

Stainless steel, austenitic, AISI 316L, wrought

Identification

Designation

AISI 316L

Condition

Solution annealed

UNS number

S31603

US name

SAE 316, ASTM TP316L, ASTM S31603, ASTM MT316L, ASTM F316L, ASTM Alloy Group A4, ASTM Alloy Group 2, ASME 316L, ~ASTM TP316LN, ~ASTM S31654, ~ASTM S31653, ~ASTM F316LN

EN name

X2CrNiMo17-12-2, ~X3CrNiMoN17-13-3, ~X3CrNiMoBN17-13-3, ~X2CrNiMoN18-12-4, ~X2CrNiMoN17-13-3, ~X2CrNiMoN17-11-2, ~X2CrNiMo18-14-3, ~X2CrNiMo17-12-2

EN number

~1.491, ~1.4439, ~1.4435, ~1.4434, ~1.4432, ~1.4429, ~1.4406, ~1.4404

ISO name

X2CrNiMo17-13, X2CrNiMo17-12, ~X3CrNiMoBN17-13-3, ~X2CrNiMoN18-12-4, ~X2CrNiMoN17-13-3, ~X2CrNiMoN17-13, ~X2CrNiMoN17-12-3, ~X2CrNiMoN17-11-2, ~X2CrNiMo18-14-3, ~X2CrNiMo17-12-3, ~X2CrNiMo17-12-2, ~X2CrNiMo18-14-3, ~19N

GB (Chinese) name

00Cr17Ni14Mo2, ~00Cr17Ni13Mo2N

JIS (Japanese) name

SUSF316L, SUS316L, ~SUSF316LN, ~SUS316LN

Tradenames

ARGESTE 4435 LA, Stahlwerk Ergste Westig GmbH (GERMANY); SPARTAN REDHEUGH 320S33, Spartan Redheugh Ltd (UK); SPARTAN REDHEUGH 316S13, Spartan Redheugh Ltd (UK); SPARTAN REDHEUGH 316S33, Spartan Redheugh Ltd (UK); ARGESTE 4436 PA, Stahlwerk Ergste Westig GmbH (GERMANY); ACX 300, Acerinox, S.A. (SPAIN); EASTERN STAINLESS TYPE 316, Eastern Stainless Corp. (USA); PROJECT 70 STAINLESS TYPE 316, Carpenter Technology Corp. (USA); SPARTAN REDHEUGH 320S31, Spartan Redheugh Ltd (UK); PROJECT 7000 STAINLESS TYPE 316, Carpenter Technology Corp. (USA); ALLEGHENY LUDLUM TYPE 316, Allegheny Ludlum Steel (USA); EASTERN STAINLESS TYPE 316L, Eastern Stainless Corp. (USA); PROJECT 70 STAINLESS TYPE 316L, Carpenter Technology Corp. (USA); ARGESTE 4404 LA/SB/VC, Stahlwerk Ergste Westig GmbH (GERMANY); SPARTAN REDHEUGH 316S11, Spartan Redheugh Ltd (UK); PROJECT 7000 STAINLESS TYPE 316L, Carpenter Technology Corp. (USA); ALLEGHENY LUDLUM TYPE 316L, Allegheny Ludlum Steel (USA); ARGESTE 4571 TB/SA/TA, Stahlwerk Ergste Westig GmbH (GERMANY); ARGESTE 4401 PA/LA/PC/SB/VC, Stahlwerk Ergste Westig GmbH (GERMANY); SPARTAN REDHEUGH 316S31, Spartan Redheugh Ltd (UK); ALLEGHENY LUDLUM TYPE 321, Allegheny Ludlum Steel (USA); EMPIRE TYPE 316EZ, Empire Specialty Steel Inc. (USA); ACX 290, Acerinox, S.A. (SPAIN); ACX 260, Acerinox, S.A. (SPAIN); RDN 280, Roldan S.A. (SPAIN); ACX 280, Acerinox, S.A. (SPAIN); RDN 255, Roldan S.A. (SPAIN); RDN 270, Roldan S.A. (SPAIN); ACX 250, Acerinox, S.A. (SPAIN); ACX 270, Acerinox, S.A. (SPAIN); SANDVIK SANMAC 316L, Sandvik Steel Co. (USA); RDN 250, Roldan S.A. (SPAIN); APMZ, Acciaierie Valbruna SpA (ITALY); SANDVIK 2R61, Sandvik Steel Co. (USA); SANDVIK 3R65, Sandvik Steel Co. (USA);

