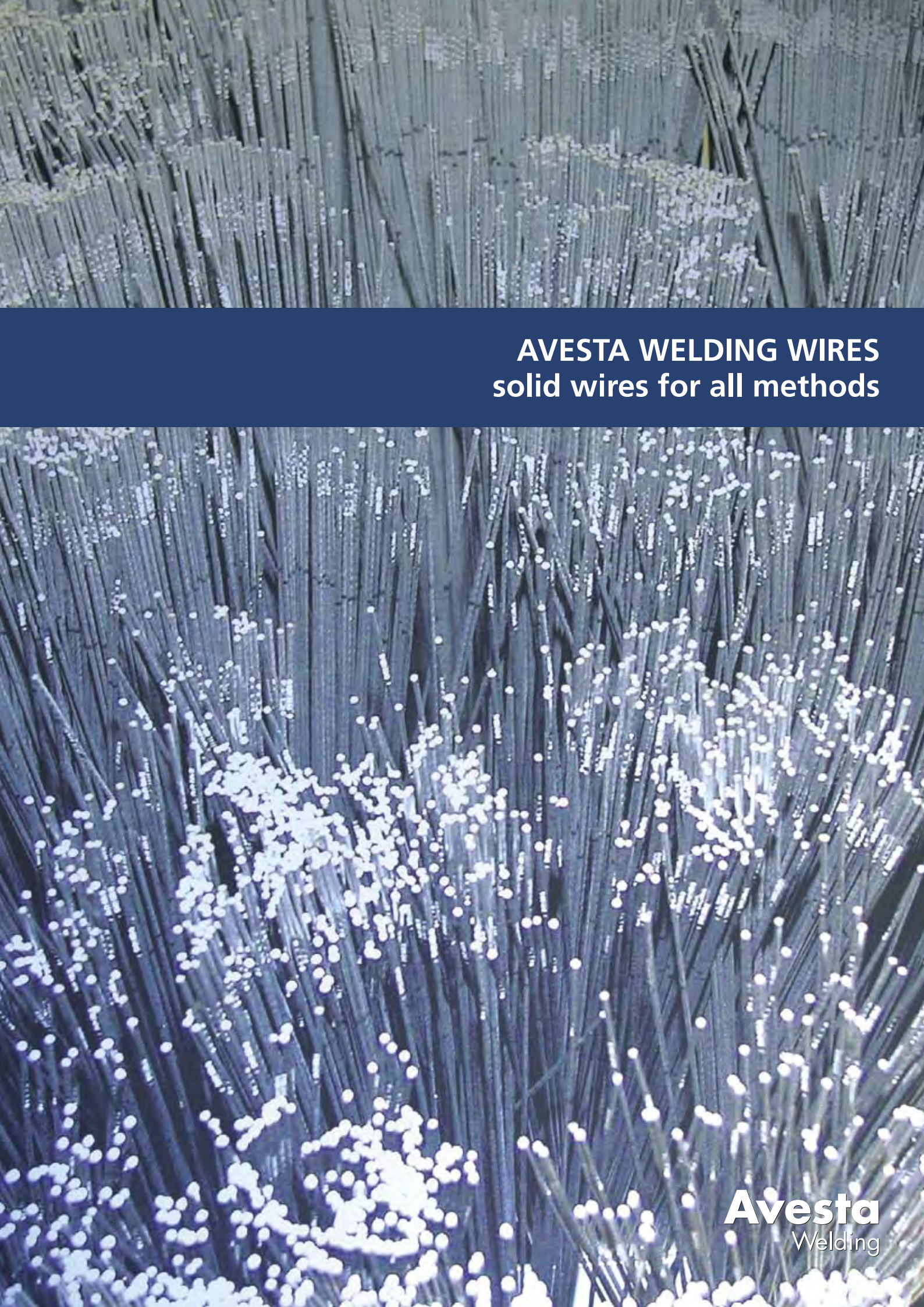


AVESTA WELDING WIRES
solid wires for all methods

Avesta
Welding

Optimal results with all methods

Solid wires are suitable for most applications and can be used with several welding methods. The most common of these are MIG/MAG (metal inert gas/metal active gas), TIG (tungsten inert gas) and SAW (submerged arc welding). Avesta solid welding wires ensure optimum results with all methods.

