HIGH MACHINING STAINLESS STEELS

MAXIVAL® GRADES, ENHANCED PH & MARTENSITIC STEELS

High level of machining performance

ACCIAIERIE VALBRUNA

High quality is our standard

WE ARE WHEREVER YOU NEED US TO BE

Mills

ITALY: Vicenza, Bolzano

USA: Fort Wayne

CANADA: Welland

VALBRUNA GROUP
SYNERGIES FOCUSED ON THE FUTURE

Valbruna, founded in 1925 and leader in the production of Stainless steel and Nickel alloys long products, is underpinned by long experience and a highly qualified customer service.

ITALY
Ancona
Bologna
Brescia
Milano
Parma
Torino
Treviso

EUROPE
Czech Republic
Denmark
Finland
France
Germany
Ireland
Nederland
Norway
Poland
Spain
Sweden
Switzerland
United Kingdom

AMERICA
Canada
Mexico
United States

ASIA - OCEANIA
Australia
Hong Kong
India
Malaysia
Turkey
UAE

AFRICA
South Africa

Vicenza plant, ITALY
(Total surface: 294.608 m²)

Bolzano plant, ITALY
(Total surface: 197.049 m²)

Fort Wayne plant, IN-USA
(Total surface: 248.356 m²)

Welland plant, ON-CANADA
(Total surface: 339.288 m²)

ACCIAIERIE VALBRUNA
High quality is our standard

IMPROVED MACHINABILITY STAINLESS STEEL GRADES

AUSTENITIC, PH & MARTENSITIC STAINLESS STEEL LONG PRODUCTS

Tailored steel melting practice and balanced chemical composition allow Valbruna to offer a set of grades well known in the market for their machinability characteristics. Across Austenitic (Maxival technology), PH and martensitic stainless steel, Valbruna has developed its own high machinability grades in order to provide a valuable alternative to any machining process need and customer application.

The main advantages offered by Valbruna Improved Machinability stainless steel grades are:

- **Shorter production cycle per machined piece**
- **Higher feed and speed thanks to a better chip breaking**
- **Less tool wear**
- **Reduction of machine downtimes**
- **Reduction of non-conform parts due to machining problems**

The best results in terms of machinability performance are then achieved when metallurgical characteristics are combined with material physical characteristics such as:

- **Tight dimensional tolerance**
- **Better surface finishing**
- **Superior straightness**
- **End facing and chamfered ends as per customer drawing**

Continuous investments in new equipment has allowed Valbruna to offer a product complying with all above characteristics.

MV188ZHS - AISI 303

Description of material: MV188ZHS is a Ca-treated free machining austenitic Chromium-Nickel stainless steel with a better machinability than the standard type 303 series. This characteristic is achieved in the steel making process by modifying both sulphide and oxide inclusions favourable to machining and by controlling the type, shape and composition of inclusions. MV188ZHS is widely used in applications where machinability is the most important factor of choice in terms of cost-saving in the production of pieces obtained by multi-spindles and screw machines.

Applications: MV188ZHS is suitable for the fabrication of many products such as flanges, valves, bolting, pump shafts, pins, rings, screws, nuts, beverage industry equipment, many organic chemicals and parts working in mild corrosive environments. MV188ZHS is not recommended for applications in pressure vessels.

Melting practice: EAF+AOD

Corrosion resistance: MV188ZHS is resistant to fresh water, many organic chemicals and inorganic compounds, atmospheric corrosion, rural applications and sterilizing solutions where the chloride content is low. 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. Pitting and crevice corrosion may occur in chloride environments if concentration, pH and temperature are at determinate levels. As with other standard austenitic grades, MV188ZHS suffers from stress corrosion cracking about forty degrees (C°) above room temperature and above certain stresses and halogens concentration. Strain hardened structures increase the risk of stress corrosion cracking. 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: MV188ZHS should not be used for cold heading or upsetting due to embrittlement effect of the Sulphur content. In case of moderate cold heading or upsetting, AU188ZU may be used without excessive reduction of machinability.

