Alleima® 254 SMO is a high-alloy austenitic stainless steel developed for use in seawater and other aggressive chloride-bearing media. The grade is characterized by:

- Excellent resistance to pitting and crevice corrosion
- High resistance to general corrosion
- High resistance to stress corrosion cracking
- Higher strength than conventional austenitic stainless steels
- Good weldability

Trademark information: Alleima® 254 SMO is a trademark owned by Outokumpu OY.

Standards

- UNS: S31254
- EN Number: 1.4547
- SS: 2378

Product standards

EN 10088-3

Suitable for production of flanges etc. according to ASTM A182 Grade F44.

Certificates

Status according to EN 10 204 3.1

Chemical composition

C	Si	Mn	P	S	Cr	Ni	Mo	N	Cu
≤0.020	≤0.80	≤1.00	≤0.030	≤0.010	20	18	6.1	0.20	0.7

Applications

Alleima® 254 SMO is used in the following applications:

- Equipment for handling seawater - for example, heat exchangers, cooling water systems, ballast water systems, firefighting systems etc.

- Equipment in pulp bleaching plants.
- Components in gas cleaning systems.

Industrial categories	Typical applications
Chemical industry	Flanges
Petrochemical industry	Valves
Pulp and paper industry	Fittings
Oil and gas industry	Couplings
	Rings
	Seals
	Bolts and nuts
	Shafts
	Forgings
	Discs

Corrosion resistance

Stress corrosion cracking (SCC)

Ordinary austenitic steels of the AISI 304 and 316 types are prone to stress corrosion cracking in chloride-containing solutions at temperatures exceeding about 60°C (140°F). For austenitic steels, resistance to SCC increases with increasing nickel and molybdenum contents. The tables below give the results of two accelerated tests, showing that Alleima® 254 SMO has very good resistance to SCC.

Stress corrosion cracking tests in boiling 25% NaCL solution, pH=1.5. U-bend specimens.

Steel	Time to failure	Remark
AISI 316	<150 h	Pitting
904L	No failure (1000 h)	Crevice corrosion
254 SMO	No failure (1000 h)	No attack

Intergranular corrosion

Alleima® 254 SMO has a very low carbon content. This means that there is very little risk of carbide precipitation during heating, for example, when welding. The steel passes the Strauss test (ASTM A262, practice E) even after sensitizing for one hour at 600-1000°C (1110-1830°F).

However, due to the high alloying content of the steel, intermetallic phases can precipitate at the grain boundaries in the temperature range at 600-1000°C (1110-1830°F). These precipitations do not involve any risk of intergranular corrosion in the environments in which the steel is intended to be used. Thus, welding can be carried out without any risk of intergranular corrosion.

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Pitting corrosion

The high chromium content and particularly the molybdenum content give Alleima 254 SMO excellent resistance to pitting and crevice corrosion.

The high nitrogen content also improves pitting resistance. The results of laboratory determination of the critical pitting temperature (CPT) in 3 % NaCl shows that Alleima® 254 SMO has a far greater CPT than 904L and it possesses very good resistance in water containing chlorides. Alleima 254 SMO is, therefore, a suitable material for use in, for example, seawater.

Crevice corrosion

The weak point of conventional stainless steels is their limited resistance to crevice corrosion. In seawater, for example, there is a considerably greater risk of crevice corrosion under gaskets, deposits or fouling. Tests in natural seawater at 60°C (140°F) have shown that Alleima® 254 SMO can be exposed for prolonged periods, without suffering crevice corrosion.

For further information regarding corrosion resistance of Alleima® 254 SMO, please see the data sheet Seamless tube and pipe - Alleima® 254 SMO. The data should be considered in the knowledge that it may not be applicable for thick sections, such as forgings.

Forms of supply

Sizes and tolerances

Round-cornered square, as well as round billets, are produced in a wide range of sizes according to the following tables. Larger sizes offered on request.

Surface conditions

Square billets

Unground, spot ground or fully ground condition.

Round billets

Peel turned or black condition.

Square billets

Size	Tolerance	Length
mm	mm	m
80	+/-2	4 - 6.3
100, 114, 126, 140, 150	+/-3	4 - 6.3
160, 180, 195, 200	+/-4	4 - 6.3
>200 - 350	+/-5	3 - 5.3

Sizes and tolerances apply to the rolled/forged condition.

Peel turned round billets

Size	Tolerance	Length

mm	mm	m
75 - 200 (5 mm interval)	+/-1	max 10
>200 - 450	+/-3	3 - 8

Unground round billets

Size	Tolerance	Length
mm	mm	m
77 - 112 (5 mm interval)	+/-2	max 10
124, 134	+/-2	max 10
127, 147, 157	+/-2	max 10
142, 152, 163	+/-2	max 10
168, 178, 188	+/-2	max 10
183, 193	+/-2	max 10

Other products

Mostly supplied in non-ESR condition

- Welded tube and pipe
- Seamless tube and pipe
- Fittings and flanges

Heat treatment

Billets are delivered in the hot worked condition. The following heat treatment is recommended.

Solution annealing

1150-1200°C (2100-2190°F), followed by quenching in water.

Mechanical properties

For billets testing is performed on separately solution annealed and quenched test pieces.

The following figures apply to material in the solution annealed condition.

