Valbruna Grade

VAL2/DE

Steel type

Martensitic Stainless Steel

Description of material

VAL2/DE is a Chromium martensitic stainless with a medium/high Carbon content able to give a high hardness after heat treatment together with a moderate corrosion resistance. This grade is designed for cutlery production and is processed by a special steel making operative practice, including a particular chemical balance and a specific heat treatment in order to obtain a suitable structure with a good polishability or mirror-like finishing capability.

Applications

VAL2/DE is widely used where high hardness and corrosion resistance are indispensable, such as table cutlery, kitchen knives and dental and surgical instruments. This grade, after hardening and tempering, provides a hardness higher than VAL2B.

Melting practices

EAF + AOD

Corrosion resistance

The corrosion resistance of VAL2/DE is at its maximum when hardened and low temperature tempered at its maximum hardness. Its use in the annealed condition (i.e. cutlery with an annealed handle) or any other situation able to reduce the surface hardness (i.e. the back and surface of knives or the serrated cutting edge of blades overheated by grinding) should be resolutely avoided. It's important to point out that the corrosion resistance of this grade is strongly dependent on the care in manufacturing. In addition, it should be considered that the blades or knives of the martensitic steel VAL2/DE are made to give a compromise between corrosion resistance and cutting edge properties and cannot compete with the austenitic steel of spoons and forks in terms of pitting and general corrosion resistance. In any case, a few simple precautions can be carried out to maintain blades and knives in good condition, keeping them free of stains and pitting. This means care to avoid prolonged immersion in salt water, vinegar or vinegar with salt or to maintain cutlery in contact with water containing certain levels of chlorides and chlorine for a long time. It's important to remember that salt and disinfectants are corrosive and strongly increase the corrosive effect of water, particularly hot water, where pits and stains can quickly form. Rainbow colored stains are usually caused by detergents, grease and juices and could be removed by rubbing with a non-abrasive polishing paste. The same operation can be done in the case of isolated micro pits that, if not removed, could generated wider rust stain zones. In the case of blades with silver handles, the tarnish remover must never be in contact with the blade and immediately washed in case of contamination. As a rule, when a dishwasher is used for washing, knives should not be left in a damp environment overnight and cycles such as "rinse and hold" should be avoided. In the manufacturing of blades and knives, an immediate washing must be done after the grinding process in order to completely remove /wash away cutting fluids that are strongly corrosive and prime a rapid pitting if left on the surface of pieces.

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Cold working

In the annealed condition, VAL2/DE is suitable for cold forming. Knives or blades can be shaped by cold rolling or cold drop forging of pickled wire rods or bars. In the case of warm working, the temperature should be well evaluated. Attention should be paid to avoid that a significant increase in temperature caused by plastic deformation of drop pieces exceeds critical points Ac1 or Ac3 entering in austenitic field. On cooling, the austenite will transform to martensite, causing cracking to happen in the flash line zones during deburring operations. When grinding and polishing knives, excessive surface heating can create a significant reduction of corrosion resistance, or grinding cracks, in the serrated edge of blades.

Machinability

Micro-resulphured VAL2/DE in the annealed condition and in the high temperature tempered after hardening condition offers a good machinability. It's important to know that the productivity gain depends on the type of machines used, the kind of tools used and their geometry, cutting fluids and the kind of machine operations on the pieces produced. Grinding and polishing of hardened + tempered material at maximum values of hardness must be carried out with great care in order to avoid the overheating of the surface of the piece resulting in poor corrosion resistance and/or grinding cracks.

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 the same composition 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, VAL2/DE 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

VAL2/DE can be readily forged but it's important to remember that, as with all the martensitic grades, it easily hardens if air cooled and is prone to cracking in the case of a delayed annealing operation or where there is an improper cooling rate. In addition, overheating must be always avoided because a large amount of scale, with a deep layer of decarburization and cracks may form. An accurate choice of heating and forging parameters will produce a good morphology of structures after the hardening and tempering of blades.

Heat treatment

Double tempering may be useful for some kinds of professional blades but is not normally used in table cutlery production where a single one should be sufficient. It's recommended to choose temperatures of heat treatment able to offer a compromise between maximum hardness and impact strength together with a good corrosion resistance. Temperatures and soaking times should be accurate, in order to avoid coarse grains and surface decarburization. VAL2/DE, due to its higher Carbon content, is prone to generate more decarburization than VAL2ACT.

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Designations

W.N.	1.4034
EN	X46Cr13

Specifications

EN	10088-3

Chemical composition

Chemical element	C	Mn	Si	P	S	Cr
Minimum value %	0,43%	-	-	-	-	12,5%
Maximum value %	0,5%	1%	1%	0,04%	0,03%	14%

Heat treatment

Description of condition	Condition	Minimum temperature °C	Maximum temperature °C	Cooling
Annealed	A	750	850	Furnace / Air
Hardened	H	950	1050	Air
Tempered	T	650	700	Air

Physical properties

Physical property	SI/metric units	US/BS Imperial units
Density	7,7 kg/dm³	0,278 lb/in³
Specific Thermal Capacity 20° C	460 J/(kg·K)	0,11 Btu/lb°F
Thermal conductivity 20° C	30 W/(m·K)	208,004 Btu in/ ft² h °F
Thermal expansion 20° - 100° C	10,5 (10^{-6}/K)	5,833 (10^{-6}/°F)
Electrical Resistivity 20° C	0,55 Ω·mm²/m	21,654 μΩin
Modulus of Elasticity 20° C	215 GPa	31183,114 ksi

Mechanical properties

Condition	Subtype	Rm [N/mm²]	Rm [Ksi]	HBW	Rp0.2% [N/mm²]	Rp0.2% [Ksi]	A5D [%]
Annealed	A	800 max.	116 max.	245 max.	-	-	-
Hardened and Tempered	QT800	800 - 1000	116 - 145	-	650 min.	94 min.	10 min.

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Hot working

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

Typical Hrc hardness values of VAL2DE with C= 0,45% and Cr=13,5%

Fully hardened			Tempered at 180 C° x 3 hours		
Temp. C°	**oil**	**air**	**Temp. C°**	**oil**	**air**
1000	58	53	**1000**	54	53
1020	60	58	**1020**	57	56
1040	62	60	**1040**	59	58
1060	63	62	**1060**	60	59

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