

Steel Grades, Properties and Global Standards

Outokumpu

Outokumpu is one of the world's leading stainless steel producers. The Group combines cost-efficient production with a global sales and distribution network and offers customers one of the broadest product ranges on the market.

Outokumpu's focus is exclusively on stainless steel and the company strive for product development in close cooperation with customers.

The vision is to become "The undisputed number one in Stainless".

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Data

The data in this publication are from the latest EN and ASTM standards or drafts. They are complemented with Outokumpu typical values, generally for hot rolled plate, 10–20 mm, transverse direction and a standard test method.

Materials data for other products forms and fabricated conditions are available in separate brochures.

Stainless Steel Standards

National standards within Europe are now being superseded by EN, and the global stainless steel market will be based on EN, ASTM and JIS standards.

Outokumpu supports further harmonisation of data and document structures within ISO to improve quality and efficiency of technical communication and facilitate growth of the total stainless steel market.

Harmonised standards and new designations are gradually being implemented in our systems. This overview is a guideline. It will be updated continuously.

Information about standards is provided by:

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Stainless Steel Products from Outokumpu

Table 1

Product	Code	Production unit or subsidiary
Hot rolled plate (Quarto)	P	Degerfors, New Castle, Siegen
Hot rolled strip/sheet (CPP)	H	Tornio Works, Avesta Works/Steckel and supplying units
Cold rolled strip/sheet	C	Tornio Works, Avesta Works, Thin Strip Nyby, Thin Strip Kloster
Bar	B	Outokumpu Stainless Bar (Richburg), Degerfors Stainless (Degerfors)
Rod	R	ASR Rod Mill (Sheffield), Fagersta Stainless (Fagersta)
Tube and pipe	T	Outokumpu Stainless Tubular Products (Torshälla, Storfors, Jakobstad, Wildwood, Riyadh)
Fittings	F	Outokumpu Stainless Tubular Products (Örnsköldsvik, Molkom, Jakobstad, Brockville)
DUPROF™, High strength profiles	D	Outokumpu PSC Nordic (Degerfors)
Manufactured products		Outokumpu Prefab (Avesta), Outokumpu Press Plate (Avesta), ÖMV (Örnsköldsvik)

Steel Grades, Chemical Composition, Products

Table 2

		Outokumpu steel name	International steel designation		Typical chemical composition, %						Products	
			EN	ASTM/UNS	JIS	C	N	Cr	Ni	Mo		Others
WET CORROSION AND GENERAL SERVICE	Ferritic	4512	1.4512	409	SUS409	0.02	–	11.5	0.2	–	Ti	C
		4003	1.4003	S40977	–	0.02	–	11.5	0.5	–	–	PHC
		4000	1.4000	410S	SUS 403	0.03	–	12.5	–	–	–	P
		4016	1.4016	430	SUS 430	0.04	–	16.5	–	–	–	HCBR
		4509	1.4509	S43932	–	0.02	–	18	–	–	Nb Ti	C
		4521	1.4521	444	SUS 404	0.02	–	18	–	2.1	Ti	PC
	Martensitic	4006	1.4006	410	SUS 410	0.12	0.04	12	–	–	–	PBR
		4005	1.4005	416	SUS 416	0.10	0.04	13	–	–	S	BR
		4021	1.4021	420	SUS 420J1	0.20	–	13	–	–	–	BR
		4028	1.4028	420	SUS 420J2	0.30	–	12.5	–	–	–	R
		4313	1.4313	S41500	SUS Ti6NM	0.03	0.04	12.5	4.1	0.6	–	P
		4548	1.4548*	–	–	0.05	0.07	15.5	4.2	–	Mn	R
	Duplex	LDX 2101®	1.4162	S32101	–	0.03	0.22	21.5	1.5	0.3	5Mn	PHCRTFD
		2304	1.4362	S32304	–	0.02	0.10	23	4.8	0.3	–	PHCRTFD
		LDX 2404™	1.4662*	S82441	–	0.02	0.27	24	3.6	1.6	3Mn	PHCTF
		2205	1.4462	S32205 ¹⁾	SUS 329J3L	0.02	0.17	22	5.7	3.1	–	PHCBRTFD
		4501	1.4501	S32760	–	0.02	0.27	25.4	6.9	3.8	W, Cu	P
		2507	1.4410	S32750	–	0.02	0.27	25	7	4	–	PCHTF
	Austenitic	4310	1.4310	301	SUS 301	0.10	–	17	7	–	–	HCBR
		4318	1.4318	301LN	SUS 301L	0.02	0.14	17.7	6.5	–	–	HC
		4372	1.4372	201	SUS 201	0.05	0.20	17	4	–	7Mn	HCR
		4568	1.4568	631	SUS 631	0.08	0.02	16.6	7.6	–	Al	R
		4301	1.4301	304	SUS 304	0.04	–	18.1	8.1	–	–	PHCBRTF
		4307	1.4307	304L	–	0.02	–	18.1	8.1	–	–	PHCBRTF
		4311	1.4311	304LN	SUS 304LN	0.02	0.14	18.5	9.2	–	–	PHCBR
		4541	1.4541	321	SUS 321	0.04	–	17.3	9.1	–	Ti	PHCBRTF
		4550	1.4550	347	SUS 347	0.05	0.04	17.5	9.5	–	Nb	PCR
		4305	1.4305	303	SUS 303	0.05	–	17.3	8.2	–	S	PBR
		4303	1.4303	305	SUS 305J1	0.04	–	17.7	12.5	–	–	PHCBR
		4306	1.4306	304L	SUS 304L	0.02	–	18.2	10.1	–	–	PHCBRTF
		4567	1.4567	S30430	SUS XM7	0.01	–	17.7	9.7	–	3Cu	BR
		4401	1.4401	316	SUS 316	0.04	–	17.2	10.1	2.1	–	PHCBRTF
		4404	1.4404	316L	–	0.02	–	17.2	10.1	2.1	–	PHCBRTF
		4427	1.4427*	–	–	0.02	0.05	16.9	10.7	2.6	S	P
		4436	1.4436	316	SUS 316	0.04	–	16.9	10.7	2.6	–	PHCBRTF
		4432	1.4432	316L	–	0.02	–	16.9	10.7	2.6	–	PHCBRTF
		4406	1.4406	316LN	SUS 316LN	0.02	0.14	17.2	10.3	2.1	–	PHCBR
		4429	1.4429	S31653	SUS 316LN	0.02	0.14	17.3	12.5	2.6	–	PR
		4571	1.4571	316Ti	SUS 316Ti	0.04	–	16.8	10.9	2.1	Ti	PHCBRTF
		4435 ²⁾	1.4435 ²⁾	316L	SUS 316L	0.02	–	17.3	12.6	2.6	–	PHCBRTF
3952		1.3952*	–	–	0.02	0.18	16.9	13.2	2.7	–	P	
4438		1.4438	317L	SUS 317L	0.02	–	18.2	13.7	3.1	–	PCBR	
4439		1.4439	317LMN ⁴⁾	–	0.02	0.14	17.3	13.7	4.1	–	PC	
725LN		1.4466	S31050	–	0.01	0.12	25	22.3	2.1	–	P	
3964		1.3964*	–	–	0.02	0.27	20.5	15.4	3.2	Mn, Nb	P	
904L		1.4539	904L	–	0.01	–	20	25	4.3	1.5Cu	PHCBRTF	
4529		1.4529	N08926/N08367	–	0.01	0.20	20.5	24.8	6.5	Cu	P	
254 SMO®		1.4547	S31254	–	0.01	0.20	20	18	6.1	Cu	PHCBRTF	
4565		1.4565	S34565	–	0.02	0.45	24	17	4.5	5.5Mn	PC	
654 SMO®		1.4652	S32654	–	0.01	0.50	24	22	7.3	3Mn, Cu	PCT	
HEAT AND CREEP	Ferritic	4713	1.4713	–	–	0.07	0.02	6.5	–	–	0.7Al	P
		4724	1.4724	–	–	0.08	0.02	12.3	–	–	0.8Al	P
		4742	1.4742	–	–	0.08	0.02	17.5	–	–	1Al	P
		4762	1.4762	–	–	0.08	0.02	23.4	–	–	1.4Al	P
	Austenitic	4948	1.4948	304H	SUS 304	0.05	–	18.1	8.3	–	–	PHCBR
		4878	1.4878 ³⁾	321H	SUS 321	0.05	–	17.3	9.1	–	Ti	PHCBR
		153 MA™	1.4818	S30415	–	0.05	0.15	18.5	9.5	–	1.3Si, Ce	PCBRT
		4833	1.4833 ³⁾	309S ³⁾	SUS 309	0.06	–	22.3	12.6	–	–	PHCBR
		4828	1.4828	–	SUH 309	0.04	–	20	12	–	2Si	PHCBR
		253 MA®	1.4835	S30815	–	0.09	0.17	21	11	–	1.6Si, Ce	PHCBRT
		4845	1.4845 ³⁾	310S ³⁾	SUS 310S	0.05	–	25	20	–	–	PHCBR
		4841	1.4841	314	–	0.07	0.05	24.5	19.5	–	2Si	P