Machinability: MV188ZHS has a very good machinability. Productivity gain depends on the type of machines, the kind of tools used and their geometry, cutting fluids and the kind of machine operations on the pieces produced. The Austenite structure is prone to transform in to α'Martensite caused by strain hardening of the tool on the surface of the machined piece. The knowledge of this behavior must be correctly considered when a piece requires two or several cutting steps to be finished. The layer of α'Martensite is very 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. MV188ZHS shouldn't be used for high polishability or mirror finishing processes.

Weldability: MV188ZHS is not suitable for welding because its Sulphur content may generate porosity and cracks in the weld zone. Moreover, MV188ZHS has a different behavior when compared to standard grades of similar alloy composition due to its special steel making process because its Calcium-treated process, in addition to high Sulphur content, influences the surface tension of liquid and the regular morphology and geometry of the fused zone. Nevertheless, if welding process were required, MV188ZHS has a chemical composition which helps to avoid solidification cracks in the fused-zone of autogenous welds, due to its Ferrite balance, but it is still unlikely to avoid porosity and inadequate geometry of the weld. A welding process with a suitable austenitic filler could help to overcome or reduce these problems using low heat inputs. In order to avoid intergranular corrosion, the welded structure should be annealed after welding if the Carbon content of the supplied heat is above 0,03%. In solid state joining such as Friction Welding, MV188ZHS provides a very poor quality bond line or no joining.

Hot working: MV188ZHS is not specifically designed for hot working and is usually supplied as cold finished round, hexagonal and square bars for machining processes. However, in case of open die forging of large ingots and shapes of this grade, it has enough plasticity when being hot worked, if suitable soaking and the right temperature are applied. No preheating is required. Small forgings can be cooled rapidly by air or water.

MV188ZHS

Designations

AISI	303
UNS	S30300
EN	X8CrNiS18-9
W.N.	1.4305
BS	303S31

Specifications

ASTM	A582
EN	10088-3

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Chemical Composition

Chemical Element	C	Mn	Si	S	P	Cr	Ni	Cu	N
Minimum Value %	-	-	-	0,3%	-	17%	8%	-	-
Maximum Value %	0,1%	2%	1%	0,35%	0,045%	19%	10%	1%	0,11%

Heat Treatment

Condition	Minimum Temperature °C	Maximum Temperature °C	Cooling
A	1040	1080	Water

Physical Properties

Physical Property	SI/metric units	US/BS imperial units
Density	7,9 kg/dm^3	0,285 lb/in^3
Specific Thermal Capacity 20° C	500 J/(kg·K)	0,119 Btu/lb°F
Thermal Conductivity 20° C	15 W/(m·K)	104,002 Btu in/ft^{2}h °F
Thermal Expansion 20° - 100° C	16 (10^{-6}/K)	8,889 (10^{-6}/ °F)
Electrical Resistivity 20° C	0,72 Ω·mm^2/m	28,346 μΩin
Modulus of Elasticity 20° C	200 GPa	29007,548 ksi

Mechanical Properties

Condition	Subtype	Rm(N/mm²)	Rm(Ksi)	Rp0.2%(N/mm²)	Rp0.2%(Ksi)	E(%)	HBW
Annealed	-	515-700	75-102	205 min.	30 min.	35 min.	230 max.

Hot Working

Condition	Minimum Temperature °C	Maximum Temperature °C	Cooling
Forging / Hot Rolling	900	1250	Air

MVAISL - AISI 304/304L

Description of material: MVAISL is a low-carbon austenitic stainless steel with both good general corrosion and good intergranular corrosion resistance after welding processes. This grade is a Ca-treated stainless steel obtained by a special steel making practice whose aim is a calculated and precise control of non-metallic inclusions. These inclusions are characterized by a particular morphology and lubricating properties, which are able to improve machinability. This results in lower tool wear and higher chip-breaking due to the formation of a layer between the tool and the chip.