Avesta MIG

– high productivity when welding thin materials in all positions

MIG/MAG is a rapid method for fully and semi-automatic welding. Depending on the arc's characteristics, welding can be carried out in all positions. Because the weld metal has low oxide and slag levels, its mechanical properties are very good. This is particularly true of impact strength. Suitable metal thicknesses are 2 – 10 mm.

Avesta TIG

– beautiful finishes and exceptional impact strength

Good TIG welds look superb. The weld metal also has the best mechanical properties – impact strength at low temperatures is particularly impressive. For this reason, TIG welding is often used for low-temperature applications. The heat input in TIG welding is normally low. Thus, there is the least possible impact on the parent metal. As the arc and weld pool are highly controllable, TIG is very suitable for the all-position single-sided welding of pipes and other components. Suitable metal thicknesses are 0.3 – 3 mm. TIG is also used for welding root beads. Subsequent welding is then with a method that has a higher productivity.

Avesta SAW

– high productivity when welding thick materials in the flat position

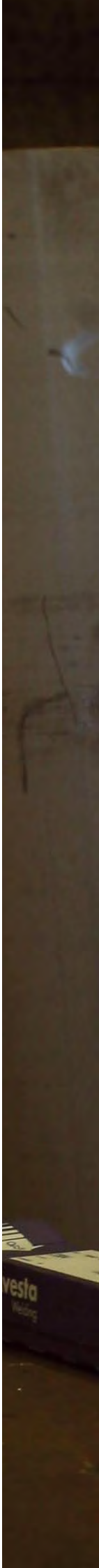
When welding in the flat position, SAW has a deposition rate of up to 8 kg per hour. This is the highest achieved by any conventional method. The weld metal has beautiful, even surfaces. An agglomerated flux (Avesta 801, 805 or 807) is used in submerged arc welding. Because heat input is relatively high, thin materials may be deformed. Suitable metal thicknesses are 10 mm upwards. Some caution must also be exercised when welding fully austenitic steels.

Wire types and designations

EN 12072	Avesta Welding's designations
Austentic	308L-Si/MVR-Si, 308L/MVR, 308H, 347-Si/MVNb-Si, 316L-Si/SKR-Si, 316L/SKR, 318-Si/SKNb-Si, 318/SKNb, 317L/SNR
Austentic-ferritic (duplex)	LDX 2101, 2304, 2205, 2507/P100
Fully austenitic	254 SFER, 904L, P12, P12-0^{Nb}, P16, P54
Special types	307-Si, 309L-Si, 309L, P5, P7, P10
Heat resistant	310, 253 MA, 353 MA

There are MIG, TIG and SAW wires for: welding ferritic, austenitic, martensitic and duplex stainless steels; welding nickel base alloys; and, dissimilar welding, e.g. stainless steels and nickel base alloys to carbon steel.

Solid wires can also be used for plasma, laser and laser hybrid welding.




TIG weld metals have
superb finishes and
the best mechanical properties

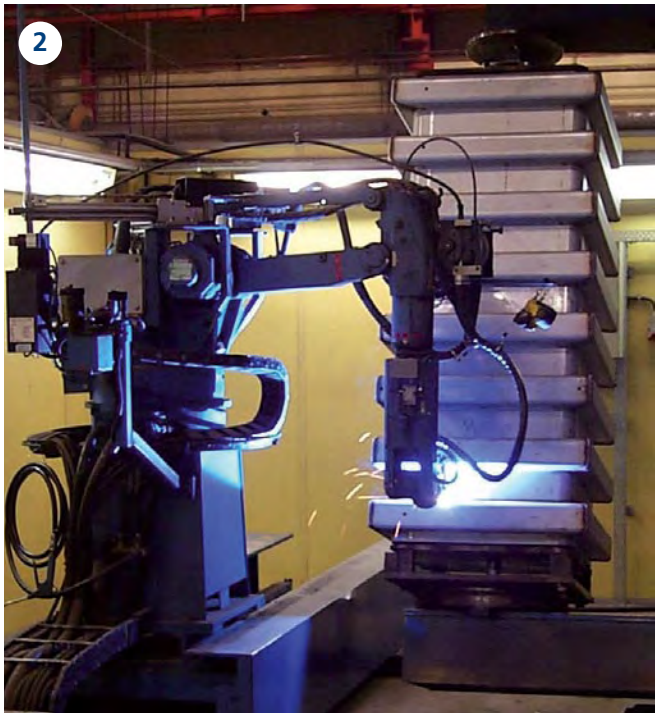
Experience and know-how in all stainless steel applications – experts in stainless steel!

