



**WELDING CONSUMABLES
FOR STEEL CONSTRUCTION**

STEEL CONSTRUCTION AND SPECIAL DESIGNS

BÖHLER WELDING is a leading supplier of corrosion – resistant, high temperature and heat – resistant welding consumables offering a highly comprehensive product range for most applications and base metals.

The BÖHLER WELDING range of welding consumables are based on many years of metallurgical experience and offer excellent quality for welding structural steel sections and plates. For metallurgically demanding structures in bridges and steel construction as well as in the field of fine-grained steels for crane and commercial vehicle manufacture, the proven quality of BÖHLER WELDING is a key to reducing manufacturing costs and ensuring structural safety. Experienced application consultants work together with the customer to develop the technically and economically optimum solution for individual

requirements. The comprehensive range of first-class welding consumables is continually attuned to the current specifications of engineering and design offices.

In addition technical documentation, datasheets, certificates, tests, packaging and labelling can be customised especially for our customers or their process requirements. For over eight decades BÖHLER WELDING has specialised in the welding of structural steel fabrications and meets the highest standards with regard to quality consumables and technical competence.

Commercial partners and contact information in an area located near to you can be found on the world wide web under www.boehler-welding.com

Welding consumables made by BÖHLER WELDING are available in moisture-proof and vacuum-sealed packages.



Selection guide

	Base metals AISI/UNS/ASTM/API	Welding process											
		SMAW	FCAW	GTAW	GMAW	Submerged arc	Page	Page	Page	Page	Page		
Unalloyed steels YS ≤ 355 N/mm ²	Sa106A+B	FOX MSU	5										
		FOX OHV	5										
		FOX KE	5										
		FOX SUM	5										
		FOX SUS	5									EMS 2+BB 24	12
		FOX ETI	5	Ti 52-FD	8	(BW VII)*	9					EMS 2+BB 25	12
		FOX SPE	5	Ti 52 W-FD	8	(BW XII)*	10					EMS 2+BB 33 M	13
		FOX SPEM	6	HL 51-FD	9	(DMO)*	15	EMK 6	10	EMS 2+BF 16	13		
		FOX HL 160 Ti	6	HL 53-FD	9	EMK 6	10			EMS 3+BB 24	14		
		FOX HL 180 Ti	6			EML 5	10	SG 3-P	11	EMS 3+BB 25	14		
		FOX EV 47	6			ER 70 S-2	11			EMS 3+BB 33 M	14		
		FOX EV 50	7							EMS 3+BF 16	15		
		FOX EV 50-A	7										
		FOX EV 50-W	7										
		FOX EV PIPE	8										
High-strength fine-grained steels Weather-resistant steels YS ≤ 420 N/mm ² YS ≤ 460 N/mm ² YS ≤ 500 N/mm ² YS ≤ 550 N/mm ² YS ≤ 620 N/mm ² YS ≤ 690 N/mm ² YS ≤ 890 N/mm ²	Corten A 36 Gr. all	FOX NiCuCr	19				NiCu 1-IG	19					
		FOX EV 50	6	Ti 52-FD	8	DMO-IG	22	EMK 6	10	EMS 2+BB 25	12		
		FOX EV 50-A	7	Ti 52 W-FD	8	Ni 1-IG	23			EMS 3+BB 24	14		
	A572 Gr. 65	FOX EV 50-W	7	HL 51-FD	9	2.5 Ni-IG	23	SG 8-P	22	EMS 3+BB 25	14		
		FOX EV 55	19	HL 53-FD	9			EMK 7	24				
		FOX EV 60	20					EMK 8	24	Ni 2-UP+BB 24	25		
	SA508 Cl.2	FOX 2.5 Ni	22					2.5 Ni-IG	23	EMS 2+BB 33 M	13		
		FOX EV 63	20	Ti 60-FD	24					EMS 3+BB 33 M	14		
	A302 Gr. A-D	FOX EV 60 PIPE	20										
		FOX EV 65	20			NiMo 1-IG		NiMo 1-IG	23	3 NiMo 1-UP+BB 24	25		
		FOX EV 70	21										
		FOX EV 70 PIPE	21										
	A517 Gr. A-C	FOX EV 70 Mo	21										
		FOX EV 75	21										
	USS-T1	FOX EV 85	22					X 70-IG	24	3 NiCrMo 2.5-UP+BB 24	23		
FOX EV 85 M		22			NiCrMo 2.5-IG		NiCrMo 2.5-IG	23					
HY-100	FOX EV 100	22					X 90-IG	24					
Multi-purpose electrodes YS ≤ 380 N/mm ² YS ≤ 460 N/mm ² YS ≤ 550 N/mm ²	Unalloyed steels, pipe steels	FOX CEL	28				DMO-IG	28					
		FOX CEL+	28										
	Unalloyed steels, pipe steels	FOX BVD 85	28										
		High-strength steels, pipe steels	FOX BVD 90	29									
Cutting / gouging electrode		FOX NUT	30										