General Properties

Density	7.87e3	-	8.07e3	kg/m ³
Price	* 4.35	-	4.79	EUR/kg

Composition overview

Composition (summary)

Fe/16-18.5Cr/10-14Ni/2-3Mo/<2.0Mn/<1.0Si/<0.045P/<0.03C/<0.03S

Base Fe (Iron)

Composition detail (metals, ceramics and glasses)

C (carbon)	0	-	0.03	%
Cr (chromium)	16	-	18.5	%

Fe (iron)	61.4	-	72	%
Mn (manganese)	0	-	2	%
Mo (molybdenum)	2	-	3	%
Ni (nickel)	10	-	14	%
P (phosphorus)	0	-	0.045	%
S (sulfur)	0	-	0.03	%
Si (silicon)	0	-	1	%
Mechanical properties				
Young's modulus	190	-	205	GPa
Flexural modulus	* 190	-	205	GPa
Shear modulus	74	-	82	GPa
Bulk modulus	134	-	152	GPa
Poisson's ratio	0.265	-	0.275	
Shape factor	63			
Yield strength (elastic limit)	170	-	310	MPa
Tensile strength	480	-	620	MPa
Compressive strength	* 170	-	310	MPa
Flexural strength (modulus of rupture)	170	-	310	MPa
Elongation	30	-	50	% strain
Hardness - Vickers	170	-	220	HV
Hardness - Rockwell B	75	-	83	
Hardness - Rockwell C	* 0	-	18.8	
Hardness - Brinell	146	-	217	MPa
Fatigue strength at 10 ⁷ cycles	* 256	-	307	MPa
Fatigue strength model (stress range)	* 151	-	225	MPa
Parameters: Stress Ratio = 0, Number of Cycles = 1e7				
Fracture toughness	53	-	72	MPa.m ^{0.5}
Mechanical loss coefficient (tan delta)	* 9.5e-4	-	0.00148	
Thermal properties				
Melting point	1.38e3	-	1.4e3	°C
Maximum service temperature	750	-	925	°C
Minimum service temperature	-273			°C
Thermal conductivity	13	-	17	W/m.°C
Specific heat capacity	490	-	530	J/kg.°C
Thermal expansion coefficient	15	-	18	µstrain/°C
Latent heat of fusion	* 260	-	285	kJ/kg
Processing properties				
Cold forming	Good			
Hot forming	Good			
Machinability - speed	* 30.5	-	36.6	m/min
Weldability - MIG	Excellent			
Weldability - plasma	Excellent			
Weldability - SAW	Excellent			
Weldability - TIG	Excellent			
Carbon equivalency	4.27	-	5.73	
Brazeability	Good			
Electrical properties				
Electrical resistivity	69	-	81	µohm.cm
Galvanic potential	* -0.17	-	-0.09	V
Magnetic properties (ambient temperature)				
Ferromagnetic?	False			
Optical properties				
Transparency	Opaque			
Durability: flammability				
Flammability	Non-flammable			

Durability: fluids and sunlight

Water (fresh)	Excellent
Water (salt)	Excellent
Weak acids	Excellent
Strong acids	Excellent
Weak alkalis	Excellent
Strong alkalis	Excellent
Organic solvents	Excellent
UV radiation (sunlight)	Excellent
Oxidation at 500C	Excellent