The choice of welding methods is governed by the application. Productivity, finishes, mechanical properties and corrosion resistance are all important factors. Avesta Welding provides expert assistance in choosing the right materials, welding methods and post-weld treatments.

1. Root welding (TIG with 316L-Si/SKR-Si wire) of a thick-walled pipe in EN 1.4404/ASTM 316L. For increased productivity, filler beads can be deposited using Avesta 3D covered electrodes, Avesta FCW-2D or FCW-3D flux cored wires or a submerged arc. With correct edge preparation and the right backing gas, TIG gives perfect root beads in the single-sided welding of pipes and pipe fittings.

2. Robotic welding (MIG with 316L-Si/SKR-Si wires) of a pressure vessel in EN 1.4404/ASTM 316L. Fillet welds are executed with perfect results in all positions.

3. Submerged arc welding of a deck plate (EN 1.4462/ASTM S32205) in a chemical tanker. Welding is with a single bead from each side – Avesta 2205 wire, Avesta Flux 805, X-joint up to 19 mm. High productivity and perfect results.



Mechanical properties, productivity,

corrosion resistance

and finishes are all important factors

Recommendations

Welding with solid wires is rapid and easy. However, for the best possible results, it is important to choose the right filler metals, parameter settings, arc characteristics and shielding gas or flux.

MIG/MAG

MIG welding normally uses a spray or pulsed arc. A spray arc is most often used in the flat position. Welding with a 1.20 mm wire, a pulsed arc and a synergic pulse machine can be carried out in all positions. Especially when welding with high-alloy stainless steel and nickel base wires such as Avesta 2507/P100, 904L and P12, a pulsed arc also helps to give a controlled, stable arc and minimum welding spatter. A short arc is normally only used for materials less than 3 mm thick, root beads and position welding. The welding machine and its characteristics play a large role.

TIG

TIG welding normally uses direct current or a pulsed negative current (DC-). Pulsed current is particularly suitable for all types of position welding and when welding thin sheets and pipes.

The type and appearance of the tungsten electrode has a major impact on welding results. Normally, tungsten alloyed with 1 – 2% thorium, zirconium or cerium is used. The angle of the tungsten electrode affects penetration ability. An electrode angle of 15 – 30° gives a wide arc that is suitable for thin materials. An angle of 60 – 75° gives narrow but deep penetration.

SAW

SAW normally uses direct current with the electrode connected the positive terminal (DC+). Where minimal parent metal fusion is the goal (e.g. overlay welding of carbon steel), the electrode can be connected to the negative pole (DC-). This reduces the amount of such fusion.

MIG/MAG

Arc type	Diameter mm	Current A	Voltage V
Short arc	0.8 1.0	90–120 110–140	19–22 19–22
Spray arc	0.8 1.0 1.2 1.6	150–170 170–200 200–270 250–330	24–27 25–28 26–29 27–30
Pulsed arc	1.2	I_{peak} = 300–400 A I_{bkg} = 35–400 A Freq = 50–200 Hz	

TIG

Diameter mm	Current A	Voltage V
1.00	50– 70	9–11
1.20	60– 80	9–11
1.60	80–110	10–12
2.00	100–130	14–16
2.40	130–160	16–18
3.20	160–200	17–18

