outokumpu
high performance stainless steel

Supra 316plus

EN 1.4420, ASTM UNS S31655

General characteristics

With its high chromium and nitrogen content Supra 316plus delivers high corrosion resistance, high strength, good formability, and excellent weldability, making it ideal for use in a variety of applications, including heat exchangers, water treatment, and piping, as well as in architectural applications such as indoor and outdoor facades.

Supra 316plus is an austenitic Cr-Ni-Mo stainless steel with 21 wt.-% chromium and relatively low nickel and molybdenum content. Due to its high nitrogen content, it has increased mechanical strength and shows a high degree of work hardening on mechanical deformation. Due to its high chromium and nitrogen content, Supra 316plus offers similar or better corrosion resistance than austenitic Cr-Ni-Mo standard grades in many corrosive environments.

Supra 316plus is used in applications where increased corrosion resistance and a combination of high mechanical strength and good formability is needed. Due to its tendency to work hardening, Supra 316plus can absorb an increased amount of energy during deformation. It can be delivered in the temper rolled condition with different strength levels.

Typical applications

- Process and transport tanks
- Water treatment and pipes
- Heat exchangers
- Architectural applications
- Food and beverage industry
- Pulp and paper industry
- Mining industry
- Tank containers

Products & dimensions

Cold rolled products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
2B	Cold rolled, heat treated, pickled, skin passed	0.70-5.00	50-1550	0.70-5.00	400-1550
2E	Cold rolled, heat treated, mech. desc. pickled	2.30-4.50	50-1550	2.30-4.50	600-1550
2K	Satin finish	0.70-4.00	50-1550	0.70-4.00	400-1550

Continous hot rolled products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
1D	Hot rolled, heat treated, pickled	3.50-8.00	50-1550	3.50-8.00	600-1550
1E	Hot rolled, heat treated, mech. desc.	2.30-4.50	50-1550	2.30-4.50	600-1550

Chemical composition

The typical chemical composition for this grade is given in the table below, together with composition limits given for the product according to different standards. The required standard will be fully met as specified on the order.

The chemical composition is given as % by mass.

	C	Mn	Cr	Ni	Mo	N	Other
Typical	**0.02**		**20.3**	**8.6**	**0.7**	**0.19**	
ASTM A240	≤0.030	≤2.00	19.5-21.5	8.0-9.5	0.50-1.50	0.14-0.25	
EN 10028-7	≤0.030	≤2.00	19.5-21.5	8.0-9.5	0.50-1.50	0.14-0.25	

Corrosion resistance

Supra 316plus has excellent corrosion resistance in solutions of many halogen-free organic and inorganic compounds over a wide temperature and concentration range. It can withstand many organic and diluted mineral acids depending on the temperature and concentration of the solution. Supra 316plus may suffer from uniform corrosion in strong mineral acids and hot strong alkaline solutions.

In aqueous solutions containing halogenides, e.g. chlorides or bromides, pitting and crevice corrosion may occur depending on halogenide concentration, temperature, pH-value, concentration of oxidizing compounds, and crevice geometry, if applicable. Due to its high chromium and nitrogen content, the pitting and crevice corrosion resistance of Supra 316plus is on the same level or even better than the corrosion resistance of the austenitic Cr-Ni-Mo standard grades EN 1.4401 and EN 1.4404 (316 and 316L type stainless steels) despite its lower molybdenum content. The presence of corrosion-inhibiting or accelerating compounds like transition metal ions or organic compounds may influence the corrosion behavior of Supra 316plus.

Supra 316plus is prone to chloride-induced stress corrosion cracking at temperatures above about 50 °C depending on the applied stress and the chloride concentration in the environment like other standard austenitic stainless steels. Prior cold deformation of the structure under load increases the risk of stress corrosion cracking.

Supra 316plus can be used for indoor and outdoor applications in urban and moderately corrosive industrial environments. In environments where chloride contamination may be high, for instance in coastal areas, pitting and staining is possible. The best material performance is reached usually with the help of adequate design, correct post-weld treatment and regular cleaning during use (if applicable).

For more information on corrosion resistance, please refer to the Outokumpu Corrosion Handbook or contact our corrosion experts.

Pitting corrosion resistance		Crevice corrosion resistance
PRE	CPT	CCT
26	35	<0

Pitting Resistance Equivalent (PRE) is calculated using the following formula: PRE = %Cr + 3.3 x %Mo + 16 x %N

Critical Pitting Corrosion Temperature (CPT) as measured in the Avesta Cell (ASTM G 150), in a 1M NaCl solution (35,000 ppm or mg/l chloride ions), wet ground (320 grid) surface. Critical Crevice Corrosion Temperature (CCT) is obtained by laboratory tests according to ASTM G 48 Method F, dry ground (120 grid) surface.

Mechanical properties

The mechanical properties of the available products in the soft annealed condition at room temperature are given in the table below. Moderate strengths can be reached at elevated temperatures (~550 °C/1022 °F). Temperatures for excessive scaling are close to 850 °C/1562 °F. This grade, along with other austenitic corrosion-resistant steels, exhibits very high ductility and high elongation to fracture. It is not susceptible to brittle fracture in the solution annealed condition.

