

Lasting Connections

# WELDING CONSUMABLES FOR PIPELINE CONSTRUCTION



## LASTING CONNECTIONS

As a pioneer in innovative welding consumables, Böhler Welding offers a unique product portfolio for joint welding worldwide. More than 2000 products are adapted continuously to the current industry specifications and customer requirements, certified by well-respected institutes and thus approved for the most demanding welding applications. As a reliable partner for customers, “lasting connections” are the brand’s philosophy in terms of both welding and people.

Our customers benefit from a partner with

- » the highest expertise in joining, rendering the best application support globally available
- » specialized and best in class product solutions for their local and global challenges
- » an absolute focus on customer needs and their success
- » a worldwide presence through factories, offices and distributors

## SOLUTIONS FOR THE PIPELINE INDUSTRY

The Böhler Welding program answers the industry’s general trend towards semi- and fully automatic welding processes, the use of high strength steels with reduced wall thickness, as well as application under demanding climatic conditions.

A wide selection of manual arc welding electrodes comprises types with cellulosic coating for highly efficient vertical-down welding and basic low-hydrogen types with vertical-down or vertical-up operability. A broad range of products for semi- and fully- mechanized welding features solid wires and rods, self- and gas-shielded cored wires and submerged arc wire/flux combinations for double jointing.

The range presented in this catalogue covers normal strength pipeline steel grades up to API X60/EN L415MB, high tensile grades up to API X100/ENL690MB, standard stainless steel grades, duplex and super duplex stainless steel, nickel base alloy 625 and CRA clad pipes alloy 316L, 625 and 825.



# SELECTION GUIDE

ISO 3183 pipe steel yield strength level		Welding process			
EN	API 5L	MMA / SMAW			MAG / GMAW
		Cellulosic	Basic vertical-down	Basic vertical-up	
L175	A25	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL-S Phoenix Cel 70	BÖHLER FOX BVD 85	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 50 Phoenix 120K	BÖHLER SG 3-P Union K 52 S
L210	A	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL-S Phoenix Cel 70	BÖHLER FOX BVD 85	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 50 Phoenix 120K	BÖHLER SG 3-P Union K 52 S
L245	B	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL-S Phoenix Cel 70	BÖHLER FOX BVD 85	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 50 Phoenix 120K	BÖHLER SG 3-P Union K 52 S
L290	X42	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL-S Phoenix Cel 70	BÖHLER FOX BVD 85	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 50 Phoenix 120K	Union K 52 S BÖHLER SG 3-P Union K 56 S Union K Nova
L320	X46	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL-S Phoenix Cel 70	BÖHLER FOX BVD 85	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 50 Phoenix 120K	Union K 52 S BÖHLER SG 3-P Union K 56 S Union K Nova
L360	X52	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL-S Phoenix Cel 70	BÖHLER FOX BVD 85	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 50 Phoenix 120K BÖHLER FOX EV 60 Phoenix SH V 1	Union K 52 S BÖHLER SG 3-P Union K 56 S Union K Nova
L390	X56	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL-S Phoenix Cel 70 BÖHLER FOX CEL Mo BÖHLER FOX CEL 70-P BÖHLER FOX CEL 75 BÖHLER FOX CEL 75-G Phoenix Cel 75	BÖHLER FOX BVD 85	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 50 Phoenix 120K BÖHLER FOX EV 60 Phoenix SH V 1	Union K 52 S BÖHLER SG 3-P Union K 56 S Union K Nova
L415	X60	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL-S Phoenix Cel 70 BÖHLER FOX CEL Mo BÖHLER FOX CEL 70-P BÖHLER FOX CEL 75 BÖHLER FOX CEL 75-G Phoenix Cel 75 BÖHLER FOX CEL 80-P BÖHLER FOX CEL 85 BÖHLER FOX CEL 85-G Phoenix Cel 80	BÖHLER FOX BVD 85	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 50 Phoenix 120K BÖHLER FOX EV 60 Phoenix SH V 1 BÖHLER FOX EV 60 PIPE BÖHLER FOX EV 65	Union K 52 S BÖHLER SG 3-P Union K 56 S Union K Nova Union K Nova Ni

	TIG / GTAW	FCAW	SAW
	BÖHLER ER 70 S-2 BÖHLER EMK 6 Union I 2 Union I 52 BÖHLER EML 5	BÖHLER Q 71 RC BÖHLER Pipeshield 71 T 8-FD BÖHLER Pipeshield 71.1 T 8-FD	Union S 2 / UV 421 TT Union S 3 Si / UV 421 TT
	BÖHLER ER 70 S-2 BÖHLER EMK 6 Union I 2 Union I 52 BÖHLER EML 5	BÖHLER Q 71 RC BÖHLER Pipeshield 71 T 8-FD BÖHLER Pipeshield 71.1 T 8-FD	Union S 2 / UV 421 TT Union S 3 Si / UV 421 TT
	BÖHLER ER 70 S-2 BÖHLER EMK 6 Union I 2 Union I 52 BÖHLER EML 5	BÖHLER Q 71 RC BÖHLER Pipeshield 71 T 8-FD BÖHLER Pipeshield 71.1 T 8-FD	Union S 2 / UV 421 TT Union S 3 Si / UV 421 TT
	BÖHLER ER 70 S-2 BÖHLER EMK 6 Union I 2 Union I 52 BÖHLER EML 5	BÖHLER Q 71 RC BÖHLER Pipeshield 71 T 8-FD BÖHLER Pipeshield 71.1 T 8-FD	Union S 2 / UV 421 TT Union S 3 Si / UV 421 TT
	BÖHLER ER 70 S-2 BÖHLER EMK 6 Union I 2 Union I 52 BÖHLER EML 5	BÖHLER Q 71 RC BÖHLER Pipeshield 71 T 8-FD BÖHLER Pipeshield 71.1 T 8-FD	Union S 2 / UV 421 TT Union S 3 Si / UV 421 TT
	BÖHLER ER 70 S-2 BÖHLER EMK 6 Union I 2 Union I 52 BÖHLER EML 5 BÖHLER Ni 1-IG	BÖHLER Q 71 RC BÖHLER Pipeshield 71 T 8-FD BÖHLER Pipeshield 71.1 T 8-FD	Union S 2 / UV 421 TT Union S 3 Si / UV 421 TT
	BÖHLER ER 70 S-2 BÖHLER EMK 6 Union I 2 Union I 52 BÖHLER EML 5 BÖHLER Ni 1-IG	BÖHLER Q 71 RC FOXcore X60 RC-Pipe BÖHLER Pipeshield 71 T 8-FD BÖHLER Pipeshield 71.1 T 8-FD	Union S 3 Si / UV 421 TT
	BÖHLER ER 70 S-2 BÖHLER EMK 6 Union I 2 Union I 52 BÖHLER EML 5 BÖHLER Ni 1-IG	BÖHLER Q 71 RC FOXcore X60 RC-Pipe BÖHLER Pipeshield 71 T 8-FD BÖHLER Pipeshield 71.1 T 8-FD	Union S 3 Si / UV 421 TT Union S 2 NiMo 1 / UV 421 TT

Legend:

- Root pass only
- FCAW Ti -X = Gas shielded flux cored wire for vertical-up and -down welding
- FCAW Pipeshield -X = Self shielded flux cored wire for vertical-down welding
- GMAW= solid wires for mechanized vertical-down welding
- FOX EV PIPE and FOX EV 50-W are special designed for root pass welding

# SELECTION GUIDE

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EN	API 5L	MMA / SMAW			MAG / GMAW	
		Cellulosic	Basic vertical-down	Basic vertical-up		
L450	X65	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL-S Phoenix Cel 70 BÖHLER FOX CEL 80-P BÖHLER FOX CEL 85 BÖHLER FOX CEL 85-G Phoenix Cel 80	BÖHLER FOX BVD 85	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 60 Phoenix SH V 1 BÖHLER FOX EV 60 PIPE BÖHLER FOX EV 65	Union K 52 S BÖHLER SG 3-P Union K 56 S Union K Nova Union K Nova Ni BÖHLER SG 8-P	
L485	X70	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL 70 Phoenix Cel-S BÖHLER FOX CEL 80-P BÖHLER FOX CEL 85 BÖHLER FOX CEL 85-G Phoenix Cel 80 BÖHLER FOX CEL 90 Phoenix Cel 90	BÖHLER FOX BVD 90	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 65 BÖHLER FOX EV 70 PIPE BÖHLER FOX EV 70	Union K 56 S Union K Nova Union K Nova Ni BÖHLER SG 8-P BÖHLER NiMo 1-IG	
L555	X80	BÖHLER FOX CEL BÖHLER FOX CEL + BÖHLER FOX CEL-S	BÖHLER FOX BVD 90 BÖHLER FOX BVD 100	BÖHLER FOX EV PIPE BÖHLER FOX EV 50-W BÖHLER FOX EV 70 PIPE BÖHLER FOX EV 75	Union K Nova Ni Union Ni Mo 80 BÖHLER NiMo 1-IG	
L625	X90		BÖHLER FOX BVD 100	BÖHLER FOX EV 85	BÖHLER NiMo 1-IG Union Ni1MoCr	
L690	X100		BÖHLER FOX BVD 110 BÖHLER FOX BVD 120	BÖHLER FOX EV 85	BÖHLER NiMo 1-IG Union Ni1MoCr	
L830	X120				Union NiMoCr	
Stainless Steel / Cladded Pipes						
13% Cr		BÖHLER FOX CN 22/9 N BÖHLER FOX CN 22/9 N-B BÖHLER FOX CN 25/9 CuT			Thermanit 22/09 Thermanit 25/09 CuT	
316L		BÖHLER FOX EAS 4 M-A BÖHLER FOX EAS 4 M			Thermanit GE-316L Si	
22% Cr		BÖHLER FOX CN 22/9 N BÖHLER FOX CN 22/9 N-B			Thermanit 22/09	
25% Cr		BÖHLER FOX CN 25/9 CuT			Thermanit 25/09 CuT	
CRA 625/825		Thermanit 625 Thermanit 686			Thermanit 625 Thermanit 686	

	TIG / GTAW	FCAW	SAW
	BÖHLER Ni 1-IG BÖHLER NiMo 1-IG	BÖHLER Q 71 RC FOXcore X60 RC-Pipe BÖHLER Ti 70 Pipe-FD BÖHLER Pipeshield 81 T8-FD	Union S 3 Si / UV 421 TT Union S 2 NiMo 1 / UV 421 TT Union S 3 NiMo 1 / UV 421 TT
	BÖHLER NiMo 1-IG	FOXcore X60 RC-Pipe BÖHLER Ti 70 Pipe-FD BÖHLER Ti 80 Pipe-FD BÖHLER Pipeshield 81 T8-FD	Union S 2 NiMo 1 / UV 421 TT Union S 3 NiMo 1 / UV 421 TT Union S 3 NiMoCr / UV 421 TT
	BÖHLER NiMo 1-IG	BÖHLER Ti 80 Pipe-FD	Union S 3 NiMoCr / UV 421 TT
	BÖHLER NiCrMo 2,5-IG		Union S 3 NiMoCr / UV 421 TT
	BÖHLER NiCrMo 2,5-IG		Union S 3 NiMoCr / UV 421 TT
	Thermanit 22/09 Thermanit 25/09 CuT	BÖHLER CN22/9 PW-FD BÖHLER CN 25/9 PW-FD	Thermanit 22/09 Marathon 431
	Thermanit GE-316L	BÖHLER EAS 4 PW-FD	Thermanit GE-316L Marathon 431
	Thermanit 22/09	BÖHLER CN22/9 PW-FD	Thermanit 22/09 Marathon 431
	Thermanit 25/09 CuT	BÖHLER CN 25/9 PW-FD	
	Thermanit 625 Thermanit 686	BÖHLER NIBAS 625 PW-FD	Thermanit 625 Marathon 444

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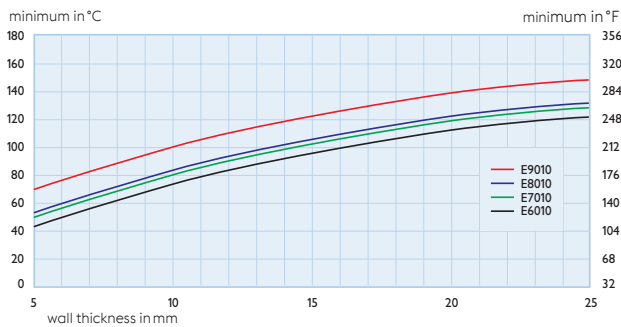
# WELDING TECHNIQUES CELLULOSIC ELECTRODES

## Preheating and interpass temperature

In order to prevent hydrogen induced cracking, it is necessary to preheat pipes before starting to weld and to maintain an interpass temperature during the welding of individual beads.

In respect of the quite often difficult site conditions, preheating at 150°C (300°F) is recommended in general. This covers all wall thicknesses up to 25 mm (1") and weld metals up to class E9010 (FOX CEL 90). Be aware that lower preheat and interpass temperatures are valid, when welding thin-walled pipes.

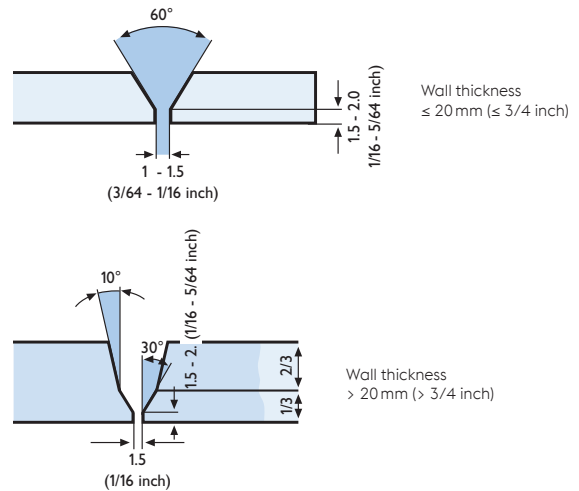
The diagram below shows minimum required pre-heat temperatures, in dependence of wall thickness and type of electrode. This is related to both preheating and interpass.



## Welding machines

Cellulosic electrodes can only be operated on direct current. Welding machines must have a dropping characteristic and high open circuit voltage.

## Recommended joint preparation



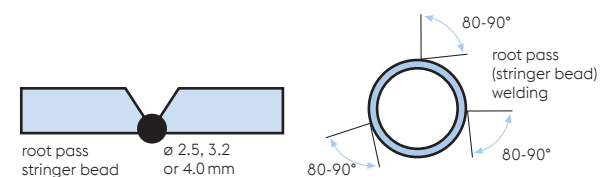
## Welding technique Stringer bead or root pass

The root pass is a critical part of any pipe weld, requiring perfect penetration. Electrode diameter, travel speed and amperage must be selected to match pipe diameter and wall thickness. For pipe diameters up to about 250 mm (10") and wall thickness up to 8 mm (5/16"), we recommend to use 3.2 mm (1/8") diameter electrodes, for larger sizes, 4 mm (5/32") diameter electrodes.

Welding is performed in vertical-down direction, with the electrode in good contact with both beveled plate edges.

Electrode diameter:		
2.5 mm	(3/32")	50 - 80 A
3.2 mm	(1/8")	80 - 100 A
4.0 mm	(5/32")	120 - 150 A

Line-up clamps should be removed only after completing the root pass over the full circumference and, when welding larger diameter pipe, only after completing the hot pass. While making the hot pass, do not move pipes in order to avoid the risk of crack formation.





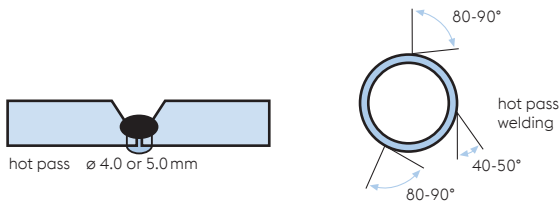
## Hot pass

In order to prevent lateral slag inclusions (showing up as „waggon tracks“ in weld radiographs), slight grinding of the stringer bead is essential.

