SPECIFICATIONS

Commercial	17-4PH & 630

Precipitation hardening stainless steels are chromium and nickel containing steels that provide an optimum combination of the properties of martensitic and austenitic grades. Like martensitic grades, they are known for their ability to gain high strength through heat treatment and they also have the corrosion resistance of austenitic stainless steel.
The high tensile strengths of precipitation hardening stainless steels come after a heat treatment process that leads to precipitation hardening of a martensitic or austenitic matrix. Hardening is achieved through the addition of one or more of the elements Copper, Aluminium, Titanium, Niobium, and Molybdenum.
The most well known precipitation hardening steel is 17-4 PH. The name comes from the additions 17% Chromium and 4% Nickel. It also contains 4% Copper and 0.3% Niobium. 17-4 PH is also known as stainless steel grade 630.
The advantage of precipitation hardening steels is that they can be supplied in a "solution treated" condition, which is readily machinable. After machining or another fabrication method, a single, low temperature heat treatment can be applied to increase the strength of the steel. This is known as ageing or age-hardening. As it is carried out at low temperature, the component undergoes no distortion.

Characterisation
Precipitation hardening steels are characterised into one of three groups based on their final microstructures after heat treatment. The three types are: martensitic (e.g. 17-4 PH), semi-austenitic (e.g. 17-7 PH) and austenitic (e.g. A-286).

Martensitic Alloys
Martensitic precipitation hardening stainless steels have a predominantly austenitic structure at annealing temperatures of around 1040 to 1065°C. Upon cooling to room temperature, they undergo a transformation that changes the austenite to martensite.

Semi-austenitic Alloys
Unlike martensitic precipitation hardening steels, annealed semi-austenitic precipitation hardening steels are soft enough to be cold worked. Semi-austenitc steels retain their austenitic structure at room temperature but will form martensite at very low temperatures.

Austenitic Alloys
Austenitic precipitation hardening steels retain their austenitic structure after annealing and hardening by ageing. At the annealing temperature of 1095 to 1120°C the precipitation hardening phase is soluble. It remains in solution during rapid cooling. When reheated to 650 to 760°C, precipitation occurs. This increases the hardness and strength of the material. Hardness remains lower than that for martensitic or semi-austenitic precipitation hardening steels. Austenitic alloys remain nonmagnetic.

Strength
Yield strengths for precipitation-hardening stainless steels are 515 to 1415 MPa. Tensile strengths range from 860 to 1520 MPa. Elongations are 1 to 25%. Cold working before ageing can be used to facilitate even higher strengths.

CHEMICAL COMPOSITION

Element	% Present
Chromium (Cr)	15.00 - 17.50
Nickel (Ni)	3.00 - 5.00
Copper (Cu)	3.00 - 5.00
Silicon (Si)	0.0 - 1.00
Manganese (Mn)	0.0 - 1.00
Molybdenum (Mo)	0.0 - 0.50
Columbium (Cb)	0.0 - 0.45
Niobium (Columbium) (Nb)	0.0 - 0.45
Carbon (C)	0.0 - 0.07
Phosphorous (P)	0.0 - 0.04
Sulphur (S)	0.0 - 0.03
Iron (Fe)	Balance

ALLOY DESIGNATIONS

This is similar to, **but may not be a direct equivalent:**
17/4 PH
UNS S17400
Grade 630
1.4548

SUPPLIED FORMS

- Bar

GENERIC PHYSICAL PROPERTIES

Property	Value
Density	7.75 g/cm³
Thermal Expansion	10.8 $\times 10^{-6}$ /K
Modulus of Elasticity	196 GPa
Thermal Conductivity	18.4 W/m.K
Electrical Resistivity	0.8 $\times 10^{-6}$ Ω .m

APPLICATIONS

Due to the high strength of precipitation hardening stainless steels, most applications are in aerospace and other high-technology industries.
Applications include:
~ Gears
~ Valves and other engine components
~ High strength shafts
~ Turbine blades
~ Moulding dies
~ Nuclear waste casks