* designation according to Stahl Eisen Liste (Register of European Steels)

1) Also available as S31803

2) 724L is a modified version of 4435 for Urea applications

3) Additional creep resisting grades are: 1.4941, 1.4950, 1.4951

4) 317LMN not available in all product forms

The grades listed represent the Outokumpu steel programme. Other grades are also available. The Outokumpu steel names are generic and cover corresponding steel numbers/names, which may not have the same chemical composition limits.

Multicertification is made on request to EN/ASTM/

ASME as well as to superseded national standards.

EN steel numbers are listed in: Stahl Eisen Liste.

ASTM/ASME steel numbers are listed in: Metals & Alloys in the Unified Numbering System (UNS).

Traditional Steel Designations

Table 3

Outokumpu steel name	National designations, superseded by EN			
	BS/UK	DIN/Germany	NF/France	SS/Sweden
4512	409S	1.4512	Z3 CT12	–
4003	–	1.4003	–	–
4000	403S17	1.4000	Z8 C12	2301
4016	430S17	1.4016	Z8 C17	2320
4509	–	1.4509	Z3 CT Nb 18	–
4521	–	1.4521	Z3 CDT 18-02	2326
4006	410S21	1.4006	Z10 C13	2302
4005	416S21	1.4005	Z11 CF13	2380
4021	420S29	1.4021	Z20 C13	2303
4028	420S45	1.4028	Z33 C13	2304
4313	–	1.4313	Z6 CN 13-04	2385
4548	–	–	–	–
LDX 2101®	–	–	–	–
2304	–	1.4362	Z3 CN 23-04 Az	2327
LDX 2404™	–	–	–	–
2205	318S13	1.4462	Z3 CND 22-05 Az	2377
4501	–	–	–	–
2507	–	–	Z3 CND 25-06 Az	2328
4310	301S21	1.4310	Z11 CN 18-08	2331
4318	–	–	Z3 CN 18-07 Az	–
4372	284S16	–	Z12 CMN 17-07 Az	–
4568	–	1.4568	Z9 CNA 17-07	2388
4301*	304S31	1.4301	Z7 CN 18-09	2333
4307*	304S11	1.4307	Z3 CN 18-10	2352
4311*	304S61	1.4311	Z3 CN 18-10 Az	2371
4541	321S31	1.4541	Z6 CNT 18-10	2337
4550	347S31	1.4550	Z6 CNNb 18-10	2338
4305	303S31	1.4305	Z8 CNF 18-09	2346
4303	305S19	1.4303	Z1 CN 18-12	–
4306*	304S11	1.4306	Z3 CN 18-10	2352
4567	304S17	1.4567	Z3 CNU 18-09 FF	–
4401*	316S31	1.4401	Z7 CND 17-11-02	2347
4404*	316S11	1.4404	Z3 CND 17-11-02	2348
4427	–	–	–	–
4436*	316S33	1.4436	Z7 CND 18-12-03	2343
4432*	316S13	1.4432	Z3 CND 18-14-03	2353
4406*	316S61	1.4406	Z3 CND 17-11 Az	–
4429*	316S63	1.4429	Z3 CND 17-12 Az	2375
4571	320S31	1.4571	Z6 CNDT 17-12	2350
4435*	316S13	1.4435	Z3 CND 18-14-03	2353
3952	–	–	–	–
4438	317S12	1.4438	Z3 CND 19-15-04	2367
4439	–	1.4439	Z3 CND 18-14-05 Az	–
725LN	–	1.4466	Z2 CND 25-22 Az	–
3964	–	–	–	–
904L	904S13	1.4539	Z2 NCDU 25-20	2562
4529	–	–	–	–
254 SMO®	–	–	–	2378
4565	–	1.4565	–	–
654 SMO®	–	–	–	–
4713	–	1.4713	–	–
4724	–	1.4724	Z13 C13	–
4742	–	1.4742	Z12 CAS18	–
4762	–	1.4762	Z12 CAS25	–
4948	304S51	1.4948	Z6 CN 18-09	2333
4878	321S51	1.4878	Z6 CNT 18-10	2337
153 MA™	–	–	–	2372
4833	309S16	1.4833	Z15 CN 23-13	–
4828	–	1.4828	Z17 CNS 20-12	–
253 MA®	–	1.4835	–	2368
4845	310S16	1.4845	Z8 CN 25-20	2361
4841	–	1.4841	Z15 CNS 25-20	–

* Available in compositions optimised for forming operations.

PRODUCT CODES

P = Hot rolled plate (Quarto)
H = Hot rolled strip/sheet (CPP)
C = Cold rolled strip/sheet
B = Bar
R = Rod
T = Tube/pipe
F = Fittings
D = DUPROF™, profiles in high strength stainless steel

LDX 2101®, LDX 2404™, 254 SMO®, 654 SMO®,
153 MA™ and 253 MA® are trademarks owned by
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Mechanical Properties, Room Temperature

