AEROVAL®

Aerospace special grades

ACCIAI E LEGHE SPECIALI PER APPLICAZIONI AEROSPAZIALI

Aerospace special grades

ACCIAIERIE VALBRUNA

Acciai e leghe speciali per applicazioni aerospaziali

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Vicenza plant

Bolzano plant

Fort Wayne, (IN) plant

Valbruna, fondata nel 1925 e leader nel campo dei prodotti lunghi in acciaio inossidabile e leghe di nichel, è oggi presente sul mercato con una produzione di titanio e acciai speciali per applicazioni aerospaziali.

Valbruna founded in 1925 and leader in the production of long products in stainless steel and nickel alloys, presents also a selected range of titanium products and special steels for Aerospace applications.

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ACCIAIERIE VALBRUNA
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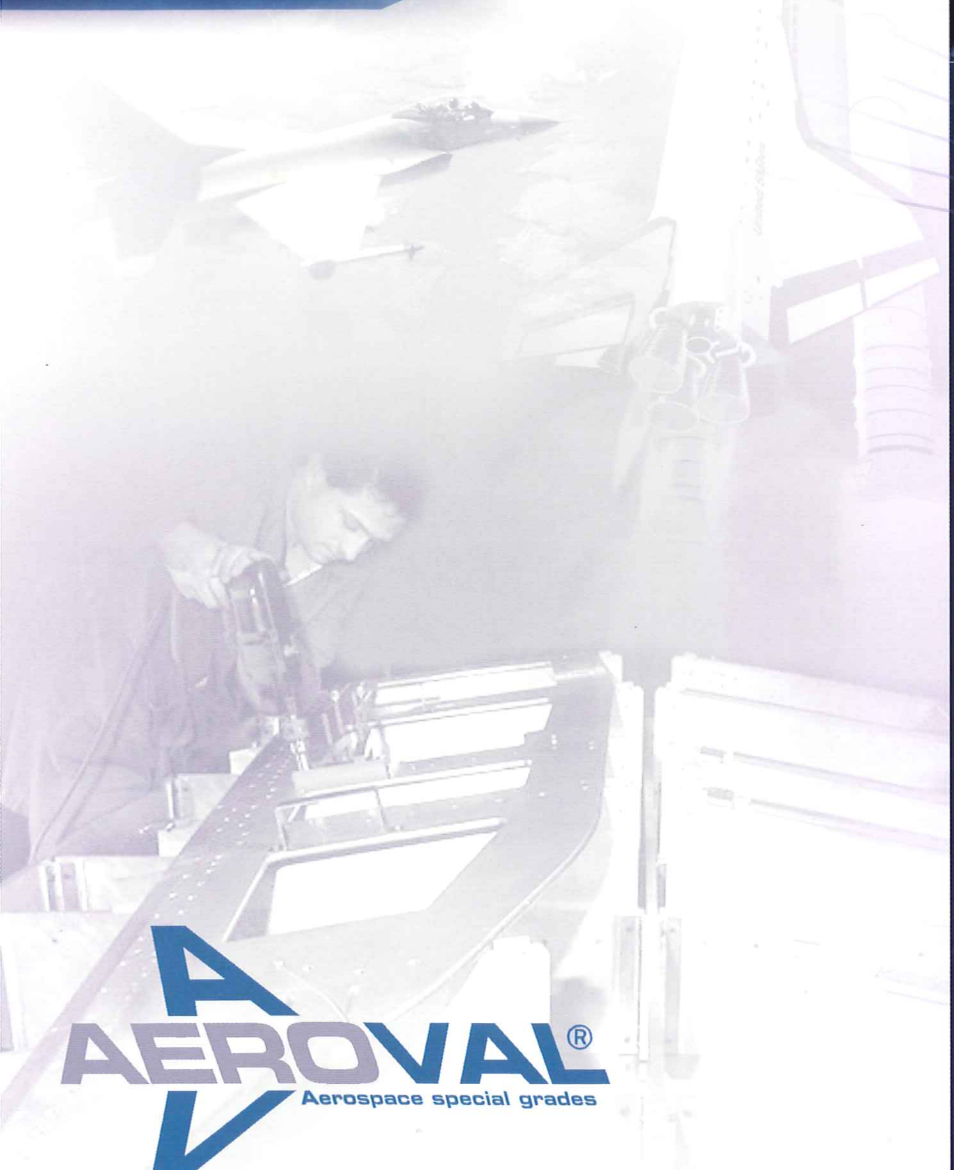
ACCIAIERIE VALBRUNA
VIALE DELLA SCIENZA, 25 36100 VICENZA ITALY
Tel. +39 (0)444 968211 Fax +39 (0)444 963836
www.acciaierie-valbruna.com
e-mail: info@valbruna.it
e-mail: special.products@valbruna.it

AEROVAL AISC

ACCIAIERIE VALBRUNA



AEROVAL®
Aerospace special grades

MATERIAL DESCRIPTION

Austenitic Stainless Steel stabilized by the addition of Columbium. Mechanical properties can be increased by cold working only. AISC exhibits good intergranular corrosion resistance.

APPLICATIONS

AISC can be used for aircraft components as collector rings, exhaust manifolds, expansion joints. Generally AISC is used for applications subjected to intermittent heating from 450° and 800°C as: fireproof bulkhead, pressure vessels, welded structures, high-temp. chemical processing and gas turbine blades.

CORROSION AND OXIDATION RESISTANCE

Because of the Columbium addition capable to enhance the intergranular corrosion resistance, AISC can be used for many different applications as chemical and oil processing, textile manufacturing and food industry.
AISC provide a good resistance to scale formation up to 860°C .

WELDABILITY

AISC can be welded. If filler metal is requested AWS E/ER347 should be used. Post-weld heat treatment is not strictly needed unless high temperature service is required.

