17-7PH

Material

17-7PH, Type 631, UNS S17700, 17Cr-7Ni

Overview

17-7PH is a chromium-nickel-aluminum semi-austenitic stainless steel which is austenitic in the annealed condition, but martensitic in the hardened condition. 17-7PH provides high strength and hardness, excellent fatigue properties, good corrosion resistance and minimum distortion upon heat treatment. It is easily formed in the annealed condition, then hardened to high strength levels by simple heat treatments.

Characteristics

17-7PH is designed to provide an austenitic structure in the annealed condition with excellent cold drawability. To achieve age-hardening properties, 17-7PH must be cold drawn.

17-7PH may be formed in a soft austenitic condition and hardened to a high strength level by low temperature heat treatments. The low temperature allows minimum distortion compared to conventional quench and temper hardening processes. In addition to material produced by the standard refining procedures, material which has been vacuum arc or electroslag remelted is available for further increase in resistance to fatigue, for those applications subject to cyclic stresses.

Application

17-7PH has been found application in aerospace, surgical parts and many spring type applications requiring high strength.

Chemical composition (wt% as per AMS 5568)

C	Si	Mn	P	S
≤0.09	≤1.0	≤1.0	≤0.040	≤0.030
Cr	Ni	Al		
16.0~18.0	6.50~7.75	0.75~1.50		

Physical property

Density: 0.282 lbs/in^3 (7.80 g/cm^3) in annealed condition
Electrical Resistivity: 68 °F (20 °C): 80 microhm-cm in all conditions
Thermal Conductivity:
in the hardened conditions in the range 70-300°F (20-150°C): 9.5 (16.5) Btu-ft/hr-ft^{2}-°F (W/m-K)
Mean Coefficient of Thermal Expansion: in/in/°F (|jm/nTK)
70 - 200 °F (21 - 93 °C): 8.5 x 10^{-6} (15.3)
70 - 400 °F (21 - 204 °C): 9.0 x 10^{-6} (16.2)
70 - 600 °F (21 - 315 °C): 9.5 x 10^{-6} (17.1)

70 - 800 °F (21 - 427 °C): 9.6 x 10^{-6} (16.0)

Modulus of easticity: ksi (MPa)
29 x 10^3 (200 x 10^3) in all conditions

Modulus of rigidity: ksi (MPa)
11 x 10^3 (75 x 10^3) in all conditions

Magnetic Permeability:
Annealed: Weakly ferromagnetic
Heat treated: Strongly ferromagnetic

Corrosion resistance

Tests have shown that the corrosion resistance of 17-7PH is comparable to that of Type 304 stainless steel in most media. In general, the corrosion resistance of 17-7PH is superior to that of the hardenable 400 series stainless steels. Its intergranular corrosion may be a problem if the material is heated between 800°F (427°C) and 1650°F (899°C) or cooled slowly through that range.

For optimum corrosion resistance, surfaces must be free of scale, lubricants, foreign particles, and coatings applied for drawing and heading. After fabrication of parts, cleaning and/or passivation should be considered.

Mechanical property (AMS 5568)

Solution heat treated condition
Tensile Strength: 150 KSI min (1034 MPa min)
Yield Strength(0.2% Offset): 55 KSI min(379 MPa min)
Elongation: 20% min
Hardness: HRB92 max.

After austenite conditioning and precipitation heat treated
Ultimate Tensile Strength: 180 KSI min (1241 MPa min)
Yield Strength: 150 KSI min (1034 MPa min)
Elongation: 6%min
Hardness: HRC38 max.

Heat treatment

17-7PH, in all forms, the material is furnished in the annealed condition.
Solution Heat Treatment
Tubing shall be solution heat treated by heating to1950±25°F (1066℃±14℃), holding at heat for a time commensurate with wall thickness and heating equipment and procedure used, and cooling in air or quenching in water.

After austenite conditioning and precipitation heat treating, tubing shall have the properties shown in above after being austenite conditioned by heating to 1400±25°F (760±14°C), holding at heat for 90±5 minutes, cooling to 55±5°F (13±3℃) within one hour, holding at that temperature for not less than 30

minutes, and precipitation heat treated by heating to 1050±10°F (566±6℃), holding at heat for 90±5minutes, and cooling to room temperature.

Workability

(1) Hot forming

17-7PH stainless can be readily forged, hot rolled, hot headed and upset.
For hot working, heat uniformly to 2100/2300°F (1149/1260°C). Preheating to an intermediate temperature is not required. Do not forge below 1700°F (927°C). Forging can be air cooled without danger of cracking. For maximum corrosion resistance, annealing after hot working is required.

(2) Cold Working

17-7PH stainless is readily cold worked by conventional methods. Cold working causes martensitic transformation resulting in a significant increase in magnetic permeability. Once the proper cold reduction practice has been established, it can be age-hardened.

(3) Welding and brazing

17-7PH is weldable by conventional inert gas methods. The precipitation hardening reaction in the alloy is dependent on the presence of aluminum, a reactive element. For this reason, inert gas methods are used to protect against the loss of aluminum.

As-welded 17-7PH will be substantially austenitic and will exhibit mechanical properties which are roughly equivalent to annealed (Condition A) material. The ductility of the weld eliminates the need for preheating and postweld annealing procedures required for the conventional and age hardenable martensitic alloys. To produce high strength welds, however, full post-weld heat treatment (solution annealing plus austenitic conditioning, transformation and precipitation hardening) is necessary.

(4) **Machinability**

17-7PH stainless machines similarly to Type 302, producing long, gummy chips. To protect the tools, a chip breaker is useful. Since 17-7PH work hardens rapidly, glazing can be prevented by keeping the tools cutting. Increasing the feed and reducing the speed will be helpful.

Available Process

(1) Hot formed, descaled
(2) Cold worked
(3) Cold worked and bright annealed

Common Tests

Chemical composition
Tension
Hardness
Micro structure
NDT
Surface condition
Shape and dimension
Positive Material Identification