Applications: MVAISL is suitable for the fabrication of many products such as flanges, valves, bolting, pump shafts, food /beverages industry equipment, storage tanks, contact with many organic chemicals and parts working in mild to medium corrosive environments.

Melting practice: EAF+AOD

Corrosion resistance: MVAISL is resistant to fresh water, many organic chemicals and inorganic compounds, atmospheric corrosion, rural applications and sterilizing solutions where the chloride level is very low. Pitting and crevice corrosion may occur in chloride environments if concentration, pH and temperature are at determinate levels. As with other standard austenitic grades, MVAISL suffers from stress corrosion cracking, about forty degrees (C°) above room temperature and with certain levels of stress and halogen concentration. Strain hardened structures increase the risk of stress corrosion cracking. 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: MVAISL is readily fabricated by cold working such as cold drawing and bending, but should only be used for a moderate amount of cold heading, because its chemical balance does not allow it to obtain a soft strain hardening structure after cold deformation, due to a high CWHF (Cold Working Hardening Factor). This could result in a rapid die wear. Valbruna produces other grades for these purpose such as AISR or AISRUH whose chemical balance provides the highest cold deformability and the lowest CWHF. However these grades have a poor machinability due to a low Sulfur content. Only MVAISRU (with Copper and Sulfur) should be used for severe cold heading. The experience is that this grade is required for its highest machinability and low strain hardening properties. MVAISL shouldn't be used for high polishability or mirror finishing processes.

Machinability: MVAISL is not a Free Machining grade (FM) but rather an alloy with enhanced machinability characteristics. In terms of machinability, MVAISL stands in an intermediate position between standard and Free Machined grades but cannot compete with FM (such as AISI 303, EN 1.4305). MVAISL offers a lot of advantages in terms of productivity when compared to standard grades. The best performances are obtained when employing the correct machining parameters while using multi-spindle and automatic screw machines. However, machinists should know that Austenitic grades are different from Ferritic and Alloy steels and require more rigid and powerful machines in addition to the correct choice of tools, coatings and cutting fluids. The Austenite structure is prone to transform in to α'Martensite caused by strain hardening of the tool on the surface of the work piece. The knowledge of this behavior must be correctly considered when a piece requires two or several cutting steps to be finished. The layer of α'Martensite is very 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.

Weldability: MVAISL has a different behavior when compared to standard grades of similar alloy composition due to its special steel making process because its Calcium-treated process influences the surface tension of liquid and the regular morphology and geometry of the fused zone. Using the correct filler may reduce or overcome the difficulties of geometry. MVAISL has a special chemical composition which helps to avoid solidification cracks in the fused-zone of autogenous welds due to a special Ferrite balance. In solid state joining such as Friction Welding, MVAISL may not provide a quality bond line.

Hot working: MVAISL is not specifically designed for hot working and is usually supplied as cold finished round, hexagonal, flat and square bars for machining processes. If a suitable level of machinability is desired on forged pieces (such as flanges, rolled rings, closed-die forgings) a special grade similar to MVAISL can be supplied. Valbruna produces a group of grades with different process and with low Ferrite. For instance: AISLF (instead of MVAISL). However, open die forging of large ingots and shapes of MVAISL have a good hot plasticity if suitable soaking and the right temperature are applied. No preheating is required. Small forgings can be cooled rapidly by air or water.