SAW

Diameter mm	Current A	Voltage V	Speed cm/min
1.60	200–300	26–30	30–50
2.00	250–350	27–31	30–50
2.40	275–375	28–32	30–60
3.20	325–450	29–33	25–55
4.00	425–575	30–34	25–50

Fluxes for SAW

Flux 801 – a chromium-compensated neutral flux for welding standard steels such as EN 1.4307/ASTM 304L and 1.4432/316L.
Flux 805 – a chromium-compensated flux with high basicity. Used for welding austenitic and duplex stainless steels as well as nickel base alloys.
Flux 807 – a flux that is not chromium compensated, but which has high basicity. Used for welding EN 1.4307/ASTM 304L and 1.4432/316L when there is a requirement that ferrite content must not exceed FN 8.

Shielding gases

MIG

For standard steels such as EN 1.4307/ASTM 304L and 1.4432/316L, MIG welding normally uses pure argon with, for improved arc stability, an addition of 1 – 2% O_2 or 2 – 3% CO_2. An addition of 30% He gives better fluidity and a more stable arc. It also permits higher welding speeds and is recommended for welding all high-alloy steels, e.g. 2205, 904L and P12. A typical gas flow in manual welding is 14 – 16 l per minute.

TIG

TIG welding normally uses argon with a minimum purity of 99.99%. In certain cases where extra purity is required, Ar 99.999% is recommended. An addition of up to 2% N_2 gives better corrosion properties and is particularly recommended when welding duplex and super duplex steels. An addition of 30% He or 2 – 3% H_2 permits higher speeds in fully automatic welding. The gas flow in manual welding is typically 4 – 10 l per minute. If full corrosion resistance is to be achieved in the TIG welding of pipes that cannot be pickled on the inside, a backing gas is often required. The backing gas should normally be pure argon or Formier gas (90% N_2 + 10% H_2). The gas flow is 15 – 20 l per minute.

Steel types	MIG shielding gas	TIG shielding gas
Austenitic standard steels (1.4307/304L, 1.4432/316L, etc.)	1. Ar+1–2%CO_2 or Ar+2–3%CO_2 2. Ar+30%He+1–3%CO_2	1. Ar 2. Ar+2–5%H_2 or Ar+1–5%H_2+10–30%He
Fully austenitic (254 SMO, etc.)	1. Ar+30%He+1–3%CO_2 2. Ar	1. Ar 2. Ar+1–5%H_2+10–30%He 3. Ar+2%N_2+10–30%He
Duplex (LDX 2101, 2304, 2205, etc.)	1. Ar+30%He+1–3%CO_2 2. Ar+1–2%CO_2 or Ar+2–3%CO_2	1. Ar+2%N_2+10–30%He 2. Ar
Super duplex (2507, etc.)	1. Ar+30%He+1–3%CO_2 2. Ar 3. Ar+30%He+1–2%N_2+1–2%CO_2	1. Ar+2%N_2+10–30%He 2. Ar
Nickel base alloys and high-temperature steels (625, 800, etc.)	1. Ar 2. Ar+30%He+1–3%CO_2	1. Ar 2. Ar+2–5%H_2 or Ar+1–5%H_2+10–30%He