Electrode sizes commonly used are

Electrode diameter:		
3.2 mm	(1/8")	80 - 130 A
4.0 mm	(5/32")	150 - 180 A
5.0 mm	(3/16")	170 - 210 A

Use of a relatively high welding current is favourable, because it gives a good penetration making any remaining slag inclusions re-melt and float to the surface, while ensuring that the root pass is annealed thoroughly. The hot pass should be welded immediately after deposition of the stringer bead, but in no case more than 10 minutes later. This is of special importance for high strength line pipe grades to avoid underbead cracking in the base material.



## Filler layers

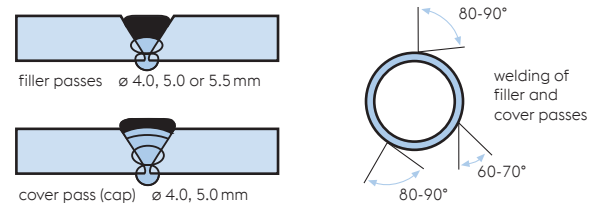
Beads will be sufficiently flat and free from undercut and slag inclusions, if the electrode is applied with a slight circular or stepping motion, especially in positions 12 to 2 o'clock, 12 to 10 o'clock, 4 to 6 o'clock and 8 to 6 o'clock. Weaving of max.  $2 \times \varnothing$  is recommended for all other positions.

Electrode sizes and amperages recommended for filler pass welding on positive (+) polarity:

Electrode diameter:		
3.2 mm	(1/8")	80 - 130 A
4.0 mm	(5/32")	100 - 180 A
5.0 mm	(3/16")	140 - 210 A

## Cover pass (cap)

The cover pass is executed with a slight weaving of the electrode. The weld should not overlap the groove edge by more than 1.5 mm (1/16"). If the cover pass is applied correctly, weld reinforcement is about 1 to 2 mm (1/16").



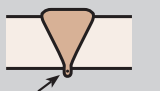


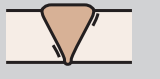



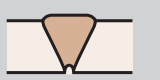
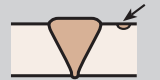


## Storage of cellulosic electrodes

The coating of cellulosic electrodes has a relatively high content of moisture which is necessary for welding characteristics and metallurgical properties of the deposit.

Electrodes must be stored in a closed area, away from solar radiation and excessive variations in temperature. Once a can has been opened, the electrodes must be used as soon as possible. Rebaking of cellulosic electrodes is not permitted.

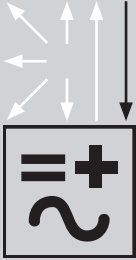
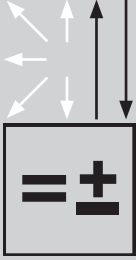
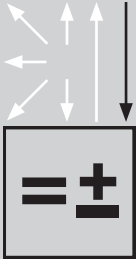
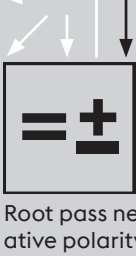
# TROUBLE SHOOTING

Trouble shooting	Defects	Causes	How to avoid defects
	Porosity visible on the surface	<ul style="list-style-type: none"> <li>» excessive and uncontrolled weaving</li> <li>» base metal overheated (increased risk in thin wall pipe)</li> <li>» moisture content of electrode coating too low</li> </ul>	<ul style="list-style-type: none"> <li>» weaving not to exceed 2 x electrode dia.</li> <li>» choose electrode dia. and amperage as a function of pipe wall thickness</li> <li>» keep electrodes in closed containers</li> </ul>
	Pinholes not visible on the surface	<ul style="list-style-type: none"> <li>» delayed deoxidation process in weld deposit</li> <li>» moisture content in electrode coating too low or too high</li> </ul>	<ul style="list-style-type: none"> <li>» avoid excessive upsetting of metal deposited</li> <li>» see chapter „storage“</li> </ul>
	Piping or hollow bead almost exclusively in the reinforcement of stringer bead - therefore, practically no reduction of cross section	<ul style="list-style-type: none"> <li>» root gap too narrow: degassing hindered by excessive dilution</li> <li>» chemical composition of base metal: high Al levels usually favour piping formation</li> </ul>	<ul style="list-style-type: none"> <li>» root gap width not less than 1 mm</li> <li>» the optimum root gap width of 1.5 mm should be observed for 0.040% Al steels in particular. If trouble continues, use smaller electrode dia.</li> </ul>
	Slag inclusions generally occurring in groove faces and in stringer bead area (wagon tracks)	<ul style="list-style-type: none"> <li>» insufficient cleaning in between passes</li> <li>» stringer bead poorly ground</li> <li>» incorrect electrode manipulation</li> <li>» amperage too low</li> </ul>	<ul style="list-style-type: none"> <li>» clean each layer with rotary wire brush</li> <li>» grind stringer bead sufficiently before applying hot pass</li> <li>» improve electrode manipulation</li> <li>» increase amperage</li> </ul>
	Lack of fusion (cold laps)	<ul style="list-style-type: none"> <li>» insufficient melting of groove faces</li> <li>» amperage too low</li> <li>» groove faces contaminated and/or oxidized</li> </ul>	<ul style="list-style-type: none"> <li>» choose amperage to match electrode dia. and welding position</li> <li>» clean groove faces properly</li> </ul>
	Underbead cracks almost exclusively in the hardened HAZ	<ul style="list-style-type: none"> <li>» combined action of hydrogen, stresses, hardened structure</li> </ul>	<ul style="list-style-type: none"> <li>» preheat pipe material to favour hydrogen effusion, increase of heat input is also advantageous</li> <li>» avoid moving pipe string</li> <li>» considerable hardening is to be expected during welding of the stringer bead, therefore the hot pass must be applied immediately after its completion</li> </ul>
	Cracks caused by mechanical stresses usually in the stringer bead region	<ul style="list-style-type: none"> <li>» moving of pipes during welding of stringer bead and/or before applying hot pass</li> <li>» edge offset too large, resulting in reduced root cross section and increased risk of crack formation</li> </ul>	<ul style="list-style-type: none"> <li>» avoid moving pipe particularly during welding of stringer bead</li> <li>» refer to relevant standards and specifications for maximum offset which, however, should be kept to a minimum</li> </ul>
	Undercut in the region of stringer bead and cover passes	<ul style="list-style-type: none"> <li>» amperage too high</li> <li>» incorrect manipulation</li> </ul>	<ul style="list-style-type: none"> <li>» selection of correct amperage to match electrode size</li> </ul>
	Excess reinforcement	<ul style="list-style-type: none"> <li>» Incorrect manipulation</li> </ul>	<ul style="list-style-type: none"> <li>» select amperage to match joint width</li> <li>» allowance for desired cap layer weld reinforcement is to be made already when applying last filler pass (e.g. by additional layers or grinding of filler layers that are too high)</li> </ul>
	Sagging stringer bead	<ul style="list-style-type: none"> <li>» amperage too high</li> <li>» poor joint preparation, root gap too large</li> </ul>	<ul style="list-style-type: none"> <li>» select correct amperage to match joint preparation for stringer bead</li> </ul>
	Striking marks	<ul style="list-style-type: none"> <li>» striking right or left of the joint causes local hardening – risk of hardening cracks</li> </ul>	<ul style="list-style-type: none"> <li>» strike arc in the groove</li> </ul>

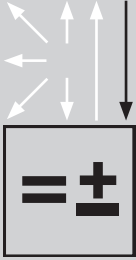
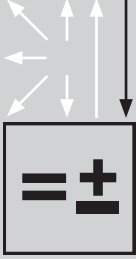
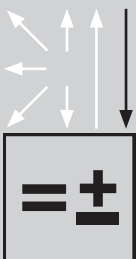
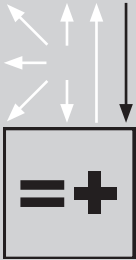


# PRODUCT OVERVIEW

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Cellulosic electrodes for vertical-down welding									
BÖHLER FOX CEL	EN ISO 2560- A: E 38 3 C 2 1	AWS A5.1: E6010	C 0.12 Si 0.14 Mn 0.50	450 (≥ 380)	550 (470- 600)	26 (≥ 22)	+20 0 -20 -30	100 90 80 50 (≥ 47)	2.5 3.2 4.0 5.0
BÖHLER FOX CEL+	EN ISO 2560- A: E 38 2 C 2 1	AWS A5.1: E6010	C 0.17 Si 0.15 Mn 0.6	450 (≥ 380)	520 (470- 600)	26 (≥ 22)	+20 0 -20 -30	105 95 65 (≥ 47) ≥ 27	2.5 3.2 4.0
BÖHLER FOX CEL-S	EN ISO 2560- A: E 38 3 C 2 1	AWS A5.1: E6010	C 0.10 Si 0.20 Mn 0.50	480 (≥ 380)	550 (470- 600)	23 (≥ 22)	+20 -30	110 ≥ 47	2.5 3.2 4.0
Phoenix Cel 70	EN ISO 2560- A: E 42 2 C 2 5	AWS A5.1: E6010	C 0.14 Si 0.18 Mn 0.55	440 (≥ 420)	540 (500- 640)	24 (≥ 20)	+20 ± 0 -20 -40	80 70 55 (≥ 47) 28	2.5 3.2 4.0 5.0

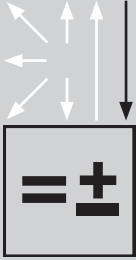
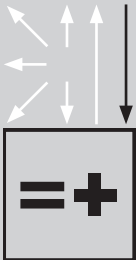
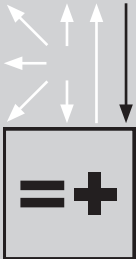
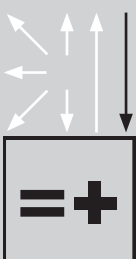
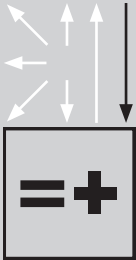
Current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
50-90 80-130 120-180 160-210	L210NB- L415NB L290MB- L415MB	A B X42 -X56	 <p>Root pass negative polarity</p>	Re-drying not allowed	Cellulosic electrode for vertical-down welding of large diameter pipelines; suitable for root runs, hot passes, filler passes and capping. Especially recommended for root run welding. Highly economical compared with vertical-up welding. Apart from its excellent welding and gap bridging characteristics, FOX CEL offers a weld deposit with outstanding impact strength values and thus offers the benefit of still more safety in field welding of pipelines. It can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC test are available too.	TÜV (01281), DNV (3), Statoil, SEPROZ, CE, NAKS (ø3.2, 4.0 mm)
50-90 80-130 120-180	L210NB- L415NB L290MB- L415MB	A B X42 -X56	 <p>Root pass positive polarity (negative polarity possible)</p>	Re-drying not allowed	Cellulosic electrode for vertical-down welding of large diameter pipelines. Especially recommended for root pass welding on DC positive polarity in the vertical-down and vertical-up welding positions. Apart from its good weldability and gap bridging characteristics, Böhler FOX CEL+ provides a powerful arc that deposits well-penetrated, smooth root passes at high travel speed as well as high safety against the formation of piping or hollow bead and undercut. Böhler FOX CEL+ can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC test are available too.	
50-90 80-130 110-170	L210NB- L415NB L290MB- L415NB	A B X42 -X56	 <p>Root pass negative polarity</p>	Re-drying not allowed	Cellulosic for the vertical-down welding of filler and cap layers on large diameter pipelines. Root passes with diameters 2.5 and 3.2 on negative polarity, vertically-up and down.	
50 - 80 80 - 130 120 - 180 160 - 220	L210NB- L390NB L290MB- L390MB	A B X42 -X56	 <p>Root pass negative polarity</p>	Re-drying not allowed	Cellulosic electrode for vertical down circumferential welds in pipeline constructions. Excellent weldability in root pass welding (DC ±); also in the vertical up position. CTOD, HIC and HSCC tested.	TÜV (00247), DB (10.132.44), ABS, DNV, GL, LR, CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER FOX CEL Mo	EN ISO 2560- A: E 42 3 Mo C 2 5	AWS A5.5: E7010-A1	C 0.1 Si 0.14 Mn 0.4 Mo 0.5	480 (≥ 420)	550 (500- 640)	23 (≥ 20)	+20 0 -20 -30 -40	100 95 85 50 (≥ 47) 42	3.2 4.0 5.0
BÖHLER FOX CEL 70-P	EN ISO 2560- A: E 42 3 C 2 5	AWS A5.5: E7010-P1	C 0.15 Si 0.10 Mn 0.45 Ni 0.17	460 (≥ 420)	550 (500- 640)	23 (≥ 22)	+20 -20 -30	100 80 65 (≥ 47)	3.2 4.0 5.0
BÖHLER FOX CEL 75	EN ISO 2560- A: E 42 3 C 2 5	AWS A5.5: E7010-P1	C 0.14 Si 0.14 Mn 0.7	480 (≥ 420)	550 (500- 640)	23 (≥ 22)	+20 -20 -30 -40	100 65 55 (≥ 47) 45	3.2 4.0 5.0
BÖHLER FOX CEL 75 G		AWS A5.5: E7010-G	C 0.17 Si 0.15 Mn 0.55 Ni 0.6	450 (≥ 390)	560 (≥ 490)	23 (≥ 22)	+20 -20 -30	90 75 55	3.2 4.0 5.0

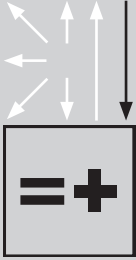
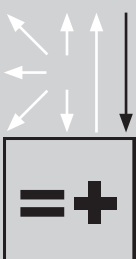
Current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	A	EN				
80-130 120-180 160-210	L210NB- L415NB L290MB- L415MB	A B X42 -X60	 Root pass negative polarity	Re-drying not allowed	Cellulosic electrode for vertical-down welding of high strength large diameter pipelines. Highly economical compared with conventional vertical-up welding. Especially recommended for hot passes, filler and cap layers. Besides the excellent weld metal toughness properties, it offers easy operation and a concentrated, intensive arc with deep penetration, in order to ensure sound joint welds with good X-ray quality. Böhler FOX CEL Mo can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC test are available too.	TÜV (01325), ABS (E7010-A1), SEPROZ, CE
60-130 100-180 140-210	L210NB- L415NB L290MB- L415MB	A B X42 -X60	 Root pass negative polarity	Re-drying not allowed	Cellulosic electrode for vertical-down welding of high strength large diameter pipelines. Especially recommended hot passes, filler and cap layers. Highly economical compared with conventional vertical-up welding. Böhler FOX CEL 70-P provides a more intensive arc and a more fluid weld metal compared with the well-known Böhler FOX CEL 75. Böhler FOX CEL 70-P can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC test are available too.	
80-130 120-180 160-210	L210- L415NB L290MB- L415MB	A B X42 -X60	 Root pass negative polarity	Re-drying not allowed	Cellulosic electrode for vertical-down welding of high strength large diameter pipelines. Especially recommended for hot passes, filler and cap layers. Highly economical compared with conventional vertical-up welding. The penetrating arc and the low slag formation allow good bead control and ensure best performance, even with larger diameter electrodes and high amperages. Böhler FOX CEL 75 can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC test are available too.	TÜV (533)
60-130 100-180 140-210	L415NB- L450NB L415MB- L450MB	X56-X65	 Root pass negative polarity	Re-drying not allowed	Cellulosic electrode for vertical-down welding of high strength large diameter pipelines. Especially recommended for hot passes, filler and cap layers. Highly economical compared with conventional vertical-up welding. The electrode has superior operating characteristics and consistently produces high quality welds with outstanding low-temperature impact toughness. Results from SSC testing are available.	