DESIGNATIONS

AISI	AECMA	UNS	AFNOR	EN
347	FE-PA 14/ FE-PA 3701	S34700	Z6CNNb18 - 10	X6CrNiNb18-10/1.4550/1.4546

CHEMICAL COMPOSITION (chemistry shall conform to the following percentages by weight)

Element	Fe	C	Mn	Si	P	S	Cr	Ni	Cb	Cu	Mo
Min[%]	Bal.	-	-	-	-	-	17.00	9.00	10xC	-	-
Max[%]		0.08	2.00	1.00	0.045	0.015	19.00	12.00	1.00	-	-

PHYSICAL PROPERTIES

Density (gr/cm³ at 20°C)	7,90		
Modulus of elasticity (GPa)	200		
Mean Coefficient of Thermal Expansion (10^{-6}/°C)	20°→ 200°C: 16.50	20°→ 400°C : 17.50	20°→ 500°C : 18.0
Thermal Conductivity (W/mK at 20°C)	15.0		
Electrical resistivity ($\mu\Omega\times$m at 20°C)	0,740		
Magnetic Permeability	Non-magnetic		

AEROVAL AISC

MECHANICAL PROPERTIES

Condition	HB	Ultimate Tensile Strength (N/mm²)	0.2% Yield Strength (N/mm²), min	Elongation [5D] (%), min
Annealing	220 max	500 - 750	205	40

HEAT TREATMENTS

Condition	Temperatures	Soaking times	Cooling
Annealing	1000°-1080°C	Commensurate to section	Water

HOT WORKING

Process	Heating temperatures	Cooling
Forging	900°-1150°C	Air

SPECIFICATIONS

ASTM	FEDERAL STANDARDS	EN	AMS
A182, A276, A479, A580	QQ-S-763	10088 - 3; 10272	5646

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e-mail: info@valbruna.it
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AEROVAL AIST

ACCIAIERIE VALBRUNA

MATERIAL DESCRIPTION

Austenitic Stainless Steel stabilized by the addition of Titanium. Since this grade is an austenitic one, it can not be precipitation hardened; mechanical properties can be increased by cold working only. AIST exhibits good intergranular corrosion resistance.

APPLICATIONS

AIST can be used for aircraft components as collector rings, exhaust manifolds, expansion joints. Generally AISC is used for applications subjected to intermittent heating from 450° and 900°C as: pressure vessels, welded structures, high-temp. chemical processing and gas turbine blades.

CORROSION AND OXIDATION RESISTANCE

Because of the Titanium addition capable to enhance the intergranular corrosion resistance, AIST can be used for many different applications as chemical and oil processing, textile manufacturing and food industry.
AIST provide a good resistance to scale formation up to 860°C.

WELDABILITY

AIST can be welded. If filler metal is requested AWS E/ER347 should be used. Post-weld heat treatment is not strictly needed unless high temperature service is required.

DESIGNATIONS

AISI	AFNOR	UNS	AECMA	EN
321	Z6CNT18-10	S32100	FE-PA 13/FE-PA 3601	X6CrNiTi18-10/1.4541/1.4544

CHEMICAL COMPOSITION (chemistry shall conform to the following percentages by weight)

Element	Fe	C	Mn	Si	P	S	Cr	Ni	Ti	Cu	Mo
Min[%]	Bal.	-	-	-	-	-	17.00	9.00	5xC	-	-
Max[%]		0.08	2.00	1.00	0.045	0.030	19.00	12.00	0.70	-	-

PHYSICAL PROPERTIES

Density (gr/cm³ at 20°C)	7,90		
Modulus of elasticity (GPa)	200		
Mean Coefficient of Thermal Expansion (10^{-6}/°C)	20° → 200°C: 16.5	20° → 400°C : 17.5	20° → 500°C : 18.0
Thermal Conductivity (W/mK at 20°C)	15.0		
Electrical resistivity (μΩ×m at 20°C)	0,730		
Magnetic Permeability	Non-magnetic		

AEROVAL AIST

MECHANICAL PROPERTIES

Condition	HB	Ultimate Tensile Strength (N/mm²)	0.2% Yield Strength (N/mm²), min	Elongation [5D] (%), min
Annealing	220 max	500 - 750	205	40

HEAT TREATMENTS

Condition	Temperatures	Soaking times	Cooling
Annealing	1000° - 1080°C	Commensurate to section	Water