MVAISL

Designations

AISI	304/304L
UNS	S30400/S30403
EN	X5CrNi18-10/X2CrNi18-9
W.N.	1.4301/1.4307
BS	304S15/304S31

Specifications

ASTM	A182 / A276 / A479
ASME	SA182 / SA276 / SA479
EN	10088-3 / 10222-5 / 10272

MAXIVAL®

Chemical Composition

Chemical Element	C	Mn	Si	P	S	Cr	Ni	Cu	Mo	N
Minimum Value %	-	-	-	-	0,02%	18%	8%	-	-	-
Maximum Value %	0,03%	2%	1%	0,04%	0,03%	19,5%	10%	1%	1%	0,1%

Heat Treatment

Condition	Minimum Temperature °C	Maximum Temperature °C	Cooling
A	1040	1100	Water

Physical Properties

Physical Property	SI/metric units	US/BS imperial units
Density	7,9 kg/dm³	0,285 lb/in³
Specific Thermal Capacity 20° C	500 J/(kg·K)	0,119 Btu/lb°F
Thermal Conductivity 20° C	15 W/(m·K)	104,002 Btu in/ft²h °F
Thermal Expansion 20° - 100° C	16 (10^{-6}/K)	8,889 (10^{-6}/ °F)
Electrical Resistivity 20° C	0,73 Ω·mm²/m	28,74 μΩin
Modulus of Elasticity 20° C	200 GPa	29007,548 ksi

Mechanical Properties

Condition	Subtype	Rm(N/mm²)	Rm(Ksi)	Rp0.2%(N/mm²)	Rp0.2%(Ksi)	E(%)	HBW
Annealed	-	515-700	75-102	205 min.	30 min.	40 min.	215 max.

Hot Working

Condition	Minimum Temperature °C	Maximum Temperature °C	Cooling
Forging / Hot Rolling	1100	1260	Air

MVAPML – AISI 316/316L

Description of material: MVAPML is a low-carbon austenitic stainless steel with Molybdenum. It has good general and pitting corrosion resistance as well as good intergranular corrosion resistance after welding processes. This grade is a Ca-treated stainless steel obtained by a special steel making practice whose aim is a calculated and precise control of non-metallic inclusions which are characterized by particular morphology and lubricating properties which are able to improve machinability. This results in lower tool wear and higher chip-breaking due to the formation of a layer between the tool and the chip.

Applications: MVAPML is suitable for the fabrication of many products such as flanges, valves, bolting, pump shafts, food/beverages industry equipment, storage tanks, many organic chemicals, and parts working in mild to medium corrosive environments.

Melting practice: EAF+AOD

Corrosion resistance: MVAPML is resistant to fresh water, many organic chemicals and inorganic compounds, atmospheric corrosion, marine environments, as well as to many products used in chemical processes, paper production equipment, rural applications and sterilizing solutions. In sea water, this grade is more resistant to pitting than type 304/304L grades such as MVAISL and similar. However, pitting and crevice corrosion may occur in environments if the chloride concentrations, pH and temperature are at determinate levels. As with other standard austenitic grades, MVAPML suffers from stress corrosion cracking about forty degrees (C°) above room temperature and above certain levels of stress and halogen concentrations. Strain hardened structures increase the risk of stress corrosion cracking. 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: MVAPML is readily fabricated by cold working such as cold drawing and bending and allows a moderate amount of cold heading thanks to its Nickel content. Its structure after cold deformation is less hard than MVAISL.

Machinability: MVAPML is not a Free Machining grade (FM) but rather an alloy with enhanced machinability characteristics. In terms of machinability, MVAPML stands in an intermediate position between standard and Free Machined grades but cannot compete with FM (such as AISI 303, EN 1.4305). MVAPML offers a lot of advantages in terms of productivity when compared to standard grades. The best performances are obtained when employing the correct machining parameters when using multi-spindle and automatic screw machines. However, machinists should know that Austenitic grades are different from Ferritic and Alloy steels and require more rigid and powerful machines in addition to the correct choice of tools, coating and cutting fluids. The Austenite structure is prone to transform in to α'Martensite caused by strain hardening of the tool on the surface of the work piece. Even if MVAPML has a hardening factor lower than MVAISL, the knowledge of this behavior must be correctly considered when a piece requires two or several cutting steps to be finished. The layer of α'Martensite is very 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. MVAPML shouldn't be used for high polish-ability or mirror finishing processes.