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Phoenix Cel 75	EN ISO 2560- A: E 42 2 C 2 5	AWS A5.5: E7010-P1	C 0.15 Si 0.20 Mn 0.60	440 (≥ 420)	540 (500- 640)	24 (≥ 20)	+20 -20 -40	80 55 (≥ 47) 28	3.2 4.0 5.0
BÖHLER FOX CEL 80-P	EN ISO 2560- A: E 46 3 1Ni C 2 5	AWS A5.5: E8010-P1	C 0.15 Si 0.15 Mn 0.7 Ni 0.8	490 (≥ 460)	580 (550- 680)	23 (≥ 20)	+20 -20 -30	90 80 60 (≥ 47)	3.2 4.0 5.0
BÖHLER FOX CEL 85	EN ISO 2560- A: E 46 4 1Ni C 2 5	AWS A5.5: E8010-P1	C 0.14 Si 0.15 Mn 0.75 Ni 0.7	490 (≥ 460)	570 (550- 680)	23 (≥ 20)	+20 0 -20 -40	110 105 100 70 (≥ 47)	3.2 4.0 5.0
BÖHLER FOX CEL 85 G		AWS A5.5: E8010-G	C 0.15 Si 0.15 Mn 0.7 Ni 0.8	490 (≥ 460)	580 (≥ 550)	23 (≥ 19)	+20 0 -30	90 85 60	3.2 4.0 5.0
Phoenix Cel 80	EN ISO 2560- A: E 46 3 C 2 5	AWS A5.5: E8010-P1	C 0.16 Si 0.20 Mn 0.85 Ni 0.2	490 (≥ 460)	580 (530- 680)	23 (≥ 20)	-20 -30	60 ≥ 47	3.2 4.0 5.0



Current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	A	EN				
80 - 130 120 - 180 160 - 220	L210NB- L415NB L290MB- L415MB	A B X42 - X60	 Root pass neg- ative polarity	Re-drying not allowed	Cellulosic electrode for vertical down circumferential welds in pipeline constructions. Excellent weldability in root and hot pass, filler and cap layers. Easy slag removal. Particularly suitable for root pass welding (DC ±); also in the vertical up position. CTOD, HIC and HSCC tested.	TÜV (03199), LR, CE
60-130 100-180 140-210	L415NB- L485NB L415MB- L485MB	X56-X70		Re-drying not allowed	Cellulosic electrode for vertical-down welding of high strength, large diameter pipelines. Highly economical compared with conventional vertical-up welding. Especially recommended for hot passes, filler and cap layers. Böhler FOX CEL 80-P provides a more intensive arc and a more fluid weld metal compared with the well-known Böhler FOX CEL 85. Böhler FOX CEL 80-P can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC test are available too.	TÜV (11181), CE
80-130 120-180 160-210	L415NB- L485NB L415MB- L485MB	X56-X70		Re-drying not allowed	Cellulosic electrode for vertical-down welding of high strength, large diameter pipelines. Highly economical compared with conventional vertical-up welding. Especially recommended for hot passes, filler and cap layers. Böhler FOX CEL 85 is the most popular cellulosic electrode, very well meeting all exacting demands of cross country pipeline field welding. It ensures highest joint weld quality down to -40 °C. Böhler FOX CEL 85 can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC test are available too.	TÜV (01361), ABS (E8010-P1), SEPROZ, CE
60-130 100-180 140-210	L415NB- L485NB L415MB- L485MB	X56-X70		Re-drying not allowed	Cellulosic electrode for vertical-down welding of high strength large diameter pipelines. Especially recommended for hot passes, filler and cap layers. Highly economical compared with conventional vertical-up welding. The electrode has superior operating characteristics and consistently produces high quality welds with outstanding low-temperature impact toughness.	
80 - 130 140 - 190 160 - 220	L415NB- L485NB L415MB- L485MB	X56 - X70		Re-drying not allowed	Cellulosic electrode for vertical-down circumferential welding of pipelines. Suitable for welding of root pass, hot pass, filler and cap layers. Welding of root pass with AC (+/-). CTOD values at -10 °C > 0,25 mm HIC and HSCC tested.	TÜV (03199), ABS, LR, CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER FOX CEL 90	EN ISO 2560- A: E 50 3 1Ni C 2 5	AWS A5.5: E9010-P1	C 0.17 Si 0.15 Mn 0.9 Ni 0.8	580 (≥ 530)	650 (620- 720)	21 (≥ 18)	+20 0 -20 -30 -40	100 90 75 65 (≥ 47) 40	4.0 5.0
Phoenix Cel 90	EN ISO 2560- A: E 50 3 1 Ni C 2 5	AWS A5.5: E9010-G	C 0.18 Si 0.20 Mn 0.85 Ni 0.75	570 (≥ 500)	640 (560- 720)	20 (≥ 18)	+20 -20 -30	70 55 ≥ 47	3.2 4.0 5.0

Power and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	A	EN				
120-180 160-210	L450MB, L485MB	X65-X80		Re-drying not allowed	Cellulosic electrode for vertical down welding of large diameter, high strength pipelines. Highly economical compared with conventional vertical-up welding. Especially recommended for hot passes, filler and cap layers. The special design of coating and core guarantees the highest metallurgical quality and soundness of the weld deposit with excellent mechanical properties. The electrode allows good weld pool visibility and easy manipulation, as well as high safety margins against porosity and slag inclusions. Böhler FOX CEL 90 can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC test are available too.	TÜV (1324), Statoil, SEPROZ, CE
80 - 140 140 - 190 160 - 220	L415NB- L555NB- L415MB- L555MB	X60 - X80		Re-drying not allowed	Cellulosic electrode for circumferential welds; developed for field welding of higher strength pipeline steels in the vertical-down position. Excellent weldability in root and hot hot pass, filler and cap layers.	TÜV (00105), CE

# WELDING TECHNIQUES BASIC ELECTRODES FOR VERTICAL-DOWN WELDING

## Combined technology with cellulosic and basic electrodes

In combination with basic vertical-down electrodes (BVD) root passes can either be welded with cellulosic or basic vertical-up electrodes.

When root passes are welded with cellulosic electrodes in the vertical-down position, hot passes shall preferably be welded with cellulosic electrodes as well.

## Preheating and interpass temperature

The interpass temperature influences the metallurgical processes that take place in the deposit during solidification and cooling and thus influences to a certain extent also the mechanical properties of the basic vertical-down weld metal.

It is generally recommended that the interpass temperature shall be maintained in the range of 100 °C - 200 °C (210 °F - 392 °F) throughout welding.

Joint preparation, preheating and interpass for cellulosic electrodes shall be according to the recommendation on page 18.

## Welding machines

Basic vertical-down electrodes can only be operated on direct current. Welding machines must have a dropping characteristic and high open circuit voltage.



## Filler passes

These passes are executed with 3.2 mm, 4.0 mm and 4.5 mm dia electrodes, depending upon pipe thickness.

Electrode diameter:		
3.2 mm	(1/8")	110 - 160 A
4.0 mm	(5/32")	180 - 210 A
4.5 mm	(3/16")	200 - 240 A

The high amperage ensures sufficient penetration and satisfactory economy of the process.

Slight weaving is always recommended as this prevents short-circuiting the arc.

For welding heavy wall pipe, we recommend to deposit two to three beads side by side, removing all slag before applying the next bead.

Keep the arc as short as possible.

## Cap

The cap is deposited with a slight weaving technique, with a maximum weave of twice the electrode diameter.

Recommended amperages:

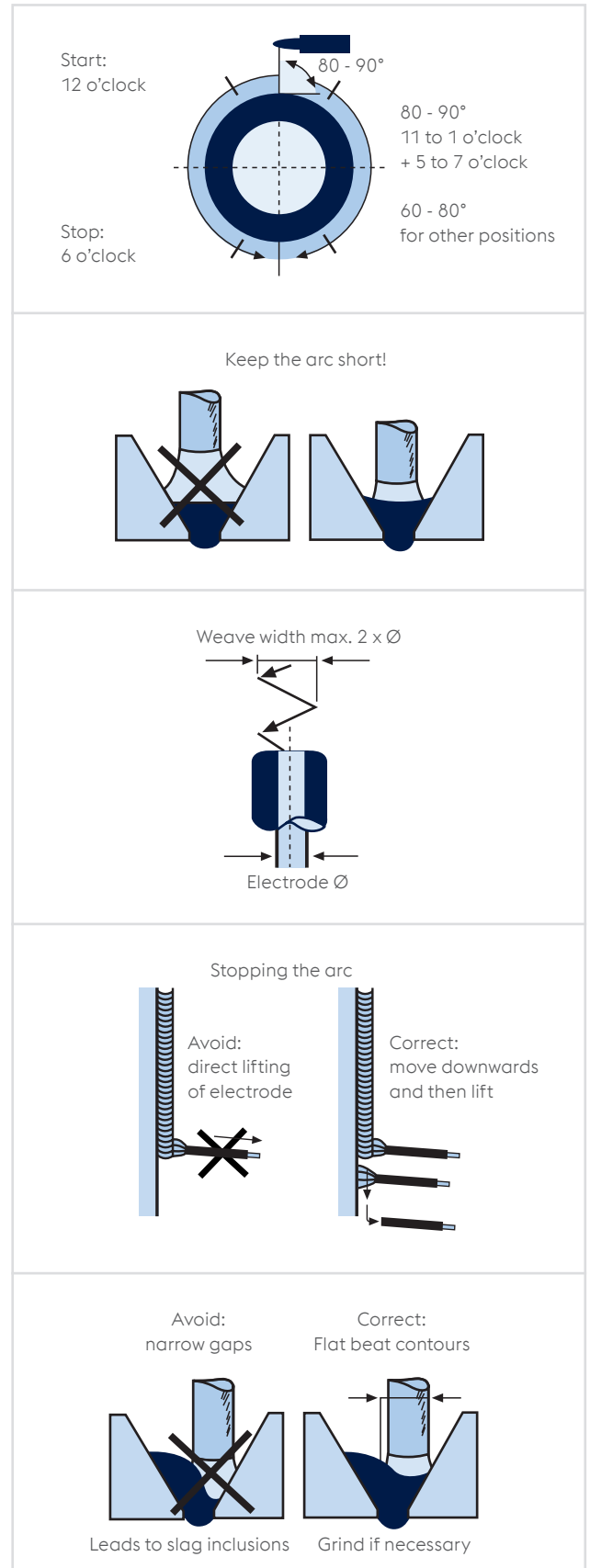
Electrode diameter:		
3.2 mm	(1/8")	110 - 160 A
4.0 mm	(5/32")	180 - 210 A

## Storage of basic electrodes

Basic electrodes which have been stored in sealed cans do not need to be rebaked. Once a can has been opened, the electrodes can be used up to 8 hours.

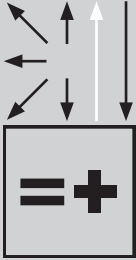
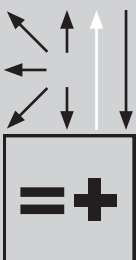
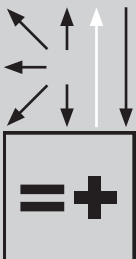
Basic electrodes which are taken from unsealed, damaged cans or those which have been kept in open storage for more than 8 hours, should be rebaked at 300 - 350 °C (570 - 660 °F) for two hours minimum and ten hours maximum.

In the event of a relative air humidity of more than 70% it is recommended to use heated quivers maintaining a temperature of 120 - 200 °C (248 - 400 °F) prior to use.



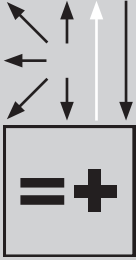
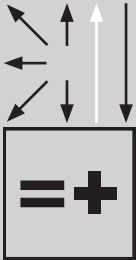
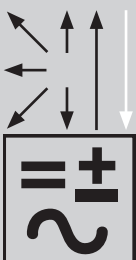
# PRODUCT OVERVIEW

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Basic electrodes for vertical-down welding									
BÖHLER FOX BVD 85	EN ISO 2560- A: E 46 5 1Ni B 4 5	AWS A5.5: E8045-P2	C 0.05 Si 0.4 Mn 1.1 Ni 0.9	510 (≥ 460)	560 (550- 680)	27 (≥ 20)	+20 0 -20 -40 -50	170 150 120 85 65 (≥ 47)	3.2 4.0 5.0
BÖHLER FOX BVD 90	EN ISO 18275- A: E 55 5 Z2Ni B 4 5	AWS A5.5: E9018-G / E9045-P2 (mod.)	C 0.05 Si 0.3 Mn 1.2 Ni 2.2	600 (≥ 550)	650 (620- 780)	27 (≥ 18)	+20 0 -20 -40 -50	170 145 130 110 80 (≥ 47)	3.2 4.0 4.5
BÖHLER FOX BVD 100	EN ISO 18275- A: E 62 5 Z2Ni B 4 5	AWS A5.5: E10018-G / E10045-P2 (mod.)	C 0.07 Si 0.4 Mn 1.2 Ni 2.3	670 (≥ 620)	730 (690- 890)	24 (≥ 18)	+20 0 -20 -50	150 125 120 70 (≥ 47)	4.0 4.5

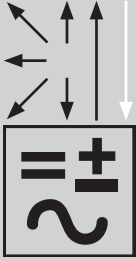
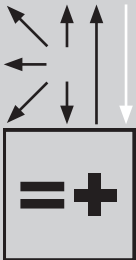
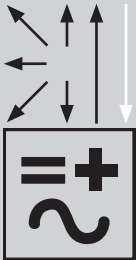
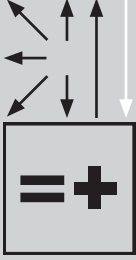
Parent and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
110-160 180-210 200-240	L290NB- L450NB L290MB- L450MB	A B X42 - X65		Re-drying if necessary: 300-350 °C (570-660 °F) / min. 2h	Basic electrode for vertical-down welding of large diameter, high strength pipelines and for structural work. Suitable for filler and cap layers in pipe welds. The deposit is extremely crack resistant and features a high toughness and very low hydrogen content. The deposition rate is 80-100% higher than obtainable in vertical-up welding. The weld deposit of Böhler FOX BVD 85 shows the ideal combination of high strength and cryogenic toughness down to -50 °C (-58 °F). Due to the specially designed electrode tip, the arc striking is improved and start porosity can be avoided. Good additional welding characteristics make this special basic electrode very suited for convenient field welding. Böhler FOX BVD 85 can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC test are available too.	TÜV (03531), SEPROZ, CE
110-160 180-210 200-240	L458MB, L555MB	X70, X80		Re-drying if necessary: 300-350 °C (570-660 °F) / min. 2h	Basic electrode for vertical-down welding of large diameter, high strength pipelines and for structural work. Suitable for filler and cap layers in pipe welds. The deposit is extremely crack resistant and features a high toughness and very low hydrogen content. The deposition rate is 80-100% higher than obtainable in vertical-up welding. Due to the specially designed electrode tip, the arc striking is improved and start porosity can be avoided. Good additional welding characteristics make this special basic electrode very suited for convenient field welding.	TÜV (03402), Staoil, SEPROZ, CE, GAZPROM (ø 3.2, 4.0, 4.5 mm)
180-210 200-240	L555MB	X80		Re-drying if necessary: 300-350 °C (570-660 °F) / min. 2h	Basic electrode for vertical-down welding of large diameter, high strength pipelines and for structural work. Suitable for filler and cap layers in pipe welds. The deposit is extremely crack resistant and features a high toughness and very low hydrogen content. The deposition rate is 80-100% higher than obtainable in vertical-up welding. Due to the specially designed electrode tip, the arc striking is improved and start porosity can be avoided. Good additional welding characteristics make this special basic electrode very suited for convenient field welding.	TÜV (06333), SEPROZ, CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER FOX BVD 110	EN ISO 18275- A: E 69 3 Mn2NiMo B 4 5	AWS A5.5: E11018-G	C 0.07 Si 0.4 Mn 1.5 Ni 2.2 Mo 0.4	720 (≥ 690)	810 (760- 960)	20 (≥ 17)	+20 -20 -30	90 70 50 (≥ 47)	4.0 4.5
BÖHLER FOX BVD 120	EN ISO 18275- A: E 69 3 Mn2NiMo B 4 5	AWS A5.5: E12018-G	C 0.07 Si 0.4 Mn 1.85 Ni 2.25 Mo 0.35	815 (≥ 740)	870 (≥ 830)	18 (≥ 17)	+20 -20 -30	80 60 50 (≥ 47)	3.2 4.0
Basic electrodes for vertical-up welding									
BÖHLER FOX EV PIPE	EN ISO 2560- A: E 42 4 B 1 2	AWS A5.5: E7016-1	C 0.06 Si 0.60 Mn 0.9	470 (≥ 420)	560 (500- 640)	29 (≥ 20)	+20 -20 -40 -45	170 100 60 (≥ 47) 55 (≥ 27)	2.0 2.5 3.2 4.0

