Valbruna Grade

VAL4

Steel type

Martensitic Stainless Steel

Description of material

This martensitic stainless steel exhibits high tensile properties combined with a fair ductility and better corrosion resistance than the common martensitic type 400 series steels thanks to its higher Chromium and Nickel contents. In general, its corrosion resistance is lower than that of type 300 series steels, even if in certain environments it could offer the same performance.

Applications

Every use where high mechanical properties together with fair values of impact (toughness) and corrosion resistance are necessary, such as dive blades, compressors, pumps, turbines, valves in the oil and gas industries, pump shafts, axles , suspensions, bolting, separation technologies, fasteners, propeller shafts , spindles, homogenizers and centrifuges.

Melting practices

EAF + AOD

Corrosion resistance

Any amounts of untempered martensite must be avoided. Best resistance to either intergranular or stress corrosion is obtained when this grade is in the hardened + tempered or double tempered condition. It’s important to point out that the surface of every kind of stainless steel should be free of contaminants, heat tint, scale and passivated for optimum resistance corrosion.

Cold working

Due to high resistance and hardness even in the tempered condition, this grade is not suitable for cold forming operations such as cold heading. A certain mediocre cold formability could be obtained after a very long lasting annealing and very slow cooling in the furnace.

Machinability

Is not as good as typical martensitic 400 grades due to its tendency to generate build up edge and long chips. A slight micro - resulphuring could reduce the gap. Depending on final specific use, a stress relieving after heavy machining process could be useful to avoid deformation of parts. However, it’s important to know that the productivity gain depends on type of machines used, the kind of tools used and their geometry, cutting fluids and the kind of machine operations on the pieces produced.

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Weldability

This process for martensitic stainless grades is always risky and a special care must be applied in the choice of welding parameters. In any case, if a welding process were required, a preheating is mandatory and the part must be maintained at temperature and followed by immediate annealing or tempering. Fillers of same or close compositions can be used to obtain mechanical properties close to that of the base metal. Alternatively, austenitic fillers may be used considering an inevitable reduction of these properties. In solid state joining such as Friction Welding, VAL4 provides a quality bond line. When friction welded with different grades, a tempering or annealing of the welded piece must be done in order to soften the martensitic structure of HAZ and bond line.

Hot working

Blooms and ingots require a suitable preheating to avoid cracks and a slow cooling in furnace after forging. Overheating must always be avoided in order to reduce the risk of internal bursts and to form a certain amount of ferrite. An improper cooling could result in stress cooling cracks. Large forgings and large cross – section shapes should be left to cool until their core reaches room temperature and, then, immediately, heat treated. A right and suitable heat treatment of pieces after the forging process creates a structure with no or little retained austenite avoiding delayed cracking.

Heat treatment

VAL4 should be double tempered after hardening. Double tempering is not normally used in dive knives where a single one could be sufficient. In any case, depending on required mechanical properties and specific utilizations of final products, quenching and tempering temperatures must be well evaluated in order to optimize impact strength values rather than higher tensile. Obviously, avoiding also those temperatures ranges able to reduce impact properties and corrosion resistance.

Designations

AISI	431
W.N.	1.4057
UNS	S43100
EN	X17CrNi16-2

Specifications

EN	10088-3 / 10272
ASTM	A276 / A479
ASME	SA276 / SA479

Chemical composition

Chemical element	C	Mn	Si	P	S	Cr	Ni
Minimum value %	0,12%	-	-	-	-	15%	1,5%
Maximum value %	0,2%	1%	1%	0,04%	0,03%	17%	2,5%

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VALBRUNA GROUP
SYNERGIES FOCUSED ON THE FUTURE

Heat treatment

Description of condition	Condition	Minimum temperature °C	Maximum temperature °C	Cooling
Annealed	A	680	800	Furnace / Air
Hardened	H	950	1050	Air
Tempered	T	650	800	Air

Physical properties

Physical property	SI/metric units	US/BS Imperial units
Density	7,7 kg/dm^3	0,278 lb/in^3
Specific Thermal Capacity 20° C	460 J/(kg·K)	0,11 Btu/lb°F
Thermal conductivity 20° C	25 W/(m·K)	173,337 Btu in/ ft^2 h °F
Thermal expansion 20° - 100° C	10 (10^{-6}/K)	5,556 (10^{-6}/°F)
Electrical Resistivity 20° C	0,7 $\Omega \cdot mm^2/m$	27,559 µΩin
Modulus of Elasticity 20° C	215 GPa	31183,114 ksi

Mechanical properties

Condition	Subtype	Rm [N/mm^2]	Rm [Ksi]	HBW	Rp0.2% [N/mm^2]	Rp0.2% [Ksi]	A5D [%]
Annealed	A	950 max.	138 max.	280 max.	-	-	-
Hardened and Tempered	QT800	880 - 1080	128 - 157	321 max.	690 min.	100 min.	12 min.

Hot working

Condition	Minimum temperature °C	Maximum temperature °C	Cooling
Forging / Hot Rolling	800	1100	Air

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