Weldability: MVAPML has a different behavior when compared to standard grades of similar alloy composition due to its special steel making process because its Calcium-treated process influences the surface tension of liquid and the regular morphology and geometry of the fused zone. Using the correct filler may reduce or overcome the difficulties of geometry. MVAPML has a special chemical composition which helps to avoid solidification cracks in the fused-zone of autogenous welds due to a special Ferrite balance. In solid state joining such as Friction Welding, MVAPML may not provide a quality bond line.

Hot working: MVAPML is not specifically designed for hot working and is usually supplied as cold finished round, hexagonal, flat and square bars for machining processes. If a suitable level of machinability is desired on forged pieces (such as flanges, rolled rings, closed-die forgings) a special grade similar to MVAPML can be supplied. Valbruna produces a group of grades with different processes and with lower Ferrite. However, in case of open die forging large ingots and shapes, MVAPML has a good hot plasticity if suitable soaking and the right forging temperature are applied. No preheating is required. Small forgings can be cooled rapidly by air or water.

MVAPML

Designations

AISI	316 / 316L
UNS	S31600 / S31603
EN	X2CrNiMo17-12-2 / X5CrNiMo17-12-2
W.N.	1.4401 / 1.4404
BS	316S14 / 316S19

Specifications

ASTM	A182 / A276 / A479
ASME	SA182 / SA276 / SA479
EN	10088-3 / 10222-5 / 10272

MAXIVAL®

Chemical Composition

Chemical Element	C	Mn	Si	S	P	Cr	Ni	Cu	Mo	N
Minimum Value %	-	-	-	-	-	16,5%	10%	-	2%	-
Maximum Value %	0,03%	2%	0,75%	0,03%	0,04%	18%	12%	1%	2,5%	0,1%

Heat Treatment

Condition	Minimum Temperature °C	Maximum Temperature °C	Cooling
A	1040	1100	Water

Physical Properties

Physical Property	SI/metric units	US/BS imperial units
Density	8 kg/dm^3	0,289 lb/in^3
Specific Thermal Capacity 20° C	500 J/(kg·K)	0,119 Btu/lb°F
Thermal Conductivity 20° C	15 W/(m·K)	104,002 Btu in/ft^{2}h °F
Thermal Expansion 20° - 100° C	16 (10^{-6}/K)	8,889 (10^{-6}/ °F)
Electrical Resistivity 20° C	0,75 Ω·mm^2/m	29,528 μΩin
Modulus of Elasticity 20° C	200 GPa	29007,548 ksi

Mechanical Properties

Condition	Subtype	Rm(N/mm²)	Rm(Ksi)	Rp0.2%(N/mm²)	Rp0.2%(Ksi)	E(%)	HBW
Annealed	-	515-700	75-102	205 min.	30 min.	40 min.	215 max.

Hot Working

Condition	Minimum Temperature °C	Maximum Temperature °C	Cooling
Forging / Hot Rolling	1100	1250	Air

V174/1 - AISI 630

Description of material: V174/1 is a precipitation hardening stainless steel with high strength and hardness. This grade has a good machinability due to a particular chemical composition that allows the material to chip more easily when being machined. The mechanical properties are obtained by a solution treatment (Cond. A) that brings the Cu in solution in the Austenitic matrix followed by a rapid cooling, obtaining a super-saturated Cu martensitic structure. A re-heating (ageing) at t° = 480°C gives a maximum Hardness and Tensile Rm with a low Kv impact due to a precipitation of Cu-rich phase, while at t°= 620°C this results in a higher Kv impact with a reduction of Rp0,2 and Rm due to a progressive softening of Martensite and the formation of both Cu-globules with a loss of coherence within the matrix and stable Austenite. It is important to know that the transformation of Austenite into Martensite is completed below 30°C and the formation of stable Austenite can start to appear at 550°. This depends on the (Cr/Ni) equivalent balance that, besides, influences the amount of Ferrite in the matrix.