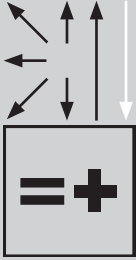
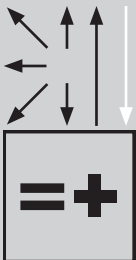
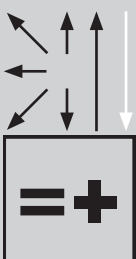
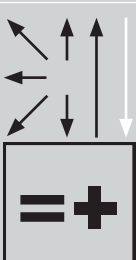
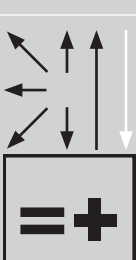


Current and position	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	A	EN				
180-210 200-240	L690	X100		Re-drying if necessary: 300-350 °C (570-660 °F) / min. 2h	Basic electrode for vertical-down welding of large diameter, high strength pipelines and for structural work. Suitable for filler and cap layers in pipe welds. The deposit is extremely crack resistant and features a high toughness and very low hydrogen content. The deposition rate is 80-100% higher than obtainable in vertical-up welding. Due to the specially designed electrode tip, the arc striking is improved and start porosity can be avoided. Good general welding characteristics make this special basic electrode suited for convenient welding, also under difficult conditions.	SEPROZ
110-160 180-220	L690	X100		Re-drying if necessary: 300-350 °C (570-660 °F) / min. 2h	Basic electrode for vertical-down welding of large diameter, high strength pipelines and for structural work. Suitable for filler and cap layers in pipe welds. The deposit is extremely crack resistant and features a high toughness and very low hydrogen content. The deposition rate is 80-100% higher than obtainable in vertical-up welding. Due to the specially designed electrode tip, the arc striking is improved and start porosity can be avoided. Good general welding characteristics make this special basic electrode suited for convenient welding, also under difficult conditions.	
30-60 40-90 60-130 110-180	L290NB- L360NB L290MB- L415MB L450MB1- 555MB1	A B X42-X60 X65 <sup>1</sup> -X80 <sup>1</sup>  <sup>1</sup> Only for root pass	 Root pass negative polarity	Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic electrode with some additions of rutile and silicates. Excellent suited for positional welding of root passes using DC- negative polarity. Also for filler and cap layers in pipes, tubes and plates using DC+ positive polarity, or even AC. User-friendly electrode with good gap bridging capability and with easy slag removal ensuring minimum grinding. Good weld metal impact toughness down to -45 °C (-50 °F). Böhler FOX EV PIPE offers considerable time savings in root pass welding compared with AWS E7018 type electrodes, due to increased travel speed. Use of diameter 3.2 mm electrodes is possible as from 8 mm wall thickness. Böhler FOX EV PIPE can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC test are available too.	TÜV (7620), DB (10.014.77), LTSS, SEPROZ, CE, NAKS (ø 2.5-4.0 mm), GAZPROM (ø 2.5-4.0 mm)

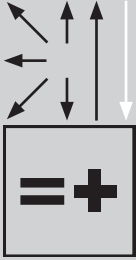
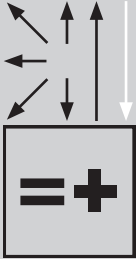
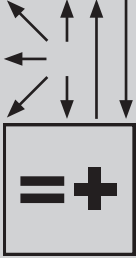
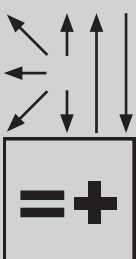
Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER FOX EV 50-W	EN ISO 2560- A: E 42 5 B 12 H5	AWS A5.1: E7016-1H4R	C 0.07 Si 0.5 Mn 1.1	460 (≥ 420)	560 (500- 640)	28 (≥ 20)	+20 -20 -50	200 150 ≥ 47	2.5 3.2 4.0 5.0
BÖHLER FOX EV 50	EN ISO 2560- A: E 42 5 B 4 2 H5	AWS A5.1: E7018-1H4R	C 0.08 Si 0.4 Mn 1.2	460 (≥ 420)	560 (500- 640)	27 (≥ 20)	+20 -20 -50	190 160 70 (≥ 47)	2.0 2.5 3.2 4.0 5.0
Phoenix 120 K	EN ISO 2560- A: E 42 5 B 3 2 H5	AWS A5.1: E7018-1	C 0.07 Si 0.35 Mn 1.20	440 (≥ 420)	530 (500- 640)	30 (≥ 20)	+20 -50	190 100	2.0 2.5 3.2 4.0 5.0
BÖHLER FOX EV 60	EN ISO 2560- A: E 46 6 1Ni B 4 2 H5	AWS A5.5: E8018-C3H4R	C 0.07 Si 0.4 Mn 1.15 Ni 0.9	510 (≥ 460)	610 (580- 740)	27 (≥ 20)	+20 -60	180 110 (≥ 47)	2.5 3.2 4.0 5.0

Erg and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	A	EN				
55-85 80-140 110-180 180-230	L245NB- L415NB L245MB- L415MB	A B X42-X60	 Root pass negative polarity	Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic electrode for high quality joint welds. Especially suited for root pass welding. Excellent weldability in all positions, except vertical-down. Smooth and slag-free welds. Crack resistant deposits of high toughness at ambient and sub-zero temperatures. Very low diffusible hydrogen content - AWS class H4/ HDM < 4 ml/100g weld metal. Especially suited for welding on AC. DC negative polarity recommended for root passes.	TÜV (4180), GL (3YH5), LTSS, SEPROZ
50-70 80-110 100-140 130-180 180-230	L245NB- L415NB L245MB- L415MB	A B X42-X60		Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic electrode designed for high-quality welds. Excellent strength and toughness properties down to -50 °C (-58 °F). Metal recovery approx. 110%. Good weldability in all positions, except vertical-down. Very low diffusible hydrogen weld metal-AWS class H4 / HDM < 4ml/100g weld metal. Suitable for welding low-purity steels with a high carbon content. Used in steel construction, boiler and tank manufacture, vehicle construction, shipbuilding and machine construction, as well as for buffer layers on high carbon steels. Especially suited for offshore construction. CTOD tested at -10 °C (14 °F). Böhler FOX EV 50 can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Results from SSC testing are available too.	TÜV (0426), DB (10.014.02), ABS (3H5, 4Y), BV (3YHHH), DNV (3YH10), GL (4Y40H15), LR (3, 3YH5), RMR (3YHH), RINA (4YH5/4H5), LTSS, VUZ, SEPROZ, PDO, CRS (3YH5), CE, NAKS
45 - 65 65 - 110 100 - 145 135 - 200 180 - 280	L245NB- L415NB L245MB- L415MB	A B X42 - X60		Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic covered electrode. Excellent welding characteristics including out of position work, except vertical-down. 120 % weld metal recovery. H <sub>2</sub> -content in the weld metal ≤ 5 ml / 100 g. Very pure cryogenic weld metal at temperatures as low as -50 °C (-58 °F); CTOD tested up to -10 °C (14 °F).	TÜV (00348), DB (10.132.17), ABS, BV, DNV, GL, LR, CE
80-100 110-140 140-180 190-230	L360NB, L415NB L360MB- L450MB	X52-X65		Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic <1% Ni-alloyed electrode with excellent mechanical properties, particularly low-temperature toughness and crack resistance. Suitable for service temperatures from 350 °C (662 °F) down to -60 °C (-76 °F). Very good impact toughness in aged condition. Metal recovery about 115%. Good weldability in all positions, except vertical-down. Very low diffusible hydrogen content - AWS class H4 / HDM < 4ml/100g weld metal. CTOD tested at -40 °C (-40 °F). Results from SSC testing available.	TÜV (1524), DNV (3YHH), RMR (3YHH), Statoil, LTSS, SEPROZ, CRS (3YH5), VG 95132, CE, ABS

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER FOX EV 60 PIPE	EN ISO 2560- A: E 50 4 1Ni B 1 2 H5	AWS A5.5: E8016-GH4R	C 0.07 Si 0.60 Mn 1.2 Ni 0.9	550 (≥ 500)	590 (560- 720)	29 (≥ 18)	+20 0 -20 -40 -45	170 150 140 110 (≥ 47) 60	2.5 3.2 4.0 5.0
BÖHLER FOX EV 65	EN ISO 18275- A: E 55 1NiMo B 4 2 H5	AWS A5.5: E8018- GH4R / E8018-D1H4R	C 0.06 Si 0.3 Mn 1.2 Ni 0.8 Mo 0.35	600 (≥ 550)	650 (620- 780)	25 (≥ 18)	+20 -60	180 80 (≥ 47)	2.5 3.2 4.0 4.8 5.0
Phoenix SH V 1	EN ISO 2560- A: E 50 6 Mn1Ni B 4 2 H5	AWS A5.1: E8018-G (E8018-C3 mod.)	C 0.07 Si 0.25 Mn 1.50 Ni 0.95	540 (≥ 500)	630 (560- 720)	28 (≥ 18)	+20 -60	180 80 (≥ 47)	3.2 4.0 5.0
BÖHLER FOX EV 70	EN ISO 18275- A: E 55 6 1NiMo B 4 2 H5	AWS A5.5: E9018- GH4R / E9018-D1H4R (mod.)	C 0.04 Si 0.3 Mn 1.2 Ni 0.9 Mo 0.4	650 (≥ 550)	700 (620- 780)	24 (≥ 18)	+20 -60	160 70 (≥ 47)	2.5 3.2 4.0 5.0
BÖHLER FOX EV 70 PIPE	EN ISO 18275- A: E 55 4 ZMn- 2NiMo B 1 2 H5	AWS A5.5: E9016-GH4R	C 0.06 Si 0.5 Mn 1.7 Ni 2.2 Mo 0.3	620 (≥ 550)	680 (620- 780)	20 (≥ 18)	+20 -20 -40 -45	140 80 70 (≥ 47) 55	2.5 3.2 4.0

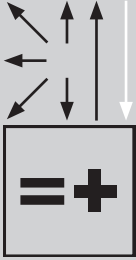
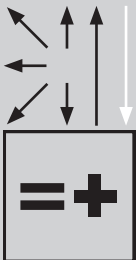
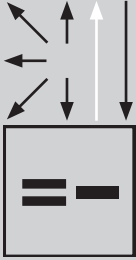
E and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	A	EN				
40-90 60-130 110-180 180-230	L210NB- L450NB L210MB- L450MB	X42-X65		Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic coated electrode for positional welding of filler and cap layers in tubes and plates. Good impact toughness down to -40 °C (-40 °F) and low hydrogen content (HDM < 5ml/100g). Packed in hermetically sealed tins.	NAKS (ø 3.2 mm), GAZ-PROM (ø 3.2 mm)
80-100 100-140 140-180 180-220 190-230	L415NB L415MB, L485MB	X60-X70		Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic electrode providing a high ductility, crack resistant weld deposit for service temperatures down to -60 °C (-76 °F). Resistant to ageing. Good weldability in position, except vertical-down. Very low diffusible hydrogen weld content - AWS class H4 / HDM < 4ml/100g weld metal.	TÜV (1802), SEPROZ, NAKS, VG 95132, BV, RMR, ABS, CE
100-150 140-200 170-250	L360NB- L485NB L360MB- L485MB	X52-X70		Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic covered MnNi-alloyed electrode. High toughness at temperatures as low as -60 °C (-76 °F). High radio-graphical soundness. H <sub>2</sub> -content ≤ 5 m l / 100 g (HD). CTOD- and NDT tested.	TÜV (00531), DB (10.132.37), ABS, BV, DNV, GL, LR, VG 95132-1, CE
80-100 100-140 140-180 190-230	L415MB, L485MB	X60-X70		Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic Mo-Ni-alloyed electrode depositing a high ductility, crack resistant weld, for welding high strength, fine-grained steels. Suitable for service temperatures from +350 °C (662 °F) down to -60 °C (-76 °F). Metal recovery of approximately 115%. Good weldability in all positions, except vertical-down. Very low diffusible hydrogen content - AWS class H4 / HDM < 4ml/100g weld metal.	TÜV (0112), SEPROZ, CE
40-90 60-130 110-180	L450MB- L555MB	X65-X80		Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Böhler FOX EV 70 PIPE is a high strength, basic electrode for positional welding of filler and cap layers in tubes, pipes and plate using DC+ positive polarity. It is user-friendly, has good gap bridging ability and easy slag removal to ensure minimal grinding. Good impact toughness down to -40 °C (-40 °F) and low hydrogen content (HDM < 5ml/100g). Packed in hermetically sealed tins.	TÜV (12809), CE

Product name	Classification		Typical analyses all weld metal %		Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS			R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER FOX EV 75	EN ISO 18275-A: E 62 6 Mn2NiCrMo B 4 2 H5	AWS A5.5: E10018- GH4R / E10018MH4R (mod.)	C 0.05 Si 0.4 Mn 1.6 Cr 0.4 Ni 2.0 Mo 0.4	700 (≥ 620)	750 (690- 980)	23 (≥ 18)	+20 -60	140 ≥ 47	2.5 3.2 4.0 5.0	
BÖHLER FOX EV 85	EN ISO 18275-A: E 69 6 Mn2NiCrMo B 4 2 H5	AWS A5.5: E11018- GH4R / E11018-MH4R (mod.)	C 0.05 Si 0.4 Mn 1.7 Cr 0.4 Ni 2.1 Mo 0.5	780 (≥ 690)	840 (760- 960)	20 (≥ 17)	+20 -60	110 60 (≥ 47)	2.5 3.2 4.0 5.0	
Flux-cored wires for automatic and semi-automatic pipeline welding										
BÖHLER Q 71 RC	EN ISO 17632-A: T 46 4 P M 1 H10 / T 42 2 P C 1 H5	AWS A5.36: E71T1- M21A4- CS1-H8 E71T1-C1A2- CS1-H4	C 0.06 Si 0.5 Mn 1.2 Ti 0.05	<b>M21:</b> 500 (≥ 460)  <b>C1:</b> 480 (≥ 420)	580 (550- 740)  550 (500- 670)	26 (≥ 20)  25 (≥ 20)	+20 -20 -40  +20 -40	180 130 90 (≥47)  160 110 (≥47)	1.2 1.6	
FOXcore X60 RC-Pipe	EN ISO 17632-A: T 50 6 1Ni P M 1 H5	AWS A5.36: E81T1- M21A8- Ni1-H4	C 0.06 Si 0.45 Mn 1.3 Ni 0.9	<b>M21:</b> 530 (≥ 500)	570 (560-720)	27 (≥ 18)	+20 -20 -40 -60	140 120 100 60 (≥47)	1.2	