HOT WORKING

Process	Heating temperatures	Cooling
Forging	900° - 1150°C	Air

SPECIFICATIONS

EN	ASTM	AMS	FEDERAL STANDARDS
10088 - 3	A276; A182; A479	5645	QQ - S - 763

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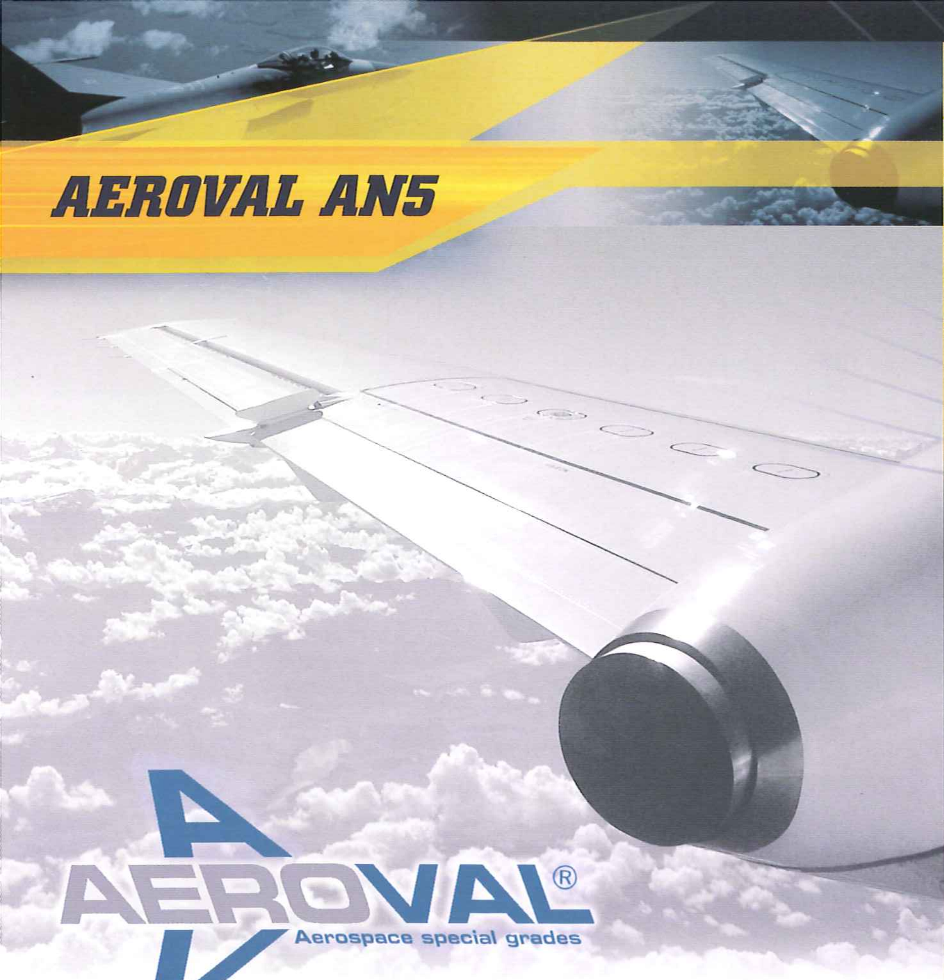
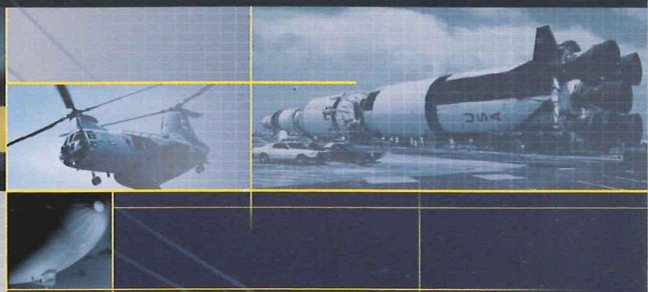
AEROVAL AN5





ACCIAIERIE VALBRUNA

AEROVAL®
Aerospace special grades

MATERIAL DESCRIPTION

AN5 is an iron-nickel-chromium alloys. Elements like Al and Ti in austenitic structure made this alloy aged-hardenable by appropriate heat treatment with increase of strength and hardness. Addition of Molybdenum provide high-temperature stability and reduce high-temperature creep.
This alloy has greater resistance to high temperature than low-alloy steel and stainless steel and shows good mechanical properties at temperatures up to 700° C.

CORROSION AND OXIDATION RESISTANCE

The corrosion resistance of this alloy is excellent up to 700°C; it shows an oxidation resistance similar to AISI 310 up to 816°C.
It maintains good corrosion and oxidation resistance for continuous service to 815°C, intermittent to 980°C. Nevertheless its corrosion resistance to sulfuric and phosphoric acid is moderate. Its aqueous corrosion resistance is similar to 316L.

COLD WORKING

After the solution heat treatment material achieves UTS 680-690 N/mm^2, in this condition it can be cold-formed by standard processes.

MELTING PRACTICES

This grade could be multiple melted using AOD practice followed by either vacuum or electroslag consumable electrode remelting.

APPLICATIONS

For their high-temperature strength and corrosion resistance this alloy is used in aerospace industry, power generation (component of aircraft and industrial gas turbines, shaft, vanes, blades, jet engines), automotive industry (fasteners, bolts and screws, springs, afterburners), thermal processing, non-magnetic cryogenic equipment.

DESIGNATIONS

UNS	AECMA	AFNOR	ASTM	EN
S66286	FE-PA 92HT/FE-PA 2601	EZ6NCT25	660	1.4980/1.4944/X6NiCrTiMoVB25-15-2

CHEMICAL COMPOSITION (chemistry shall conform to the following percentages by weight)

Element	C	Mn	Si	P	S	Cr	Mo	Fe	Al	Ti	Ni	Cu	V	B
Min[%]	-	1.00	-	-	-	13.50	1.00	56.00	-	1.80	24.00	-	0.10	0.003
Max[%]	0.08	2.00	1.00	0.030	0.015	16.00	1.50	-	0.40	2.30	27.00	0.50	0.50	0.010

HEAT TREATMENTS

Condition	Temperatures	Soaking times	Cooling
solution treatment (S. T.)	900 +/-14°C	hold 2 hrs min	liquid quench
	980 +/-14°C	hold 1 hrs min	liquid quench
precipitation hardening treatment (P. T.)	720 +/-14°C	hold 16 hrs	air cool
	775 +/-14°C 650 +/-14°C (*)	hold 16 hrs	air cool

The solution treatment at 980°C produces a slightly coarser grain size inducing highest creep-rupture strength after aging.
The solution treatment at 900°C produces a finer grain size with effect a better ductility and tensile strength at room temperature.
(*)The second heat treatment is intended to increase notch strength.

