

Supra 316/4436

EN 1.4436, ASTM TYPE 316

General characteristics

Supra 316/4436 is a Supra 316L/4432 alternative with higher carbon content and similar corrosion resistance. Supra 316/4436 is an austenitic stainless steel that belongs to the standard CrNiMo stainless steel family. Supra 316/4436 has the variant with increased molybdenum content for slightly improved corrosion resistance.

Due to their molybdenum content, the austenitic CrNiMo standard grades can be used in applications that demand increased corrosion resistance. Their well-balanced material properties make them suitable for the fabrication of many products.

Supra 316/4436 is available in many product forms and dimensions. It can be supplied with a wide range of functional and aesthetic surface finishes.

Typical applications

- Pulp and paper industry equipment
- Pharmaceutical industry equipment
- Flanges and valves

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	0.40-6.35	35-2050	0.40-6.35	300-2050
2D	Cold rolled, heat treated, pickled	0.40-6.35	35-1610	0.40-6.35	35-1610
2E	Cold rolled, heat treated, mech. desc. pickled	1.50-6.35	96-2050	1.50-6.35	300-2050
2G	Ground	0.60-4.00	35-1530	0.60-4.00	35-1530
2K	Satin finish	0.60-2.00	35-1280	0.60-2.00	400-1280

Continuous hot rolled products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width

1D	Hot rolled, heat treated, pickled	2.70-12.70	50-2050	2.70-12.70	50-2050
1E	Hot rolled, heat treated, mech. desc.	1.46-4.50	50-1610	1.46-4.50	50-1610

Quarto plate products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
1D	Hot rolled, heat treated, pickled			5.00-130.00	400-3200

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	0.04		16.9	10.7	2.6		
EN 10028-7	≤0.05	≤2.00	16.5-18.5	10.5-13.0	2.50-3.00	≤0.10	
EN 10088-2	≤0.05	≤2.0	16.5-18.5	10.5-13.0	2.5-3.0	≤0.10	
EN 10088-3	≤0.05	≤2.00	16.5-18.5	10.5-13.0	2.50-3.00	≤0.10	
EN 10088-4	≤0.05	≤2.0	16.5-18.5	10.5-13.0	2.5-3.0	≤0.10	

Corrosion resistance

Supra 316/4436 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 316/4436 may suffer from uniform corrosion in strong mineral acids and hot strong alkaline solutions. More detailed information on the corrosion properties of Supra 316/4436 can be found in Outokumpu's Corrosion Tables published in the [Outokumpu Corrosion Handbook](#) and on www.outokumpu.com.

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, or crevice geometry, if applicable. Due to its increased molybdenum content, the resistance of Supra 316/4436 against pitting and crevice corrosion is slightly increased compared to the basic austenitic CrNiMo grades 4401 and 4404. The presence of corrosion-inhibiting or accelerating compounds like e.g. transition metal ions or organic compounds may influence the corrosion behavior of Supra 316/4436.

Supra 316/4436 is prone to chloride-induced stress corrosion cracking at temperatures over about 50 °C depending on the applied stress and the chloride concentration in the environment. Prior cold deformation of the structure under load increases the risk of stress corrosion cracking.

Supra 316/4436 can be used for indoor and outdoor applications in rural, 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 the Outokumpu corrosion experts.

Pitting corrosion resistance		Crevice corrosion resistance
PRE	CPT	CCT
25	27±3	<0

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

Corrosion Pitting Temperature (CPT) as measured in the Avesta Cell (ASTM G 150), in a 1M NaCl solution (35,000 ppm or mg/l chloride ions).