CORROSION RESISTANCE

Precipitation hardening stainless steels have moderate to good corrosion resistance in a range of environments. They have a better combination of strength and corrosion resistance than when compared with the heat treatable 400 series martensitic alloys. Corrosion resistance is similar to that found in grade 304 stainless steel.
In warm chloride environments, 17-4 PH is susceptible to pitting and crevice corrosion. When aged at 550°C or higher, 17-4 PH is highly resistant to stress corrosion cracking. Better stress corrosion cracking resistance comes with higher ageing temperatures.
Corrosion resistance is low in the solution treated (annealed) condition and it should not be used before heat treatment.

HEAT RESISTANCE

17-4 PH has good oxidation resistance. In order to avoid reduction in mechanical properties, it should not be used over its precipitation hardening temperature. Prolonged exposure to 370-480°C should be avoided if ambient temperature toughness is critical.

FABRICATION

Fabrication of all stainless steels should be done only with tools dedicated to stainless steel materials or tooling and work surfaces must be thoroughly cleaned before use. These precautions are necessary to avoid cross contamination of stainless steel by easily corroded metals that may discolour the surface of the fabricated product.

COLD WORKING

Cold forming such as rolling, bending and hydroforming can be performed on 17-4PH but only in the fully annealed condition. After cold working, stress corrosion resistance is improved by re-ageing at the precipitation hardening temperature.

HOT WORKING

Hot working of 17-4 PH should be performed at 950°-1200°C. After hot working, full heat treatment is required. This involves annealing and cooling to room temperature or lower. Then the component needs to be precipitation hardened to achieve the required mechanical properties.

MACHINABILITY

In the annealed condition, 17-4 PH has good machinability, similar to that of 304 stainless steel. After hardening heat treatment, machining is difficult but possible.
Carbide or high speed steel tools are normally used with standard lubrication. When strict tolerance limits are required, the dimensional changes due to heat treatment must be taken into account

HEAT TREATMENT

The key to the properties of precipitation hardening stainless steels lies in heat treatment.
After solution treatment or annealing of precipitation hardening stainless steels, a single low temperature "age hardening" stage is employed to achieve the required properties. As this treatment is carried out at a low temperature, no distortion occurs and there is only superficial discolouration. During the hardening process a slight decrease in size takes place. This shrinking is approximately 0.05% for condition H900 and 0.10% for H1150.
Typical mechanical properties achieved for 17-4 PH after solution treating and age hardening are given in the table on the attached page. Condition designations are given by the age hardening temperature in °F.

Condition: Tensile Strength Range (N/mm² or MPa) QT 650: 650 - 850
QT 700: 700 - 850
QT 800: 800 - 950
QT 850: 850 - 1000
QT 900: 900 - 1050

WELDABILITY

Precipitation hardening steels can be readily welded using procedures similar to those used for the 300 series of stainless steels.
Grade 17-4 PH can be successfully welded without preheating. Heat treating after welding can be used to give the weld metal the same properties as for the parent metal. The recommended grade of filler rods for welding 17-4 PH is 17-7 PH.

MECHANICAL PROPERTIES

Condition	0.2% Proof Stress (MPa Min)	Tensile Strength (MPa Min)	Elongation (% Min)	Reduction of area (% min)	Hardness (HB)
			Longitude / Transverse	Longitude / Transverse	
H900	1172	1310	10 / 6	35 / 20	388 - 444 max
H1000	1069	1172	10 / 7	38 / 25	375 - 429 max
H1025	1000	1069	12 / 8	45 / 32	331 - 401 max
H1050	862	1000	13 / 9	45 / 33	311 - 375 max
H1100	793	965	14 / 10	45 / 34	302 - 363 max
H1150	724	931	16 / 11	50 / 35	277 - 352 max

CONTACT

Web:	www.dalsteel.com.au

REVISION HISTORY

Datasheet Updated	13 March 2020

DISCLAIMER