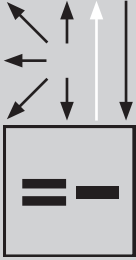
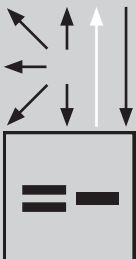
Welding process and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
80-100 100-140 140-180 190-230	L555MB	X80		Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic Cr-Ni-Mo-alloyed electrode depositing a high ductility, crack resistant weld, for welding high strength, fine-grained steels. Suitable for service temperatures from +400 °C (752 °F) down to -60 °C (-76 °F). Metal recovery of approximately 120%. Good weldability in all positions, except vertical-down. Very low diffusible hydrogen content - AWS class H4 / HDM 4ml/100g weld metal.	SEPROZ
70-100 100-140 140-180 190-230	L625, L690	X90, X100		Re-drying if necessary: 300 - 350 °C (570 - 660 °F) / min. 2h	Basic Cr-Ni-Mo-alloyed electrode depositing a high ductility, crack resistant weld, for welding high strength, fine-grained steels. Suitable for service temperatures down to -60 °C (-76 °F). Good weldability in all positions, except vertical-down. Very low diffusible hydrogen content - AWS class H4 / HDM < 4ml/100g weld metal.	TÜV (4313), DB (10.014.22), SEPROZ, BV, CE
	L245NB- L415NB L450QB L245MB- L450MB	A B X42-X65	 Shielding gas: M21: Ar + 15-25% CO <sub>2</sub> C1: 100% CO <sub>2</sub>	Re-drying possible at 150 °C (300 °F) / 24h, but generally not needed	All-positional rutile flux-cored wire with fast freezing slag system. Welder-friendly characteristics. The diameter 1.2 mm size can be used in all welding positions with the same parameter setting. Low spatter losses, easy slag removal, finely rippled bead surface. High X-ray quality welds with excellent mechanical properties. The most productive consumable for manual positional welding with deposition rates up to three times as high as with SMAW / mmA. Can be used with conventional non-pulse power sources.	TÜV (11164), DB (42.014.35), ABS, GL, LR, DNV, BV, CRS, CE
	L245NB- L415NB L245MB- L485MB	B X42-X70	 Shielding gas: M21: Ar + 15-25% CO <sub>2</sub>	Re-drying possible at 150 °C (300 °F) / 24h, but generally not needed	All-positional rutile flux-cored wire with fast freezing slag system for welding low-temperature steels. Outstanding welding characteristics in all positions. Low spatter losses, good slag detachability, finely rippled smooth beads and notch-free toes. Exceptionally good low-temperature impact toughness down to -60 °C (-80 °F). The wire is CTOD tested. The most productive consumable for manual positional welding with deposition rates up to three times as high as with SMAW / mmA. Can be used with conventional non-pulse power sources. FOX-core X60 RC-Pipe can be used for sour gas applications (HIC test acc. to NACE TM 02-84). Test results from SSC testing available too.	TÜV (11544), DB (42.014.42), GL (6Y46H5S), ABS, DNV, LR, BV, CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER Ti 70 Pipe-FD	EN ISO 18276- A: T 55 4 Mn1Ni P M 1 H5	AWS A5.36: E91T1- M21A4-G	C 0.07 Si 0.50 Mn 1.50 Ni 0.95	≥ 550	640-820	≥ 18	-40	≥47	1.2
BÖHLER Ti 80 Pipe-FD	EN ISO 18276- A: T 69 4 Z P M 1 H5	AWS A5.36: E111T1- M21A4-GH4	C 0.07 Si 0.3 Mn 1.8 Ni 2.1	790 (≥ 690)	850 (770- 940)	18 (≥ 17)	-40	65 (≥ 47)	
Self-shielded flux-cored wires for semi-automatic pipeline welding									
BÖHLER Pipeshield 71 T8-FD		AWS A5.36: E71T8-A4-K6	C 0.045 Si 0.14 Mn 1.1 Al 0.8 Ni 0.7	435 (≥ 400)	535 (490- 660)	28 (≥ 22)	+20 -30 -40	200 150 100 (≥27)	2.0

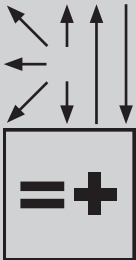
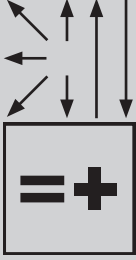
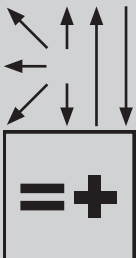
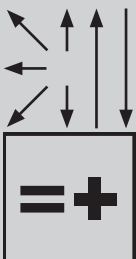


Parent and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
A	L450MB- L485MB (L555MB)	X65-X70 (X80)	 <p>Shielding gas: M21: Ar + 15-25% CO<sub>2</sub></p>	Re-drying possible at 150 °C (300 °F) / 24h, but generally not needed	Rutile micro alloyed flux-cored wire for single or multipass welding of carbon-manganese steels and high strength steels with Ar-CO <sub>2</sub> shielding gas. Main features: excellent weldability in all positions, excellent bead appearance, no spatter; fast freezing and easily removable slag. The exceptional mechanical properties of this wire even at the low temperature (-40 °C) (-40 °F), as well as the low content of diffusible hydrogen make it especially suitable for pipeline applications. Further applications are found in the offshore industry, shipbuilding and structures built with high strength steels. Spray arc operation with all parameters allows the use of standard, non-pulse power sources.	TÜV (12279), CE, GAZPROM
	L485MB, L555MB	X70, X80	 <p>Shielding gas: M21: Ar + 15-25% CO<sub>2</sub></p>	Re-drying possible at 150 °C (300 °F) / 24h, but generally not needed	Seamless rutile Ni-Mo alloyed flux-cored wire for single- or multi-pass welding of high strength steels, using Ar-CO <sub>2</sub> shielding gas. It features excellent weldability in all positions, excellent bead appearance, no spatter and a fast freezing slag that is easily removed. Its very low hydrogen weld metal and good impact toughness down to -40 °C (-40 °F) make the wire especially suited for pipeline applications. Further use is found in offshore fabrication, shipbuilding and in high strength steel structures. Spray arc operation with all parameters allows the use of standard, non-pulse power sources.	
		A B X42-X60	 <p>Self-shielded</p>	Recommended stick-out: 10-25 mm (0.4-1")	BÖHLER PIPESHIELD 71 T8-FD is a self-shielded flux-cored wire especially developed for semi-automatic pipe welding in vertical-down (5G) position. It is also suitable for welding unalloyed steel constructions. This wire has a fast freezing, easily removable slag, excellent welding characteristics, is welderfriendly and provides high productivity. BÖHLER PIPESHIELD 71 T8-FD is designed to provide good mechanical properties as well as high impact toughness at low temperatures. Outstanding characteristics for vertical-down welding of hot pass, fill and cap layers. Due to the fluoride-basic filling, a similar interpass temperatures as with basic electrodes can be applied (we recommend 80 - 200 °C (176-392 °F)). This self-shielded flux cored wire is easy to handle by welders, due to a very tolerant stick-out length and low tendency to porosity also when welding with a high arc length as a result of higher voltage.	NAKS, GAZPROM

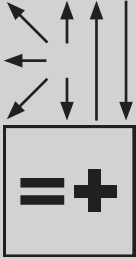
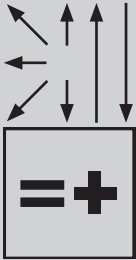
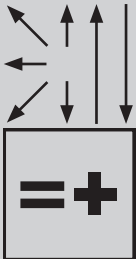
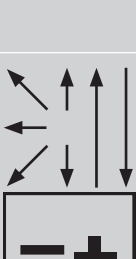
Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER Pipeshield 71.1 T8-FD		AWS A5.36: E71T8-A4-Ni1	C 0.045 Si 0.14 Mn 1.1 Al 0.8 Ni 0.95	435 (≥ 400)	535 (490- 660)	28 (≥ 22)	+20 -30 -40	200 150 120 (≥27)	2.0
BÖHLER Pipeshield 81 T8-FD		AWS A5.36: E81T8-A4-Ni2	C 0.05 Si 0.15 Mn 1.4 Al 0.8 Ni 1.95	500 (≥ 470)	600 (550- 690)	25 (≥ 19)	+20 -30 -40	170 120 90 (≥27)	2.0

Welding process and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	A	EN				
			 <p>Self-shielded</p>	<p>Recommended stick-out: 10-25 mm (0.4-1")</p>	<p>BÖHLER Pipeshield 71.1 T8-FD is a self-shielded flux-cored wire especially developed for semi-automatic pipe welding in vertical-down (5G) position. It is also suitable for welding unalloyed steel constructions. This wire has a fast freezing, easily removable slag, excellent welding characteristics, is welder-friendly and provides high productivity. BÖHLER Pipeshield 71.1 T8-FD is designed to provide good mechanical properties as well as high impact toughness at low temperatures. Outstanding characteristics for vertical-down welding of hot pass, fill and cap layers. Due to the fluoride-basic filling, a similar interpass temperatures as with basic electrodes can be applied (we recommend 80 - 200 °C (176-392 °F)). This self-shielded flux cored wire is easy to handle by welders, due to a very tolerant stick-out length and low tendency to porosity also when welding with a high arc length as a result of higher voltage.</p>	
			 <p>Self-shielded</p>	<p>Recommended stick-out: 10-25 mm (0.4-1")</p>	<p>BÖHLER Pipeshield 81 T8-FD is a self-shielded flux-cored wire especially developed for semi-automatic pipe welding in vertical-down (5G) position. It is also suitable for welding low-alloyed steel constructions. This wire has a fast freezing, easily removable slag, excellent welding characteristics, is welderfriendly and provides high productivity. BÖHLER Pipeshield 81 T8-FD is designed to provide good mechanical properties as well as high impact toughness at low temperatures. Outstanding characteristics for vertical-down welding of hot pass, fill and cap layers. Due to the fluoride-basic filling, similar interpass temperatures as with basic electrodes can be applied (we recommend 80 - 200 °C (176-392 °F)). This self-shielded flux cored wire is easy to handle by welders, due to a high tolerance for stick-out length and low tendency to porosity also when welding with a high arc length as a result of higher voltage.</p>	<p>NAKS, GAZPROM</p>

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Solid-wires for automatic pipeline welding									
BÖHLER SG 3-P	EN ISO 14341- A: G 46 5 M21 Z / G 42 4 C1 Z	AWS A5.18: ER70S-G	C 0.06 Si 0.75 Mn 1.55 Ti +	<b>M21:</b> 670 (≥ 460)  <b>C1:</b> 630 (≥ 420)	720 (530-680)  690 (500-640)	29 (≥ 20)  30 (≥ 20)	+20 -40 -50  +20 -40	100 75 55 (≥ 47)  195 50 (≥ 47)	0.9 1.0 1.2
Union K 52 S	EN ISO 14341- A: G 42 4 M31 3Si1	AWS A5.18: ER70S-6	C 0.07 Si 0.85 Mn 1.50	<b>M31:</b> 490 (≥ 420)	590 (500-640)	27 (≥ 22)	+20 -30 -40	155 105 95 (≥ 47)	0.9 1.0 1.2
Union K 56 S	EN ISO 14341- A: G 46 4 M21 4Si1 / G 46 2 C1 4Si1	AWS A5.18: ER70S-6	C 0.08 Si 1.05 Mn 1.65	<b>M21:</b> 520 (≥ 460)  <b>C1:</b> 470 (≥ 460)	620 (530-680)  580 (530-680)	25 (≥ 20)  30 (≥ 20)	+20 -20 -40  +20 -20 -40	170 160 100 (≥ 47)  130 95 (≥ 47) 60	1.0 1.2
Union K Nova	EN ISO 14341- A: G 46 5 M21 Z / G 42 4 C1 Z	AWS A5.18: ER70S-G	C 0.06 Si 0.75 Mn 1.55 Ti +	<b>M21:</b> 670 (≥ 460)  <b>C1:</b> 630 (≥ 420)	720 (530-680)  690 (500-640)	29 (≥ 20)  30 (≥ 20)	+20 -40 -50  +20 -40	100 65 ≥ 47  95 50 (≥ 47)	0.9 1.0 1.2

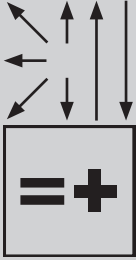
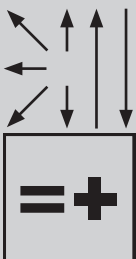
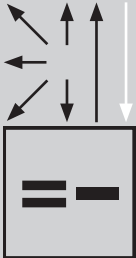
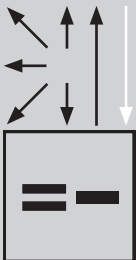
Type and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
A	L290MB-L485MB	X42-X70	 <p>Shielding gas: M21: Ar + 15-25 % CO<sub>2</sub> C1: 100 % CO<sub>2</sub></p>	Preheating and inter-pass temperature as required by the base metal	BÖHLER SG 3-P is a micro alloyed GMAW solid wire designed for high quality automatic welding of pipelines. An optimally balanced alloying concept ensures good weld metal properties to fulfil the high requirements in the on- and offshore pipeline industry. Deposit is extremely crack resistant with good weld metal toughness down to -50 °C. Good wire feeding properties are promoted due to close control of important quality aspects during production, such as cast and helix, copper coating, narrow diameter tolerance and precision layer wound spooling. BÖHLER SG 3-P can be used in sour gas applications (HIC-test acc. to NACE TM 02-84). Test values for SSC-test available too.	TÜV (07682), CE, NAKS
	L290MB-L450MB	A B X42 - X65	 <p>Shielding gas: M31: Ar + 40 % CO<sub>2</sub></p>	Preheating and inter-pass temperature as required by the base metal	Mn, Si-alloyed solid wire electrode with a highly purified weld metal. Very low trace element content. Low spatter development in short and spray arc. For fully automatic vertical-down and vertical-up welding of pipe steels up to X70.	
	L290MB - L485MB	X42 - X70	 <p>Shielding gas: M21: Ar + 15-25 % CO<sub>2</sub> C1: 100 % CO<sub>2</sub></p>	Preheating and inter-pass temperature as required by the base metal	All-purpose Mn-, Si-alloyed solid wire electrode for use with C1 and Ar/CO <sub>2</sub> mixed gas. Low-spatter metal transfer in short and spray arc mode. For fully automatic vertical-down and vertical-up welding on steel pipes.	
	L290MB - L485MB	X42 - X70	 <p>Shielding gas: M21: Ar + 15-25 % CO<sub>2</sub> C1: 100 % CO<sub>2</sub></p>	Preheating and inter-pass temperature as required by the base metal	Union K Nova is a GMAW solid wire for automatic circumferential pipe welding. All quality characteristics regarding chemical composition, arc stability and feeding behaviours are optimised to meet the special quality requirements. CTOD values up to -5° C (- 21° F). Fulfils strength-overmatching of X70 pipe steel.	TÜV (05926), CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER SG 8-P	EN ISO 14341- A: G 50 6 M21 Z3Ni1 / G 46 4 C1 Z3Ni1	AWS A5.18: ER80S-G (ER80S-Ni1(- mod.))	C < 0.09 Si 0.75 Mn 1.60 Ni 0.9 Ti +	<b>M21:</b> 590 (≥ 500)  <b>C1:</b> 560 (≥ 460)	670 (560-720)  630 (530-680)	26 (≥ 18)  25 (≥ 20)	+20 -60  +20 -40	200 100 (≥47)  110 95 (≥ 47)	0.9 1.0 1.2
Union K Nova Ni	EN ISO 14341- A: G 50 6 M21 Z3Ni1 / G 46 4 C1 Z3Ni1	AWS A5.18: ER80S-G (ER80S-Ni1 (mod.))	C < 0.09 Si 0.75 Mn 1.60 Ni 0.9 Ti +	<b>M21:</b> 590 (≥ 500)  <b>C1:</b> 91 (≥ 68)	670 (≥560-720)  100 (≥ 80)	26 (≥ 18)  25 (≥ 24)	+20 -60  +20 -40	200 100(≥ 47)  110 95 (≥ 47)	0.9 1.0 1.2
BÖHLER NiMo 1-IG	EN ISO 14341- A: G 55 6 M21 Mn3NiMo G 55 4 C1 Mn3Ni1Mo	AWS A5.18: ER90S-G	C 0.08 Si 0.6 Mn 1.8 Mo 0.3 Ni 0.9	<b>M21:</b> 620 (≥ 550)  <b>C1:</b> 590 (≥ 550)	700 (640- 820)  680 (620-770)	23 (≥ 18)  22 (≥ 20)	+20 -40 -60  +20 -40	140 110 ≥ 47  140 ≥ 47	0.9 1.0 1.2
Union NiMo 80	EN ISO 16834- A: G 62 5 M21 Mn3Ni1Mo	AWS A5.28: ER90S-G	C 0.09 Si 0.65 Mn 1.55 Ni 1.10 Mo 0.40 Ti +	<b>M21:</b> 680 (≥ 620)  <b>C1:</b> 620	760 (700-890)  705	22 (≥ 18)  21	+20 -50  +20 -40	190 90 (≥ 47)  110 75	0.9 1.0 1.14