Table 4

Outokumpu steel name	Outokumpu typical values					EN, min. values, RT					ASTM, min. values, RT				
		R _{p0.2} MPa	R _{p1.0} MPa	R _m MPa	A ₅ %	No.	R _{p0.2} MPa	R _{p1.0} MPa	R _m MPa	A ₅ %	KV J	No.	R _{p0.2} MPa	R _m MPa	A _{2"} %
4512	C					1.4512	220		380	25		S40910	170	380	20
4003	P	360	430	570	28	1.4003	280		450	18		S40977	280	450	18
4000	P	270	320	490	30	1.4000	230		400	19		S41008	205	415	22
4016	C	380		520	25	1.4016	280		450	20		S43000	205	450	22
4509	C	360		520	30	1.4509	250		430	18		S43932	205	415	22
4521	P	360	400	540	26	1.4521	300		420	20		S44400	275	415	20
4006 ¹⁾	P	300	360	560	30	1.4006	450		650	12		S41000	205	450	20
4005	R	350	450	550	20	–						–			
4021 ¹⁾	P	500	580	650	20	1.4021	450		650	12		S42010			
4028	P					1.4028	600		800	10		S42000		690	15
4313 ²⁾	P	700	770	850	20	1.4313	630		780	15	70	S41500	620	795	15
4548	R	850	1050	1100	22	–						–			
LDX 2101®	P	480		700	38		450 ⁴		650 ⁴	30 ⁴	40 ⁴	S32101	450	650	30
2304	P	450		670	40	1.4362	400		630	25	60	S32304	400	600	25
LDX 2404™	P	480		680	33	1.4662						S82441			
2205	P	510		750	35	1.4462	460		640	25	60	S32205	450	655	25
4501 ³⁾	P	540		830	35	1.4501	530		730	25	60	S32760	550	750	25
2507	P	560		830	35	1.4410	530		730	20	60	S32750	550	795	15
4310	C	300	330	800	50	1.4310	250	280	600	40		S30100	205	515	40
4318	C	360	395	765	47	1.4318	350	380	650	40	60	S30153	240	550	45
4372	C	390	420	720	45	1.4372	350	380	750	45		S20100	310	655	40
4568	R	210	240	700	50	1.4568						–			
4301	P	290	330	600	55	1.4301	210	250	520	45	60	S30400	205	515	40
4307	P	280	320	580	55	1.4307	200	240	500	45	60	S30403	170	485	40
4311	P	320	360	640	55	1.4311	270	310	550	40	60	S30453	205	515	40
4541	P	250	290	570	55	1.4541	200	240	500	40	60	S32100	205	515	40
4550	P	260	290	595	45	1.4550	200	240	500	40	60	S34700	205	515	40
4305	P	275	–	585	35	1.4305	190	230	500	35		S30300	205	515	40
4303	C	250	280	570	50	1.4303	220	250	500	45		S30500	170	485	40
4306	P	280	320	580	55	1.4306	200	240	500	45	60	S30403	170	485	40
4567	B					1.4567	175	–	450	45		S30430			
4401	P	280	320	570	55	1.4401	220	260	520	45	60	S31600	205	515	40
4404	P	280	320	570	55	1.4404	220	260	520	45	60	S31603	170	485	40
4427	p	260	300	550	22	–						–			
4436	P	300	340	590	50	1.4436	220	260	530	40	60	S31600	205	515	40
4432	P	280	320	570	50	1.4432	220	260	520	45	60	S31603	170	485	40
4406	P	320	360	620	50	1.4406	280	320	580	40	60	S31653	205	515	40
4429	P	350	390	670	45	1.4429	280	320	580	40	60	S31653	205	515	40
4571	P	270	310	570	50	1.4571	220	260	520	40	60	S31635	205	515	40
4435	P	270	310	570	55	1.4435	220	260	520	45	60	S31603	170	485	40
3952	P	330	380	670	50	–						–			
4438	P	300	340	610	50	1.4438	220	260	520	40	60	S31703	205	515	40
4439	P	310	350	640	50	1.4439	270	310	580	40	60	S31726	240	550	40
725LN	P	290	320	630	55	1.4466	250	290	540	40	60	S31050	270	580	25
3964	P	460	510	800	40	–						–			
904L	P	260	300	600	50	1.4539	220	260	520	35	60	N08904	220	490	35
4529	P	360	430	750	55	1.4529	300	340	650	40	60	N08926/N08367	295	650	35
254 SMO®	P	340	380	680	50	1.4547	300	340	650	40	60	S31254	310	655	35
4565	P	440	480	825	55	1.4565	420	460	800	30	90	S34565	415	795	35
654 SMO®	P	450	500	830	60	1.4652	430	470	750	40	60	S32654	430	750	40
4713	P	320	350	475	30	1.4713	220	–	420	20		–			
4724	P	340	370	515	30	1.4724	250	–	450	15		–			
4742	P	375	405	535	25	1.4742	270	–	500	15		–			
4762	P	405	440	555	30	1.4762	280	–	520	15		–			
4948	P	290	330	600	55	1.4948	190	230	510	45	60	S30409	205	515	40
4878	P	250	290	570	55	1.4878	190	230	500	40		S32109	205	515	40
153 MATM	P	340	380	660	55	1.4818	290	330	600	40		S30415	290	600	40
4833	P	300	340	620	50	1.4833	210	250	500	35		S30908	205	515	40
4828	P	270	310	610	55	1.4828	230	270	550	30		–			
253 MA®	P	370	410	700	50	1.4835	310	350	650	40		S30815	310	600	40
4845	P	270	310	600	50	1.4845	210	250	500	35		S31008	205	515	40
4841	P	275	315	595	55	1.4841	230	270	550	30		S31400	205	515	40

1) annealed condition 2) quenched and tempered condition 3) max 31 mm for orders acc. to ASTM 4) according to EN 10088-4

Outokumpu typical values apply for the product listed. Cold and hot rolled strip values are generally higher than plate and bar.

EN/ASTM values: Mainly for hot rolled plate, transverse direction, from EN 10088, EN 10095, EN 10028-7, ASTM A240, A176 and ASME Code Cases. Also values from EN 10269 and ASTM A473.

EN min. values for cold rolled strip are 10 – 20 MPa higher. Hot rolled strip may on request be certified to the higher level.

Conversion from EN to ASTM, ASME:

$$\begin{aligned}
 1 \text{ MPa} &= 0.1450 \text{ ksi} & 1 \text{ J} &= 0.7376 \text{ ft-lbf} \\
 ^\circ\text{C} &= 5/9 \times (^\circ\text{F} - 32) & ^\circ\text{F} &= 9/5 \text{ }^\circ\text{C} + 32
 \end{aligned}$$

Mechanical Properties, Elevated Temperatures

Table 5

Outokumpu steel name	EN – min. R _{p0.2} MPa					Max. design stress for pressure equipment σ, MPa									
						EN				ASME VIII-1 (II D)					
	No.	RT	100	200	400°C	RT	100	200	400°C	No.	RT	100	200	400°C	
4512	1.4512	220	200	190	–										
4003	1.4003	280	240	230		187	160	153	–	S40977	–	–	–	–	
4000	1.4000	230	220	210	190	–	–	–	–	S41008	118	118	114	101	
4016	1.4016	280	220	210	190	–	–	–	–	S43000	128	126	120	108	
4509	1.4509	250	230	210		166	153	140	–	S43932	–	–	–	–	
4521	1.4521	300	250	230	200	175	167	153	–	S44400	118	118	112	–	
4006	1.4006	450	420	400	305	–	–	–	–	S41000	128	126	120	108	
4005	1.4005					–	–	–	–	S41600	–	–	–	–	
4021	1.4021	450	420	400	305	–	–	–	–	S42010	–	–	–	–	
4028	1.4028	600				–	–	–	–	S42000	–	–	–	–	
4313	1.4313	630	590	560		325	325	325	–	S41500	–	–	–	–	
4548	–					–	–	–	–	–					
LDX 2101®	1.4162	450	380	330		271 ³⁾	253 ³⁾	220 ³⁾	–	S32101 ¹⁾	186	184	171	–	
2304	1.4362	400	330	280		263	220	187	–	S32304	172	164	150	–	
LDX 2404™	1.4662	–	–	–		–	–	–	–	S82441	–	–	–	–	
2205	1.4462	460	360	315		267	240	210	–	S31803	177	177	165	–	
4501	1.4501	530	450	400		304	300	267	–	S32760	–	–	–	–	
2507	1.4410	530	450	400		304	300	267	–	S32750	228	227	208	–	
4310	1.4310	250	210	190		–	–	–	–	S30100	–	–	–	–	
4318	1.4318	350	265	185		247	177	153	–	S30153	–	–	–	–	
4372	1.4372	350	295	230		–	–	–	–	S20100	–	–	–	–	
4568	1.4568					–	–	–	–	–					
4301	1.4301	210	157	127	98	173	150	131	104	S30400	138	137	126	107	
4307	1.4307	200	147	118	89	167	137	120	–	S30403	115	115	110	91	
4311	1.4311	270	205	157	125	207	163	143	–	S30453	138	137	126	107	
4541	1.4541	200	176	157	125	167	147	130	125	S32100	138	138	129	119	
4550	1.4550	200	177	157	125	167	145	124	110	S34700	138	137	123	116	
4305	1.4305					–	–	–	–	S30300	–	–	–	–	
4303	1.4303	220	155	127	98	–	–	–	–	S30500	138	137	126	107	
4306	1.4306	200	147	118	89	167	137	120	–	S30403	115	115	110	91	
4567	1.4567					–	–	–	–	S30430	–	–	–	–	
4401	1.4401	220	177	147	115	173	143	130	–	S31600	138	138	134	111	
4404	1.4404	220	166	137	108	173	143	130	113	S31603	115	115	109	91	
4427	–					–	–	–	–	S31620	–	–	–	–	
4436	1.4436	220	177	147	115	177	153	140	120	S31600	138	138	134	111	
4432	1.4432	220	166	137	108	173	143	130	113	S31603	115	115	109	91	
4406	1.4406	280	211	167	135	213	173	153	–	S31653	138	138	131	105	
4429	1.4429	280	211	167	135	213	173	153	137	S31653	138	138	131	105	
4571	1.4571	220	185	167	135	173	147	131	125	S31635	138	138	134	111	
4435	1.4435	220	165	137	108	173	140	127	90	S31603	115	115	109	91	
3952	–					–	–	–	–	–					
4438	1.4438	220	172	147	115	173	143	130	–	S31703	138	138	131	109	
4439	1.4439	270	225	185	150	207	173	153	–	S31726	–	–	–	–	
725LN	1.4466	250	195	160		193	163	153	–	S31050	158	155	148	–	
3964	–					–	–	–	–	–					
904L	1.4539	220	205	175	125	173	167	153	103	N08904	140	114	95	–	
4529	1.4529	300	230	190	160	227	183	173	–	N08926/N08367	–	–	–	–	
254 SMO®	1.4547	300	230	190	160	227	205	187	158	S31254	187	186	170	158	
4565	1.4565	420	350	270	210	–	–	–	–	S34565	–	–	–	–	
654 SMO®	1.4652	430	350	315	295	–	–	–	–	S32654	214	214	199	178	
Steel name	EN R _{p1.0} /10 000h, MPa					EN R _m /100 000h, MPa				ASME max. design stress σ, MPa					
No.	600	700	800	900°C	600	700	800	900°C	No.	600	700	800	900°C		
4948	1.4948 ²⁾				89	28			S30409 ²⁾	64	27	11			
4878	1.4878	85	30	10	65	22	10	–	S32109 ²⁾	59	23	9			
153 MA™	1.4818	126	42	15	88	35	14	5	S30415						
4833	1.4833	70	25	10	65	16	7,5	3	S30909 ²⁾	49	16	6			
4828	1.4828	80	25	10	65	16	7,5	3	–						
253 MA®	1.4835	126	45	19	88	35	15	8	S30815 ²⁾	59	22	10	5		
4845	1.4845	90	30	10	80	18	7	3	S31009 ²⁾	49	16	6			
4841	1.4841	95	35	10	80	18	7	3	S31400						