* For range of applications of gas welding rods, see product description

Unalloyed steels



Steel grid construction, Acconci Island, welded with **BÖHLER EMK 6**, **BÖHLER EAS 2 IG** (GTAW) and **BÖHLER FOX EV 50**.

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Knuckle-boom cranes, Palfinger AG, welded with **BÖHLER EMK 8**, **BÖHLER X 70-IG**, **BÖHLER X 90-IG**, flux cored wire **BÖHLER HL 51-FD** and wire/flux combination **BÖHLER EMS 2 / BB 24**

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Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis	Typical mechanical properties	Ø mm	Approvals	Characteristics and applications	Base metals
FOX MSU E 38 0 RC 11 E 43 13 A E6013 E4313	SMAW	C 0.06 Si 0.4 Mn 0.5	YS 430 N/mm ² TS 490 N/mm ² EL 26% CVN 75 J 58 J...-10 °C	2.5 3.2 4.0	TÜV-D, DB, ÖBB, ABS, DNV, BV, GL, LR, RMR, SEPROZ, CE	Rutile-cellulosic covered electrodes with very good weldability in all positions, including vertical down. Viscous weld pool, good gap bridging ability, easy handling. For industry and handwork, assembly and factory welding.	Steels up to a yield strength of 380 N/mm ² (52 Ksi) S275JR, S235J0G3 - S355J0G3, P235GH, P265GH, P255NH, P235T1, P355T1, P235T2 - P355T2, P235G1TH, P255G1TH, L210 - L360NB, L290MB, S235JRS1 - S235JOS1, S235JRS2 - S235JOS2
FOX OHV E 38 0 RC 11 E 43 13 A E6013 E4313	SMAW	C 0.06 Si 0.4 Mn 0.45	YS 460 N/mm ² TS 520 N/mm ² EL 25% CVN 75 J 47 J...-10 °C	2.0 2.5 3.2 4.0 5.0	TÜV-D, TÜV-A, DB, ÖBB, ABS, DNV, LR, LTSS, SEPROZ, CE	Rutile-cellulosic covered electrodes with very good weldability in all positions, including vertical down. Universal electrode, especially suitable for small transformers. Flexible coating. Multi-purpose application in steel construction, boiler and tank manufacture, vehicle manufacture, shipbuilding, as well as for galvanised components.	ASTM A36 & A53 Gr. all; A106 Gr. A, B, C; A135 Gr. A, B; A283 Gr. A, B, C, D; A366; A285 Gr. A, B, C; A500 Gr. A, B, C; A570 Gr. 30, 33, 36, 40, 45; A607 Gr. 45; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A935 Gr.45; A936 Gr. 50; API 5 L Gr. B, X42-X52
FOX KE E 38 0 RC 11 E 43 13 A E6013 E4313	SMAW	C 0.06 Si 0.3 Mn 0.5	YS 430 N/mm ² TS 490 N/mm ² EL 26% CVN 75 J 50 J...-10 °C	2.0 2.5 3.2 4.0	LR, SEPROZ, ÖBB	Rutile-cellulosic covered electrodes with good weldability in all positions, including vertical down. Excellent weldability with alternating current, good start and restart properties, reliable penetration, flat seam. Preferred for building fitters and assembly work.	A366; A285 Gr. A, B, C; A500 Gr. A, B, C; A570 Gr. 30, 33, 36, 40, 45; A607 Gr. 45; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A935 Gr.45; A936 Gr. 50; API 5 L Gr. B, X42-X52
