Valbruna Grade

AN5

Steel type

Corrosion Resistant Alloys

Description of material

AN5 is a high Nickel–Chromium–Molybdenum-Titanium and Aluminum precipitation hardening austenitic stainless steel with good general corrosion resistance as well as oxidation resistance at high temperatures. This grade has been designed in order to offer a good cold deforming and cold head ability thanks to an exact chemical balance and high level of strength both at room temperature and at high temperatures after solution treatment and aging heat treatment.

Applications

AN5 is suitable for the fabrication of many products such as bolting/fasteners in automotive engines, gas turbines, nozzles, exhaust parts and in any kind of device where a high temperature resistance and creep resistance are indispensable requirements.

Corrosion resistance

AN5 provides a very good resistance to oxidation at temperatures up to 690°C. In addition, this grade is resistant to fresh water, many organic chemicals and inorganic compounds, atmospheric corrosion, rural applications and sterilizing solutions where the chloride content is low. Pitting and crevice corrosion may occur in chloride environments if concentration, pH and temperature are at determinate levels. 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

AN5 offers a higher cold working hardening factor compared to typical austenitic grades designed for cold heading. AN5 is usually supplied in different conditions such as: (1) annealed + pickled (2) annealed + pickled and special mill coating (3) annealed + cold drawn with some kind of mill coating and ready to be entered in the header (4) annealed + cold drawn + protective atmosphere annealed + mill coated ready for cold heading with or without sizing operations before entering in the header. It should be noted that, as with all hot rolled wire rod surfaces, conditions (1) and (2) offer a higher surface roughness compared to other ones. It is useful to point out that AN5 cannot be cold headed in the aged condition due to its high strength.

Machinability

AN5 has a poor machinability due to its high Nickel content and low Sulfur content if compared to typical Austenitic grades. The best performance is obtained when employing the correct machining parameters while using multi spindle and automatic screw machines and it requires more rigid and powerful machines in addition to the correct choice of tools, coatings and cutting fluids. This grade can be machined in the aged condition or in the solution treated condition.

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The company reserves the right to alter any details without any prior notice.

Weldability

AN5 is a difficult to weld steel alloy. When welded, this grade solidifies entirely as Austenite and is susceptible to weld hot cracking and suffers from both HAZ micro-fissuring and FZ hot cracking. This behavior in FZ is caused by a low melting point eutectic in the grain boundaries while in HAZ is associated with a liquation which allows the boundaries to separate under the welding stresses. In any case, a correct welding procedure could prevent these kinds of cracking. Postweld Heat Treatments (PWHT) of autogenous and filler metals welding are suggested to obtain good mechanical properties after aging. Stud welding of bolts offers acceptable results if a correct operative practice is applied and good mechanical properties could be obtained after an aging heat treatment.

Hot working

AN5 is usually supplied in wire or wire rod for cold heading processes. In any case, it has a good hot plasticity and is suitable for processing by hot extrusion or by upsetting with electric resistance heating. This grade can be hot headed but it's important to point out that its forging temperature is lower than that of typical austenitic stainless steels. Because this grade has hot high hardness, overheating must be always avoided. The choice of hot working temperature and process parameters must always evaluate both the strain rate and the consequent increasing of temperature that is reached after hot deformation. High strain rates and temperatures at the top of the range during the hot forming process, could generate structural loss of cohesion or internal bursts of the stems of bolts. Small forged pieces could be rapid quenched in air or water cooled but a solution treatment must be done before aging processes in order to obtain required mechanical properties.

Heat treatment

AN5 should be always used in solution treated + aged. Two kind of heat treatment are normally applied and this choice depends on mechanical properties required.

Designations

Commercial name	Alloy 660 / Alloy A286
International Designation	X6NiCrTiMoVB25-15-2
W.N.	1.4980
UNS	S66286

Specifications

ASTM	A453 / A638
EN	10269 / 10302
AMS	5731 / 5732 / 5734 / 5737

Chemical composition

Chemical element	C	Mn	Si	P	S	Cr	Mo	Al	Ti	Ni	Cu	V	B	Co
Minimum value %	-	-	-	-	-	13.5%	1%	-	1.9%	24%	-	0.1%	0.003%	-
Maximum value %	0.08%	2%	1%	0.025%	0.025%	16%	1.5%	0.35%	2.3%	27%	0.5%	0.5%	0.01%	1%

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Heat treatment

Description of condition	Condition	Minimum temperature °C	Maximum temperature °C	Cooling
Solution Annealed cl. A/type 1	A	886	914	Liquid Quench
Solution Annealed cl. B/type 2	A	966	994	Liquid Quench
Aged	PH	706	734	Air

Physical properties

Physical property	SI/metric units	US/BS Imperial units
Density	7.91 kg/dm³	0.286 lb/in³
Specific Thermal Capacity 20° C	460 J/(kg·K)	0.11 Btu/lb°F
Thermal conductivity 20° C	15 W/(m·K)	104.002 Btu in/ ft² h °F
Thermal expansion 20° - 100° C	16.5 (10^{-6}/K)	9.167 (10^{-6}/°F)
Electrical Resistivity 20° C	0.91 Ω·mm²/m	35.827 μΩin
Modulus of Elasticity 20° C	201 GPa	29152.585 ksi

Mechanical properties

Condition	Subtype	Rm [N/mm²]	Rm [Ksi]	Rp0.2% [N/mm²]	Rp0.2% [Ksi]	E4d [%]	HBW
Solution Annealed	A	580 min.	84 min.	260 min.	38 min.	40 min.	-
Solution Annealed and Aged	A + PH	895 min.	130 min.	585 min.	85 min.	15 min.	248 - 341

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