Application: It can be used in different kinds of application as valves, chemical and power production components, engine parts, fitting, fasteners, shafts, pump shafts and parts of oil & gas plants.

Melting practice: EAF+AOD

Corrosion resistance: This grade has the same general corrosion resistance as TP 304, but better than the group of standard martensitic TP 400 series. However, solution treatment (cond. A) without aging should be avoided. For maximum resistance to Chloride stress corrosion cracking, it should be aged at a higher temperature, not less than 550-580°C. In Sulfide aggressive environments, aged 620° C or overaged. The same choice applies in case of situations or environments prone to cause H-embrittlement. It should be noted that this grade, as for every kind of stainless steel, surfaces should be free of contaminant and scale, and passivated for optimum resistance to corrosion.

Cold working: This grade has limited cold deforming capacity in the annealed condition (cond. A) due to untempered Martensite. More severe cold working requires aging at the highest temperature or overaging. To restore or increase mechanical properties such as tensile Rm and toughness, a new solution treatment followed by a suitable aging temperature should be carried out. Nevertheless, the repetition of a single aging could be sufficient if compliant with the final use.

Machinability: Machinability is good both in the solution-treated (cond. A) and precipitation hardened conditions, considering that this property improves when hardness decreases. A certain amount of dimensional changes, in terms of contraction, happens after the aging of parts; these dimensional variations should be evaluated.

Weldability: This grade has a good weldability and doesn't normally need preheating, but welding design should be well evaluated in order to avoid situations prone to generate stress. In short, small sections could be welded in the solution treatment condition followed by an aging; large or heavy sections require a high temperature aging or overaging obviously followed by a new solution treatment (cond. A) and an aging.

Hot working: Ingots or large forgings require a suitable preheating in order to avoid thermal cracking. Avoid overheating and improper cooling. Large forging bars should be equalized at 1030 -1040°C in the heating furnace prior to cooling. Both small or large forgings, rolled rings or bars must be cooled under 30°C after solution treatment (cond. A) in order to complete the transformation of martensite, obtaining both a good structure and mechanical properties after aging.

V174/1

Designations

AISI	630
UNS	S17400
EN	X5CrNiCuNb17-4-4
W.N.	1.4542

Specifications

ASTM	A564
EN	10088-3

IMPROVED MACHINABILITY

Chemical Composition

Chemical Element	C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Ta+Nb
Minimum Value %	-	-	-	-	-	3%	15%	-	3%	0,15%
Maximum Value %	0,07%	1%	0,7%	0,03%	0,04%	5%	17%	0,6%	5%	0,45%

Heat Treatment

Condition	Minimum Temperature °C	Maximum Temperature °C	Cooling
A	1025	1050	Air
H900	480	480	Air
H925	495	495	Air
H1025 (P1070)	550	550	Air
H1075	580	580	Air
H1100 (P960)	595	595	Air
H1150 (P930)	620	620	Air
H1150M (P800)	760 + 620	760 + 620	Air
H1150D	620 + 620	620 + 620	Air

V174/1

Physical Properties

Physical Property	SI/metric units	US/BS imperial units
Density	7,8 kg/dm³	0,282 lb/in³
Specific Thermal Capacity 20° C	500 J/(kg·K)	0,119 Btu/lb°F
Thermal Conductivity 20° C	16 W/(m·K)	110,936 Btu in/ft²h °F
Thermal Expansion 20° - 100° C	10,9 (10⁻⁶/K)	6,056 (10⁻⁶/ °F)
Electrical Resistivity 20° C	0,71 Ω·mm²/m	27,953 µΩin
Modulus of Elasticity 20° C	200 GPa	29007,548 ksi