Weld metal composition

Standard designations

Product types and designations				Chemical composition, typical values							Ferrite*	EN 12072/	AWS A5.9/
Avesta wire	MIG	TIG	SAW	C	Si	Mn	Cr	Ni	Mo	Other		EN 18274	AWS A5.14
248 SV	X	X		0.02	0.35	1.3	16.0	5.5	1.0	–	10	–	–
308L-Si/MVR-Si	X	X		0.02	0.85	1.8	20.0	10.5	–	–	11	19 9 L Si	ER308LSi
308L/MVR	X	X	X	0.02	0.40	1.7	20.0	10.0	–	–	8	19 9 L	ER308L
308H	X	X	X	0.05	0.40	1.8	20.0	9.0	–	–	10	19 9 H	ER308H
347-Si/MVNb-Si	X	X		0.05	0.85	1.2	19.5	10.0	–	Nb>12xC	10	19 9 Nb Si	ER347Si
347/MVNb		X	X	0.04	0.40	1.3	19.5	9.5	–	Nb>12xC	6	19 9 Nb	ER347
316L-Si/SKR-Si	X	X		0.02	0.85	1.7	18.5	12.0	2.6	–	9	19 12 3 L Si	ER316LSi
316L/SKR	X	X	X	0.02	0.40	1.7	18.5	12.0	2.6	–	8	19 12 3 L	ER316L
318-Si/SKNb-Si	X	X		0.04	0.85	1.3	19.0	12.0	2.6	Nb>12xC	10	19 12 3 Nb Si	–
318/SKNb		X	X	0.04	0.40	1.3	19.0	12.0	2.6	Nb>12xC	8	19 12 3 Nb	ER318
317L/SNR	X	X	X	0.02	0.40	1.7	19.0	13.5	3.5	–	9	18 13 4 L	ER317
LDX 2101	X	X	X	0.02	0.50	0.5	23.0	7.5	<0.3	N 0.15	40	–	–
2304	X	X	X	0.02	0.50	0.5	23.0	7.5	<0.3	N 0.15	40	–	–
2205	X	X	X	0.02	0.50	1.6	23.0	8.5	3.1	N 0.17	50	22 9 3 N L	ER2209
2507/P100	X	X	X	0.02	0.35	0.4	25.0	9.5	4.0	N 0.25	50	25 9 4 N L	ER2594
254 SFER		X		0.01	0.20	4.5	25.0	22.0	2.2	N 0.13 Cu 1.5	0	25 22 2 N L	–
904L	X	X	X	0.01	0.35	1.7	20.0	25.5	4.5	Cu 1.5	0	20 25 5 Cu L	ER385
P12	X	X	X	0.01	0.10	0.1	22.0	65	9.0	Nb 3.6 Fe<1	0	NiCr22Mo9Nb	ERNiCrMo-3
P12-0^{Nb}	X	X	X	0.01	0.10	0.1	22.0	65	9.0	Nb<0.1 Fe<1	0	NiCr22Mo9	ERNiCrMo-20
P16	X	X	X	0.01	0.10	0.2	25.0	60	15.0	Nb<0.1 Fe<1	0	NiCr25Mo16	–
P54	X	X		0.02	0.20	5.1	26.0	22.0	5.5	N 0.35 Cu 0.9	0	–	–
307-Si	X	X		0.09	0.80	7.0	19.0	8.0	–	–	0	18 8 Mn	–
309L-Si	X	X		0.02	0.80	1.8	23.5	13.5	–	–	13	23 13 L Si	ER309LSi
309L		X	X	0.02	0.40	1.8	23.5	14.0	–	–	11	23 13 L	ER309L
P5	X	X	X	0.02	0.35	1.5	21.5	15.0	2.7	–	9	23 12 2 L	ER309LMo**
P7	X	X	X	0.11	0.45	1.9	30.0	9.5	–	–	60	29 9	ER312
P10	X	X		0.03	0.10	2.9	20.0	73	–	Nb 2.5 Fe <2	0	NiCr20Mn3Nb	ERNiCr-3
310	X	X		0.12	0.35	1.6	25.5	21.0	–	–	0	25 20	ER310
253 MA	X	X	X	0.07	1.60	0.6	21.0	10.0	–	N 0.15 REM	10	–	–
353 MA	X	X		0.05	0.85	1.6	27.5	35.0	–	N 0.15 REM	0	–	–

** The ferrite content of pure weld metal. FN 0 – 18 in Schaeffler-DeLong, FN >18 in WRC-92. ** Cr lower and Ni higher than standard.*

MIG wire characteristics

Avesta Welding MIG wire is suitable for:

- Manual welding
- Welding with robots or automatic welding machines
- Automated TIG

The principal features of Avesta Welding MIG wire are:

- Silver-grey surface
- Strenght of around 1,500 N/mm^2 (medium hard)
- Extremely good feedability
- Controlled cast, 800–1,400 mm
- Minimal helix, max. 25 mm
- Tight tolerances, +0.000/–0.010

Friction in the wire conduit has a critical impact on wire feedability.

