Valbruna Grade

V155

Steel type

Precipitation Hardening

Description of material

It is a martensitic precipitation hardening stainless steel with strength and good toughness comparable to standard V174 and V174LC. The mechanical properties are obtained by a solution treatment (Cond. A) that brings the Cu in solution in the Austenitic matrix followed by a rapid cooling, obtaining a super-saturated Cu martensitic structure. A re-heating (ageing) at t° = 480°C gives a maximum Hardness and resistance Rm with a low Kv impact due to a precipitation of a Cu –rich phase while at t°= 620°C this results in a higher Kv impact with a reduction of Rp0, 2 and Rm due to a progressive softening of Martensite and the formation of both Cu-globules with a loss of coherence within the matrix, and stable Austenite. It is important to know that the transformation of Austenite to Martensite is completed below 30°C and the formation of stable Austenite during aging can start to appear at the lowest aging temperature. This strongly depends on the specific chemical balance, to avoid the formation of Ferrite, thereby providing better transversal toughness.

Applications

All parts or devices where better toughness, and resistance to certain kinds of corrosion, compared to standard V174, are required. Typical applications are aircraft components, valves, large forging, shafts, chemical industry and nuclear devices.

Melting practices

AOD, AOD + ESR, AOD + VAR

Corrosion resistance

This grade has the same general resistance corrosion as 304, but better than the group of standard martensitic 400 series. However, solution treatment (cond. A) without aging should be avoided. For maximum resistance to Chloride stress corrosion cracking, it should be aged at a higher temperature, not less than 550-580°C. For Sulfide aggressive environments, aging at 620° C or overaging, is better. The same choice should be made in the case of situations or environments prone to cause H-embrittlement. It should also be noted that for this grade, as for every kind of stainless steel, surfaces should be free of contaminants and scale and passivated for optimum resistance corrosion.

Cold working

This grade has limited cold deforming capacity in the annealed condition (cond.A) due to untempered Martensite. More severe cold working requires aging at highest temperature or overaging. For restoring or increasing mechanical properties, such as Tensile Rm, a new solution treatment (cond.A) followed by a suitable aging temperature, should be done.

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Machinability

Machinability is good in both solution-treated (cond.A) and precipitation hardened conditions, considering that this property improves when hardness decreases. A certain amount of dimensional changes, in terms of contraction, happens after the aging of parts: these dimensional variations should be evaluated.

Weldability

This grade has a good weldability and doesn't normally need preheating, but welding design should be well evaluated in order to avoid situations prone to generate stress. In short, small sections could be welded in the solution treatment condition followed by an aging; large or heavy sections require a high temperature aging or overaging obviously followed by a new solution treatment (cond. A) and an aging. Autogenous high energy welding, with their typical fast cooling rates, together with high welding speeds, may cause weld solidification cracking in fused zones.

Hot working

Ingots or large forgings require a suitable preheating, in order to avoid thermal cracking. Avoid overheating (high temperatures could cause the formation of delta ferrite, jeopardizing transverse toughness) and also avoid improper cooling. Large forging bars should be equalized at 1030 -1040°C in the heating furnace prior to cooling. Both small or large forgings, rolled rings or bars must be cooled under 30°C after solution treatment (cond. A) in order to complete the transformation of martensite obtaining both a good structure and mechanical properties after aging.

Designations

AISI	XM-12
W.N.	1.4545
UNS	S15500
EN	X5CrNiCuNb15-5

Specifications

ASTM	A564

Chemical composition

Chemical element	C	Mn	Si	S	P	Ni	Cr	Cu	Mo	Ta+Nb	Nb
Minimum value %	-	-	-	-	-	3,5%	14%	2,5%	-	0,15%	5*C
Maximum value %	0,07%	1%	1%	0,03%	0,04%	5,5%	15,5%	4,5%	0,5%	0,45%	0,45%

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Heat treatment

Description of condition	Condition	Minimum temperature °C	Maximum temperature °C	Cooling
Solution Annealed	A	1025	1055	Air
Solution Annealed-Aged	H900	480	-	Air
Solution Annealed-Aged	H925	495	-	Air
Solution Annealed-Aged	H1025	550	-	Air
Solution Annealed-Aged	H1075	580	-	Air
Solution Annealed-Aged	H1100	595	-	Air
Solution Annealed-Aged	H1150	620	-	Air
Solution Annealed-Double Aged	H1150M	760 + 620	-	Air

Physical properties

Physical property	SI/metric units	US/BS Imperial units
Density	7,8 kg/dm³	0,282 lb/in³
Specific Thermal Capacity 20° C	500 J/(kg·K)	0,119 Btu/lb°F
Thermal conductivity 20° C	18,3 W/(m·K)	126,883 Btu in/ ft² h °F
Thermal expansion 20° - 100° C	11,3 (10^{-6}/K)	6,278 (10^{-6}/°F)
Electrical Resistivity 20° C	0,77 Ω·mm²/m	30,315 μΩin
Modulus of Elasticity 20° C	200 GPa	29007,548 ksi

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Mechanical properties

Condition	Subtype	HBW	Rm [N/mm²]	Rm [Ksi]	Rp0.2% [N/mm²]	Rp0.2% [Ksi]	E4d [%]
Solution Annealed	A	363 max.	-	-	-	-	-
Solution Annealed-Aged	H900	388 min.	1310 min.	190 min.	1170 min.	170 min.	10 min.
Solution Annealed-Aged	H925	375 min.	1170 min.	170 min.	1070 min.	155 min.	10 min.
Solution Annealed-Aged	H1025	331 min.	1070 min.	155 min.	1000 min.	145 min.	12 min.
Solution Annealed-Aged	H1075	311 min.	1000 min.	145 min.	860 min.	125 min.	13 min.
Solution Annealed-Aged	H1100	302 min.	965 min.	140 min.	795 min.	115 min.	14 min.
Solution Annealed-Aged	H1150	277 min.	930 min.	135 min.	725 min.	105 min.	16 min.
Solution Annealed-Double Aged	H1150M	255 min.	795 min.	115 min.	515 min.	75 min.	18 min.

Hot working

Condition	Minimum temperature °C	Maximum temperature °C	Cooling
Forging / Hot Rolling	1000	1150	Air

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