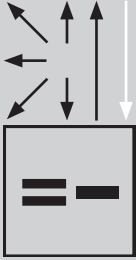
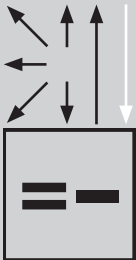
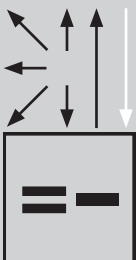
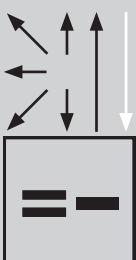
Wire and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
A	L290MB-L555MB	X42-X80	 <p>Shielding gas: M21: Ar + 15-25 % CO<sub>2</sub> C1: 100 % CO<sub>2</sub></p>	Preheating and inter-pass temperature as required by the base metal	BÖHLER SG 8-P is a micro alloyed GMAW solid wire designed for high quality automatic welding of pipelines. An optimally balanced alloying concept ensures good weld metal properties to fulfil the high requirements in the on- and offshore pipeline industry. Deposit is extremely crack resistant with good weld metal toughness down to -50 °C (-58 °F).	DNV (IV Y46 MS)
	L290MB - L555MB	X42 - X80	 <p>Shielding gas: M21: Ar + 15-25 % CO<sub>2</sub> C1: 100 % CO<sub>2</sub></p>	Preheating and inter-pass temperature as required by the base metal	Union K Nova Ni is a GMAW solid wire electrode for fully automatic circumferential vertical-down and vertical-up pipe welding with especially good impact toughness even at low temperatures.	TÜV (11542), DNV, CE
	L415MB-L555MB L515QB-L555QB	X60-X80 X60Q-X80Q	 <p>Shielding gas: M21: Ar + 15-25 % CO<sub>2</sub> C1: 100 % CO<sub>2</sub></p>	Preheating and inter-pass temperature as required by the base metal	Copper-coated GMAW wire for high strength, quenched and tempered, fine-grained construction steels. The wire is used for joint welding in boiler, pressure vessel, pipeline, and crane construction, as well as in structural steel engineering. The typical composition of the wire satisfies the requirements of the NORSOK7 regulation for water injection systems. Due to precise addition of micro alloying elements and low weld metal hydrogen, NiMo 1-IG wire features excellent ductility and crack resistance, in spite of its high strength. Good low-temperature impact energy down to -60 °C (-76 °F). Good wire feeding properties.	TÜV (11763), DB (42.014.06), GL (4Y55S), SEPROZ, NAKS (1.2 mm), GAZ-PROM (1.2 mm), CE, VG 95132
	L485MB - L555MB	X70 - X80	 <p>Shielding gas: M21: Ar + 15-25 % CO<sub>2</sub> C1: 100 % CO<sub>2</sub></p>	Preheating and inter-pass temperature as required by the base metal	Union NiMo 80 is a GMAW solid wire for automatic girth welding. All quality characteristics regarding chemical composition, arc stability and feeding behaviour are optimised to meet the special quality requirements. Fulfils strength-overmatching of X80 pipe steel.	TÜV (06525), CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Union Ni1MoCr	EN ISO 16834-A: G Z Mn3Ni0.9 MoCr	AWS A5.28: ER100S-G	C 0.08 Si 0.50 Mn 1.60 Ni 0.9 Mo 0.40 Cr 0.27	<b>M21:</b> 630	720	22	+20 -40 -60	135 95 80	1.0 1.2
Union NiMoCr	EN ISO 16834-A: G 69 6 M21 Mn4Ni1.5 CrMo	AWS A5.28: ER100S-G (ER100S-1 (mod.))	C 0.08 Si 0.60 Mn 1.70 Ni 1.50 Mo 0.50 Cr 0.20	M21: 750 (≥ 690)	830 (770-940)	21 (≥ 17)	+20 -60	135 70 (≥ 47)	0.8 1.0 1.2
Rods for TIG welding									
BÖHLER ER 70 S-2		AWS A5.18: ER70S-2	C 0.05 Si 0.5 Mn 1.2	420 (≥ 400)	520 (≥ 480)	23 (≥ 22)	+20 -30 -50	180 120(≥ 27) 80	1.6 2.0 2.4
BÖHLER EMK 6	EN ISO 636-A: W 42 5 W3Si1	AWS A5.18: ER70S-6	C 0.08 Si 0.9 Mn 1.45	450 (≥ 420)	560 (500-640)	28 (≥ 20)	+20 -40 -50	180 80 ≥47	1.6 2.0

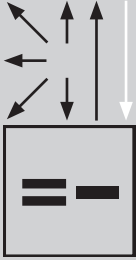
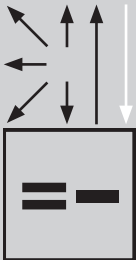


Parent and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
A	L625M - L690MB	X90 - X100	 <p>Shielding gas: M21: Ar + 15-25 % CO<sub>2</sub></p>	Preheating and inter-pass temperature as required by the base metal	Union Ni1MoCr is a copper coated, medium-alloy wire electrode for quenched and tempered and thermomechanically rolled fine-grained structural steels. Excellent weld metal toughness at low temperatures when deposited in combination with gas mixtures. Application in components of offshore equipment like pipework and tubes.	
	L830M	X120	 <p>Shielding gas: M21: Ar + 15-25 % CO<sub>2</sub> C1: 100 % CO<sub>2</sub></p>	Preheating and inter-pass temperature as required by the base metal	Union NiMoCr is low-alloyed solid wire electrode for shielded arc welding of quenched and tempered and thermomechanically treated fine grained structural steels. For use with CO <sub>2</sub> and Ar/CO <sub>2</sub> mixed gas. Outstanding toughness of the weld metal at low temperatures.	TÜV (02760), DB (42.132.08), ABS, BV, DNV, GL, LR, VG 95132-1, CE
	L245NB-L415NB L245MB-L415MB	A B X42-X60	 <p>Shielding gas: I1: 100 % Ar</p>	Preheating and inter-pass temperature as required by base metal	Copper-coated GTAW rod containing Al, Ti and Zr as strong deoxidizers in addition to Mn and Si - often referred to as triple deoxidized. This has advantages when rimming or semi-killed steels are welded or where joint preparations are rusty or contaminated. BÖHLER ER 70 S-2 is primarily used for single pass welding. For applications involving single and multi pass GTAW - and/or low-temperature toughness demands down to -50 °C (-58 °F) - we recommend our GTAW rod BÖHLER EML 5 (ER70S-3). BÖHLER ER 70 S-2 can be used in sour gas applications (HIC-test acc. to NACE TM-02-84).	
	L245NB-L415NB L245MB-L415MB	A B X42-X60	 <p>Shielding gas: I1: 100 % Ar</p>	Preheating and inter-pass temperature as required by base metal	GTAW rod with high silicon content, suited for joints in boiler and vessel fabrication, as well as in structural engineering. BÖHLER EMK 6 can be used in sour gas applications (HIC-test acc. to NACE TM-02-84). Results from SSC testing are available too.	TÜV (09717), LTSS, SEPROZ, CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Union I 2	EN ISO 636-A: W 42 5 W2Si	AWS A5.18: ER70S-3	C 0.08 Si 0.60 Mn 1.15	435 (≥ 420)	520 (500-640)	28 (≥ 20)	+20 -50	220 200(≥ 47)	1.6 2.0 2.4 3.0
Union I 52	EN ISO 636-A: W 42 5 W3Si1	AWS A5.18: ER70S-6	C 0.08 Si 0.60 Mn 1.15	450 (≥ 420)	580 500-640	27 (≥ 20)	+20 -50	210 90(≥ 47)	1.6 2.0 2.4 3.0
BÖHLER EML 5	EN ISO 636-A: W 46 5 W2Si	AWS A5.18: ER70S-3	C 0.1 Si 0.6 Mn 1.2	520 (≥ 460)	620 (530-680)	26 (≥ 23)	+20 -20 -50	220 200 90 (≥47)	1.6 2.0 2.4 3.0
BÖHLER Ni 1-IG	EN ISO 636-A: W 46 5 W3Ni1	AWS A5.28: ER80S-Ni1 (mod.)	C 0.07 Si 0.7 Mn 1.4 Ni 0.9	500 (≥ 460)	600 (550-740)	25 (≥ 20)	-20 -50	150 ≥ 47	2.0 2.4

Product and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
A	L245NB- L415NB L245MB- L415MB	A B X42 - X60	 Shielding gas: I1: 100 % Ar	Preheating and inter-pass temperature as required by base metal	Copper coated, unalloyed GTAW rod for TIG welding of unalloyed structural steels. Due to its high purity the weld metal obtains high impact values down to -50 °C (-58 °F). Suited for root pass welding.	TÜV (09482), CE
	L245NB- L415NB L245MB- L415MB	A B X42 - X60	 Shielding gas: I1: 100 % Ar	Preheating and inter-pass temperature as required by base metal	Copper coated, GTAW rod for TIG welding. Suited for root pass welding. Can be used in sour gas applications (HIC-test acc. to NACE TM-02-84).	TÜV (09482), CE
	L245NB- L415NB L245MB- L415MB	A B X42-X60	 Shielding gas: I1: 100 % Ar	Preheating and inter-pass temperature as required by base metal	GTAW rod for high integrity welds. The low S-content makes this filler metal particularly suited for joint welds that are subjected to enamelling or galvanizing. Especially suited for root pass welding (approved at -50 °C) (-58 °F). BÖHLER EML 5 can be used in sour gas applications (HIC-test acc. to NACE TM-02-84). Results from SSC testing are available too.	TÜV (1096) DB (42.014.02), Statoil, CE
	L360NB- L415NB L360MB- L450MB	X52-X65	 Shielding gas: I1: 100 % Ar	Preheating and inter-pass temperature as required by base metal	Ni-alloyed GTAW rod for the welding of offshore pipework and similar high integrity applications. Good impact toughness down to -50 °C (-58 °F). Results from SSC testing are available too.	TÜV (12808), CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER NiMo 1-IG	EN ISO 16834-A: W 55 6 1Mn3Ni 1Mo	AWS A5.28: ER90S-G	C 0.08 Si 0.6 Mn 1.8 Mo 0.3 Ni 0.9	620 (≥ 550)	700 (640-820)	23 (≥ 18)	+20 -40 -60	140 110 ≥ 47	2.4
BÖHLER NiCrMo 2.5-IG	EN ISO 16834-A: W 69 6 1Mn3Ni 2.5CrMo	AWS A5.28: ER110S-G	C 0.08 Si 0.6 Mn 1.4 Cr 0.3 Ni 2.5 Mo 0.4	750 (≥ 690)	830 (770-960)	22 (≥ 17)	+20 -40 -60	160 80 ≥ 47	2.4
Wires and flux for SAW welding									
Union S 2 UV 421 TT	<b>Classification Flux:</b> EN ISO 14174: SA FB 1 55 AC H5 <b>Classification Wire:</b> EN ISO 14171-A: S2 <b>Classification Weld metal:</b> EN ISO 14171-A: S 35 4 FB S2	<b>Classification Wire:</b> AWS A5.17: EM12 <b>Classification Weld metal:</b> AWS A5.17: F7A6-EM12 / F6P6-EM12	<b>Wire:</b> C 0.10 Si 0.10 Mn 1.00  <b>Weld metal:</b> C 0.07 Si 0.10 Mn 1.00	420	515	29	+20 -20 -40	200 170 140	2.0 2.5 3.0 4.0
Union S 3 Si UV 421 TT	<b>Classification Flux:</b> EN ISO 14174: SA FB 1 55 AC H5 <b>Classification Wire:</b> EN ISO 14171-A: S3Si <b>Classification Weld metal:</b> EN ISO 14171-A: S 46 6 FB S3Si	<b>Classification Wire:</b> AWS A5.17: EH12K <b>Classification Weld metal:</b> AWS A5.17 : F7A8- EH12K / F6P10-EH12K	<b>Wire:</b> C 0.10 Si 0.30 Mn 1.70  <b>Weld metal:</b> C 0.07 Si 0.30 Mn 1.55	465	560	24	+20 -40 -60	200 170 140	2.0 2.5 3.0 4.0

