature range of 1742°-2192°F (950°-1200°C). A full heat treatment including solution annealing, cooling lower than 76°F (25°C) and aging at the required temperature must be made after hot forming (function of the requested mechanical properties).

Cold forming

Cold forming can be performed only to a limited extent and only on plates in the fully softened condition. Stress corrosion resistance is improved by re-aging at the precipitation hardening temperature after cold working.

The following processes may be performed: rolling, bending, hydroforming, etc. (fully softened conditions).

Cutting

Thermal cutting (plasma, thermal sawing, etc.). Due to the HAZ, the grade requires a suited cutting process. After cutting, grinding is necessary to eliminate the oxide formed layer.

Mechanical cutting (shearing, stamping, cold sawing, etc.).

Welding

Alloy 17-4PH can be welded by the following welding processes: SMAW, GTAW, PAW, and GMAW. SAW should not be used without preliminary testing (to check freedom of cracks and toughness of the weld metal).

Due to a ferrite delta primary type of solidification, the hot cracking risk of the weld metal or the HAZ is reduced.

Generally, no preheating must be done, and interpass temperature must be limited to 248°F (120°C). The better toughness is obtained in the weld after a complete heat treatment (solution annealing + precipitation hardening).

Due to the martensitic microstructure, a low oxygen content in the weld metal is preferable to increase ductility and toughness. To avoid cold cracking, the introduction of hydrogen in the weld must be limited.

Alloy 17-4PH can be welded with homogeneous filler metals such as E 630 (AWS A5.4) electrodes and ER 630 (AWS A5.9) wires.

Austenitic filler material can be used when the mechanical properties of 17-4PH steel are not required in the weld and, in this case, no post-weld heat treatment must be applied.

Machining

Alloy 17-4PH can be machined in both solution treated and precipitation hardened conditions. Machining condition may vary according to the hardness of the material. High speed steel tools or, preferably, carbide tools with standard lubrication are normally used. If very stringent tolerances are required, it is necessary to take into account the dimensional changes during heat treatment.

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