- 1) Values according to code case no: 2418
- 2) Creep resisting grades for pressure purposes listed in EN 10028-7 and ASME IID.
- 3) Not yet included in EN 10028-7

EN/ASME values: For hot rolled plate from EN 10028-7, EN 10088, EN 10095, ASME IID Tables 1A and 1B, and Code Cases.

Outokumpu offers multi-certification of the grades 4307/4301 and 4404/4401.

Max allowed values of the nominal design stress		
Steel type	EN 13445	ASME VIII
Ferritic, Mart. Duplex	$\min\left[\frac{R_{p0.2T}}{1,5}; \frac{R_{mT}}{2,4}\right]$	$\min\left[\frac{R_{p0.2RT}}{1,5}; \frac{R_{mRT}}{3,5}\right]$ or $\min\left[\frac{R_{p0.2T}}{1,5}; \frac{R_{mT}}{3,5}\right]$
Austenitic A>30%	$\frac{R_{p1.0T}}{1,5}$	$\min\left[\frac{R_{p0.2RT}}{1,5}; \frac{R_{mRT}}{3,5}\right]$ or $\min\left[\frac{R_{p0.2T}}{1,1}; \frac{R_{mT}}{3,5}\right]$
Austenitic A>35%	$\min\left[\frac{R_{p1.0T}}{1,2}; \frac{R_{mT}}{3,0}\right]$ or $\max\left[\frac{R_{p1.0T}}{1,5}\right]$	$\min\left[\frac{R_{p0.2T}}{1,1}; \frac{R_{mT}}{3,5}\right]$

Mechanical Properties, Low Temperatures

Table 6

Outokumpu steel name	EN No.	EN min. values, MPa and %											
		-196°C				-80°C				RT			
		R _{p0.2}	R _{p1.0}	R _m	A ₅	R _{p0.2}	R _{p1.0}	R _m	A ₅	R _{p0.2}	R _{p1.0}	R _m	A ₅
4307	1.4307	300	400	1200	30	220	290	830	35	200	240	500	45
4301	1.4301	300	400	1250	30	270	350	860	35	210	250	520	45
4311	1.4311	550	650	1250	35	350	420	850	40	270	310	550	40
4541	1.4541	200	240	1200	30	200	240	855	35	200	240	500	40
4404	1.4404	350	450	1200	35	275	355	840	40	220	260	520	45
4406	1.4406	600	700	1150	30	380	450	800	35	280	320	580	40
4429	1.4429	600	700	1150	30	380	450	800	30	280	320	580	35

From EN 10028-7 Annex F.

Common Design Codes for Stainless Steel

Table 7

EN 13445	Unfired pressure vessels
EN 13480	Metallic industrial piping
EN 13458-2C	Cryogenic vessels. Annex C Pressure strengthening of vessels from austenitic stainless steel
EN 12285-C	Tanks for underground storage. Annex C Positive liquid-list of material/liquid combinations
ADR	International carriage of dangerous goods by road (Accord européen... Dangereuses par Route)
RID	International carriage of dangerous goods by rail (Règlement... International... Dangereuses)
IMDG	International Maritime Dangerous Goods code
UN ST/SG/AC.10/1	Recommendations on the transport of dangerous goods (United Nations)
ENV 1993-1.4	Eurocode 3: Design of steel structures – Supplementary rules for stainless steel
ENV 1090-6	Execution of steel structures – Supplementary rules for stainless steel
ASME VIII-1	ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code
AD 2000	Arbeitsgemeinschaft Druckbehälter Regelwerk
CODAP	Code Français de construction des Appareils à Pression
BS 5500	Unfired fusion welded pressure vessels

Microstructures

Austenite

Good to excellent corrosion resistance combined with very good weldability and formability characterize the austenitic stainless steels. The austenitic structure has good creep resistance and good oxidation resistance that makes them useful at elevated temperatures. Austenitic steel can also be used in cryogenic applications and is in annealed condition the only non-magnetic steel.

Martensite

These stainless steels are characterized by high strength and high wear resistance. The corrosion resistance is limited and the weldability degrades with increasing strength, i.e. increasing carbon content.

