Valbruna Grade

AV718HTV

Steel type

Corrosion Resistant Alloys

Description of material

AV718HTV is an age hardening Nickel - Chromium - Iron - Molybdenum alloy with the additions of Niobium, Titanium and Aluminum that provide its strengthening by an aging heat treatment enable to generate a precipitation hardening of secondary phases such as ϒI and ϒII. AV718CRV and AV718HTV have basically same chemical composition and differ only by their heat treatments and are produced by special steel making remelting such as VIM-VAR-ESR.

Applications

The structure and composition of AV718HTV offers high strength together with corrosion resistance properties in both oxidizing and reducing environments. These characteristics provide a good resistance to differing kinds of corrosion, such as pitting, crevice and stress corrosion cracking as well. AV718HTV is widely used in sour gas application due to its resistance to SSC caused by Hydrogen Sulphide, in petrochemical industries, in crude oil and natural gas components and in drilling equipment for oil and gas production. It is suitable for the fabrication of many products such as flanges, valves, bolting, pump shafts, turbine blades, fittings and parts working in corrosive environments typical of chemical processing. Moreover, AV718HTV is widely used in aeronautics and aerospace components and devices working in high or cryogenic temperature and in several application where a good creep and fatigue resistance are important and indispensable requirements.

Corrosion resistance

AV718HTV is resistant to several organic chemicals and inorganic compounds, atmospheric corrosion and marine environments. This grade is resistant to uniform corrosion providing a high resistance to Chloride-induced stress corrosion cracking and an outstanding pitting corrosion resistance. In sour gas application, this alloy offers a good resistance to Hydrogen embrittlement typical of Hydrogen Sulphide environments. All these properties against pitting and crevice corrosion are obtained by the Chromium and Molybdenum contents while the high Nickel provides the resistance against the SCC. The high mechanical properties can only be reached by an ageing heat treatment. It should be noted that AV718HTV, as for every kind of stainless steel, surfaces should be free of contaminant and scale, heat tint and surface finishing for optimum resistance to corrosion.

Cold working

AV718HTV can fabricated by cold working operations such as cold drawing and bending, but should not be used for a large amount of cold heading, because its chemical balance does not allow it to obtain a soft strain hardened structure after cold deformation. In any case, cold processes shall be carried out in the annealed condition, avoiding high levels of cold working, applying an intermediate annealing if necessary. Obviously, high cold deformation in the aged condition should be avoided. However, after cold working, this grade should be solution annealed before the aging hardening, depending on final use. Cold working doesn’t increase its magnetic permeability as compared to type 316 and similar steels.

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Machinability

AV718HTV has the typical machinability of strengthened austenitic structures not micro-resulphured and some difficulties could happen in drilling, turning, threading and milling processes due to its capacity to work harden combined with low chip-ability. Operators should know that this grade requires more rigid and powerful machines, in addition to the correct choice of tools, coating carbides and cutting fluids. AV718HTV has a high hardening factor and the knowledge of this behavior must be correctly considered when a piece requires two or several cutting steps to be finished. The cold worked layer caused by the cutting tool is hard and, if the subsequent turning or milling processes work on this hardened layer, a rapid tool wear could happen. The tool must work under this layer. Some improvement could be obtained by dissipating heat using an appropriate and large amount of cutting fluids and tools with a correct edge geometry with a suitable chip breaker. This is particularly important when using multi - spindle and automatic screw machines. This alloy can be machined in the solution treatment or aged condition but it is recommended to machine in the solution treatment condition for less tool wear and to make finishing operations after age hardening. A correct choice of both cutting fluids and a right dimension of chip breakers helps to reduce the typical machining difficulties of this alloy.