AEROVAL AN5

PHYSICAL PROPERTIES

Density (gr/cm³ at 20°C)	7.94		
Modulus of elasticity (GPa)	201		
Mean Coefficient of Thermal Expansion (10^{-6}/°C)	20° →200°C : 16.80	20°→ 400°C : 17.40	20°→ 500°C : 17.60
Thermal Conductivity (W/mK at 150°C)	15.0		
Electrical resistivity (μΩ×m at 20°C)	0.910		
Magnetic Permeability (20°C, 200 oersted)	sol annealed: 1.010	sol annealed and aged: 1.007	

HOT WORKING

Process	Heating temperatures	Cooling
Forging	1038° - 1150°C	Air

Below 930°C it is recommend not to subject the material to any hot forming operation.

MECHANICAL PROPERTIES

	Condition		Mechanical Properties (in S.T.P.T. Condition)					Stress Rupture Test			
								Test Parameters		Requirements	
Spec. Standard	S.H [°C]	P.H [°C]	Ultimate Tensile Strength (N/mm²), min	0.2% Yield Strength (N/mm²), min	Elongation [50mm or 4D] (%), min	Reduction of Area (%), min	Hardness Brinell (HB)	Test Temp. (C°)	Test Load (N/m²)	Hours min (h)	E in 4D min (%)
AMS	900	720	965	655	12	15	277-363	650	448	23	5
	980	720	895	586	15	20	248-341	650	482	23	5
ASTM class A	900	720	895	586	15	18	248-341	650	386	100	5
ASTM class B	980	720	895	586	15	18	248-341	650	386	100	5
ASTM class C	980 (***)	775	895	586	15	18	248-341	650	386	100	5
ASTM class D	900 or 980	720 (**)	895	725	15	18	248-321	-	-	-	-
ASTM tipe 1	900	705 - 760	895	586	15	18	min 248	650	386	23	3
ASTM tipe 2	980	705 - 760	895	586	15	18	min 248	650	386	23	3

(**) if necessary to achieve properties second age at 650 +/-14°C, hold 16 hrs and air cool.

(***) oil quenched

SPECIFICATIONS

ASTM	BS	EN	AMS
A453, A638	HR51	10269, 10302	5731, 5732, 5734, 5737

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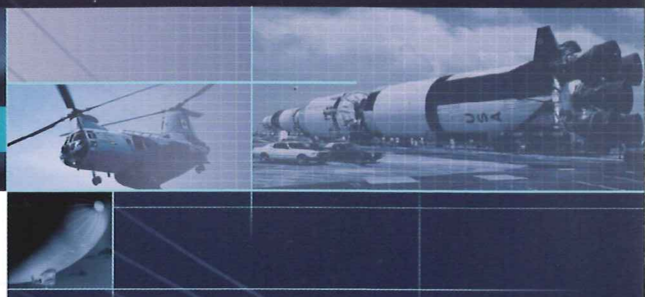
AEROVAL GL3



ACCIAIERIE VALBRUNA

AEROVAL®
Aerospace special grades

MATERIAL DESCRIPTION

GL3 is a solid solution nickel-base alloy. This alloys shows high mechanical properties at temperatures up to 450°C and above 600°C, good corrosion resistance in different environment (mineral and organic acids), to crevice corrosion, pitting, erosion, intergranular attack, stress corrosion cracking resistance.
This performances are achieved by the combination of Nickel, Chromium, Molybdenum and Columbium.
This grade can be subjected to two different heat treatments to achieve appropriate mechanical properties for different application: annealing (grade 1) and solution annealing (grade 2).

MELTING PRACTICES

This grade could be multiple melted using AOD practice followed by either vacuum or electroslag consumable electrode remelting.

APPLICATIONS

Aerospace component (aircraft-engine and airframe components, gas turbine engine ducting, combustion liners, ...), chemical-processing equipment handling mixed acids both oxidizing and reducing, power generation equipment (superheater-tube shield, soot-blower tubes, boiler-tube separator and hangers), sea water application (ship and submarine parts, offshore industry), pollution control equipment for environmental protection, nuclear water reactors (reactor-core and control-core components), heat shields, furnace hardware, plant equipment, MIG / TIG electrodes.

Grade 1 is recommended for application where combination of tensile and rupture properties is requested (above 1038°C). In this condition ductility and toughness at cryogenic temperature are very good.
Grade 2 is recommended for application where the resistance to creep is important (above 815°C) and where cold drawing or cold rolling operation are further requested. It shows good resistance to many corrosion atmospheres. It is not used for application below at 816°C.
Above 650°C both grade could be used.
When this alloy is requested for application below 649°C it is recommended an other heat treatment (900°C + air quench).

CORROSION AND OXIDATION RESISTANCE

This alloy exhibits high resistance to corrosive attack in a wide variety of environment. The combination of Nickel and Chromium provides to oxidizing media, while the combination of Nickel and Molybdenum provides resistance to reducing conditions, however the Columbium content prevents intergranular corrosion and the Molybdenum content enhances the resistance to pitting and crevice corrosion. At high temperatures this grade maintains good resistance to scaling and oxidation.

COLD WORKING

This grade can be cold-formed by standard processes. Generally after cold working with more than 15% deformation a solution annealed heat treatment (grade 2) is requested.

