Industeel

ArcelorMittal

VIRGO™ 17.4 PH

VIRGO™ 17.4 PH: A 17Cr 4Ni 3Cu precipitation hardening martensitic stainless steel

Alloy VIRGO™ 17.4 PH is a maraging martensitic stainless steel with Cu and Nb/Cb additions. The grade combines high strength, hardness (up to 300°C - 572°F) and corrosion resistance. Mechanical properties can be optimised with heat treatment. Very high yield strength up to 1100 - 1300 MPa can be achieved. The grade should not be used at temperatures above 300°C (572°F) 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 UR™ 304L or SOLEIL™ B4 (430). If there are potential risks of stress corrosion cracking, higher aging temperatures must be selected over 550°C (1022°F), preferably 590°C (1094°F).

The main applications are :

> mechanical components
> aerospace
> offshore industry
> food industry...

PROPERTIES

STANDARDS

> EURONORM	1.4542	X5Cr Ni Cu Nb 16-4
> ASTM	A693 Grade 630 (AMS5604B) UNS S17400	

CHEMICAL ANALYSIS - WEIGHT %

Typical values

C	Cr	Ni	Cu	Nb-Cb	Mn
.04	16.5	4.5	3.3	.3	.7

PREN (%Cr +3.3% Mo + 16%N) ≥ 17

PHYSICAL PROPERTIES

Density: 7.8 kg/dm³

Following physical properties have been obtained after hardening 480°C (896°F) - 1 hour - air cooling

Interval temperature °C (°F)	Thermal expansion (αx10^{-6} K^{-1})	T (°C)	T (°F)	Thermal conductivity (W m^{-1} K^{-1})	Young modulus E (GPa)
0-100	10.8	20	68	14	197
0-200	11	100	212	16	193
0-300	11.3	200	392	18.5	186
0-400	11.6	300	572	20	180
0-500	12	400	752	22	175
		500	932	23	170

Room temperature properties

> Resistivity 80 µΩ cm
> Specific heat 460 $J.kg^{-1}.K^{-1}$
> Tension modulus 77 Gpa

The alloy is magnetic.

Martensitic transformation - Indicative values

> Ms 130°C (266°F)
> Mf 30°C (86°F)

MECHANICAL PROPERTIES

Room temperature properties (longitudinal direction)

Guaranteed values (ASTM A693 hot rolled plates). Thickness from 5 up to 75 mm (.20" to 2.95").

Heat treatment		Y.S. 0.2%		UTS		Elongation
		MPa	ksi	MPa	ksi	%
Hardening 496 °C (925 °F) 4 h, air cooling	mini	1070	155	1170	170	8
	Typical	1207	175	1310	190	14
Hardening 593 °C (1100°F) 4 h, air cooling	mini	790	115	965	140	10
	Typical	931	135	1034	150	17

Other Hardening Heat Treatments may be applied (refer to ASTM A693). For specific request, 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 5 up to 75 mm (.20" up to 2.95")

Heat treatment Hardening 590°C (1094°F) 4h - air cooling		Yield Strength	
°C	°F	MPa	ksi
100	212	730	106
150	302	710	103
200	392	690	100
250	482	670	97
300	572	650	95

For specific request, please consult us.

Impact values - Minimum guaranteed room temperature

Minimum guaranteed values following ASTM A693 hot rolled plates - The ASTM guaranteed values are valid for a thickness from 5 up to 75 mm (.20" up to 2.95")

Heat treatment	KV transverse	
	J	ft.lb
Hardening 590°C (1094°F) 4h - air cooling	20	15

Hardness values - Minimum guaranteed room temperature

Minimum guaranteed values following ASTM A693 hot rolled plates - The ASTM guaranteed values are valid for a thickness from 5 up to 75 mm (.20" up to 2.95")

Heat treatment	Hardness	
	Rockwell	Brinell
Hardening 496°C (925°F) 4h - air cooling	C38	375
Hardening 593°C (7100°F) 4h - air cooling	C29	293

For specific request, please consult us.

IN SERVICE CONDITION

CORROSION RESISTANCE

Alloy VIRGO™ 17.4 PH withstands corrosive attack 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 550°C (1022°F), preferably 590°C (1094°F). 550°C (1022°F) is the optimum tempering temperature in chloride media. 590°C (1094°F) is the optimum tempering temperature in H_2S 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).

DELIVERY CONDITIONS

SIZE RANGE

	Quarto plates	Plates cut to length	Clad plates
Thickness	5 to 150 mm 3/16" to 6"	3 to 12 mm 1/8" to 1/2"	6 to 150 mm 1/4" to 6"
Width	Up to 3800 mm Up to 150"	Up to 2000 mm Up to 79"	Up to 3900 mm Up to 154"
Length	Up to 16000 mm Up to 52 ft	Up to 12000 mm Up to 39 ft	Up to 16000 mm Up to 52 ft

Indicative dimensional offer. Width related to thickness. For specific request, please consult.

PLATE PROCESSING

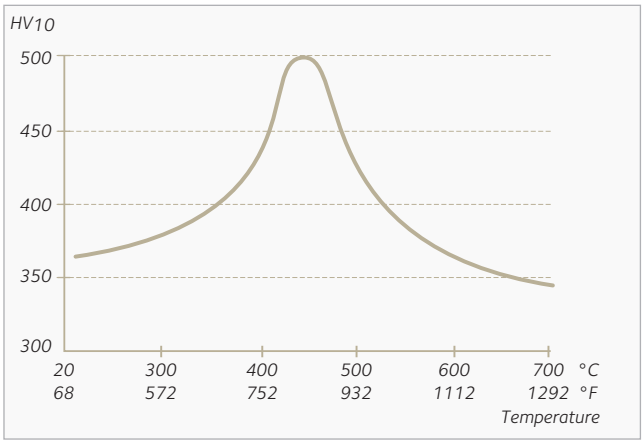
HEAT TREATMENT

Solution annealing

1050°C ±25°C (1925°F ±50°F) 30 minutes, up to 1 hour air cooling / oil quenching below 25°C (76°F)

Aging / Tempering

The highest mechanical properties are obtained with the following heat treatment : 480°C (896°F), 1 hour, air cooling. Higher ductilities are obtained when using higher aging temperatures up to 620°C (1148°F). Hardness / Temperature tempered for 4 hours after austenitizing at 1040°C (1904°F) for 30 min. quenched 100°C/sec. (212°F/sec.).



HOT FORMING

Hot forming should be carried out in a temperature range of 950-1200°C (1742-2192°F). A full heat treatment including solution annealing, cooling lower than 25°C (76°F) 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. Following processes may be performed: rolling, bending, hydroforming... (fully softened conditions).

WELDING

VIRGO™ 17.4 PH 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 thoughness 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 120°C (248°F). 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.
VIRGO™ 17.4 PH 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 VIRGO™ 17.4 PH steel are not required in the weld and in this case no post weld heat treatment must be applied.

CUTTING

Thermal cutting (plasma, thermal sawing...). 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...)

MACHINING

Alloy VIRGO™ 17.4 PH 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 lubrification are normally used. If very stringent tolerances are required, it is necessary to take into account the dimensionnal changes during heat treatment.

APPLICATIONS

> Offshore (foils, helicopter deck plateforms...)
> Food industry
> Pulp and paper industry
> Aerospace (turbine blades...)
> Mechanical components
> Nuclear container casks
> Gate valves for water industry

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