Weldability

AV718HTV can be welded in the annealed or age hardened condition by using any one of the welding processes employed with typical austenitic grades but requires some different welding process evaluations when compared to these ones. Correct welding practices such as right heat inputs, inert shielding gas and cleanliness before/after welding must be followed to obtain best results in terms of corrosion resistance. In the case of high energy autogenous welding processes, there could be some risk of hot cracking in the fused zone. Therefore, AV718HTV requires special filler metals to obtain a high corrosion resistance together with high strength and toughness of the weld. No preheating or post welding heat treatment are normally necessary but it’s important to point out that better properties are obtained by a new annealing after welding and then aging. In the case of welding in the aged condition, the structure of HAZ will be softer than the age hardened one and is not so prone to cracking, permitting weld repair. The weld discoloration should be removed by acid pickling or, at least, by mechanical pickling (shot blasting or grinding) if it were impossible to perform the first one.

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Hot working

AV718HTV 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 range is less wide than that of typical austenitic stainless steels. In any case, overheating must be always be 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 during the 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. Good rules impose that in Primary hot transformation processes, a high temperature homogenization with a long-lasting soaking of cast ingots and dynamic recrystallization parameters should be rightly evaluated. It's important to point out that the homogenization is a diffusion controlled process for reduce micro-segregations of elements and should be well considered in terms of grain size and complete or acceptable dissolution of segregations. However, in the case of open die forging of large ingots and shapes, AV718HTV offers a good hot plasticity if a suitable soaking and a right temperature are applied. In Secondary hot transformation processes, such as extrusion, rolling or close die forging, temperatures, strain and strain rate should be well evaluated. Suitable strain in terms of section reduction (for instance: 20-30%) at lower range of hot working temperature is recommended especially in case of open – die forging. For close die forging, at least 15% could be acceptable. This practice is suggested in order to obtain a fine grain structure which is very important for mechanical, fatigue and corrosion resistance properties and make it easier for ultrasonic testing to detect small indications as required by several International Norms. Forgings can be cooled in air but a solution annealing should be performed before aging for the best results in terms of resistance corrosion and uniform mechanical properties even if a fast air cooling followed by direct aging may offer acceptable mechanical properties according to specific applications. Two kinds of heat treatment are normally applied to forgings: the choice between each to other depends of product final use. In short, these heat treatments differ by solution annealing temperature while the aging process is substantially the same for both. The high temperature annealing offers a better combination of impact-strength and cryogenic properties while the lower temperature annealing creates the best tensile and stress rupture properties, together with a better fatigue resistance, thanks to the fine grain usually obtained with this heat treatment.

Designations

Commercial name	Alloy 718
International Designation	NiCr19Fe19Nb5Mo3 / NiCr19NbMo
W.N.	2.4668
UNS	N07718

Specifications

ASTM	B637
ASME	SB637
AMS	5662 / 5663

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Chemical composition

Chemical element	C	Mn	Si	S	P	Ni	Cr	Fe	Al	Cu	Ti	Al	Co	Ta+Nb	B	Pb	S
Minimum value %	-	-	-	-	-	50%	17%	15%	2.8%	-	0.65%	0.2%	-	4.75%	-	-	-
Maximum value %	0.08%	0.35%	0.35%	0.015%	0.015%	55%	21%	21%	3.3%	0.3%	1.15%	0.8%	1%	5.5%	0.006%	0.001%	0.00

Heat treatment

Description of condition	Condition	Minimum temperature °C	Maximum temperature °C	Cooling
Solution Annealed	A	924	1010	Water
Aged	PH	718	760	Air

Physical properties

Physical property	SI/metric units	US/BS Imperial units
Density	8.2 kg/dm³	0.296 lb/in³
Specific Thermal Capacity 20° C	440 J/(kg·K)	0.105 Btu/lb°F
Thermal conductivity 20° C	13 W/(m·K)	90.135 Btu in/ ft² h °F
Electrical Resistivity 20° C	1.23 Ω·mm²/m	48.425 µΩin
Modulus of Elasticity 20° C	205 GPa	29732.736 ksi

Mechanical properties

Condition	Subtype	Rm [N/mm²]	Rm [Ksi]	Rp0.2% [N/mm²]	Rp0.2% [Ksi]	E4d [%]	HBW
Solution Annealed and Aged	A + PH	1276 min.	185 min.	1034 min.	150 min.	12 min.	330 min.

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