DESIGNATIONS

UNS	AECMA	AFNOR	EN
N06625	Ni-P97HT/Ni-PH3601	NC22DNb	2.4856/NiCr22Mo9Nb

CHEMICAL COMPOSITION (chemistry shall conform to the following percentages by weight)

Element	C	Mn	Si	P	S	Cr	Ta	Cb+Ta	Co	Mo	Fe	Al	Ti	Ni
Min[%]	-	-	-	-	-	20.00	-	3.15	-	8.00	-	-	-	58.00
Max[%]	0.10	0.50	0.50	0.015	0.015	23.00	0.05	4.15	4.00	10.00	5.00	0.40	0.40	-

HEAT TREATMENTS

Condition		Temperatures	Soaking times	Cooling
Grade 1	Annealed	870°C min	depend on volume and section thickness. Generally 0.5 - 1hrs	Water quenching or rapid air cooling
Grade 2	Sol Annealed	1090°C min (*)	depend on volume and section thickness. Generally 0.5 - 1hrs	

(*)with or without subsequent stabilization anneal at 982°C min to increase resistance to sensitization

AEROVAL GL3

PHYSICAL PROPERTIES

Density (gr/cm^3 at 20°C)	8.44		
Modulus of elasticity (GPa)	annealed: 208	sol annealed: 201	
Mean Coefficient of Thermal Expansion (10^{-6}/°C)	20° →200°C : 13.10	20°→ 400°C : 13.90	20°→ 500°C : 14.40
Thermal Conductivity (W/mK at 20°C)	9.8		
Electrical resistivity ($\mu\Omega \times$m at 20°C)	1.26		
Magnetic Permeability (20°C, 200 oersted)	1.006		

MECHANICAL PROPERTIES

Condition	Dimension (mm)	Ultimate Tensile Strength (N/mm^2), min	0.2% Yield Strength (N/mm^2), min	Elongation [50mm or 4D] (%), min	Reduction of Area (%), min	Hardness Brinell (HB)
Grade 1	ϕ< 100	820	410	30	40	240 max
	101< ϕ <254	740	340	25		
Grade 2	all	670	270	30	50	

HOT WORKING

Process	Heating temperatures	Cooling
Forging	900° - 1150°C (**)	Water quenching or rapid air

(**) At temperature below of 1010°C this grade becomes very difficult to be hot formed, for this reason different steps of hot working with intermediate heat treatment are necessary. An reduction of 15/20% is recommended for finishing steps.

To achieve properties and corrosion resistance annealing or solution annealing treatments are requested on the final product.

WELDABILITY

It is designed for use with gas-tungsten-arc or a consumable electrode. After the welding final heat treatment is not requested because material maintains same behavior of base metal. Nevertheless standard practices should be followed.

SPECIFICATIONS

ASTM	DIN	EN	BS	AMS
B446, B564	17744, 17752	10095	3076-NA21	5666

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Tel. +39 (0)444 968211 Fax +39 (0)444 963836
www.acciaierie-valbruna.com
e-mail: info@valbruna.it
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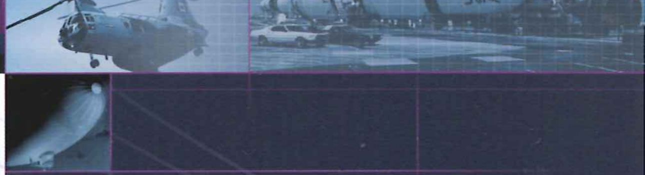
AEROVAL TI-GR5



AEROVAL® Aerospace special grades

ACCIAIERIE VALBRUNA

MATERIAL DESCRIPTION

TI-GR5 is the most frequently used Ti - Alloy because of its excellent strength-to-weight ratio which makes it particularly suitable for aerospace applications where also a good combination of mechanical properties up to approximately 400°C, formability, weldability and toughness is a mandatory engineering requirement. The alloying elements influence the temperature at which the cristallographic transformation (β-Transus) from Alpha (α) phase (HCP) to the Beta (β) phase (BCC) occurs. The nominal 6,0% of Aluminium (an α-phase stabilizer element) contributes to strengthen the low temperature α-phase by solid solution; nominal 4% Vanadium (a β-phase stabilizer element), although exceeding the α-solubility limit at any temperature, confers heat-treatment capability allowing the achievement of consistent strengthening.

MELTING PRACTICES

Multiple melted Ti - Alloy with at least final melting cycle under vacuum.

APPLICATIONS

The outstanding set of properties of this alloy make it the first choice for the manufacturing of structural parts, aeroengine components and fastening systems.
Among the variety of possible aerospace applications of TI-GR5 we find blades and discs for jet engines, landing gears, fasteners, airframe components, space vehicles and structures, missile components.
TI-GR5 is used where the device is manufactured starting from annealed full section long products as machined wire-rod or bars in different profiles and sizes. Some among the possible finished products obtainable are pivots, rivets and screws along with a wide range of forged and/or machined components .

CORROSION AND OXIDATION RESISTANCE

The excellent corrosion resistance of titanium alloys results from the formation of very stable, continuous, highly adherent, and protective surface oxide films. Because titanium metal itself is highly reactive and has an extremely high affinity for oxygen, these beneficial surface oxide films form spontaneously and instantly when fresh metal surfaces are exposed to air and/or moisture. In fact, a damaged oxide film can generally reheal itself instantaneously if at least traces of oxygen or water are present in the environment. However, certain anhydrous conditions in the absence of a source of oxygen may result in titanium corrosion, because the protective film may not be regenerated if damaged.