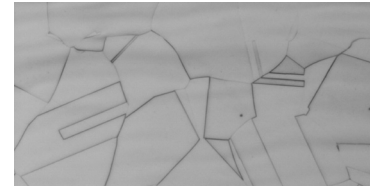
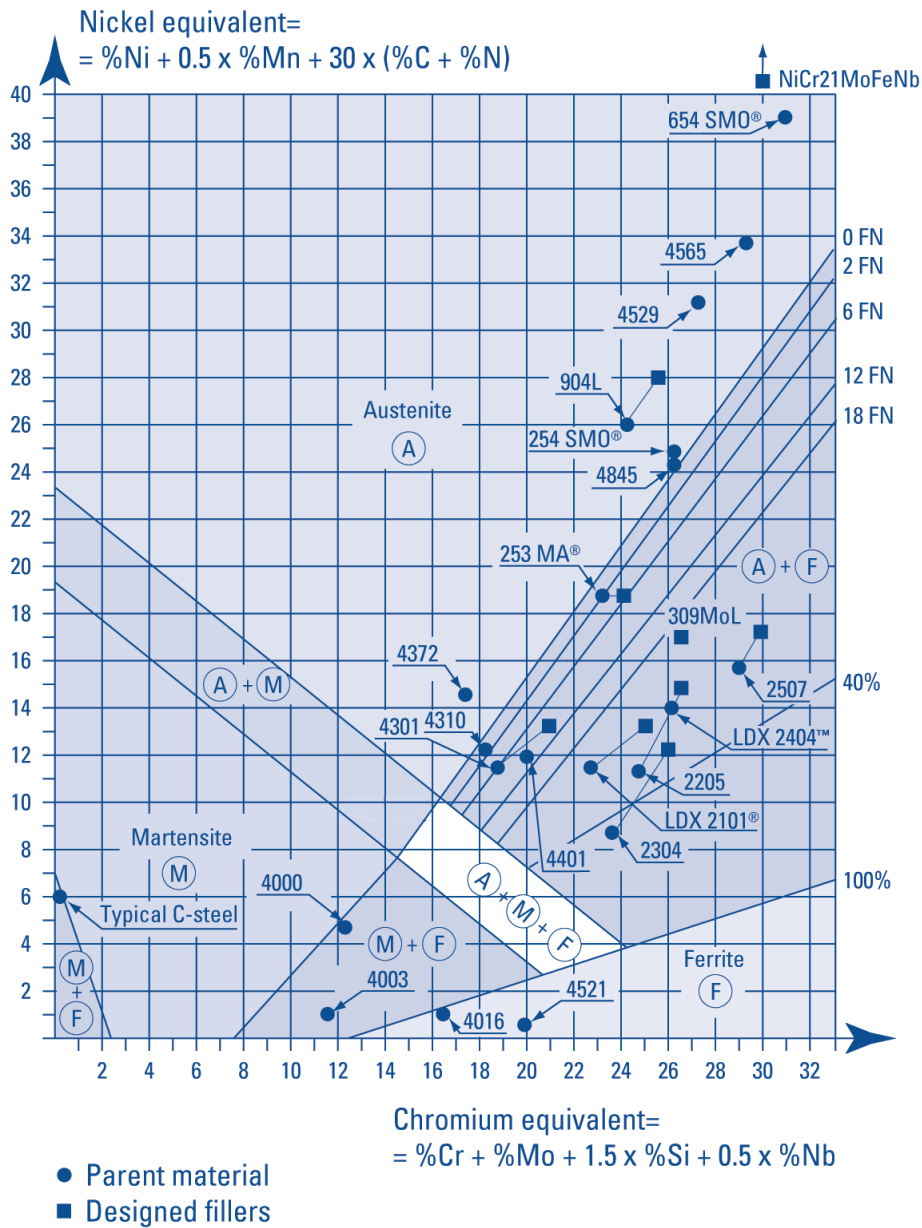
Ferrite

Ferritic stainless steels have good corrosion resistance, especially towards stress corrosion cracking. Lower carbon and nitrogen contents improve both weldability and toughness which otherwise can be limited.

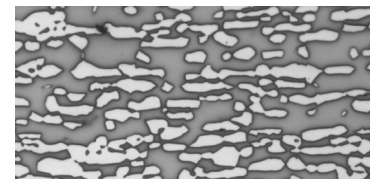
Duplex (austenite-ferrite)

Duplex stainless steels have high strength, good toughness and very good corrosion resistance, especially towards stress corrosion cracking and corrosion fatigue. These steels have also good weldability and reasonable formability.

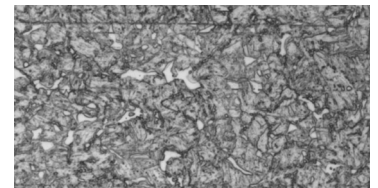
Schaeffler Diagram and Microstructures



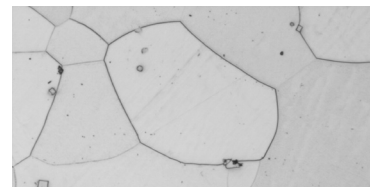
Austenite (γ-iron). Face centered cubic with 12 atom neighbours. 74% close packing.



Duplex. (austenitic-ferritic). Wellbalanced two-phase structure with ferrite content between 30-50%.



Martensite. Undercooled, oversaturated solution of carbon in ferrite, achieved by heat treatment or cold working.



Ferrite (α-iron). Body centered cubic with 8 atom neighbours. 68% packing.

The Schaeffler diagram, here a version modified by Outokumpu, is traditionally used to predict delta ferrite content in weld metal from chemical composition. It may also be used to characterise stainless steel microstructures (ferritic, martensitic, austenitic), and to compare the structural balance in similar grades or casts with the same processing history.

Physical Properties

Table 8

Outokumpu steel name	EN	Density, ρ kg/dm ³		Modulus of elasticity, E GPa		Coefficient of thermal expansion between 20°C and T, 10 ⁻⁶ /°C		Thermal conductivity, λ W/m°C		Thermal capacity, c J/kg°C	Electrical resistivity, ρ μΩm	Magnet-izable
		RT		RT	400°C	100°C	400°C	RT	400°C	RT	RT	RT
Non alloy steel	1.0345	7.8		210	175	12.0	14.0	55	44	460	0.18	Y
4512	1.4512	7.7		220		11.0		25				Y
4003	1.4003	7.7		220	195	10.4	11.6	25		430	0.60	Y
4000	1.4000	7.7		220	195	10.5	12.0	30		460	0.60	Y
4016	1.4016	7.7		220	195	10.0	10.5	25	25	460	0.60	Y
4509	1.4509	7.7		220	195	10.0	10.5	25		460	0.60	Y
4521	1.4521	7.7		220	195	10.4	11.6	23		430	0.80	Y
4006	1.4006	7.7		215	190	10.5	12.0	30		460	0.60	Y
4005	1.4005	7.7		215	190	10.5	12.0	30		460	0.60	Y
4021	1.4021	7.7		215	190	10.5	12.0	30	25	460	0.60	Y
4028	1.4028	7.7		215	190	10.5	12.0	30	25	460	0.65	Y
4313	1.4313	7.7		200	170	10.5	11.6	25		430	0.60	Y
4548	–											
LDX 2101®	1.4162	7.8		200	172	13.0	14.5	15	20	500	0.80	Y
2304	1.4362	7.8		200	172	13.0	14.5	15	20	500	0.80	Y
LDX 2404™	1.4662	7.7		205		13.0		14.5		500	0.80	Y
2205	1.4462	7.8		200	172	13.0	14.5	15	20	500	0.80	Y
4501	1.4501	7.8		200	172	13.0	14.5	15	20	500	0.80	Y
2507	1.4410	7.8		200	172	13.0	14.5	15	20	500	0.80	Y
4310	1.4310	7.9		200	172	16.0	18.0	15	20	500	0.73	N
4318	1.4318	7.9		200	172	16.0	17.5	15	20	500	0.73	N
4372	1.4372	7.8		200	172			15	20		0.70	N
4568	1.4568	7.8		200	170	13.0		16		500	0.80	Y
4301	1.4301	7.9		200	172	16.0	17.5	15	20	500	0.73	N
4307	1.4307	7.9		200	172	16.0	18.0	15	20	500	0.73	N
4311	1.4311	7.9		200	172	16.0	17.5	15	20	500	0.73	N*
4541	1.4541	7.9		200	172	16.0	17.5	15	20	500	0.73	N
4550	1.4550	7.9		200	172	16.0	17.5	15		500	0.73	N
4305	1.4305	7.9		200	172	16.0	17.5	15	20	500	0.73	N
4303	1.4303	7.9		200	172	16.0	17.5	15	20	500	0.73	N*
4306	1.4306	7.9		200	172	16.0	17.5	15	20	500	0.73	N
4567	1.4567	7.9		200	172	16.7	18.1					N
4401	1.4401	8.0		200	172	16.0	17.5	15	20	500	0.75	N
4404	1.4404	8.0		200	172	16.0	17.5	15	20	500	0.75	N
4427 ¹⁾	–	8.0		200	172	16.5	18.5	15		500	0.75	N
4436	1.4436	8.0		200	172	16.0	17.5	15	20	500	0.75	N
4432	1.4432	8.0		200	172	16.0	17.5	15	20	500	0.75	N
4406	1.4406	8.0		200	172	16.0	17.5	15	20	500	0.75	N*
4429	1.4429	8.0		200	172	16.0	17.5	15	20	500	0.75	N
4571	1.4571	8.0		200	172	16.5	18.5	15	20	500	0.75	N
4435	1.4435	8.0		200	172	16.0	17.5	15	20	500	0.75	N
3952 ¹⁾	–	7.9		200		16.5		15		500	0.75	N
4438	1.4438	8.0		200	172	16.0	17.5	14	20	500	0.85	N
4439	1.4439	8.0		200	172	16.0	17.5	14	20	500	0.85	N
725LN	1.4466	8.0		195	166	15.7		14	17	500	0.80	N
3964 ¹⁾	–	7.9		195	165	15.7	17.8	14		475	0.81	N
904L	1.4539	8.0		195	166	15.8	16.9	12	18	450	1.00	N
4529	1.4529	8.1		195	166	15.8	16.9	12	18	450	1.00	N
254 SMO®	1.4547	8.0		195	166	16.5	18.0	14	18	500	0.85	N
4565	1.4565	8.0		190	165	14.5	16.8	12	18	450	0.92	N
654 SMO®	1.4652	8.0		190	164	15.0	16.2	8.6		500	0.78	N
						400°C	1000°C	500°C				
4713	1.4713	7.7				12.0	13.5	23	25	450	0.70	Y
4724	1.4724	7.7				11.5		21	23	500	0.75	Y
4742	1.4742	7.7				11.5	13.5	19	25	500	0.93	Y
4762	1.4762	7.7				11.5	13.5	17	23	500	1.10	Y
				500°C	1000°C	500°C	1000°C	500°C	1000°C	500°C		
4948	1.4948	7.9		158	120	18.4	20.0	21.9	28.8	582	0.71	N
4878	1.4878	7.9		158		18.4	20.5	21.6		582	0.74	N
153 MA™	1.4818	7.8		163	120	18.2	19.5	21.2	29.0	585	0.84	N
4833	1.4833	7.8		158	120	18.4	20.0	20.5	27.5	582	0.87	N
4828	1.4828	7.8		158	120	18.4	20.0	20.5	27.5	582	0.87	N
253 MA®	1.4835	7.8		163	120	18.2	19.5	21.2	29.0	585	0.84	N
4845	1.4845	7.8		158	120	18.4	20.0	19.8	27.1	582	0.96	N
4841	1.4841	7.8		158	120	18.8	20.0	19.0	27.8	582	0.96	N