The significance of silicon in MIG welding

Avesta Welding's MIG and TIG wires are available with low or high silicon contents. A high silicon content gives better arc stability and fluidity. It also contributes to a more attractive weld finish and reduces the risk of pore formation and welding spatter. Wire with a high silicon content is made only for steel grades for which it has been shown that welding has no negative impact on hot cracking resistance.

SAW wire is made only with a low silicon content. This is because most granulated fluxes include silicon. A too high silicon content can lead to hot cracking.

Mechanical properties, typical values (MIG wire) Approvals*

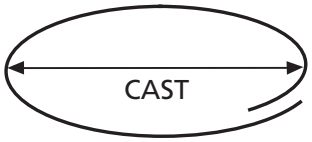
Avesta Welding wire designation	$R_{p0,2}$ N/mm$_2$	R_m N/mm$_2$	A_5 %	Impact strength KV, J +20°C	Low temp.	Brinell hardness	DNV	TÜV	Other
248 SV	460	840	23	80	–	260			
308L-Si/MVR-Si	420	600	36	110	60 (–196°C)	200	M, T	M, T	X
308L/MVR	390	590	38	110	50 (–196°C)	200	M, T, S (801)	M, T, S (801, 805)	X
308H	400	610	37	95	–	210		M	X
347-Si/MVNb-Si	430	620	36	100	90 (–40°C)	210		M, T	X
347/MVNb**	450	640	34	60	–	220		S (801)	X
316L-Si/SKR-Si	400	600	36	110	50 (–196°C)	210	M, T	M, T	X
316L/SKR	390	580	37	100	50 (–196°C)	210	M, T, S (801, 805)	M, T, S (801, 805)	X
318-Si/SKNb-Si	420	600	33	85	80 (–40°C)	220		M, T	X
318/SKNb**	490	660	30	50	–	220		S (801)	X
317L/SNR	420	630	31	85	–	200			
LDX 2101	520	600	30	150	110 (–40°C)	240			
2304	520	710	30	150	110 (–40°C)	240		T, S (805)	
2205	550	770	30	150	110 (–40°C)	240	M, T, S (805)	M, T, S (805)	X
2507/P100	570	830	29	140	–	280		T	
254 SFER***	430	640	33	170	130 (–196°C)	200			
904L	340	570	38	130	100 (–196°C)	170		M, T, S (805)	X
P12	480	750	42	170	150 (–40°C)	220		M, T	X
P12-0^{Nb}	380	630	36	240	220 (–70°C)	210			
P16	470	700	33	120	–	220			
P54	480	750	35	90	–	220			
307-Si	470	710	42	120	110 (–40°C)	220	M	M, T	X
309L-Si	400	600	32	110	–	220		M, T	X
309L**	410	580	36	70	–	220	S (805)	T	X
P5	390	610	31	75	60 (–40°C)	210	M, T, S (801, 805)	M, T	X
P7	560	750	25	40	–	240	S (801)		X
P10***	410	660	33	160	–	200			
310	360	570	35	120	–	210			
253 MA	440	680	38	130	–	210			
353 MA	320	590	43	160	–	200			

** For detailed information, contact Avesta Welding. ** Welded with SAW wire. ** Welded with TIG wire. M = MIG, T = TIG, S = SAW (flux).*

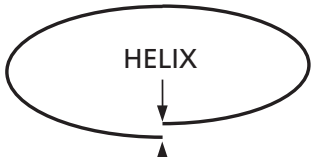
Cast och helix

Cast and helix are terms used to describe two wire properties that are very important in MIG welding.

Cast is the diameter of a loop of wire that has been cut from the spool and laid on a flat surface. Too high or too low a cast can lead to problems in the wire feeder and/or at the contact tip. Such problems have a negative effect on arc stability.



Helix is the vertical distance between the ends of a loop of wire that has been cut from the spool and laid on a flat surface. Too large a helix will cause the wire to rotate in the feeder and at the contact tip.



MIG wire from Avesta Welding has a cast of 800 – 1,400 mm and a helix of no more than 25 mm. In most applications and welding machines, this guarantees the best feedability and the best welding properties. The cast and helix values satisfy the requirements of AWS A5.9.

