outokumpu
high performance stainless steel

Core 441/4509

EN 1.4509, ASTM UNS S43940

General characteristics

Core 441/4509 is a nickel-free 17% chromium ferritic stainless steel originally designed for exhaust systems, with good corrosion resistance and high-temperature strength. Core 441/4509 is available with a single (niobium) or dual (niobium and titanium) stabilizer. Due to good formability and weldability, it is often a suitable replacement for Core 301/4310.

Core 441/4509 can be supplied with a wide range of functional and aesthetic surface finishes.

Typical applications

- Indoor cladding
- Restaurant equipment and appliances
- Tubes
- Heat exchangers

Products & dimensions

Cold rolled products, available dimensions (mm)

		Coil / Strip		Plate / Sheet	
Surface finish		Thickness	Width	Thickness	Width
2B	Cold rolled, heat treated, pickled, skin passed	0.30-3.58	12-1550	0.30-3.58	18-1550
2BB	Bright-pickled	0.30-3.50	30-1500	0.30-3.50	350-1530
2C	Cold rolled, heat treated	0.80-3.50	30-1500		
2D	Cold rolled, heat treated, pickled	0.40-3.50	30-1530	0.40-3.50	350-1530
2E	Cold rolled, heat treated, mech. desc. pickled	0.33-3.58	12-1530	0.33-3.58	18-1530
2F	Cold rolled, heat treated, skin passed	0.33-3.58	12-1524	0.33-3.58	18-1524
2G	Ground	0.30-3.58	12-1550	0.30-3.58	18-1550
2H	Work hardened	0.80-3.50	30-1530		
2J	Brushed or dull polished	0.30-3.00	30-1530	0.30-3.00	350-1530
2K	Satin finish	0.53-3.58	12-1524	0.53-3.58	18-1524
2M	Patterned	0.30-3.50	30-1500	0.30-3.50	350-1500
2R	Cold rolled, bright annealed	0.05-1.50	3-1500	0.40-1.50	350-1500

Continous hot rolled products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
1C	Hot rolled, heat treated, not descaled	2.00-8.00	50-1550		
1D	Hot rolled, heat treated, pickled	3.00-6.36	50-1550	3.00-6.36	350-1524
1E	Hot rolled, heat treated, mech. desc.	5.00-5.00	50-1550		
1G	Ground	2.00-3.00	750-1455	2.00-3.00	750-1455
1M	Patterned	2.00-3.00	750-1455	2.00-3.00	750-1455
1U	Black hot rolled	2.00-8.00	50-1550		

Chemical composition

The chemical composition may vary slightly between different product standards. The required standard will be fully met as specified in the order.

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**		**17.6**				**Ti Nb**
ASME II A SA-240	≤0.030	≤1.00	17.0-19.0	≤0.50		≤0.030	
ASME II A SA-240	≤0.030	≤1.00	17.5-18.5				Ti
ASTM A240	≤0.030	≤1.00	17.0-19.0	≤0.50		≤0.030	
ASTM A240	≤0.030	≤1.00	17.5-18.5				Ti
EN 10028-7	≤0.030	≤1.00	17.50-18.50				Ti
EN 10088-2	≤0.030	≤1.0	17.5-18.5				Ti
EN 10088-4	≤0.030	≤1.0	17.5-18.5				Ti
IS 6911	≤0.030	≤1.00	17.0-19.0	≤0.50	≤0.30	≤0.030	

Corrosion resistance

Outokumpu Core 441/4509 has good corrosion resistance in solutions of many halogen-free organic and inorganic compounds over a wide temperature and concentration range. It can withstand many sufficiently diluted organic and mineral acids depending on the temperature and concentration of the solution. Core 441/4509 may suffer from uniform corrosion in strong organic and mineral acids, as well as in hot concentrated alkaline solutions. More detailed information on corrosion properties of Core 441/4509 can be found in Outokumpu's Corrosion Tables published in the Outokumpu Corrosion Handbook and on Stainless Steel Finder.

In aqueous solutions containing halogenides, e.g. chlorides or bromides, pitting and crevice corrosion may occur depending on the halogenide concentration, temperature, pH-value, concentration of oxidizing compounds, or crevice geometry, if applicable. For short periods of time, for instance when cooking food in stainless steel dishes, Core 441/4509 can even tolerate relatively high chloride concentrations. The presence of corrosion inhibiting or accelerating compounds like e.g. transition metal ions or organic compounds may influence the corrosion behavior of Core 441/4509. Due to its ferritic crystal structure, Core 441/4509 is not prone to chloride-induced stress corrosion cracking.

Core 441/4509 can be used for indoor applications in rural areas and urban environments where chloride contamination is low. The best material performance is typically achieved with the help of adequate design, correct post-weld treatment, and regular cleaning during use (if applicable).

Due to its titanium and niobium content, the risk of sensitization for intergranular corrosion is strongly reduced when compared to non-stabilized ferritic grades. Core 441/4509 can be used in the temperature range in which chromium carbides would precipitate in non-stabilized ferritic grades. Its maximum service temperature in dry air is 950 °C. The presence of other corrosive compounds in the hot environment like water or sulfur compounds may reduce the maximum service temperature significantly.

Pitting corrosion resistance		Crevice corrosion resistance
PRE	CPT	CCT
18	<10	<0

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

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

Mechanical properties

The mechanical properties of the available products are given in the table below.

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)	**310**	**330**	**480**	**55**				
ASTM A240	≥ 205		≥ 415			≤ 89HRB	≤ 183	
ASTM A240	≥ 250		≥ 430			≤ 88HRB	≤ 180	
EN 10088-2	≥ 230		430 - 630	≥ 18				
EN 10088-4	≥ 230		430 - 630	≥ 18				
IS 6911	≥ 205		≥ 415			≤ 89HRB	≤ 183	

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)	**365**	**395**	**500**	**31**			**78**	
IS 6911	≥ 205		≥ 415			≤ 89HRB	≤ 183	

Hot rolled quarto plate	$R_{p0.2}$ MPa	$R_{p1.0}$ MPa	R_m MPa	Elongation[1)] %	Impact strength J	Rockwell	HB	HV
IS 6911	≥ 205		≥ 415			≤ 89HRB	≤ 183	

[1)]Elongation according to EN standard:
A_{80} for thickness below 3 mm.
A for thickness = 3 mm.
Elongation according to ASTM standard $A_{2"}$ or A_{50}.

Physical properties

Data according to EN 10088

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

7.7	220	10,0	25	460	0.60	Yes

Fabrication

Core 441/4509 can be formed using typical forming processes like folding, bending, drawing, etc. It has slightly higher proof strength than standard austenitic stainless steel grade 1.4301 / AISI 304 in combination with lower work hardening. Due to the titanium stabilization, its R-value is higher compared to non-stabilized ferritic stainless steel. These characteristics mean excellent deep-drawability.

Welding

Conventional welding methods and filler materials applied to austenitic 300-series can be used. Heat input in welding should be kept to a minimum level. Welded structures generally show lower ductility compared to that of base material.

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
ASME SA-240M Code Sect. II. Part A	UNS S43940; UNS S43940
ASTM A240/A240M	UNS S43940; UNS S43940
EN 10028-7, PED 2014/68/EU	1.4509
EN 10088-2	1.4509
EN 10088-4	1.4509
IS 6911, AMENDMENT NO. 2	ISS 439Ti1

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.

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