Mechanical Properties

Condition	Subtype	Rm(N/mm²)	Rm(Ksi)	Rp0.2%(N/mm²)	Rp0.2%(Ksi)	E(%)	HBW
Solution Annealed	A	1200 max	174 max	-	-	-	363 max
Solution Annealed Aged	H900	1310 min	190 min	1170 min	170 min.	10 min.	388 min
Solution Annealed Aged	H925	1170 min	170 min	1070 min	155 min	10 min.	375 min
Solution Annealed Aged	H1025 (P1070)	1070 min	155 min	1000 min	145 min	12 min.	331 min
Solution Annealed Aged	H1075	1000 min	145 min	860 min	125 min	13 min.	311 min
Solution Annealed Aged	H1100 (P960)	965 min	140 min	795 min	115 min	14 min.	302 min
Solution Annealed Aged	H1150 (P930)	930 min	135 min	725 min	105 min	16 min.	277 min
Solution Annealed Double Aged	H1150M (P800)	795 min	115 min	520 min	75 min	18 min.	255 min
Solution Annealed Double Aged	H1150D	860 min	125 min	725 min	105 min	16 min.	255 - 311

Hot Working

Condition	Minimum Temperature °C	Maximum Temperature °C	Cooling
Forging / Hot Rolling	900	1150	Air

VAL1HS - AISI 416

Description of material: VAL1HS is a special variant of the most popular free machining martensitic stainless steel with a Carbon content able to give sufficient values of hardness after heat treatment but with high machinability compared to the standard type 416 grade (i.e. VAL1Z) and similar grades. This characteristic allows a high productivity in terms of machinability and is widely used in automatic machining industries.

Applications: All applications where a suitable hardness with a moderate corrosion resistance are indispensable, such as parts of pumps, pump shafts, gears, wear resistant devices, bolts, nuts, valves stems and shafting. VAL1HS, after hardening and low temperature tempering condition, provides a hardness similar to the type 410 series. This grade is not recommended for applications in pressure vessels and shouldn't be used for high polishability or mirror finishing processes.

Melting Practice: EAF+AOD

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. VAL1HS has a good resistance to mildly corrosive environments such as fresh water, crude oil, gasoline, alcohol and some beverages. VAL1HS has its maximum corrosion resistance when hardened + low temperature tempered condition and with 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 VAL1HS is to be used in the annealed condition, it should be considered that its resistance corrosion will depend on the corrosive capacity of environment. This means that this condition may not 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: Even in the annealed condition, this grade is not suitable for cold heading and up-setting due to the embrittlement effect of the high Sulphur content; 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. Cold shearing of small billets and bars is not recommended because this process may cause shear or stress cracks due to its structure embrittled by its high Sulphur content.

Machinability: VAL1HS offers a machinability better than the typical martensitic free machined grades. 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. As a general rule, machinability depends on both Sulphur content and hardness in addition to a suitable structure of bars or shapes. All these characteristics are typical of VAL1HS allowing both high cutting speed and cheap-breaking.

Welding: VAL1HS is not recommended for both fusion and friction welding.

Hot working: VAL1HS 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 such as this grade with a higher Sulphur, 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 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, VAL1HS 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 temperatures or annealing temperatures impair the corrosion resistance of all martensitic grades.

VAL1HS

Designations

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

Specifications

ASTM	A582
EN	10088-3

IMPROVED MACHINABILITY

Chemical Composition

Chemical Element	C	Mn	Si	S	P	Cr	Mo
Minimum Value %	0,08%	-	-	0,30%	-	12%	-
Maximum Value %	0,15%	1,25%	1%	0,35%	0,04%	14%	0,6%

Heat Treatment

Condition	Minimum Temperature °C	Maximum Temperature °C	Cooling
A	750	900	Air
Hardened	950	980	Air
Tempered	595	-	Air