DESIGNATIONS

Commercial trade-name	ASTM	UNS	AECMA	DIN
Ti6Al4V	Grade 5	R56400	TI-P64001	3.7164

CHEMICAL COMPOSITION (chemistry shall conform to the following percentages by weight)

Element	Al	V	Fe	O	C	N	H	Residuals (each)	Residuals (all)	Ti
Min[%]	5.50	3.50	-	-	-	-	-	-	-	Rem.
Max[%]	6.75	4.50	0.30	0.20	0.08	0.05	0.0125	0.10	0.40	

HEAT TREATMENTS

Condition	Temperatures	Soaking times	Cooling
Annealing	705°- 790°C	1 hr min.	Air cooling
Solution heat-treatment (*)	940°- 970°C	1-2 hrs	Water quenching
Aging treatment (*)	525°- 550°C	4-8 hrs	Air cooling

MECHANICAL PROPERTIES (minimum values in longitudinal direction at room temperature)

Condition	Nominal diameter or distance between parallel surfaces	Ultimate Tensile Strength (N/mm^2), min	0.2% Yield Strength (N/mm^2), min	Elongation [4D] (%), min	Reduction of Area (%), min
Annealed (supply condition)	≤ 50.00 mm	930	860	10	25
	> 50.00 mm	895	830		
STA (*) (solution treated and aged)	Depending on diameter	1035 - 1135	965 - 1070	10	20

(*) Acciaierie Valbruna SpA supplies material in bar form only in the Annealed condition

AEROVAL TI-GR5

PHYSICAL PROPERTIES

Density (gr/cm³ at 20°C)	4.43
Melting temp. (°C)	1650°C
Modulus of elasticity (GPa)	110
Specific heat (J/Kg°C)	586
Mean Coefficient of Thermal Expansion (10^{-6}/°C) : 20°- 200°C	9.0
Mean Coefficient of Thermal Expansion (10^{-6}/°C) : 20°- 400°C	9.8
Thermal Conductivity (W/m°C at 20°C)	6.6
Electrical resistivity ($\mu\Omega\times$m at 20°C)	1.71
Magnetic Permeability at 1.6kAm	1.00005
β-Transus temp. (°C)	995° ± 15°C

HOT WORKING

Process		Temperatures	Cooling
Forging	Conventional	870° - 980°C	Air Cooling
	Beta (supra transus)	900° - 1065°C	

TI-GR5 can be heated up to forging temperatures by many different types of furnaces as for example: induction heating, resistance heating, electric (radiant), oil and natural gas. Nevertheless, TI-GR5 has a low coefficient of thermal conductivity therefore, heating rate should be equal to 4 to 12 min/cm of thickness to make sure temperature homogeneity throughout the section. It is preferred to heat TI-GR5 in oxidizing atmospheres in order to avoid hydrogen pickup from furnace products of combustion. Oxidizing atmosphere creates an oxide layer (α-case), that can be removed from finished product by pickling with suitable solutions of hydrofluoric and nitric acids.

WELDABILITY

When heated at temperatures above 500°C, titanium is severely contaminated by atmospheric gases like oxygen, nitrogen and hydrogen. Therefore, the melting, solidification, and solid-state cooling associated with fusion welding must be conducted in completely inert or vacuum environments. The fusion welding processes most widely used for joining titanium are gas-tungsten arc welding (GTAW), gas-metal arc welding (GMAW), plasma arc welding (PAW), laser-beam welding (LBW), and electron-beam welding (EBW). Titanium welding requires also weld joint and weld wire being properly cleaned and free of all foreign material during welding. Moreover inert gases shall be free of moisture and impurities.

MACHINABILITY

TI-GR5 machinability can be compared to the austenitic stainless steel type 18-8 provided that some precautions are observed. Sharp tools to reduce heat build-up and galling, rigid set-ups between tooling and component, generous amounts of non-chlorinated cutting fluids, low cutting speeds, high feed rates and safety precautions, no interruption of feedings while tools and component are in contact, are necessary to achieve high machinability performances.

SPECIFICATIONS

ASTM	AMS	AMS	Military Specification	Werkstoff-Leistungsblatt
B348 (Bars; Ann.)	4928 (Bars; Ann.)	4967 (Bars; Ann., Heat-treat.)	MIL-T-9047 [Withdrawn] (Bars; Ann.)	WL 3.7164.1; Teil 2 (Bars; Ann.)

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AEROVAL V155

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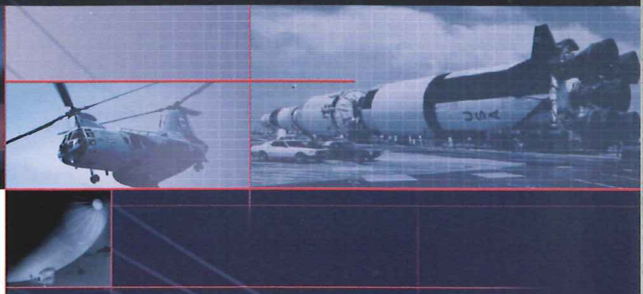


ACCIAIERIE VALBRUNA

MATERIAL DESCRIPTION

GENERAL: V155 is a martensitic SS which could be strengthened by precipitation treatment leading a Cu-containing phase to precipitate in the alloy. It is typically used for parts requiring corrosion resistance and high mechanical properties up to 315°C. The proper chemical composition and the manufacturing process promote improved toughness in the transversal section and good ductility; these features are obtained by balanced chemistry capable to limit the content of δ - ferrite and by consumable electrode remelting practice capable to control the inclusion content tight.

APPLICATIONS

Aircraft components (structural parts, flap Tracks and engine pylons), fabricated parts in high pressure corrosive environments including valves, shafts, fasteners, fittings and gears.

MELTING PRACTICES

This grade could be multiple melted using AOD practice followed by either vacuum or electroslag consumable electrode remelting.

CORROSION AND OXIDATION RESISTANCE

V155 exhibits good resistance to oxidation up to 600°C. Long-term exposure to elevated temperatures can result in reduced toughness in precipitation hardenable stainless steels. Decreased toughness caused by prolonged exposure to high temperatures can be reduced by high-temperature aging.
Corrosion resistance of V155 is pretty comparable to AISI 304 and similar to AISI 630. Stress-corrosion cracking resistance is achieved by precipitation treatment at temperatures equal or higher than 550°C in order to provide lowest hardness compatible with the specific use. V155 exhibits also good erosion-corrosion resistance thanks to its corrosion resistance combined with high hardness.
For better corrosion resistance surfaces should be clean, free of scale and residuals. Passivation is recommended for fabricated parts.
Annealed condition is not suitable for applications or services. Precipitation hardening after solution treatment is recommended in order to avoid delayed crackings.