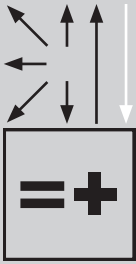
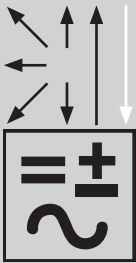
Wire and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
A	L450MB-L555MB	X65-X80	 <p>Shielding gas: I1: 100 % Ar</p>	Preheating and inter-pass temperature as required by base metal	GTAW rod for welding high strength, quenched & tempered, fine-grained construction steels. The rod is suited for joint welding in boiler, pipeline and crane construction, as well as in structural steel engineering. BÖHLER NiMo 1-IG features excellent ductility and crack resistance in spite of its high strength, due to precise addition of micro-alloying elements. Very low-hydrogen weld deposit and good impact toughness down to -60 °C (-76 °F).	
	L625, L690	X90, X100	 <p>Shielding gas: I1: 100 % Ar</p>		GTAW rod for welding high strength, fine-grained constructional steels with stringent requirements on low-temperature impact toughness down to -60 °C (-76 °F) e.g. in the construction of LPG tankers.	
	L175(P) L210 L245 (R) L290M- L360M	A25 A B X42 - X52		Flux has to be redried before use for approx. 2h at 300 - 350 °C (570 - 660 °F) Pre-heating and interpass temperature as required by base metal: 150 - 200 °C (300-400 °F)	Flux UV 421 TT is a high basicity, fluoride-basic agglomerated flux combining good weldability with excellent CVN toughness properties down to -60 °C. It has a neutral metallurgical behaviour and has been designed to promote a homogeneous weld chemistry and consistent mechanical properties in multi-layer welds, such as in double- and triple-jointing. This wire/flux combination features good wetting properties along with good slag detachability and a nice bead appearance. It is welded on DC+ polarity. The flux yields a low-hydrogen weld deposit ( $\leq 5$ ml/100g acc ISO 3690).	TÜV (05497), DB (51.132.06), LR, CE
	L175(P) L210 L245 (R) L290M- L360M	A25 A B X42 - X52		Flux has to be redried before use for approx. 2h at 300 - 350 °C (570 - 660 °F) Pre-heating and interpass temperature as required by base metal: 150 - 200 °C (300-400 °F)	Flux UV 421 TT is a high basicity, fluoride-basic agglomerated flux combining good weldability with excellent CVN toughness properties down to -60 °C. It has a neutral metallurgical behaviour and has been designed to promote a homogeneous weld chemistry and consistent mechanical properties in multi-layer welds, such as in double- and triple-jointing. This wire/flux combination features good wetting properties along with good slag detachability and a nice bead appearance. It is welded on DC+ polarity. The flux yields a low-hydrogen weld deposit ( $\leq 5$ ml/100g acc ISO 3690).	TÜV (05497), DB (51.132.06), LR, CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Union S 3 Si UV 421 TT	<b>Classification Flux:</b> EN ISO 14174: SA FB 1 55 AC H5 <b>Classification Wire:</b> EN ISO 14171- A: S3Si <b>Classification Weld metal:</b> EN ISO 14171- A: S 46 6 FB S3Si	<b>Classification Wire:</b> AWS A5.17: EH12K <b>Classification Weld metal:</b> AWS A5.17 : F7A8- EH12K / F6P10-EH12K	<b>Wire:</b> C 0.10 Si 0.30 Mn 1.70  <b>Weld metal:</b> C 0.07 Si 0.30 Mn 1.55	465	560	24	+20 -40 -60	160 90 50	2.5 3.0 4.0
Union S 2 NiMo 1 UV 421 TT	<b>Classification Flux:</b> EN ISO 14174: SA FB 1 55 AC H5 <b>Classification Wire:</b> EN ISO 14174- A: SZ <b>Classification Weld metal:</b> EN ISO 14171- A: S 50 6 FB SZ	<b>Classification Wire:</b> AWS A5.23: ENi1 <b>Classification Weld metal:</b> AWS A5.23: F8A10- ENi-Ni1 / F8P10-ENi- 1-Ni	<b>Wire:</b> C 0.10 Si 0.10 Mn 1.10 Ni 0.90 Mo 0.25  <b>Weld metal:</b> C 0.06 Si 0.20 Mn 1.10 Ni 0.90 Mo 0.25	505	590	26	+20 -40 -60	180 120 70	2.5 3.0 4.0
Union S 3 NiMo 1 UV 421 TT	<b>Classification Flux:</b> EN ISO 14174: SA FB 1 55 AC H5 <b>Classification Wire:</b> EN ISO 14171-A S3Ni1Mo <b>Classification Weld metal:</b> EN ISO 14295: S 55 6 FB S3Ni1Mo	<b>Classification Wire:</b> AWS A5.23: EF3 <b>Classification Weld metal:</b> AWS A5.23: F9A8-EF3-F3	<b>Wire:</b> C 0.12 Si 0.10 Mn 1.60 Ni 0.60 Mo 0.95  <b>Weld metal:</b> C 0.08 Si 0.20 Mn 1.55 Ni 0.55 Mo 0.90	589	670	24	+20 -20 -40 -60	180 160 100 55	1.6 2.0 2.5 3.0 4.0

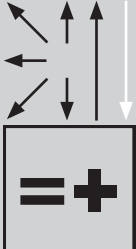
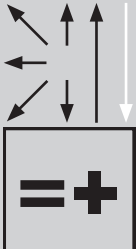
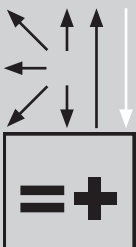
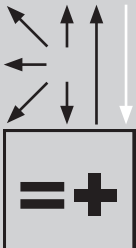
Welding process and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
	L175(P) L210 L245 (R) L290M- L450M	A25 A B X42 - X65		Flux has to be redried before use for approx. 2h at 300 - 350 °C (570 - 660 °F) Preheating and interpass temperature as required by base metal: 150 - 200 °C (300-400 °F)	Flux UV 421 TT is a high basicity, fluoride-basic agglomerated flux combining good weldability with excellent CVN toughness properties down to -60 °C. It has a neutral metallurgical behaviour and has been designed to promote a homogeneous weld chemistry and consistent mechanical properties in multi-layer welds, such as in double- and triple-jointing. This wire/flux combination features good wetting properties along with good slag detachability and a nice bead appearance. It is welded on DC+ polarity. The flux yields a low-hydrogen weld deposit (≤ 5 ml/100g acc ISO 3690).	TÜV (10424), DNV, LR, CE
	L415M- L485M	X60-X70		Flux has to be redried before use for approx. 2h at 300 - 350 °C (570 - 660 °F) Preheating and interpass temperature as required by base metal: 150 - 200 °C (300-400 °F)	Flux UV 421 TT is a high basicity, fluoride-basic agglomerated flux combining good weldability with excellent CVN toughness properties down to -60 °C. It has a neutral metallurgical behaviour and has been designed to promote a homogeneous weld chemistry and consistent mechanical properties in multi-layer welds, such as in double- and triple-jointing. This wire/flux combination features good wetting properties along with good slag detachability and a nice bead appearance. It is welded on DC+ polarity. The flux yields a low-hydrogen weld deposit (≤ 5 ml/100g acc ISO 3690).	TÜV (10425), DNV, LR, CE
	L450M- L485M	X65 - X70		Flux has to be redried before use for approx. 2h at 300 - 350 °C (570 - 660 °F) Preheating and interpass temperature as required by base metal: 150 - 200 °C (300-400 °F)	Flux UV 421 TT is a high basicity, fluoride-basic agglomerated flux combining good weldability with excellent CVN toughness properties down to -60 °C. It has a neutral metallurgical behaviour and has been designed to promote a homogeneous weld chemistry and consistent mechanical properties in multi-layer welds, such as in double- and triple-jointing. This wire/flux combination features good wetting properties along with good slag detachability and a nice bead appearance. It is welded on DC+ polarity. The flux yields a low-hydrogen weld deposit (≤ 5 ml/100g acc ISO 3690).	TÜV (10425), DNV, LR, CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Union S 3 NiMoCr UV 421 TT	<b>Classification Flux:</b> EN ISO 14174: SA FB 1 55 AC H5 <b>Classification Wire:</b> EN ISO 26304-A: SZ3Ni2,5CrMo <b>Classification Weld metal:</b> EN ISO 26304- A: S 69 6 FB SZ3Ni2,5CrMo	<b>Classifica- tion Wire:</b> AWS A5.23: (EG) EF 6 mod. <b>Classifica- tion Weld metal:</b> AWS A5.23: F11A8-EG-F6	<b>Wire:</b> C 0.14 Si 0.10 Mn 1.75 Cr 0.35 Mo 0.60 Ni 2.10  <b>Weld metal:</b> C 0.08 Si 0.20 Mn 1.60 Cr 0.32 Mo 0.58 Ni 2.0	730	805	21	+20 0 -20 -40 -60	145 100 120 110 55	2.0 2.4 3.0 4.0
Electrodes for corrosion resistant alloys (CRA)									
BÖHLER FOX EAS 4 M-A	EN ISO 3581- A: E 19 12 3 L R 3 2	AWS A5.4: E316L-17	C 0.03 Si 0.8 Mn 0.8 Cr 18.8 Ni 11.5 Mo 2.7	460 (≥ 320)	600 (≥ 510)	36 (≥ 25)	+20 -120	70 ≥ 32	1.5 2.0 2.5 3.2 4.0 5.0
BÖHLER FOX EAS 4 M	EN ISO 3581- A: E 19 12 3 L B 2 2	AWS A5.4: E316L-15	C 0.03 Si 0.4 Mn 1.2 Cr 18.8 Ni 11.8 Mo 2.7	460 (≥ 320)	600 (≥ 510)	38 (≥ 25)	+20 -120 -196	90 ≥ 32 ≥ 27	2.5 3.2 4.0
BÖHLER FOX CN 22/9 N	EN ISO 3581- A: E 22 9 3 N L R 3 2	AWS A5.4: E2209-17	C 0.03 Si 0.8 Mn 0.9 Cr 22.6 Ni 9.0 Mo 3.1	650 (≥ 450)	820 (≥ 690)	25 (≥ 20)	+10 -10 -20	55 50 ≥ 32	2.5 3.2 4.0 5.0

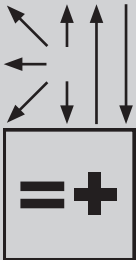
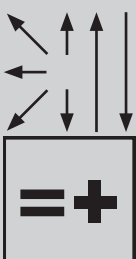
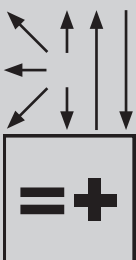
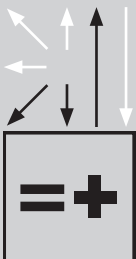


Parent and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals	
	A	EN					API 5L
		L485M-L690M	X70 - X100		Flux has to be redried before use for approx. 2h at 300 - 350 °C (570 - 660 °F) Pre-heating and interpass temperature as required by base metal: 150 - 200 °C (300-400 °F)	Flux UV 421 TT is a high basicity, fluoride-basic agglomerated flux combining good weldability with excellent CVN toughness properties down to -60 °C. It has a neutral metallurgical behaviour and has been designed to promote a homogeneous weld chemistry and consistent mechanical properties in multi-layer welds, such as in double- and triple-jointing. This wire/flux combination features good wetting properties along with good slag detachability and a nice bead appearance. It is welded on DC+ polarity. The flux yields a low-hydrogen weld deposit (≤ 5 ml/100g acc ISO 3690).	TÜV (05063), DB (51.132.06), ABS, BV, DNV, GL, LR, CE
25-40 40-60 50-90 80-120 120-160 140-200	1.4404 X2CrNiMo 17-12-2 1.4435 X2CrNiMo 18-14-3	S31603 316L		Re-drying if necessary: 120-200 °C (250-400 °F) / min. 2h	Stainless steel, rutile electrode, preferably used for 1.4435 / 316L steel grades. The fully alloyed core wire ensures most reliable corrosion resistance.	TÜV (0773), DB (30.014.14), ABS (E316L-17), DNV (316L), GL (4571), LR (316Lm), Statoil, VUZ, SEPROZ, CE, CWB, NAKS (ø 3.2 mm; ø 4.0 mm)	
50-80 80-110 110-140	1.4404 X2CrNiMo 17-12-2 1.4435 X2CrNiMo 18-14-3	S31603 316L			Stainless steel, basic electrode, preferably used for 1.4435 / 316L steel grades. Designed to provide high quality weld deposits with reliable impact toughness values down to -196 °C (-320 °F). The fully alloyed core wire ensures most reliable corrosion resistance.	TÜV (0772), DNV (316), Statoil, SEPROZ, CE	
40-75 70-120 110-150 150-200	1.4462 X2CrNiMoN 22-5-3	S31803 S32205	 Re-drying if necessary: 250-300 °C (480-570 °F) / min. 2h	Preheating and interpass temperature max. 150 °C (302 °F)	Rutile stainless steel electrode designed for the welding of ferritic-austenitic duplex stainless steels such as 1.4462 and UNS 31803. BÖHLER FOX CN 22/9 N offers excellent positional weldability, making it perfectly suited for pipe welding. Pitting resistance equivalent (PREN) of > 35.	TÜV (3636), ABS (E 22 09-17), DNV (Duplex), GL (4462), LR (X), RINA (2209), Statoil, SEPROZ, CE	

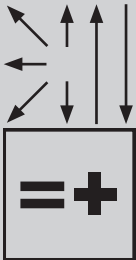
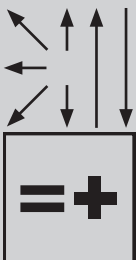
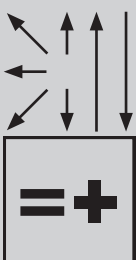
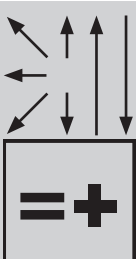
Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
BÖHLER FOX CN 22/9 N-B	EN ISO 3581- A: E 22 9 3 N L B 2 2	AWS A5.4: E2209-15	C 0.03 Si 0.3 Mn 1.1 Cr 22.6 Ni 8.8 Mo 3.1 Ni 0.16	630 (≥ 450)	830 (≥ 690)	27 (≥ 20)	+20 -20 -40 -60	110 90 75 40 (≥ 32)	2.5 3.2 4.0 5.0
BÖHLER FOX CN 25/9 CuT	EN ISO 3581- A: E 25 9 4 N L B 2 2	AWS A5.4: E2595-15	C 0.03 Si 0.5 Mn 1.0 Cr 25.0 Ni 9.5 Mo 3.7 N 0.22 Cu 0.7 W 0.7	650 (≥ 550)	850 (≥ 760)	25 (≥ 18)	+20 -50	75 50 (≥ 32)	2.5 3.2 4.0
Thermanit 625	EN ISO 14172: E Ni 6625 (NiCr22M- o9Nb)	AWS A5.11: ENiCrMo-3	C < 0.04 Si < 0.7 Mn < 1.0 Cr 21.5 Ni Bal. Mo 9.0 Nb 3.3 Fe < 2.0	470 (≥ 420)	760 (≥ 760)	40 (≥ 27)	+20 -196	90 70 (≥ 32)	2.5 3.2 4.0 5.0
Thermanit 686	EN ISO 14172: E Ni 6686 (NiCr- 21Mo14W4)	AWS A5.11: ENiCrMo-14	C 0.02 Si < 0.2 Mn < 0.5 Cr 21.0 Ni Bal. Mo 16.0 W 3.5 Fe < 1.0	480 (≥ 350)	770 (≥ 690)	38 (≥ 27)	+20	60	2.5 3.2 4.0

Temperature range and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	A	EN				
50-75 80-110 100-145 140-180	1.4462 X2CrNiMoN 22-5-3	S31803 S32205	 Re-drying if necessary: 250-300 °C / min. 2h	Re-drying if necessary: 250-300 °C (480-570 °F) / min. 2h	Basic stainless steel electrode designed for the welding of ferritic-austenitic duplex stainless steels such as 1.4462 and UNS 31803. Very good impact toughness down to -60 °C (-76 °F). Pitting resistance equivalent (PREN) of > 35.	TÜV (7084), CE
55-85 80-105 90-140	1.4501 X2CrNi- MoCuWN 25-7-4	S32750 S32760	 Re-drying if necessary: 250-300 °C (480-570 °F) / min. 2h	Re-drying if necessary: 250-300 °C (480-570 °F) / min. 2h	Basic stainless steel electrode designed for the welding of ferritic-austenitic duplex stainless steels. Excellent resistance to pitting corrosion and stress corrosion cracking. Suited for service temperatures from -50 (-58 °F) up to +250 °C (482 °F). Well suited for conditions in offshore oil and gas exploration.	
45-70 65-105 85-130 130-160	Alloy 316L Alloy 625 Alloy 825		 Re-drying if necessary: 250-300 °C (480-570 °F) / min. 2h	Re-drying if necessary: 250-300 °C (480-570 °F) / min. 2h	Basic stick electrode with alloyed core wire for high quality welding of corrosion resistant alloyed (CRA) clad steel - Alloy 316L, 625 and 825.	TÜV (03463), ABS, GL, CE
50-70 70-105 90-120	Alloy 316L Alloy 625 Alloy 825		 Re-drying if necessary: 250-300 °C (480-570 °F) / min. 2h	Re-drying if necessary: 250-300 °C (480-570 °F) / min. 2h	Basic stick electrode with alloyed core wire for high quality welding of corrosion resistant alloyed (CRA) clad steel - Alloy 316L, 625 and 825.	