Critical Crevice Corrosion Temperature (CCT) is obtained by laboratory tests according to ASTM G 48 Method F

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)	295	330	600	70				
EN 10028-7	≥ 240	≥ 270	550 - 700	≥ 40				
EN 10088-2	≥ 240	≥ 270	550 - 700	≥ 40				
EN 10088-4	≥ 240	≥ 270	550 - 700	≥ 40				

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)	315	360	615	50			165	
EN 10028-7	≥ 240	≥ 270	550 - 700	≥ 40				
EN 10088-2	≥ 240	≥ 270	550 - 700	≥ 40				
EN 10088-4	≥ 240	≥ 270	550 - 700	≥ 40				

Hot rolled quarto plate	R _{p0.2} MPa	R _{p1.0} MPa	R _m MPa	Elongation ¹⁾ %	Impact strength J	Rockwell	HB	HV
Typical (thickness 15 mm)	260	300	590	50				
EN 10028-7	≥ 220	≥ 260	530 - 730	≥ 40				
EN 10088-2	≥ 220	≥ 260	530 - 730	≥ 40				
EN 10088-4	≥ 220	≥ 260	530 - 730	≥ 40				

Wire rod	R _{p0.2} MPa	R _{p1.0} MPa	R _m MPa	Elongation ¹⁾ %	Impact strength J	Rockwell	HB	HV
Typical	220	260	530	55				

¹⁾Elongation according to EN standard:

A₈₀ for thickness below 3 mm.

A for thickness = 3 mm.

Elongation according to ASTM standard A₂ or A₅₀.

Physical properties

Physical properties according to EN 10088 are shown below.

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
8.0	200	16.0	15	500	0.75	No

Fabrication

Cold forming

Supra 316/4436 can be readily formed and fabricated by the full range of cold forming operations. They can be used in heading, drawing, and bending. Any cold forming operations will increase the strength and hardness of the material.

Hardening

Supra 316/4436 cannot be hardened by heat treatment. However, it can be hardened by cold forming.

Hot forming

Hot forming can be carried out in the 850–1150 °C temperature range. For maximum corrosion resistance, forgings should be annealed at 1070 °C and rapidly cooled in air or water after hot forming operations.

Annealing

Quench annealing should be performed at 1030–1110 °C and followed by rapid cooling in water or air. In applications where high residual stresses cannot be accepted, stress relief treatment may be necessary. This can be performed by annealing as outlined above, but may also be performed at lower temperatures.

Please contact us for further information.

Machining

Supra 316/4436 is more difficult to machine than ordinary carbon steels but is still comparatively easy to machine compared to more highly alloyed stainless grades. Unless modified for improved machinability, it requires higher cutting forces than carbon steels, shows resistance to chip breaking and a high tendency to built-up edge formation. The best machining results are obtained by using high-power equipment, sharp tooling, and a rigid set-up.

Better machinability performance is given by Outokumpu Prodec products, which have been modified for improved machinability.

Prodec is available as hot rolled plate and bar in 4401, 4404, 4436, and 4432 grades.

Welding

Supra 316/4436 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.

Supra 316/4436 has about 50% higher thermal expansion and lower heat conductivity compared to carbon steels. This means that larger deformation and higher shrinkage stresses may result from welding.

In thin sections, autogenous welding may be used. In thicker sections, the low-carbon containing grade Supra 316L/4432 is preferred. 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. The recommended filler metal is 19 12 3L.

Post-weld heat treatment is generally not required. In special cases where there is high risk 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

The most commonly used international product standards are given in the table below.

Standard	Designation
EN 10028-7, PED 2014/68/EU	1.4436
EN 10088-2	1.4436
EN 10088-3	1.4436
EN 10088-4	1.4436

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.

Information given in this brochure may be subject to alterations without notice. Care has been taken to ensure that the contents of this publication are accurate but Outokumpu and its affiliated companies do not accept responsibility for errors or for information which is found to be misleading. Suggestions for or descriptions of the end use or application of products or methods of working are for information only and Outokumpu and its affiliated companies accept no liability in respect thereof. Before using products supplied or manufactured by the company the customer should satisfy himself of their suitability



outokumpu.com
steelfinder.outokumpu.com