At 20°C (68°F)

Metric units

Proof strength		Tensile strength	Elong	Hardness
$R_{p0.2}$[a]	$R_{p1.0}$[a]	R_m	A[b]	Brinell
MPa	MPa	MPa	%	

≥310	≥340	675-850	≥35	≤260

Imperial units

Proof strength		Tensile strength	Elong.	Hardness
$R_{p0.2}$[a]	$R_{p1.0}$[a]	R_m	A[b]	Brinell
ksi	ksi	ksi	%	
≥45	≥49	98-123	≥35	≤260

1 MPa = 1 N/mm^2
a) $R_{p0.2}$ and $R_{p1.0}$ correspond to 0.2% offset and 1.0% offset yield strength, respectively.
b) Based on $L_0 = 5.65 \sqrt{S_0}$ where L_0 is the original gauge length and S_0 the original cross-section area.

Impact strength

Due to its austenitic microstructure, Alleima® 254 SMO has very good impact strength both at room temperature and at cryogenic temperatures.
Tests have demonstrated that the steel fulfils the requirements (60 J (44 ft-lb) at -196 °C (-320 °F) according to the European standards EN 13445-2 (UFPV-2) and EN 10216-5.

At high temperatures

Intermetallic phases are precipitated within the temperature range of 600-1000°C (1110-1830°F). The steel should therefore not be exposed to these temperatures for prolonged periods. Minimum proof strength properties at high temperatures are based on datasheets seamless tubes and pipe. Since the tubes have thin walls the values should only be used as indicative values for billets.

Metric units

Temperature	Proof strength	
°C	$R_{p0.2}$	$R_{p1.0}$
	MPa	MPa
	min.	min.
100	230	270
200	190	225
300	170	200
400	160	190

Imperial units

Temperature	Proof strength	
°F	$R_{p0.2}$	$R_{p1.0}$
	ksi	ksi
	min.	min.

200	34	40
400	27	32
600	24	29
700	24	28

Physical properties

Density: 8.0 g/cm^3, 0.29 lb/in^3

Thermal conductivity

Temperature, °C	W/m °C	Temperature, °F	Btu/ft h °F
20	10	68	6
100	12	200	7
200	14	400	8
300	16	600	9.5
400	18	800	10.5
500	20	1000	11.5
600	21	1200	12.5
700	23	1300	13

Specific heat capacity

Temperature, °C
J/kg °C
Temperature, °F
Btu/ft h °F
20
485
68
0.12
100
510
200
0.12
200

535	
400	
0.13	
300	
565	
600	
0.14	
400	
585	
800	
0.14	
500	
600	
1000	
0.14	
600	
615	
1200	
0.15	
700	
625	
1400	
0.15	

Thermal expansion [1)]

Temperature, °C	Per °C	Temperature, °F	Per °F
30-100	16	86-200	9
30-200	16	86-400	9
30-300	16.5	86-600	9
30-400	16.5	86-800	9.5
30-500	17	86-1000	9.5
30-600	17	86-1200	9.5

30-700	17.5	86-1300	10

1) mean values in temperature ranges (x10^6)

Modulus of elasticity [1)]

Temperature, °C	MPa	Temperature, °F	ksi
20	195	68	28.3
100	190	200	27.6
200	182	400	27.5
300	174	600	25.1
400	166	800	23.8
500	158	1000	22.5

1) (x10^3)

Hot working

Hot working should be carried out at a material temperature of 950-1200°C (1740-2190°F). Hot working of Alleima® 254 SMO should be followed by rapid cooling in air or water. Subsequent heat treatment should be carried out in accordance with the recommendations given for heat treatment.

Welding

The weldability of Alleima® 254 SMO is good. Suitable methods of fusion welding are manual metal-arc welding (MMA/SMAW) and gas-shielded arc welding, with the TIG/GTAW method as first choice. Preheating and post-weld heat treatment are normally not recommended.

In common with all fully austenitic stainless steels, Alleima® 254 SMO has low thermal conductivity and high thermal expansion. Welding plans should therefore be carefully selected in advance, so that distortions of the welded joint are minimized. If residual stresses are a concern, solution annealing can be performed after welding.

For Alleima® 254 SMO, heat-input of <1.0 kJ/mm and interpass temperature of <100°C (210°F) are recommended. A string bead welding technique should be used.

Nickel alloys with high molybdenum and chromium must be used as filler metals to have good corrosion resistance in as welded condition.

Recommended filler metals

TIG/GTAW or MIG/GMAW welding

ISO 18274 S Ni 6625/AWS A5.14 ERNiCrMo-3 (e.g. Exaton Sanicro 60)

ISO 18274 S Ni 6059/AWS A5.14 ERNiCrMo-13 (e.g. Exaton Sanicro 59)

MMA/SMAW welding

ISO 14172 E Ni 6625/AWS A5.11 ENiCrMo-3 (e.g. Exaton Sanicro 60)

ISO 14172 E Ni 6059/AWS A5.11 ENiCrMo-13 (e.g. Exaton Sanicro 59)

Machining

Machining Alleima® 254 SMO, as with other stainless steels, requires an adjustment to tooling data and machining method, in order to achieve satisfactory results. Compared to Sanmac 316/316L, the cutting speed must be reduced by approximately 55-60% when turning 254 SMO with coated, cemented carbide tools. Much the same applies to other operations. Feeds should only be reduced slightly and with care.

Detailed recommendations for the choice of tools and cutting data are provided in the data sheet for Sanmac 316/316L.

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