Corrosion resistance (relative to other metals)

Pitting resistance equivalent number (PREN)	22.6	-	28.4
Pitting and crevice corrosion	Medium (20-30)		
Stress corrosion cracking	Moderate		
Intergranular (weld line) corrosion	Good		
Inorganic acids	Moderate		
Organic acids	Good		
Alkalis	Moderate		
Humidity / water	Excellent		
Sea water	Good		
Sour oil and gas	Moderate		

Primary material production: energy, CO2 and water

Embodied energy, primary production	* 95.7	-	106	MJ/kg
CO2 footprint, primary production	* 5.95	-	6.58	kg/kg
Water usage	* 144	-	159	l/kg

Material processing: energy

Rough rolling, forging energy	* 2.11	-	2.33	MJ/kg
Extrusion, foil rolling energy	* 3.93	-	4.35	MJ/kg
Wire drawing energy	* 14	-	15.4	MJ/kg
Metal powder forming energy	* 37	-	40.6	MJ/kg
Vaporization energy	* 1.09e4	-	1.2e4	MJ/kg
Coarse machining energy (per unit wt removed)	* 0.749	-	0.827	MJ/kg
Fine machining energy (per unit wt removed)	* 3.21	-	3.55	MJ/kg
Grinding energy (per unit wt removed)	* 5.95	-	6.57	MJ/kg
Non-conventional machining energy (per unit wt removed)	* 109	-	120	MJ/kg

Material processing: CO2 footprint

Rough rolling, forging CO2	* 0.158	-	0.175	kg/kg
Extrusion, foil rolling CO2	* 0.295	-	0.326	kg/kg
Wire drawing CO2	* 1.05	-	1.16	kg/kg
Metal powder forming CO2	* 2.96	-	3.25	kg/kg
Vaporization CO2	* 815	-	900	kg/kg
Coarse machining CO2 (per unit wt removed)	* 0.0561	-	0.0621	kg/kg
Fine machining CO2 (per unit wt removed)	* 0.241	-	0.266	kg/kg
Grinding CO2 (per unit wt removed)	* 0.446	-	0.493	kg/kg
Non-conventional machining CO2 (per unit wt removed)	* 8.15	-	9	kg/kg

Material recycling: energy, CO2 and recycle fraction

Recycle	True			
Embodied energy, recycling	* 19.2	-	21.3	MJ/kg
CO2 footprint, recycling	* 1.51	-	1.67	kg/kg
Recycle fraction in current supply	35.5	-	39.3	%
Downcycle	True			
Combust for energy recovery	False			
Landfill	True			
Biodegrade	False			
A renewable resource?	False			

Notes

Typical uses

Process plant parts, particularly in thick sections; Used for the containment of nitric acid that has been contaminated by halides, or mixed with certain other acids;

Warning

Although this alloy is the best choice for some specialist situations involving nitric acid, 304L is preferable for general nitric acid use, on both cost and corrosion criteria. If HNO₃ concentration > 65%, use aluminum or a high-silicon cast iron.