DESIGNATIONS

UNS	AFNOR	ASTM	AECMA	EN
S15500	EZ5CNU15-04	XM-12	FE-PM64/FE-PM1802	1.4545/X5CrNiCuNb15-5

CHEMICAL COMPOSITION (chemistry shall conform to the following percentages by weight)

Element	Fe	C	Mn	Si	P	S	Cr	Ni	Cb	Cu	Mo
Min[%]	Bal.	-	-	-	-	-	14.00	3.50	5xC	2.50	-
Max[%]		0.07	1.00	1.00	0.030	0.015	15.50	5.50	0.45	4.50	0.50

HEAT TREATMENTS

Condition		Temperatures	Soaking times	Cooling
Solution Treatment	Cond. A	1040° ±15°C	Commensurate to section, Min 30'	Air to below 30°C, alt.: ϕ≥ 75mm → rapid air cooling ϕ< 75mm → air
Precipitation hardening	H900	480° ±5°C	1 hrs ±5'	Air cooling
	H925	500° ±5°C	4 hrs ±15'	Air cooling
	H1025	550° ±5°C	4 hrs ±15'	Air cooling
	H1075	580° ±5°C	4 hrs ±15'	Air cooling
	H1100	590° ±5°C	4 hrs ±15'	Air cooling
	H1150	620° ±5°C	4 hrs ±15'	Air cooling
	H1150M (double PH)	760° ±5°C	2 hrs ±15'	Air cooling
		620° ±5°C	4 hrs ±15'	Air cooling

AEROVAL V155

PHYSICAL PROPERTIES

		Cond. A	Cond. H900	Cond. H1075	Cond. H1150
Density (gr/cm^3 at 20°C)		7,75	7.81	7.83	7.86
Modulus of elasticity (GPa)		196			
Mean Coefficient of Thermal Expansion (10^{-6}/°C)	-73 +21° C	-	10.4	10.8	11.0
	+21 +427° C	11.3	11.7	12.2	13.0
Thermal Conductivity (W/mK at 20°C)	+20° C	18.3	17.8	-	-
	+500° C	22.7	22.7	-	-
Electrical resistivity ($\mu\Omega \times$m at 20°C)		-	0.770	0.800	-
Magnetic Permeability		Ferromagnetic			

MECHANICAL PROPERTIES

Condition		Charpy V-notch Impact Strength (J)	Hardness		Ultimate Tensile Strength (N/mm^2), min	0.2% Yield Strength (N/mm^2), min	Elongation [50mm or 4D] (%), min	Reduction of Area (%), min
			HRC	HB				
Solution Treatment	Cond.A			363 max				
Precipitation treated	H900	20	40-44	388-444	1300	1170	10	35
	H925	34	38-42	375-429	1170	1070	10	38
	H1025	48	33-38	331-401	1070	1000	12	45
	H1075	54	29-36	311-375	1000	860	13	45
	H1100	61	29-34	302-363	965	795	14	45
	H1150	68	26-33	277-352	930	725	16	50
	H1150M	138	26-36	277	790	515		

HOT WORKING

V155 could be easily forged and hot-formed. Before forging, material should be heated at 1180-1200°C for 1 hour.
Forging below 1000°C is not recommended. In order to have material exhibiting best grain size and mechanical properties, forgings should be cooled in air to below 35°C before further processing.

COLD WORKING

The material could be moderately but not hardly formed in the overaged conditions. Best machinability or cold deformation can be achieved in the double-aged conditions (H1150M).

WELDABILITY

V155 can be satisfactorily welded by conventional inert gas, shielded fusion and resistance processes. Because of Carbon pickup. Preheating is generally not required to prevent cracking, while post-welding heat treatment is recommended to generate the precipitation-hardening properties.
Material could be welded in the solution annealed condition, and can be precipitation treated to the requested hardness after welding; nevertheless, in order to minimize the effect of several thermal cycles, to have more uniform properties and to have best corrosion resistance in the aged material, solution annealing is suggested before precipitation treatment. In case high welding stresses are expected, it could be better to weld in the overaged conditions (H1150); in this case, the component should be solution treated after welding and aged.
Should the weld not exhibit high strength an austenitic stainless filler as E/ER308L has to be used If welding has to provide properties similar to the ones of the base metal in the precipitation treated condition than E/ER630 filler metal is required in order to have the filler producing the precipitation hardening effect.

SPECIFICATIONS

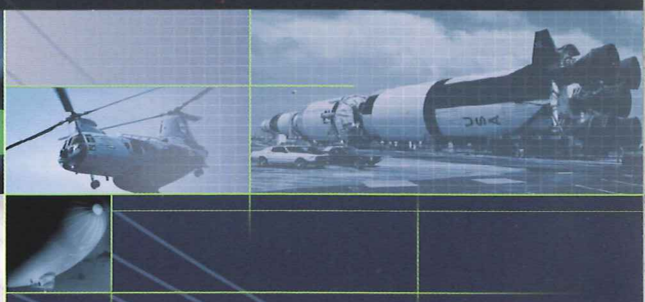
ASTM	AMS
A 564	5659

AEROVAL® Aerospace special grades

ACCIAIERIE VALBRUNA

ACCIAIERIE VALBRUNA
VIALE DELLA SCIENZA, 25 36100 VICENZA ITALY
Tel. +39 (0)444 968211 Fax +39 (0)444 963836
www.acciaierie-valbruna.com
e-mail: info@valbruna.it
e-mail: special.products@valbruna.it

AEROVAL X122MV



ACCIAIERIE VALBRUNA

AEROVAL®
Aerospace special grades

MATERIAL DESCRIPTION

Hardenable martensitic grade with high tensile properties, good ductility and good creep rupture strength.