Cold rolled coil and sheet	$R_{p0.2}$ MPa	$R_{p1.0}$ MPa	R_m MPa	Elongation[1)] %	Impact strength J	Rockwell	HB	HV
Typical (thickness 1 mm)	**380**		**700**	**45**				
ASTM A240	≥ 310		≥ 635			≤ 100HRB	≤ 241	
EN 10028-7	≥ 350	≥ 380	650 - 850	≥ 35				

Hot rolled coil and sheet	$R_{p0.2}$ MPa	$R_{p1.0}$ MPa	R_m MPa	Elongation[1)] %	Impact strength J	Rockwell	HB	HV
Typical (thickness 4 mm)	**390**	**400**	**710**	**45**				
ASTM A240	≥ 310		≥ 635				≤ 241	
EN 10028-7	≥ 350	≥ 380	650 - 850	≥ 35				

Hot rolled quarto plate	$R_{p0.2}$ MPa	$R_{p1.0}$ MPa	R_m MPa	Elongation[1)] %	Impact strength J	Rockwell	HB	HV
ASTM A240	≥ 310		≥ 635			≤ 100HRB	≤ 241	

[1)]Elongation according to EN standard: Thickness < 3 mm: A_{80} initial length = 80 mm. Thickness ≥ 3 mm initial lentgh = $5.65\sqrt{S_0}$
Elongation according to ASTM standard: Gauge length 2 in. or 50 mm

Physical properties

The crystal structure is austenitic, and therefore the material is non-ferromagnetic in the soft annealed condition. The Md_{30} temperature is lower than 110° C, which makes this material very stable against martensite transformation.

Density kg/dm^3	Modulus of elasticity GPa	Thermal exp. at 100 °C 10^{-6}/°C	Thermal conductivity W/m°C	Thermal capacity J/kg°C	Electrical resistance µΩm	Magnetizable
7.9	200	16,0	15	500	0.73	No

Fabrication

Supra 316plus can be formed using typical forming processes like folding, bending, drawing, etc.

Higher strength values typically correspond to higher springback after forming.

Supra 316plus has remarkably higher proof strength than the standard austenitic stainless steel grade 316L / 1.4404 in combination with the same degree of work hardening.

Due to the design of the composition, the Erichsen Index and LDR (Limiting Drawing Ratio) match those of well-known austenitic stainless steels like 1.4307 or 1.4404.
These characteristics mean good deep drawability and excellent stretch-forming capabilities.

Welding

Supra 316plus has excellent weldability and is suitable for the full range of conventional welding methods (like MMA, MIG, MAG, TIG, SAW, LBW, or RSW), except gas welding. To ensure that the weld metal properties (e.g. strength, corrosion resistance) are equivalent to those of the parent metal, matching or slightly over-alloyed fillers should preferably be used. Austenitic 19 12 3 L (316L) filler metals can be used to get matching corrosion resistance and 22 09 NL type duplex welding consumables to get matching strength. Shielding gases should be Ar/He based or contain up to 3% nitrogen to minimize nitrogen drop. Typical heat input values for austenitic grades can be utilized. The high nitrogen content tends to restrict grain growth during the thermal cycle. Welds are not sensitized when normal welding procedures are followed.
Generally, post-weld heat treatment is not required. In special cases with high risks of stress corrosion cracking or fatigue, stress relief treatment may be considered.

In order to fully restore the corrosion resistance of the weld seam, the weld discoloration should be removed by pickling and passivation.

More detailed information concerning welding procedures can be obtained from the Outokumpu Welding Handbook, available from our sales offices.

Standards & approvals

EN 10028-7: 2016 Flat products made of steels for pressure purposes – Part 7: Stainless steels.
PED Directive 2014/68/EU European Pressure Equipment Directive
ASTM A240/A240M-17 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASME Code Case 2903 Case 2903 20Cr-8.5Ni-0.7Mo-0.2N, UNS S31655 Austenitic Steel, alloy Plate, Sheet, and Strip Section VIII, Division 1
AD 2000-Merkblatt W2 Available Particular Material Appraisal (PMA) for AD 2000-Merkblatt W2
Lloyds Register approval Certificate No: MD00/1165/0008/1. Steelmaking, Semi-Finished Products, Plates, Hot Rolled Coil and Coil
DNV-GL approval Certificate No: AMMM00001DW. Steelmaking and Rolled Steel Products
ASTM A249/A249M-16a Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes
ASTM A269/A269M-15a Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A358/A358M-15 Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications
ASTM A554-16 Standard Specification for Welded Stainless Steel Mechanical Tubing
ASTM A312/S312M-17 Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
NACE NACE MR0103 / ISO 17945 and NACE MR0175/ISO 15156-1 / NACE MR0175/ISO 15156-3

Work is in progress for further standardization.

Standard	Designation
ASTM A240/A240M	UNS S31655
EN 10028-7, PED 2014/68/EU	1.4420

Contacts & Enquiries

Contact your nearest sales office

www.outokumpu.com/contacts

Working towards forever.

We work with our customers and partners to create long lasting solutions for the tools of modern life and the world's most critical problems: Clean energy, clean water and efficient infrastructure. Because we believe in a world that lasts forever.

outokumpu
high performance stainless steel

outokumpu.com
steelfinder.outokumpu.com

5 - Outokumpu 4420 Printed: 2 Jul 2020, supersedes all previous editions.