

416 Stainless Steel Bar

Steel Type - Martensitic



VAL1Z is the oldest and most popular free machining martensitic stainless steel, with a Carbon content capable of producing a suitable value of hardness after heat treatment, together with a very good machinability, and is widely used in automatic machining industries.

DESIGNATIONS

VALBRUNA	VAL1Z
AISI	416
W.N.	1.4005
UNS	S41600
EN	X12CrS13
BS	416S21

SPECIFICATIONS

ASTM	A582
EN	10088-3

CHEMICAL COMPOSITION

CHEMICAL ELEMENT	C	Mn	Si	P	S	Cr	Mo
MINIMUM VALUE %	0.08%	-	-	-	0.15%	12%	-
MAXIMUM VALUE %	0.15%	1.25%	1%	0.04%	0.3%	14%	0.6%

APPLICATIONS

All applications where moderate hardness with a moderate corrosion resistance are indispensable, such as parts of pumps, pump shafts, gears, wear resistant devices, bolts, nuts, valves stems and shaftings. VAL1Z, in the hardened and low temperature tempered condition, provides a hardness matching that of VAL1. This grade is not recommended for applications in pressure vessels and shouldn't be used for high polishability or mirror finishing processes.

MACHINABILITY

VAL1Z has the good machinability typical of martensitic free machining grades. Productivity gain depends on the types of machines, the kind of tools used and their geometry, cutting fluids and the kind of machine operations on the pieces produced. As in general rule, machinability depends on either Sulphur content or hardness in addition to a suitable structure of bars or shapes.

MECHANICAL PROPERTIES

CONDITION	SUBTYPE	HBW
Annealed	A	262 max.
Hardened and Tempered	H+T	248 - 302

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	30 W/(m·K)	208.004 Btu in/ ft ² h °F
Thermal expansion 20° - 100° C	10.5 (10 ⁻⁶ /K)	5.833 (10 ⁻⁶ /°F)
Electrical Resistivity 20° C	0.6 Ω·mm ² /m	23.622 μΩin
Modulus of Elasticity 20° C	215 GPa	31183.114 ksi

HEAT TREATMENT

Description of condition	Condition	Minimum temperature °C	Maximum temperature °C	Cooling
Annealed	A	750	825	Air
Hardened	H	950	980	Air
Tempered	T	595	-	Air

HOT WORKING

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

WELDABILITY

VAL1Z is not recommended for both fusion and friction welding.

CORROSION RESISTANCE

It should be well considered that, as with all free machining grades, Sulphur is added to improve machinability, and the formation of MnS inclusions could prime points of pitting if exposed to some corrosive environments. VAL1Z has a good resistance to mildly corrosive environments such as fresh water, crude oil, gasoline, alcohol, some beverages and atmospheres. VAL1Z has its maximum corrosion resistance when hardened + low temperature tempered to its maximum hardness. Its use in the annealed condition or any other situation able to reduce the surface hardness, and in environments containing Chloride, should be avoided. Nevertheless, in case if VAL1Z were used in the annealed condition, it should be considered that its corrosion resistance will depend on the corrosive capacity of the environment. This means that the annealed condition wouldn't be so detrimental in atmospheric corrosion, or only slightly reduced in mild aqueous environments. It should be noted that this grade, as for every kind of stainless steel, surfaces should be free of contaminant and scale, heat tint, and passivated for optimum resistance to corrosion.

COLD WORKING

In the annealed condition, this grade is not suitable for cold heading and up-setting due to the embrittlement effect of the Sulphur content, and it has not been specifically designed for cold forming and is usually supplied as cold finished round, hexagonal and square bars for machining processes. Blooms or large cross section billets can be cut by band and circular saw or abrasive wheel. If small billets or bars had to be cut by cold shearing paying attention on low temperatures and to the clearance of tools, because this process may cause shear or stress cracks due to the Sulphur embrittled structure.

HOT WORKING

VAL1Z has not been designed for hot working and is usually supplied as cold finished round, hexagonal and square bars for machining processes. It's important to know that all free machining grades, particularly Martensitic ones, have a poor hot plasticity and this characteristic must be well evaluated in forging processes. Blooms and ingots require a suitable preheating to avoid cracks and a slow cooling in the furnace after forging. Overheating must always be avoided, in order to reduce the risk of internal bursts. 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.

HEAT TREATMENT

Depending on thickness, geometry and required mechanical properties of parts, VAL1Z could be air or oil hardened. The choice of quenching method depends on the thickness, shape and geometry of pieces and their metallurgical-mechanical requirements as well. The tempering temperature has to be chosen in order to offer the best properties, avoiding those ranges of temperatures and cooling rates able to cause a strong reduction of toughness and resistance. It's important to point out that high tempering or annealing temperatures impair the corrosion resistance of all martensitic grades.

MELTING PRACTICES

EAF+AOD