¹⁾Outokumpu typical values

Magnetizable: Y = Magnetizable ferritic, martensitic, duplex grades, N = Non-magnetizable austenitic grades with a typical magnetic permeability $\mu = 1.05 - 1.2$.

Small amounts of ferrite or martensite from composition or cold deformation will increase the magnetizability. Data from EN 10088, EN 10095 or typical values.

*Grades suitable for low permeability requirements, i.e., $\mu = \max. 1.005$.

Conversion from EN to ASTM, ASME:

1 kg/dm³ = 0.361 lb/in³

1 GPa = 0.145 x 10⁶ psi

1x10⁻⁶/°C = 0.556 in/in °F

1 W/m °C = 0.578 Btu/h ft °F

1 J/kg °C = 0.000239 Btu/lb °F

Non alloy steel are added for comparison in Table 8 and Table 9.

Fabrication and Use Characteristics

Table 9

Outokumpu steel name	EN	Fabrication				Use		
		Heat treatment temperature ¹⁾ °C	Welding consumables ²⁾	Forming ³⁾ n/A ^{hom}	Machining index ⁴⁾	Pressure purpose ⁵⁾	IGC resistance ⁶⁾	CPT ⁷⁾ °C
Non alloy steel	1.0345	N 920 ± 30	P5	0.2/20		EN ASME		
4512	1.4512		13 or 19 9L					
4003	1.4003	A 730 ± 30	13 or 19 9L			EN	A N/-	< 10
4000	1.4000	A 780 ± 30	13 or 19 9L			ASME	A N/-	< 10
4016	1.4016	A 800 ± 30	19 9L or 23 12L	0.2/20		ASME	A Y/-	< 10
4509	1.4509	A 900 ± 30	19 9 Nb or 18 8 Mn			EN	A N/-	
4521	1.4521	A 850 ± 30	19 12 3L or 23 12 2L			EN ASME	A Y/-	
4006	1.4006	A 780 ± 30	13 or 18 9			ASME		< 10
4005	1.4005		248 SV*					< 10
4021	1.4021	T 740 ± 40	248 SV*					< 10
4028	1.4028	T 690 ± 40	248 SV*					< 10
4313	1.4313	T 600 ± 40	248 SV*			EN		< 10
4548	–		248 SV*					
LDX 2101®	1.4162	A 1050 ± 30	23 7 NL or 22 9 3 NL	0.4/20	130	ASME	A Y/Y	17±3
2304	1.4362	A 1000 ± 50	23 7 NL or 22 9 3 NL	0.4/20	75	EN ASME	A Y/Y	22±3
LDX 2404™	1.4662	A 1100 ± 20	22 9 3 NL	0.4/20	80			43±2
2205	1.4462	A 1060 ± 40	22 9 3 NL	0.4/20	55	EN ASME	C Y/Y	52±3
4501	1.4501	A 1080 ± 40	25 9 4 NL	0.4/20		EN	C Y/Y	84±2
2507	1.4410	A 1080 ± 40	25 9 4 NL	0.4/20	45	EN ASME	C Y/Y	84±2
4310	1.4310	A 1050 ± 40	19 9L	0.8/35			A N/-	< 10
4318	1.4318	A 1060 ± 40	19 9L	0.8/35		EN	A Y/Y	< 10
4372	1.4372	A 1050 ± 50	18 8 Mn or 23 12L	0.8/35			A Y/-	< 10
4568	1.4568		19 9L					
4301	1.4301	A 1050 ± 50	19 9L	0.6/40	105	EN ASME	A Y/-*	< 10
4307	1.4307	A 1050 ± 50	19 9L	0.6/40	105	EN ASME	A Y/Y	< 10
4311	1.4311	A 1050 ± 50	19 9L	0.6/40	80	EN ASME	A Y/Y	< 10
4541	1.4541	A 1050 ± 50	19 9 Nb or 19 9 L	0.6/40	100	EN ASME	A Y/Y	< 10
4550	1.4550	A 1070 ± 50	19 9 Nb or 19 9 L			EN ASME	A Y/Y	
4305	1.4305	A 1050 ± 50	19 9L	0.6/40			A N/-	< 10
4303	1.4303	A 1050 ± 50	19 9L	0.6/40	105	ASME	A Y/-*	< 10
4306	1.4306	A 1050 ± 50	19 9L	0.6/40	105	EN ASME	A Y/Y	< 10
4567	1.4567	A 1050 ± 50	19 9L	0.6/40				< 10
4401	1.4401	A 1070 ± 40	19 12 3L	0.6/35	100	EN ASME	A Y/-*	20±2
4404	1.4404	A 1070 ± 40	19 12 3L	0.6/35	100	EN ASME	A Y/Y	20±2
4427 ⁹⁾	–	A 1060 ± 40	19 12 3L					
4436	1.4436	A 1070 ± 40	19 12 3L	0.6/35	100	EN ASME	A Y/-*	27±3
4432	1.4432	A 1070 ± 40	19 12 3L	0.6/35	100	EN ASME	A Y/Y	27±3
4406	1.4406	A 1070 ± 40	19 12 3L	0.6/35	75	EN ASME	A Y/Y	23±2
4429	1.4429	A 1070 ± 40	19 12 3L	0.6/35	100	EN ASME	A Y/Y	25
4571	1.4571	A 1070 ± 40	19 12 3 Nb or 19 12 3L	0.6/35	95	EN ASME	A Y/Y	15±2
4435	1.4435	A 1070 ± 40	19 12 3L	0.6/35	100	EN ASME	A Y/Y	21±2
3952 ⁹⁾	–	A 1075 ± 25	20 16 3 Mn L					
4438	1.4438	A 1110 ± 40	317	0.6/35	90	EN ASME	C Y/Y	33±3
4439	1.4439	A 1100 ± 40	19 13 4 NL or 20 25 5 CuL	0.6/35	70	EN	C Y/Y	50±3
725LN	1.4466	A 1110 ± 40	25 22 2 N L			EN ASME	C Y/Y	
3964 ⁹⁾	–	A 1055 ± 25	20 16 3 Mn L					
904L	1.4539	A 1100 ± 40	20 25 5 CuL	0.6/30	75	EN ASME	C Y/Y	62±3
4529	1.4529	A 1150 ± 30	Ni Cr 21 Mo Fe Nb or Ni Cr 25 Mo 16 or P54*	0.6/30		EN	C Y/Y	> 90
254 SMO®	1.4547	A 1175 ± 25	Ni Cr 21 Mo Fe Nb or Ni Cr 25 Mo 16 or P54*	0.6/30	45	EN ASME	C Y/Y	87±3
4565	1.4565	A 1145 ± 25	Ni Cr 21 Mo Fe Nb or Ni Cr 25 Mo 16 or P54*	0.6/30			C Y/Y	> 90
654 SMO®	1.4652	A 1180 ± 30	Ni Cr 25 Mo 16 or P54*	0.6/30	15	ASME	C Y/Y	> 90
4713	1.4713	A 810 ± 30	18 8 Mn or 18.9 MnMo or 309					
4724	1.4724	A 830 ± 30	22 12 or 25 4					
4742	1.4742	A 830 ± 30	22 12 L or 21 10 N					
4762	1.4762	A 830 ± 30	25 20 or 22 12					
								Maximum temp, °C
4948	1.4948	A 1080 ± 30	19 9	0.6/40	105	EN ASME	A Y/-	800
4878	1.4878	A 1070 ± 50	19 9 Nb	0.6/40	100	ASME	A Y/Y	800
153 MA™	1.4818	A 1070 ± 50	21 10 N or 253 MA-NF*	0.6/40	70		A Y/-	1000
4833	1.4833	A 1100 ± 50	22 12 or 253 MA-NF*	0.6/35	95	ASME	A Y/-	1000
4828	1.4828	A 1100 ± 50	21 10 N or 253 MA-NF*	0.6/35	95		A Y/-	1000
253 MA®	1.4835	A 1070 ± 50	21 10 N or 253 MA-NF*	0.6/35	70	ASME	A Y/-	1100
4845	1.4845	A 1100 ± 50	25 20 or 21 10 N	0.6/35	95	ASME	A Y/-	1100
4841	1.4841	A 1100 ± 50	25 20 or 21 10 N					1125