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Flux-cored wires for corrosion resistant alloys (CRA)									
BÖHLER EAS 4 PW-FD	EN ISO 17633-A: T 19 12 3 L P M21 1 / T 19 12 3 L P C1 1	AWS A5.22: E316LT1-4 / E316LT1-1	C 0.03 Si 0.7 Mn 1.5 Cr 19.0 Ni 12.0 Mo 2.7	<b>M21:</b> 400 (≥ 320)	560 (≥ 510)	38 (≥ 30)	+20 -120	65 45 (≥ 32)	1.2 1.6
BÖHLER CN 22/9 PW-FD	EN ISO 17633-A: T 22 9 3 N L P M21 1 / T 22 9 3 N L P C1 1	AWS A5.22: E2209T1-4 / E2209T1-1	C < 0.03 Si 0.8 Mn 0.9 Cr 22.7 Ni 9.0 Mo 3.2 N 0.13 FN 30-50	<b>M21:</b> 600 (≥ 450)	800 (≥ 690)	27 (≥ 20)	+20 -20 -40 -46	80 65 55 45 (≥ 32)	1.2
BÖHLER CN 25/9 PW-FD	EN ISO 17633-A: T 25 9 4 N L P M21 2 / T 25 9 4 N L P C1 2	AWS A5.22: E2594T1-4 / E2594T1-1	C < 0.03 Si 0.7 Mn 0.9 Cr 25.3 Ni 9.8 Mo 3.7 N 0.23 FN > 35	<b>M21:</b> 670 (≥ 550)	880 (≥ 760)	27 (≥ 18)	+20 -40	≥ 50 ≥ 32	1.2
BÖHLER NIBAS 625 PW-FD	EN ISO 12153: T Ni 6625 P M21 2	AWS A5.34M: Tni 6625-14	C 0.05 Si 0.4 Mn 0.4 Cr 21.0 Ni Bal. Mo 8.5 Nb 3.3 Fe < 1.0	M21: 500 (≥ 420)	740 (≥ 690)	40 (≥ 25)	-20 -196	90 80 (≥ 32)	1.2

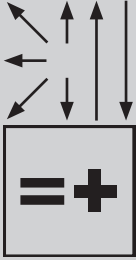
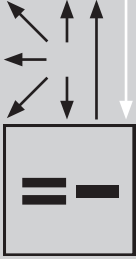
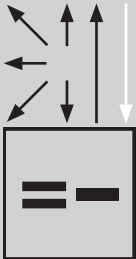
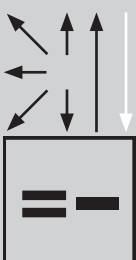
Parent and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
A	1.4404 X2CrNiMo 17-12-2 1.4435 X2CrNiMo 19-14-3	S31603 316L	 Shielding gas: M1-M3 C1	Re-drying possible at 150 °C (300 °F) / 24h, but generally not needed	BÖHLER EAS 4 PW-FD is an all-positional rutile flux-cored wire with fast freezing slag. It has excellent welding characteristics in all welding positions and allows high travel speed and deposition rate. Welds are well suited for service temperatures from -120 (-184 °F) up to + 400 °C (752 °F).	TÜV (09118), DB (43.014.24), CWB (E316LT-1(4)), LR (DXVu.O, BF 316LS), GL (4571S (C1, M21), SEPROZ, CE, DNV, ABS
	1.4462 X2CrNiMoN 22-5-3	S31803 S32205	 Shielding gas: M1-M3 C1	Re-drying possible at 150 °C (300 °F) / 24h, but generally not needed	BÖHLER CN 22/9 PW-FD is an all-positional rutile flux-cored wire with fast freezing slag, for welding duplex stainless steel grades 1.4462 / S31803. Weld metal features good pitting corrosion resistance (CP ASTM G48/method A / 24h up to 25 °C, +77 °F) (PREN ≥ 35) and resistance to stress corrosion cracking in chloride-containing fluids e.g. sea water. Welds are well suited for service temperatures from -46 (-50 °F) up to +250 °C (482 °F).	TÜV (07666), ABS (E 22 09 T1-4(1)), CWB (E2209T1-1(4)), DNV (- (M21, C1) ø 1.2 mm), GL (4462S (M21)), LR (X (M21, C1)), RINA (2209S), SEPROZ, CE
	1.4410 X2CrNiMoN 25-7-4 1.4501 X2CrNi- MoCu W N 2507-4	SAF 2507 S32750 S32760	 Shielding gas: M1-M3 C1	Re-drying possible at 150 °C (300 °F) / 24h, but generally not needed	BÖHLER CN 25/9 PW-FD is an all-positional rutile flux-cored wire with fast freezing slag, for welding super duplex and equivalent stainless steel grades, such as UNS S32760 and EN 1.4501. Weld metal features excellent resistance to stress corrosion and localized corrosion (PREN > 41) and is suited for service temperatures from -50 (-58 °F) up to +240 °C (464 °F).	
		Alloy 316L Alloy 625 Alloy 825	 Shielding gas: M1-M3	Re-drying possible at 150 °C (300 °F) / 24h, but generally not needed	Rutile flux-cored wire for high quality joint welding of corrosion resistant alloy (CRA) clad pipes, -alloys 316L, 625 and 825.	TÜV (11223), CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Solid wires for corrosion resistant alloys (CRA)									
Thermanit GE - 316L Si	EN ISO 14343- A: G 19 12 3 L Si	AWS A5.9: ER316LSi	C 0.02 Si 0.8 Mn 1.7 Cr 18.8 Ni 12.5 Mo 2.8	<b>M21:</b> 430 (≥ 320)	600 (≥ 510)	38 (≥ 25)	+20	130	0.8 1.0 1.2
Thermanit 22/09 LH	EN ISO 14343- A: G 22 9 3 N L	AWS A5.9: ER2209	C 0.025 Si 0.5 Mn 1.6 Cr 23.0 Ni 9.0 Mo 3.0 N 0.14 FN 30-60	<b>M12:</b> 615 (≥ 450)	790 (≥ 550)	30 (≥ 20)	+20 -40	120 90	1.0 1.2
Thermanit 25/09 CuT LH	EN ISO 14343- A: G 25 9 4 N L	AWS A5.9: ER2594	C 0.02 Si 0.3 Mn 1.5 Cr 25.5 Ni 9.5 Mo 3.7 N 0.22 Cu 0.8 W 0.6	<b>M12:</b> 720 (≥ 550)	850 (≥ 620)	27 (≥ 18)	+20 -46	135 90	1.0
Thermanit 625	EN ISO 18274: S Ni 6625 (NiCr22M- o9Nb)	AWS A5.14: ERNiMo-3	C 0.03 Si 0.25 Mn 0.20 Cr 22.0 Ni Bal. Mo 9.0 Nb 3.6 Fe < 0.5	<b>M12:</b> 480 (≥ 460)	760 (≥ 760)	42 (≥ 25)	+20 -196	160 130	0.8 1.0 1.2 1.6

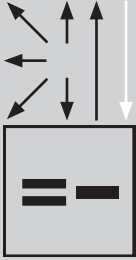
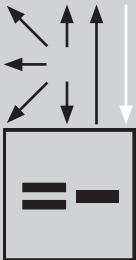
Parent and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
A	1.4404	S31603, 316L	 Shielding gas: M12		ER316LSi type GMAW solid wire. Good wire feeding properties, excellent weldability, nice wetting and reliable corrosion resistance up to 400 °C (752 °F). For service temperatures down to -196 °C (-320 °F).	TÜV (00489), DB (132.10), DNV, GL, LR, CE
	1.44062 X2CrNiMoN 22-5-3	S31803 S32205	 Shielding gas: M12, M13		GMAW solid wire for welding ferritic-austenitic duplex stainless steel. Excellent resistance to stress corrosion cracking and pitting (PREN > 35). For service temperatures from -40 up to 250 °C. Specifically designed for welding super martensitic stainless steel in offshore applications. Very low weld metal hydrogen content. (H <sub>2</sub> < 3 ppm.)	
	1.4501 X2CrNi- MoCuWN 25-7-4	S32750 S32760	 Shielding gas: M12, M13		GMAW solid wire for welding ferritic-austenitic super duplex stainless steel. Excellent resistance to stress corrosion cracking and pitting (PREN > 40). For service temperatures from -50 (-58 °F) up to 250 °C (482 °F). Specifically designed for welding super martensitic stainless steel in offshore applications. Very low weld metal hydrogen content (H <sub>2</sub> < 3 ppm).	
			 Shielding gas: I1 M12 (Argon + 30% He + 0.5% CO <sub>2</sub> )		GMAW solid wire for high quality joint welding of corrosion resistant alloyed (CRA) clad pipes.	TÜV (03462), DB (43.132.25), CE

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Thermanit 686	EN ISO 18274: S Ni 6686 (NiCr- 21Mo16W4)	AWS A5.14: ERNiMo-14	C 0.01 Si 0.8 Mn < 0.5 Cr 22.8 Ni Bal. Mo 16.0 W 3.8 Fe < 1.0 Al 0.3	<b>M12:</b> 550 (≥ 460)	790 (≥ 760)	30 (≥ 25)	+20	55	1.2
TIG rods for corrosion resistant alloys (CRA)									
Thermanit GE-316L	EN ISO 14343- A: W 19 12 3 L	AWS A5.9: ER316L	C 0.02 Si 0.5 Mn 1.7 Cr 18.5 Ni 12.3 Mo 2.6	480 (≥ 320)	620 (≥ 510)	37 (≥ 25)	+20	140	0.8 1.6 2.0 2.4 4.0
Thermanit 22/09	EN ISO 14343- A: W 22 9 3 N L	AWS A5.9: ER2209	C 0.02 Si 0.4 Mn 1.7 Cr 22.5 Ni 8.8 Mo 3.2 N 0.15	620 (≥ 450)	800 (≥ 550)	32 (≥ 20)	+20 -60	220 90 (≥ 32)	1.6 2.0 2.4 3.2
Thermanit 25/09 CuT	EN ISO 14343- A: W 25 9 4 N L	AWS A5.9: ER2594	C 0.02 Si 0.3 Mn 0.7 Cr 25.2 Ni 9.2 Mo 3.6 N 0.22 Cu 0.6 W 0.62	710 (≥ 550)	860 (≥ 620)	28 (≥ 18)	+20 -50	220 160	1.6 2.0 2.4 3.2



Welding process and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
A			 <p>Shielding gas: I1 Ar + 30He + 2% H2 + ~0.1% CO<sub>2</sub></p>		GMAW solid wire for high quality joint welding of corrosion resistant alloyed (CRA) clad pipes - alloy 316L, 625 and 825.	
	1.4404 X2CrNiMoN 17-12-2	S31603 316L	 <p>Shielding gas: I1: 100% Ar</p>	Preheating and interpass temperature as required by base metal	E316L type GTAW rod. Alloyed with great precision to create a high purity weld deposit with superior hot cracking resistance. Good CVN impact toughness down to -196 °C (-320 °F). resistant to intergranular corrosion up to 400 °C (752 °F).	TÜV (09500), DB (43.132.20), DNV, GL, CE
	1.4462 X2CrNiMoN 22-5-3	S31803 S32205	 <p>Shielding gas: I1: 100% Ar Ar + 1-2% N<sub>2</sub></p>	Preheating and interpass temperature as required by base metal	GTAW rod of the ER2209/W 22 9 3 N L type for the welding of ferritic-austenitic duplex stainless steel. Excellent resistance to stress corrosion cracking and pitting (PREN > 35). Weld metal is suited for service temperatures from -60 °C (-76 °F) up to +250 °C (482 °F). Especially designed for the welding of super martensitic stainless steel in offshore fabrication.	TÜV (03343), ABS, DNV, GL, LR, CE
	1.4501 X2CrNiMo CuWN	S32750 S32760	 <p>Shielding gas: I1: 100 % Ar Ar + 2-3 % N<sub>2</sub></p>	Preheating and interpass temperature as required by base metal	GTAW rod for the welding of ferritic-austenitic super duplex stainless steel. Excellent resistance to stress corrosion cracking and pitting (PREN > 40). Weld metal is suited for service temperatures from -50 °C (-58 °F) up to +250 °C (482 °F). Especially designed for the welding of super martensitic stainless steel in offshore fabrication.	

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Thermanit 625	EN ISO 18274: S Ni 6625 (NiCr22Mo9Nb)	AWS A5.14: ERNiCrMo-3	C 0.03 Si 0.1 Mn 0.1 Cr 22.0 Ni Bal. Mo 9.0 Nb 3.6 Fe < 0.05	490 (≥ 460)	775 (≥ 760)	40 (≥ 35)	+20 -196	140 120	1.6 2.0 2.4 3.2
Thermanit 686	EN ISO 18274: S Ni 6686 (NiCr-21Mo16W4)	AWS A5.14: ERNiCrMo-14	C ≤ 0.01 Si 0.08 Mn < 0.5 Cr 22.8 Ni Bal. Mo 16.0 W 3.8 Al 0.3 Fe < 1.0	540 (≥ 460)	800 (≥ 760)	30 (≥ 25)	+20	55	1.6 2.0 2.4

Welding process and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	A	EN				
			 <p>Shielding gas: I1: 100 % Ar</p>	Preheating and interpass temperature as required by base metal	GTAW rod for high quality joint welding of corrosion resistant alloyed (CRA) clad pipes - alloy 316L, 625 and 825.	TÜV (03464), DB (43.132.33), DNV, CE
			 <p>Shielding gas: I1: 100 % Ar R1: Ar + 2 % He</p>	Preheating and interpass temperature as required by base metal	GTAW rod for high quality joint welding of corrosion resistant alloyed (CRA) clad pipes - alloy 316L, 625 and 825.	

Product name	Classification		Typical analyses all weld metal %	Mechanical properties* Typical values					Diameter welding mm
	EN ISO	AWS		R <sub>e</sub> Mpa	R <sub>m</sub> Mpa	A5 %	CVN °C	J	
Wire / flux combinations for corrosion resistant alloys (CRA)									
Thermanit GE-316L Marathon 431	<b>Classification Flux:</b> EN ISO 14174: SA FB 2 DC <b>Classification Wire:</b> EN ISO 14343- A: S 19 12 3 L	<b>Classification Wire:</b> AWS A5.9: ER316L	<b>Wire:</b> C 0.01 Si 0.5 Mn 1.7 Cr 18.5 Mo 2.8 Ni 12.2  <b>Weld metal:</b> C 0.01 Si 0.6 Mn 1.2 Cr 18.0 Mo 2.8 Ni 12.2	350	550	30	+20 -120	70 60	2.0 2.4 3.2 4.0
Thermanit 22/09 Marathon 431	<b>Classification Flux:</b> EN ISO 14174: SA FB 2 DC <b>Classification Wire:</b> EN ISO 14343- A: S 22 9 3 N L	<b>Classification Wire:</b> AWS A5.9: ER2209	<b>Wire:</b> C 0.01 Si 0.40 Mn 1.6 Cr 22.5 Mo 3.0 Ni 8.8 N 0.15  <b>Weld metal:</b> C 0.02 Si 0.50 Mn 1.4 Cr 22.2 Mo 3.1 Ni 8.3 N 0.14	450	690	20	+20 -40	80 40	2.0 2.5 3.0
Thermanit 625 Marathon 444	<b>Classification Flux:</b> EN ISO 14174: SA FB 2 AC <b>Classification Wire:</b> EN ISO 18274: S Ni 6625 (NiCr22M- o9Nb)	<b>Classification Wire:</b> AWS A5.14: ERNiCrMo-3	<b>Wire:</b> C 0.01 Si 0.10 Mn 0.2 Cr 22.0 Mo 9.0 Ni Rest Nb 3.6 Fe < 1.0  <b>Weld metal:</b> C 0.01 Si 0.16 Mn 0.2 Cr 21.8 Mo 9.0 Ni Rest Nb 3.2 Fe < 1.0	420	700	40	+20 -196	80 70	1.6 2.0 2.4

Welding process and current	Pipeline steel grades		Position & Polarity	Additional information	Characteristics and applications	Approvals
	EN	API 5L				
				Flux has to be redried before use for approx. 2h at 300 - 350 °C (570 - 660 °F)		TÜV (06113), CE
				Flux has to be redried before use for approx. 2h at 300 - 350 °C (570 - 660 °F)		TÜV (06112), ABS, DNV, GL, LR, CE
				Flux has to be redried before use for Alloy 800, approx. 2h at 300 - 350 °C (570 - 660 °F)		TÜV (10173), GL, CE



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