Keywords

ARGESTE 4435 LA, Stahlwerk Ergste Westig GmbH (GERMANY); SPARTAN REDHEUGH 320S33, Spartan Redheugh Ltd (UK); SPARTAN REDHEUGH 316S13, Spartan Redheugh Ltd (UK); SPARTAN REDHEUGH 316S33, Spartan Redheugh Ltd (UK); ARGESTE 4436 PA, Stahlwerk Ergste Westig GmbH (GERMANY); ACX 300, Acerinox, S.A. (SPAIN); EASTERN STAINLESS TYPE 316, Eastern Stainless Corp. (USA); PROJECT 70 STAINLESS TYPE 316, Carpenter Technology Corp. (USA); SPARTAN REDHEUGH 320S31, Spartan Redheugh Ltd (UK); PROJECT 7000 STAINLESS TYPE 316, Carpenter Technology Corp. (USA); ALLEGHENY LUDLUM TYPE 316, Allegheny Ludlum Steel (USA); EASTERN STAINLESS TYPE 316L, Eastern Stainless Corp. (USA); PROJECT 70 STAINLESS TYPE 316L, Carpenter Technology Corp. (USA); ARGESTE 4404 LA/SB/VC, Stahlwerk Ergste Westig GmbH (GERMANY); SPARTAN REDHEUGH 316S11, Spartan Redheugh Ltd (UK); PROJECT 7000 STAINLESS TYPE 316L, Carpenter Technology Corp. (USA); ALLEGHENY LUDLUM TYPE 316L, Allegheny Ludlum Steel (USA); ARGESTE 4571 TB/SATA, Stahlwerk Ergste Westig GmbH (GERMANY); ARGESTE 4401 PA/LA/PC/SB/VC, Stahlwerk Ergste Westig GmbH (GERMANY); SPARTAN REDHEUGH 316S31, Spartan Redheugh Ltd (UK); ALLEGHENY LUDLUM TYPE 321, Allegheny Ludlum Steel (USA); EMPIRE TYPE 316EZ, Empire Specialty Steel Inc. (USA); ACX 290, Acerinox, S.A. (SPAIN); ACX 260, Acerinox, S.A. (SPAIN); RDN 280, Roldan S.A. (SPAIN); ACX 280, Acerinox, S.A. (SPAIN); RDN 255, Roldan S.A. (SPAIN); RDN 270, Roldan S.A. (SPAIN); ACX 250, Acerinox, S.A. (SPAIN); ACX 270, Acerinox, S.A. (SPAIN); SANDVIK SANMAC 316L, Sandvik Steel Co. (USA); RDN 250, Roldan S.A. (SPAIN); APMZ, Acciaierie Valbruna SpA (ITALY); SANDVIK 2R61, Sandvik Steel Co. (USA); SANDVIK 3R65, Sandvik Steel Co. (USA);

Reference sources

Data compiled from multiple sources. See links to the References table.

Standards with similar compositions

The following information is taken from ASM AlloyFinder 3 - see link to References table for further information.

ONORM M3121 X2CrNiMo17132KKW (Austria)
EN 10088/2(95) 1.4307 (Europe)
EN 10088/2(95) 1.4404 (Europe)
EN 10088/2(95) 1.4432 (Europe)
EN 10088/2(95) 1.4435 (Europe)
EN 10088/2(95) X2CrNi18-9 (Europe)
EN 10088/2(95) X2CrNiMo17-12-2 (Europe)
EN 10088/2(95) X2CrNiMo17-12-3 (Europe)
EN 10088/2(95) X2CrNiMo18-14-3 (Europe)
EN 10088/3(95) 1.4307 (Europe)
EN 10088/3(95) 1.4404 (Europe)
EN 10088/3(95) 1.4432 (Europe)
EN 10088/3(95) 1.4435 (Europe)
EN 10088/3(95) X2CrNi18-9 (Europe)
EN 10088/3(95) X2CrNiMo17-12-2 (Europe)
EN 10088/3(95) X2CrNiMo17-12-3 (Europe)
EN 10088/3(95) X2CrNiMo18-14-3 (Europe)
GB 1220(92) 00Cr17Ni14Mo2 (China)
GB 12770(91) 00Cr17Ni14Mo2 (China)
GB 12771(91) 00Cr17Ni14Mo2 (China)
GB 13296(91) 00Cr17Ni14Mo2 (China)
GB 3280(92) 00Cr17Ni14Mo2 (China)