Choice of filler metals

EN	ASTM	Outokumpu steel designation	Recommended wire type
1.4418	–	248 SV	248 SV
1.4301 1.4307 1.4311 1.4541	304 304L 304LN 321	4301 4307 4311 4541	308L-Si/MVR-Si 308L/MVR 308H
1.4541 1.4550	321 347	4541 [123] 4550	347-Si/MVNb-Si 347/MVNb
1.4436 1.4432 1.4429 1.4571	316 316L 316LN 316Ti	4436 4432 4429 4571	316L-Si/SKR-Si 316L/SKR
1.4571	316Ti	4571	318-Si/SKNb-Si 318/SKNb
1.4438 1.4439	317L 317LMN	4438 4439	317L/SNR
1.4162 1.4362 1.4462 1.4410 1.4501	S32101 S32304 S32205 S32750 S32760	LDX 2101 2304 2205 SAF 2507 [123] 4501	LDX 2101 2304 2205 2507/P100
1.4539 1.4547 1.4529 1.4565	904L S31254 N08926 S34565	904L 254 SMO 4529 4565	904L P12, P12-0^{Nb}, P54 P12, P12-0^{Nb}, P54 P16, P54
Joints between stainless and carbon steels as well as welding of certain high-strength steels such as Hardox 600.			307-Si
Joints between molybdenum free stainless steels and carbon or low-alloy steels. Overlay welding of carbon or low-alloy steels.			309L 309L-Si
Joints between molybdenum alloyed stainless steels and carbon or low-alloy steels. Overlay welding of carbon or low-alloy steels.			P5
For welding "difficult" steels (Mn steels, tool steels, high-temperature steels and high-strength steels such as Hardox 600). Welding stainless steels to unalloyed steels.			P7
Inconel 600, 9% Ni steels. Welding nickel base alloys to stainless or unalloyed steels.			P10
1.4845 1.4835 1.4854	310S S30815 S35315	4845 253 MA 353 MA	310 253 MA 353 MA

Standard dimensions

Wire type	Diameter, mm 0.80	1.00	1.20	1.60	2.00	2.40	3.20	4.00
MIG	X	X	X	X				
TIG		X	X	X	X	X	X	
SAW				X	X	X	X	X

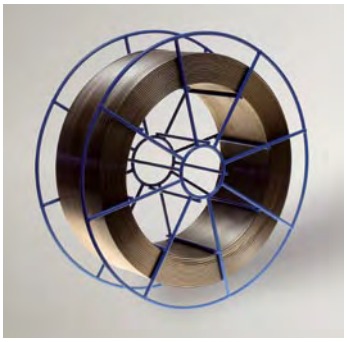
Other dimensions can be supplied.

Packaging data

MIG

Layer wound on wire basket spools.
OD, 300 mm.
ID, 51 mm.
Width, 100 mm.
Weight, 15 kg.

Also available in 250 kg drums.



TIG

Packed in cardboard boxes that are easy to reseal.
Length, 1,000 mm.
Weight, 5 kg.

SAW

Layer wound on wire basket spools.
OD, 415 mm.
ID, 300 mm.
Width, 100 mm.
Weight, 25 kg.

Flux

Flux for SAW is supplied in moisture-proof 25-kilo sacks.

Storage and handling

Filler metals must be stored in their original packagings and protected from moisture, dirt and dust. Flux is moisture sensitive and, up until it is used, must be stored in its unbroken packaging in a dry environment. Damp flux should be rebaked at 250 – 300°C for 2 hours.

Quality assurance and marking

Avesta Welding's solid wires are supplied with a 3.1 certificate. This shows the chemical composition of the supplied item and typical values for yield strength, tensile strength and elongation.

Each MIG or SAW spool and each TIG pack has the following markings:

- Avesta Welding's product designation
- Lot number
- Weight
- Standard designation (where applicable)
- Approvals (where applicable)
- Warning text

For maximum traceability, each TIG wire is also stamped with Avesta Welding's product designation, lot number and standard designation.

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