- 1) Heat treatment temperature: A = Annealing, T = Tempering from EN 10088-2, EN 10095, EN 10028-7 (N = Normalising).
- 2) Covered electrodes, ISO 3581/ISO 14172, *Avesta Welding designations.
- 3) Cold forming characteristics: Strain-hardening exponent (n) and homogeneous elongation (A^{hom}) in tension test.
- 4) Machining index: From Outokumpu Machining Guidelines, for carbide tools in relation to 4404. PRODEC® steel conditions have some 30% higher machining index.
- 5) Pressure purpose grades: From EN 10028-7, ASME IID and

ASME Code Cases.

- 6) Intergranular corrosion (IGC) resistance: From EN 10088. Tested in highly acidic solution according to ISO 3651-2 Method A, B or C with Y = Yes and N = No, for delivery/sensitised conditions.
 - 7) Typical Critical Pitting Temperature (CPT): From potentiostatic testing at +700 mV_{SCE} with the Avesta Cell method in 1M NaCl, 320 mesh (ASTM G150). Other surfaces/products may, other methods (ASTM G48 etc.) will, give other CPT values.
 - 8) Maximum service temperature in dry air.
 - 9) Outokumpu typical values.
- * = May be multi-certified as Y/Y.

Ordering and Classification Principles

Table 10

Ordering concepts	Classification principles	Typical codes
MATERIAL STANDARD	Stainless steel: Iron major element. Cr min. 10.5% – Corrosion resisting grades – Heat and creep resisting grades, for use over 550°C	EN 10088-2, EN 10028-7 EN 10095, EN 10302, EN 10028-7
Additional specification	– Customer specification – Technical approval of new material – Multi-certification of other global standard – Multi-certification of withdrawn national standard	VdTÜV WB418 ASTM A240, JIS G4304 DIN 17440, BS 1501-3, SS 2333-28
STEEL GRADE	– Ferritic – Martensitic – Precipitation hardening – Duplex – Austenitic – Multi-certification of two grades	Example, 1.4404+1.4401 (316L+316)
Special steel condition	Outokumpu optimised fabrication properties	See table 11 below
PRODUCT	– Flat products – Long products – Tube, pipe – Forgings – Castings – Articles	P/Hot rolled plate (Quarto), H/Hot rolled strip/sheet (CPP), C/Cold rolled strip/sheet (KBR, Sendzimir), N/Cold rolled narrow strip S/Semi-finished products, B/Bar, R/Rod T/Welded and seamless tubes Welding consumables, fittings, fasteners...
Product condition	EN 10088 codes for process route/surface finish	See table 11 below
Dimensions	Thickness x width x length	8 x 2000 x 5000
Special tolerances	EN codes for special tolerance classes	B (pressure purpose) C, D in EN 10029, S in EN 10259, F, P in EN 10258
CERTIFICATE	EN 10204 codes for inspection documents: – Manufacturers' inspection – Notified body inspection or third party inspection	3.1 3.2
QUALIFICATION	Some orders may require approval of the manufacturer: – Production system for pressure purpose materials – Quality system – Customer list of approved suppliers	AD 2000 W0, EN 13445 ISO 9001:2000
MATERIAL DECLARATIONS	– Material Safety Data Sheet – Declarations for certain branches, orders and products: Building, food, water piping etc.	Info no 1005 Avesta Research Centre

Steel and Product Conditions

Table 11

Outokumpu Special Steel Conditions		EN Product Conditions	
LIC	for improved steel cleanness	1D	Hot rolled, heat treated, pickled
PRODEC®	for improved machinability	1E	Hot rolled, heat treated, mechanically descaled
HyTens®	for improved mechanical properties	1G	Hot rolled, ground
		1Q	Hot rolled, quenched and tempered, pickled
CCS®	for improved mechanical properties	2H	Work hardened
VKS®	for improved thickness tolerances	2E	Cold rolled, heat treated, mech. desc. pickl.
RAP™2E	or improved thickness tolerances and improved surface finish	2D	Cold rolled, heat treated, pickled
		2B	Cold rolled, heat treated, pickled, skin passed
		2F	Cold rolled, heat treated, pickled, skin passed on roughened rolls
		2R	Cold rolled, bright annealed
		2G	Ground
		2J	Brushed or dull polished
		2K	Satin polished
		2M	Patterned
		2W	Profile rolled
		2L	Coloured

Multicertification is made on request to EN/ASTM/ASME as well as to superseded national standards

Stainless Steel Material Standards – Basic EN and ASTM Documents

Table 12

Stainless steel – referenced standards for flat products (chemical compositions, product tolerances, typical properties)

EN 10029	Hot rolled steel plates. Tolerances
EN 10051	Hot rolled steel strip. Tolerances
EN 10088-1	Stainless steels. – List of stainless steels
EN ISO 9445	Cold rolled stainless narrow strip, wide strip, plate/sheet and cut lengths. Tolerances
ASTM A480	General requirements for flat-rolled stainless and heat resisting steel (+ASME SA480)
ASTM A959	Harmonized standard grade compositions for wrought stainless
ASME IID	Materials – Physical properties tables