GB 4237(92) 00Cr17Ni14Mo2 (China)
GB 4239(91) 00Cr17Ni14Mo2 (China)
GB 4240(93) 00Cr17Ni14Mo2 (China)
GB/T 14975(94) 00Cr17Ni14Mo2 (China)
GB/T 14976(94) 00Cr17Ni14Mo2 (China)
CSN 417349 17349 (Czech Republic)
CSN 417350 17350 (Czech Republic)
SFS 750(86) X2CrNiMo17122 (Finland)
SFS 752 XCrNiMo1812 (Finland)
SFS 752(86) X2CrNiMo17133 (Finland)
AFNOR NFA35573 Z2CND17.12 (France)
AFNOR NFA35574 Z2CND17.12 (France)
AFNOR NFA35575 Z2CND17.12 (France)
AFNOR NFA35577 Z2CND17.12 (France)
AFNOR NFA36209 Z2CND17.12 (France)
AFNOR NFA36607 Z2CND17.12 (France)
DIN 17440(96) GX2CrNiMoN18-10 (Germany)
DIN 17440(96) WNr 1.4404 (Germany)
DIN 17440(96) WNr 1.4435 (Germany)
DIN 17440(96) X2CrNiMo18-14-3 (Germany)
DIN 17441(97) GX2CrNiMoN18-10 (Germany)
DIN 17441(97) WNr 1.4404 (Germany)
DIN 17441(97) WNr 1.4435 (Germany)
DIN 17441(97) X2CrNiMo18-14-3 (Germany)
MSZ 4360(87) X3CrNiMo17143 (Hungary)
IS 1570/5(85) X02Cr17Ni12Mo2 (India)
IS 6527 02Cr17Ni12Mo2 (India)
IS 6528 02Cr17Ni12Mo2 (India)
IS 6529 02Cr17Ni12Mo2 (India)
IS 6603 02Cr17Ni12Mo2 (India)
IS 6911 02Cr17Ni12Mo2 (India)
UNI 6901(71) X2CrNiMo1712 (Italy)
UNI 6901(71) X2CrNiMo1713 (Italy)
UNI 6904(71) X2CrNiMo1712 (Italy)
UNI 6904(71) X2CrNiMo1713 (Italy)
UNI 7500(75) X2CrNiMo1712 (Italy)
UNI 7500(75) X2CrNiMo1713 (Italy)
UNI 8317(81) X2CrNiMo1712 (Italy)
JIS G3214(91) SUSF316L (Japan)
JIS G3447(94) SUS316LTBS (Japan)
JIS G3459(94) SUS316LLTP (Japan)
JIS G4303(91) SUS316L (Japan)
JIS G4304(91) SUS316L (Japan)
JIS G4305(91) SUS316L (Japan)
JIS G4306 SUS316L (Japan)
JIS G4307 SUS316L (Japan)
JIS G4308(98) SUS316L (Japan)
JIS G4309 SUS316L (Japan)
JIS G4315 SUS316L (Japan)
DGN B-229 TP316L (Mexico)
NMX-B-171(91) MT316L (Mexico)
NMX-B-176(91) TP316L (Mexico)
NS 14455 (Norway)
AS 1449(94) 316L (NSW Australia)
AS 2837(86) 316L (NSW Australia)
CSA G110.3 316L (ON Canada)