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

Mechanical Properties

Condition	HBW
Annealed	220 max
Hardened + Tempered	248 - 302

Hot Working

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


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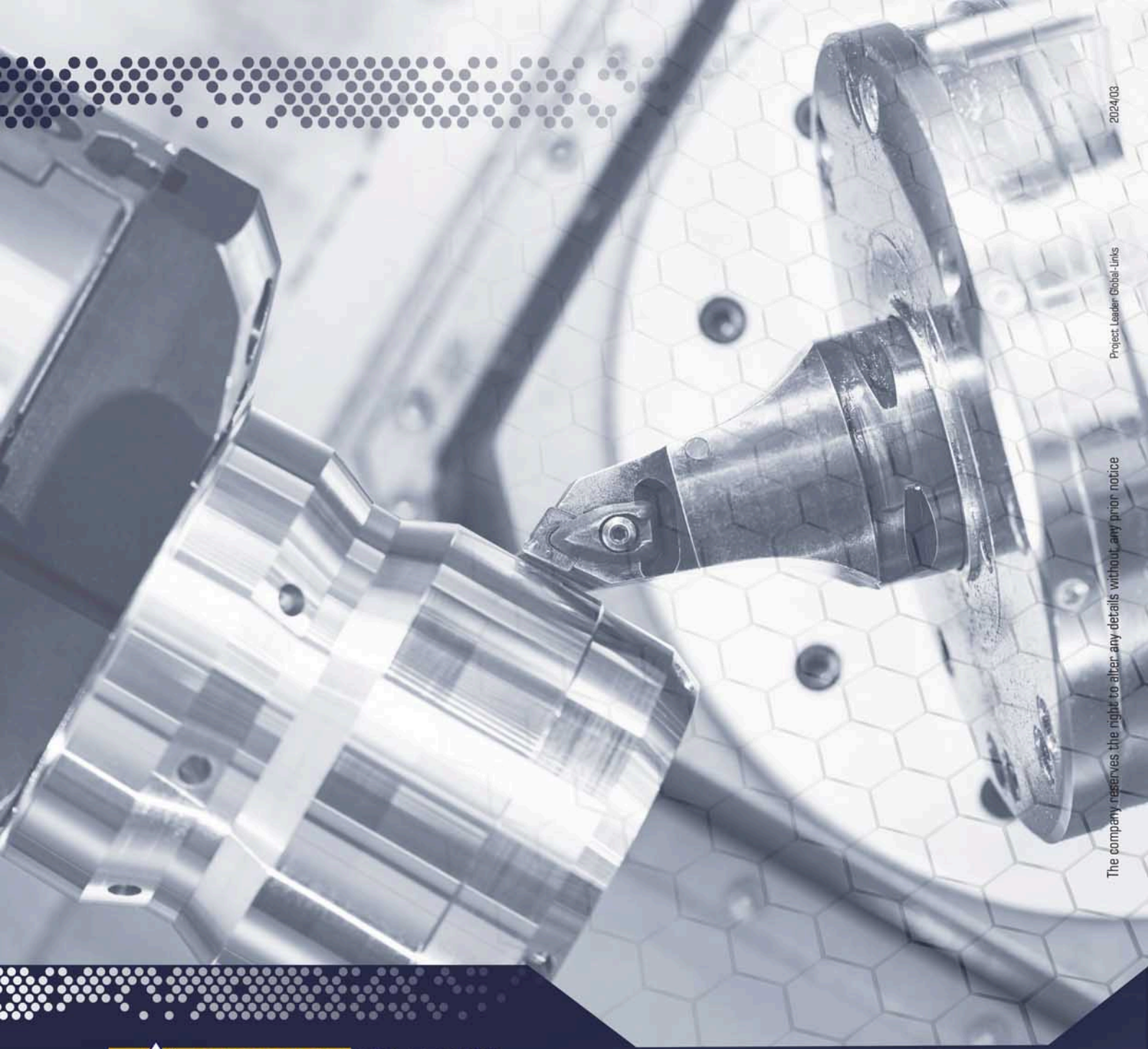

2024/03

Project Leader Global-Links

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