Flat (and long) products

EN 10028-7	Flat products for pressure purposes. – Stainless steels
EN 10088-2	Stainless steels. – Sheet/plate and strip for general purposes
EN 10088-4	Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes
EN 10095	Heat resisting steels and nickel alloys
EN 10151	Stainless steel strip for springs
EN 10302	Creep resisting steels, nickel and cobalt alloys
ASTM A167	Stainless and heat-resisting Cr-Ni steel plate, sheet and strip
ASTM A176	Stainless and heat-resisting Cr steel plate, sheet and strip
ASTM A240	Heat-resisting Cr and Cr-Ni stainless steel plate, sheet and strip for pressure vessels (+ASME SA240)
ASTM A666	Austenitic stainless steel sheet, strip, plate, bar for structural and architectural applications (+ASME SA666)
ASME IIA	Materials. Part A – Ferrous Material Specifications

Long products

EN 10058	Hot rolled flat steel bars. Tolerances
EN 10060	Hot rolled round steel bars. Tolerances
EN 10088-3	Stainless steels. – Semi-finished products, bars, rods, sections for general purposes
EN 10088-5	Technical delivery conditions for bars, rods wire, sections and bright products of corrosion resisting steels for construction purposes
EN 10263-5	Steel rod, bars and wire for cold heading and extrusion. – Stainless steel
EN 10270-3	Steel wire for springs. – Stainless steels
EN 10269	Steels and nickel alloys for fasteners with specified properties at elevated or low temperatures
EN 10272	Stainless steel bars for pressure purposes
ASTM A193	Alloy and stainless steel bolting material for high-temperature service
ASTM A276	Stainless and heat-resisting steel bars and shapes
ASTM A479	Stainless steel bars for boilers/pressure vessels (+ASME SA479)
ASTM A484	General requirements for stainless and heat-resisting steel bars, billets, forgings (+ASME SA484)
ASTM A493	Stainless and heat-resisting steel rod and wire for cold heading and forging
ASTM A555	General requirements for stainless and heat resistant steel wire and wire rod
ASTM A580	Stainless and heat-resisting steel wire

Tube and Pipe

EN 10217-7	Welded steel tubes for pressure purposes. – Stainless steels
EN 10296-2	Welded steel tubes for mechanical and general engineering purposes. – Stainless steels
ASTM A249	Welded austenitic steel boiler, superheater, heat exchanger and condenser tubes
ASTM A269	Seamless and welded austenitic stainless steel tubing for general service
ASTM A270	Seamless and welded austenitic and duplex stainless steel sanitary tubing
ASTM A312	Seamless, welded, and heavily cold worked austenitic stainless steel pipes
ASTM A358	Electric fusion-welded austenitic CrNi alloy steel pipe for high temperature
ASTM A789	Seamless and welded duplex stainless steel tubing for general service
ASTM A790	Seamless and welded duplex stainless steel pipe
ASTM A928	Duplex stainless steel pipe electric fusion welded with addition of filler metal

Fittings

EN 10253-3	Butt-welding pipe fittings, without specific requirements
EN 10253-4	Butt-welding pipe fittings, with specific inspection requirements
EN 1092-1	Flanges and their joints
ASTM A403	Standard Specification for Wrought Austenitic Stainless Piping Fittings
ASTM A815	Wrought Ferritic, Ferritic/Austenitic and Martensitic Stainless Steel Piping Fittings

12 Steel Grades, Properties and Global Standards

Product Properties and Test Methods

Table 13

Property		Test methods	Reported result
Delivery testing at RT			
0.2% Proof strength		EN 10002-1	ASTM A370, E8
1.0% Proof strength		EN 10002-1	–
Tensile strength		EN 10002-1	ASTM A370, E8
Elongation ¹⁾	A ₅ , A ₂ , also LT	EN 10002-1	ASTM A370, E8
Impact energy ²⁾		EN 10045-1	ASTM A370, E23
Hardness ³⁾	conv. to HB for martensite for < 1.5 mm	EN 10109-1 EN 10109-1 EN 10003-1 ISO 6507-1	ASTM A370, E18 ASTM A370, E18 ASTM A370, E10 ASTM E92
			R _{p0.2} MPa R _{p1.0} MPa R _m MPa A % KV J HRB HRC HB HV
Mechanical properties at HT, LT			
Tensile strength at HT	max. 600°C	EN 10002-5	ASTM E21
Tensile strength at LT	min. –196°C	EN 10002-5	
Derivation of yield strengths for HT		EN 10314	R _{p0.2} MPa R _{p0.2} MPa R _{p1.0} MPa R _m MPa
IGC resistance	Strauss Strauss Streicher Huey	4301/4401 > 20Cr/Mo for high-alloy for urea	ISO 3651-2 A ISO 3651-2 B ISO 3651-2 C ISO 3651-1
		ASTM A262 E ASTM A262 E ASTM A262 B ASTM A262 C	Approved Approved Approved or mpy/g/m ² h g/m ² h

Explanations, see below Table 14

Microstructure Characterisation and Test Methods

Table 14

Parameter	Test methods	Reported result
Grain size ⁴⁾	ISO 643 ASTM E112	µm, mean value, s, 95% conf int, %rel accuracy; ASTM grain size number G
Austenite spacing	ASTM E112 with amendments	µm
Phase content	ASTM E562, E1245	vol% ± 95% conf int; %rel accuracy
Inclusion content ⁵⁾	ISO 4967 ASTM E45 DIN 50602 M DIN 50602 K EN 10247 SS111116	At r, Ah s; Bt t, Bh u; Ct v, Ch w; Dt x, Dh y SS x, OA y, OS z, OG w K0; K1; K2; K3; K4, resp. Length µm/mm ² , number/mm ² , area µm ² /mm ² Area%, length mm/mm ² , number/mm ² (total, per types A, B, C, D and thickness groups Thick, Medium, Heavy)
Carbides ⁶⁾	ASTM A262 A	Approved
Intermetallic phases ⁶⁾	ASTM 923 A (for duplex)	Approved

Reported result: Format of the test result which is dependent on specified requirements.

¹⁾ Elongation is converted according to ISO 2566-2.

²⁾ Impact energy with 10x10 mm test pieces: 1 KV (J) = 1.25 KCV (J/cm²).

³⁾ Hardness is converted according to ASTM E140.

⁴⁾ Conversion from ASTM No. to EN according to ASTM E112:

5 = 64 µm; 6 = 45 µm; 7 = 32 µm; 8 = 23 µm; 9 = 16 µm.

⁵⁾ Type A = ductile, B = brittle, C = brittle/ductile, D = undeformed.

Assessment and conversion according to SS 111116.

⁶⁾ Indirect method for approval only

Common Acronyms and Abbreviations

Table 15

ASTM	American Society for Testing and Materials	JIS	Japanese Industrial Standard	CPP	Continuously Produced Plate
		NF	Norme Française	KBR®	Cold rolled 2 m wide stainless
ASME	American Society of Mechanical Engineers	SS	Svensk Standard	VKS®	Hot rolled with cold pass
		TÜV	Technischer Überwachungs-Verein	CCS®	Continuously Cold Stretched
BS	British Standard			PRODEC®	PRODUCTION Economy in machining
DIN	Deutsches Institut für Normung	RT	Room Temperature	LIC	Low Inclusion Content
EN	Europäische Norm	HT	High (elevated) Temperatures		
ISO	International Organization for Standardization	LT	Low (cryogenic) Temperatures		

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Outokumpu is a global leader in stainless steel. Our vision is to be the undisputed number one in stainless, with success based on operational excellence. Customers in a wide range of industries use our stainless steel and services worldwide. Being fully recyclable, maintenance-free, as well as very strong and durable material, stainless steel is one of the key building blocks for sustainable future.

What makes Outokumpu special is total customer focus – all the way, from R&D to delivery. You have the idea. We offer world-class stainless steel, technical know-how and support. We activate your ideas.

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