CSA G110.6 316L (ON Canada)
CSA G110.9 316L (ON Canada)
PNH86020 00H17N14M2 (Poland)
STAS 3583(87) 2MoNiCr175 (Romania)
UNE 36016(75) F.3533 (Spain)
UNE 36016(75) X2CrNiMo17-12-03 (Spain)
UNE 36016/1(89) E-316L (Spain)
UNE 36016/1(89) F.3533 (Spain)
UNE 36016/1(89) F.3537 (Spain)
UNE 36016/1(89) F.3539 (Spain)
UNE 36016/1(89) F.3544 (Spain)
UNE 36087/4(89) F.3533 (Spain)
UNE 36087/4(89) F.3537 (Spain)
UNE 36087/4(89) F.3544 (Spain)
UNE 36087/4(89) X2CrNiMo17 13 2 (Spain)
UNE 36087/4(89) X2CrNiMo17 13 3 (Spain)
UNE 36087/4(89) X2CrNiMoN17 13 5 (Spain)
SS 142348 2348 (Sweden)
SS 142353 2353 (Sweden)
ISO 2604-1(75) F59 (International)
ISO 2604-4 P57 (International)
ISO 2604-4 P58 (International)
ISO 4954(93) X2CrNiMo17133E (International)
ISO 683-13(74) 19 (International)
ISO 683-13(74) 19a (International)
BS 1449/2(83) 316S11 (United Kingdom)
BS 1449/2(83) 316S13 (United Kingdom)
BS 1501 316S37 (United Kingdom)
BS 1501/3(71) 316S82 (United Kingdom)
BS 1501/3(73) 316S12 (United Kingdom)
BS 1501/3(73) 316S49 (United Kingdom)
BS 1501/3(90) 316S11 (United Kingdom)
BS 1501/3(90) 316S13 (United Kingdom)
BS 1503(89) 316S11 (United Kingdom)
BS 1503(89) 316S13 (United Kingdom)
BS 1503(89) 316S63 (United Kingdom)
BS 1506(90) 316S11 (United Kingdom)
BS 1506(90) 316S13 (United Kingdom)
BS 1506(90) 316S63 (United Kingdom)
BS 1554(90) 316S14 (United Kingdom)
BS 2056(83) 316S42 (United Kingdom)
BS 3605(73) 316S14 (United Kingdom)
BS 3605(73) 316S22 (United Kingdom)
BS 3605/1(91) 316S11 (United Kingdom)
BS 3606(78) 316S29 (United Kingdom)
BS 3606(92) 316S11 (United Kingdom)
BS 970/1(96) 316S11 (United Kingdom)
BS 970/1(96) 316S13 (United Kingdom)
BS 970/4(70) 316A12 (United Kingdom)
AMS 5507 (USA)
AMS 5653 (USA)
ASME SA182 316L (USA)
ASME SA213 316L (USA)
ASME SA240 316L (USA)
ASME SA249 316L (USA)
ASME SA312 316L (USA)

ASME SA403 316L (USA)
ASME SA479 316L (USA)
ASME SA688 316L (USA)
ASTM A167(96) 316L (USA)
ASTM A182 316L (USA)
ASTM A182/A182M(98) F316L (USA)
ASTM A213 316L (USA)
ASTM A213/A213M(95) TP316L (USA)
ASTM A240/A240M(98) S31603 (USA)
ASTM A249/249M(96) TP316L (USA)
ASTM A269 316L (USA)
ASTM A276(98) 316L (USA)
ASTM A312/A312M(95) 316L (USA)
ASTM A314 316L (USA)
ASTM A336/A336M(98) F316L (USA)
ASTM A403 316L (USA)
ASTM A473 316L (USA)
ASTM A478 316L (USA)
ASTM A479 316L (USA)
ASTM A511(96) MT316L (USA)
ASTM A554(94) MT316L (USA)
ASTM A580/A580M(98) 316L (USA)
ASTM A632(90) TP316L (USA)
ASTM A666(96) 316L (USA)
ASTM A688/A688M(96) TP316L (USA)
ASTM A774/A774M(98) TP316L (USA)
ASTM A778(90) TP316L (USA)
ASTM A793(96) 316L (USA)
ASTM A813/A813M(95) TP316L (USA)
ASTM A814/A814M(96) TP316L (USA)
ASTM A943/A943M(95) TP316L (USA)
ASTM A965/965M(97) F316L (USA)
ASTM A988(98) S31603 (USA)
FED QQ-S-763F(96) 316L (USA)
FED QQ-S-766D(93) 316L (USA)
MIL-T-8973(69) 316L (USA)
SAE J405(98) S31603 (USA)
AISI 316L (USA)
COPANT 513 TP316L (Venezuela)

Links

[ProcessUniverse](#)

[Producers](#)

[Reference](#)

[Shape](#)

Values marked * are estimates.

No warranty is given for the accuracy of this data