CORROSION RESISTANCE AND SCALING TEMPERATURE

Scaling temperature : 650° C
Best corrosion properties are achieved when material is hardened & tempered .

HOT WORKING

Preheating is required for large sections. This grade should be hot worked at t° = 1000-1170°C.
Slow cooling to room temperature and immediate annealing or tempering are recommended.

MACHINABILITY

This grade could be machined as AISI 431 or AISI 630 (H1100 , H1150)

WELDABILITY

Standard precautions for martensitic grades should be applied in order to avoid HAZ cracking.
In general, a preheating at t° = 200-300° C and a post welding tempering at 30-40°C under the tempering temperature of base metal. This post weld tempering has to be done when the weld part drops to room temperature and then has to be immediately tempered.

MELTING PRACTICES

This grade could be multiple melted using AOD practice followed by either vacuum or electroslag consumable electrode remelting.

APPLICATIONS

Aircraft structural parts, gas turbine compressor components, shafts, turbine discs and high temperature bolting.

DESIGNATIONS

UNS	AISI/SAE	AFNOR	AECMA	EN
S64152	XM-32	Z12CNDV12	FE-PM37/FE-PM1502	1.4939/X12CrNiMoN12

CHEMICAL COMPOSITION (chemistry shall conform to the following percentages by weight)

Element	Fe	C	Mn	Si	P	S	Cr	Ni	N	Mo	V
Min[%]	Bal.	0.08	0.50	-	-	-	11.00	2.00	0.02	1.50	0.25
Max[%]		0.15	0.90	0.35	0.025	0.015	12.50	3.00	0.05	2.00	0.40

HEAT TREATMENT

Condition	Temperatures	Soaking times	Cooling
Annealing(*)	680° - 700°C	4 - 6 hrs	Air cooling
Hardening	990° - 1060°C	1 - 2 hrs	Oil or Air(**) cooling
Tempering(***)	560° - 690°C To desired hardness	2 - 4 hrs	Air cooling
Stress Relieving(****)	30°C below actual tempering temp.	Enough to restore proof stress	Air cooling

(*) recommended for cold workability
(**) for bars with dia.<25mm
(***) double tempering is recommended
(****)recommended for hardened & tempered bars subjected to cold working operations

AEROVAL X122MV

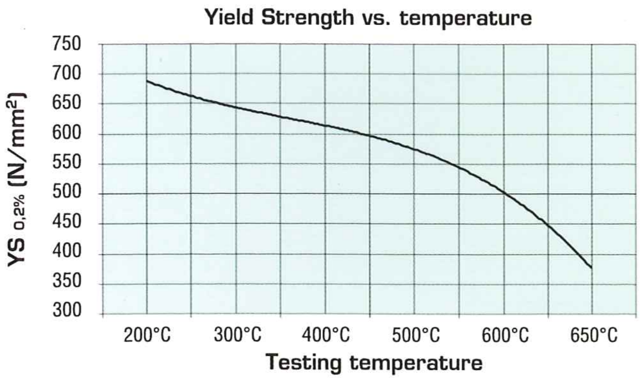
PHYSICAL PROPERTIES	
Density (kg/dm³) at 20°C	7.70
Modulus of elasticity (GPa)	216 at + 20°C 207 at + 200°C 192 at + 400°C 175 at + 600°C
Mean Coefficient of Thermal Expansion (10^{-6}/°C)	10.5 between 20°C and 100°C 11.0 between 20°C and 200°C 12.0 between 20°C and 400°C 12.5 between 20°C and 600°C
Thermal Conductivity (W/mK at 20°C)	30
Specific heat (J/g x K)	0.46 at 20°C 0.50 at 100°C 0.60 at 600°C
Electrical resistivity ($\mu\Omega \times$m at 20°C)	0.65
Magnetic Properties	Magnetic

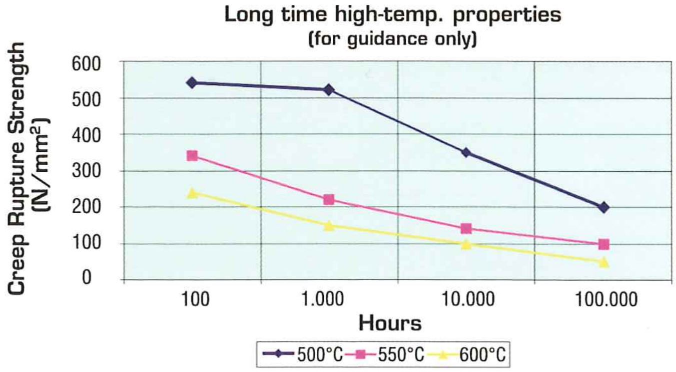
MECHANICAL PROPERTIES AT ROOM TEMP. – MATERIAL HARDENED 1000° C, OIL & TEMPERED

Tempering Temperature	Charpy V-notch Impact Strength (J)	Hardness (HB)	Ultimate Tensile Strength (N/mm²), min	0.2% Yield Strength (N/mm²), min	Elongation [50mm or 4D] (%), min	Reduction of Area (%), min
560°C(*)	100	369	1220	1000	20	65
560°C+560°C	160	350	1180	950	19	64
660°C+620°C	115	305	1020	870	20	60

(*) Tempering in the 450°- 550°C should be avoided

TYPICAL MECHANICAL PROPERTIES AT HIGH TEMP. – MATERIAL HARDENED AT 1050°C & TEMPERED AT 650°C





SPECIFICATIONS

BS	EN	ASTM	AMS
S151, S159	10269,1.4939	A 565, XM-32	5719

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