FOX SUM E 38 0 RR 12 E 43 13 A E6013 E4313	SMAW	C 0.07 Si 0.3 Mn 0.5	YS 430 N/mm ² TS 500 N/mm ² EL 26% CVN 75 J	2.5 3.2 4.0	-	Rutile covered electrode with extraordinarily good weldability in all positions except vertical down. Good alternating current weldability and restart ability. Soft arc, extremely low spatter loss, excellent slag detachability, particularly smooth finish and clean seams.	
FOX SPE E 38 2 RB 12 E 43 03 A U E6013 (mod.) E4313 (mod.)	SMAW	C 0.08 Si 0.2 Mn 0.45	YS 420 N/mm ² TS 500 N/mm ² EL 28% CVN 90 J 60 J...-20 °C	2.0 2.5 3.2 4.0 5.0	TÜV-D, TÜV-A, DB, ÖBB, LTSS, SEPROZ, CE	Rutile basic covered electrode particularly suitable for positional welding, with the exception of vertical-down welds. Excellent for root passes. High-quality, x-ray safe welding seams. Very good alternating current weldability, intensive depositing behaviour. Preferred application in steel, container and pipeline construction. Excellent mechanical properties, therefore suitable for many groups of materials.	
FOX SUS E 42 0 RR 12 E 43 13 A E6013 E4313	SMAW	C 0.07 Si 0.5 Mn 0.6	YS 430 N/mm ² TS 510 N/mm ² EL 27% CVN 75 J 45 J...-10 °C	2.0 2.5 3.2 4.0 5.0	TÜV-D, DB, ÖBB, ABS, BV, DNV, GL, LR, SEPROZ, CE	Rutile covered electrode with excellent weldability in all positions except vertical-down welds, even under unfavourable conditions. It also features excellent restart and low spatter formation as well as very good alternating current weldability. The seam is very clean with a smooth finish, the slag is self-detaching.	Steels up to a yield strength of 420 N/mm ² (60 Ksi) S275JR, S235J0G3 - S355J0G3, P235GH, P265GH, P255NH, P295GH, P235T1, P355T1, P235T2-P355T2, P235G1TH, P255G1TH, L210 - L360NB, L290MB, S235JRS1 - S235JOS1, S235JRS2 - S235JOS2
FOX ETI E 42 0 RR 12 E 43 13 A E6013 E4313	SMAW	C 0.07 Si 0.4 Mn 0.5	YS 460 N/mm ² TS 520 N/mm ² EL 26% CVN 65 J	1.5 2.0 2.5 3.2 4.0 5.0	TÜV-D, TÜV-A, ABS, BV, DNV, GL, LR, LTSS, SEPROZ, CE	Rutile covered electrode with excellent weldability in all positions except vertical down. Especially smooth seams, self-releasing slag. Low spatter formation and good alternating current weldability. Excellent restart properties and easy handling. Longer bead lengths attainable. Multi-purpose in industry and handwork.	ASTM A36 & A53 Gr. all; A106 Gr. A, B, C; A135 Gr. A, B; A283 Gr. A, B, C, D; A366; A285 Gr. A, B, C; A500 Gr. A, B, C; A570 Gr. 30, 33, 36, 40, 45; A607 Gr. 45; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A935 Gr.45; A936 Gr. 50; API 5 L Gr. B, X42-X56

Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechanical properties	Ø mm	Approvals	Characteristics and applications	Base metals
FOX SPEM E 38 2 RB 12 E 43 03 A U E6013 (mod.) E4313 (mod.)	SMAW	C 0.08 Si 0.3 Mn 0.6	YS 450 N/mm ² TS 540 N/mm ² EL 27% CVN 70 J ≥ 47 J...-20 °C	2.5 3.2 4.0 5.0	TÜV-D, DB, ÖBB, TÜV-A, DNV, LR, GL, ABS, CE, BV	Rutile basic covered electrodes, especially suitable for positional welding, except vertical down welds. Preferred use in pipeline and boiler manufacture. Especially suitable for X-ray safe root passes and positional welding. Due to the weld metal's high Mn content, slightly higher strength values compared to BÖHLER FOX SPÉ.	Steels up to a yield strength of 380 N/mm ² (52 ksi) S275JR, S235J2G3 - S355J2G3, P235GH, P265GH, P255NH, P235 T1 - P355T1, P235T2 - P355T2, P235G1TH, P255G1TH, L210 - L360NB, L290MB - L360MB, S235JRS1 - S235J2S1, S235JRS2 - S235J2S2, S255N-S355N ASTM A36 u A53 Gr. all; A106 Gr. A, B, C; A135 Gr. A, B; A283 Gr. A, B, C, D; A366; A285 Gr. A, B, C; A500 Gr. A, B, C; A570 Gr. 30, 33, 36, 40, 45; A607 Gr. 45; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A935 Gr.45; A936 Gr. 50; API 5 L Gr. B, X42-X52
FOX HL 160 Ti E 38 0 RR 54 E 49 24-1 A E7024-1 E4924-1	SMAW	C 0.08 Si 0.4 Mn 0.7	YS 420 N/mm ² TS 520 N/mm ² EL 26% CVN 100 J 30 J...-20 °C	3.2 4.0 5.0	ABS, GL, LR, SEPROZ	Rutile covered high-efficiency electrode with 160% metal recovery. Quick-flowing, easy slag removal for cold seams and in tight angles. Can be used on rusted or coated-finish sheets. Preferable for fillet and butt seams in the horizontal position.	Steels up to a yield strength of 380 N/mm ² (52 ksi) S235JR, S275JR, S235J0G3, S275J0G3, S355J0G3, P235GH, P265GH, S255N, P295GH, S235JRS1 - S235J0S1, S235JRS2 - S235J0S2
FOX HL 180 Ti E 38 0 RR 74 E 49 24 A E7024 E4924	SMAW	C 0.07 Si 0.5 Mn 0.8	YS 440 N/mm ² TS 510 N/mm ² EL 27% CVN 85 J 50 J...-10 °C	3.2 4.0 5.0	TÜV-A, ABS, DNV, GL, LR, RINA, SEPROZ, ÖBB, RMR	Rutile covered high-efficiency electrode with approximately 180% metal recovery. Very long bead lengths, self-releasing slag, smooth and dent-free seams are the special advantages of this electrode. Excellent striking properties, weldable with trailing torch angle. High efficiency when filling thicker cross-sections.	ASTM A36 Gr. all; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A366; A570 Gr. 30, 33, 36, 40, 45; A607 Gr. 45; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A935 Gr.45; A936 Gr. 50
FOX EV 47 E 38 4 B 42 H5 E 49 16-1 A U H5 E7016-1H4R E4916-1H4R	SMAW	C 0.06 Si 0.5 Mn 0.7	YS 460 N/mm ² TS 530 N/mm ² EL 27% CVN 190 J 90 J...-40 °C	2.5 3.2 4.0 5.0	TÜV-D, TÜV-A, DB, ÖBB, ABS, BV, DNV, GL, LR, RMR, RINA, LTSS, VUZ, SEPROZ, CE	Basic covered electrodes for high-quality welds. Good weldability for positional welding excepting vertical down welds. Weld metal recovery approx. 110%. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g). Especially tough, crack- and ageing-resistant weld metal, therefore particularly suitable for rigid components with large seam cross-sections.	Steels up to a yield strength of 380 N/mm ² (52 ksi) S235JR-E295, S235J2G3 - S355J2G3, C22, P235T1-P275T1, P235T2, P275T2, L210 - L320, L290MB - L320MB, P235G1TH, P255G1TH, P235GH, P265GH, P295GH, S235JRS1 - S235J4S, S355G1S - S355G3S, S255N - S355N, P255NH-P355NH, S255NL - S355NL, GE200-GE240 ASTM A 27 & A36 Gr. all; A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285, Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A570 Gr. 30, 33, 36, 40, 45; A 572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5 L Gr. B, X42 - X52

Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis	Typical mechani- cal properties	Ø	Approvals	Characteristics and applications	Base metals
		%		mm			
FOX EV 50 E 42 5 B 42 H5 E 49 18-1 A U H5 E7018-1H4R E4918-1H4R	SMAW	C 0.07 Si 0.5 Mn 1.1	YS 490 N/mm ² TS 560 N/mm ² EL 27% CVN 190 J 100 J...-50 °C	2.0 2.5 3.2 4.0 5.0 6.0	TÜV-D, DB, ÖBB, TÜV-A, ABS, BV, DNV, GL, LR, RMR, RINA, LTSS, VUZ, SEPROZ, PDO, CRS, CE, NAKS	Basic covered electrodes for high-quality welds. Excellent strength and toughness properties down to -50 °C. Weld metal recovery approx. 110%. Good weldability in all positions except vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g). The electrode is suitable for joining welds in steel construction, boiler and tank manufacture, vehicle manufacture, shipbuilding, machine construction as well as buffer layers for surfacing of high carbon steels. Also suitable for welding of steels with low purity and high carbon content. Especially suitable for off-shore construction, CTOD tested at -10 °C. BÖHLER FOX EV 50 can also be used in sour gas applications (HIC test acc. to NACE TM-02-84). Values for the SSC test are also available.	Steels up to a yield strength of 420 N/mm ² (60 KSI) S235JR-E335, S235J2G3 - S355J2G3, C22, P235T1-P355T1, P235T2, P355T2, L210 - L360NB L290MB - L320MB, P235G1TH, P255G1TH, P235GH, P265GH, P295GH, S235JR1 - S235J4S, S355G1S - S355G3S, S255N - S355N, P255NH-P355NH, S255NL - S355NL, GE200-GE260, GE300
FOX EV 50-W E 42 5 B 12 H5 E 49 16-1 A U H5 E7016-1H4R E4916-1H4R	SMAW	C 0.07 Si 0.5 Mn 1.1	YS 460 N/mm ² TS 560 N/mm ² EL 28% CVN 200 J ≥ 47 J...-50 °C	2.0 2.5 3.2 4.0 5.0	TÜV-D, GL, LTSS, PDO, SEPROZ	Basic covered electrodes for high-quality welds. Very good weldability in all positions except vertical down. The electrode is also well suited for root pass welding. Excellent, smooth and slag-free seams. The weld metal is extremely crack resistant and impervious to cold. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g). Especially suitable for welding with alternating current. For root pass welding, negative polarity is recommended.	ASTM A 27 & A36 Gr. all; A214; A242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 A27 & A36 Gr. all; A214; A242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A570 Gr. 30, 33, 36, 40, 45; A 572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5 L Gr. B, X42 - X56
FOX EV 50-A E 42 3 B 12 H10 E 49 16 A U H10 E7016 E4916	SMAW	C 0.05 Si 0.6 Mn 1.0	YS 440 N/mm ² TS 550 N/mm ² EL 28% CVN 180 J ≥ 47 J...-30 °C	2.5 3.2 4.0 5.0	TÜV-D, DB, ÖBB, CE	Basic covered double-jacket electrode with extraordinarily good weldability in all positions except vertical down. Due to very well directed arc, especially suitable for positional welding. Very good weldability for root passes. Well suited for alternating current. Low spatter, good slag detachment, uniform seam. Also suitable for small transformers.	Steels up to a yield strength of 420 N/mm ² (60 KSI) S235J2G3 - S355J2G3, S235JR-E295, C22, P235T1-P355T1, P235T2-P355T2, L210 - L360NB, L290MB - L360MB, P235G1TH, P255G1TH, P235GH, P265GH, S255N, P295GH, S235JR1 - S235J3S, S355G1S - S355G3S, S255N - S355N, P255NH-P355NH, GE200-GE260 ASTM A27 & A36 Gr. all; A214; A242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A570 Gr. 30, 33, 36, 40, 45; A 572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5 L Gr. B, X42 - X56

Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechanical properties	Ø mm	Approvals	Characteristics and applications	Base metals
FOX EV PIPE E 42 4 B 12 H5 E 49 16-1 A E7016-1H4R E4916-1H4R	SMAW	C 0.06 Si 0.6 Mn 0.9	YS 470 N/mm ² TS 560 N/mm ² EL 29% CVN 170 J ≥ 27 J...-46 °C	2.0 2.5 3.2 4.0	TÜV-D, LTSS, SEPROZ, VNIIST, VNIIGAZ, DB, CE	BÖHLER FOX EV PIPE is a basic covered electrode which has excellent welding characteristics for vertical pipe seam welding of root passes with negative polarity as well as filler and cap passes with positive polarity. For wall thicknesses of 8 mm or more, a 3.2 mm electrode diameter can be used for root pass welding. The shorter depositing times that can thereby be achieved as well as the longer bead lengths per electrode result in considerable cost savings as compared to the type AWS E 7018 electrodes that are normally used for this. The electrode is likewise well suited for alternating current and can therefore also be used in alternating current welds in building and plant construction. The electrode offers excellent cryogenic CVN toughness as well as a low hydrogen content of max. 5 ml/100 g in the weld metal.	EN P235GH, P265GH, P295GH, P235T1, P275T1, P235G2TH, P255G1TH, S255N - S420N ¹⁾ , S255NL1 to S420NL1, L290NB to L360NB, L290MB to L415MB, L450MB ²⁾ to L555MB ²⁾ API Spec. 5L: A, B, X 42, X46, X52, X56, X60, X65-X80 ²⁾ ASTM A53 Gr. A-B, A106 Gr. A-C, A179, A192, A210 Gr. A-1 ¹⁾ stress-relieved to S380N / S380NL1 ²⁾ only for root pass welding
Ti 52-FD T 46 2 P M 1 H10 E71T-1MH8	FCAW	C 0.06 Si 0.5 Mn 1.2 Ti +	YS 490 N/mm ² TS 580 N/mm ² EL 26% CVN 180 J 90 J...-40 °C (80%Ar / 20%CO ₂)	1.2 1.6	TÜV-D, ABS, BV, DNV, GL, LR, CRS, DB, CE	Rutile flux cored welding wire with fast freezing slag. Excellent welding characteristics in all positions with one wire diameter and the same parameter setting. Excellent mechanical properties, easy slag removal, low spatter loss, smooth, finely rippled bead surface, high x-ray safety, dent-free seam joints. The product performs to the highest productivity with significant time and cost savings when used for positional welding.	Steels up to a yield strength of 460 N/mm ² (67 KSI) S235J2G3 - S355J2G3, GE200, GE240, GE260, S235JRS1 - S235J2S, AH, DH, EH, S255N - S355N, P235GH, P265GH, S255N, P295GH, S235G2T, S255GT, S355GT, L210 - L360NB, P235G1TH, P255G1TH
Ti 52 W-FD T 46 4 P M 1 H10 T 42 2 P C 1 H5 E71T-1CJH8 E71T-1MJH8	FCAW	C 0.05 Si 0.5 Mn 1.3 Ti +	YS 520 N/mm ² TS 580 N/mm ² EL 24% CVN 140 J 95 J...-40 °C (80% Ar/20% CO ₂) YS 480 N/mm ² TS 540 N/mm ² EL 25% CVN 130 J 100 J...-20 °C (100% CO ₂)	1.2 1.6	TÜV-D, DB, ÖBB, GL	Rutile flux cored welding wire with fast freezing slag. Excellent welding properties in all positions. Excellent mechanical properties, easy slag removal, low spatter loss, smooth, finely rippled bead surface, high x-ray safety, dent-free seam joints. Especially suitable for welding of coated base metals in shipbuilding, steel construction and bridge construction. The product performs to the highest productivity with significant time and cost savings when used for positional welding.	ASTM A27 & A36 Gr. all; A106 Gr. A, B A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45; A572 Gr. 42, 50; A606 G907 Gr. 30, 33, 36, 40; Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; AA841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5L X42 - X56

Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechanical properties	Ø mm	Approvals	Characteristics and applications	Base metals
HL 51-FD T 46 4 M M 2 H5 E70C-6MH4 E48C-6MH4	FCAW	C 0.07 Si 0.7 Mn 1.5	YS 490 N/mm ² TS 610 N/mm ² EL 27% CVN 130 J 90 J...-40 °C (80% Ar/20% CO ₂)	1.2 1.6	TÜV-D, DB, ÖBB, ABS, GL, LR, DNV, CE	Metal cored high-efficiency wire for automatic and semiautomatic welds on non-alloy constructional and fine-grained steels at temperatures from -40 to +450 °C. The specially designed powder filling enables a very high metal recovery of from 93 to 97% and deposition rates of up to 9 kg/h. Due to low slag formation, multiple layers can be welded without intermediate cleaning. Good penetration, high resistance to porosity and good flow characteristics are further quality features of this wire electrode.	Steels up to a yield strength of 460 N/mm ² (67 KSI) S235J2G3 - S355J2G3, GE240, GE260, S235JRS1 - S235J4S, AH, DH, EH, S255N - S380N, P235GH, P265GH, S255N, P295GH, S235G2T, S255GT, S355GT, L210 - L360NB, P235G1TH, P255G1TH ASTM A27 & A36 Gr. all; A106 Gr. A, B A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45; A572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5L X42 - X60
HL 53-FD T 42 5 Z M M 2 H5 E70C-GMH4 E48C-GMH4	FCAW	C 0.06 Si 0.5 Mn 1.2 Ni 0.9	YS 490 N/mm ² TS 610 N/mm ² EL 27% CVN 130 J 70 J...-50 °C (80% Ar/20% CO ₂) PWHT 600 °C/2 h YS 470 N/mm ² TS 530 N/mm ² EL 27% CVN 190 J (80% Ar/20% CO ₂)	1.2 1.6	TÜV-D	Metal cored high-efficiency wire for semi and fully automatic single-pass and multi-pass welds. The specially adapted filling enables a very high metal recovery of 93-97% and deposition rates of up to 8 kg/h. Smooth spray-arc type droplet transfer with the lowest spatter formation. Due to low slag formation, multiple layers can be welded without intermediate cleaning. Good penetration, high resistance to porosity and good flow characteristics, as well as low hydrogen content in the weld metal (≤ 5 ml/100 g) are further quality features of this wire electrode. HL 53-FD is especially advantageous when used in the temperature range of -50/+450 °C for fillet welds and butt welds on standard constructional steels as well as fine-grained constructional steels in tank manufacture, steel construction, machine construction, vehicle manufacture and shipbuilding.	Steels up to a yield strength of 420 N/mm ² (60 ksi) S235 - S355J2G3, GE200, GE240, GE260, S235JRS1 - S235J4S, AH, DH, EH, S255N - S380N, P235GH, P265GH, S255N, P295GH, S235G2T, S255GT, S355GT, L210 - L360NB, X 42-X 60, P235G1TH, P255G1TH ASTM A27 & A36 Gr. all; A106 Gr. A, B A214; A242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45 572 Gr. 42, 50; A606 Gr. all A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5L X42-X60
BW VII O I R45-G	OAW	C 0.08 Si 0.1 Mn 0.6	YS ≥ 235 N/mm ² TS ≥ 340 N/mm ² EL ≥ 14% CVN ≥ 35 J	2.0 2.5 3.2 4.0	TÜV-D, LTSS, CE	Copper, non-alloy gas welding rod for joining with normal stress up to steel S275JR. Low viscosity weld pool.	Steels up to a yield strength of 235 N/mm ² (34 ksi) S235JR, L195 ASTM A36 Gr. all; A283 Gr. B, C, D; A570 Gr. 33, 36, 40

Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis	Typical mechani- cal properties	Ø	Approvals	Characteristics and applications	Base metals
		%		mm			
BW XII O III R60-G	OAW	C 0.1 Si 0.15 Mn 1.1 Ni 0.45	YS ≥ 275 N/mm ² TS ≥ 410 N/mm ² EL $\geq 14\%$ CVN ≥ 47 J	2.0 2.5 3.0	TÜV-D, DB, ÖBB, CE	Copper-coated gas welding rod with nickel additive for high-quality joint welds in the construction of steam boilers and tanks up to S275JR steel or P265GH boiler plating. Due to its viscous weld pool, easy slag control and good gap bridging ability, this welding rod is very easy to handle. The weld pool is impervious to overheating, even when using a flame that is too hot.	Steels up to a yield strength of 275 N/mm ² (40 ksi) S235JR - S275JR, P265GH, L235- L290NB ASTM A36 Gr. all; A283 Gr. B, C, D; A285 Gr.B; A414 Gr.C; A442 Gr.60; A515 Gr. 60; A516 Gr. 55, 60; A570 Gr. 33, 36, 40
EMK 6 G3Si1 (wire) G42 4 M G3Si1 G 42 4 C G3Si1 ER70S-6 ER48S-6 W 42 5 W3Si1 (GTAW rod) ER70S-6 ER48S-6	GMAW GTAW	C 0.08 Si 0.9 Mn 1.45	YS 440 N/mm ² TS 530 N/mm ² EL 30% CVN 160 J 80 J...-40 °C Ar + 15 - 25% CO ₂	0.8 1.0 1.2 1.6	TÜV-D, TÜV-A, DB, ÖBB, ABS, CWB, GL, LR, DNV, LTSS, SEPROZ, CE	GTAW welding rod and GMAW wire electrode for weld joints in the manufacture of boilers and tanks and in building construction. Due to the excellent mechanical properties and the high current carrying capacity, optimally suited for welding thick-walled components; can also be used in sour gas applications (HIC test acc. to NACE TM-02-84). The non copper coated version of the solid wire is also available as the TOP version and was designed for low spatter formation and best feeding properties even at higher wire feed rates. These types are especially suited for robotic welding.	Steels up to a yield strength of 420 N/mm ² (60 KSI) S235J2G3 - S355J2G3, E360, P235T1-P355T1, P235G1TH, L210, L290MB, P255G1TH, P235GH, P265GH, P295GH, P310GH, P255NH, S235JRS1 - S235J4S, S355G1S - S355G3S, S255N - S385N, P255NH- P385NH, GE200-GE260 ASTM A27 & A36 Gr. all; A106 Gr. A, B A214; A242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45; A572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50
EML 5 W 46 5 W2Si ER70S-3 ER48S-3	GTAW	C 0.1 Si 0.6 Mn 1.2	YS 500 N/mm ² TS 600 N/mm ² EL 26% CVN 220 J ≥ 47 J...-50 °C	1.6 2.0 2.4 3.0	TÜV-D, TÜV-A, DB, ÖBB, Statoil, CE	GTAW welding rod for welding of non-alloy and low-alloy steels. For thin-walled sheets and pipes as well as for root past welding (approved to -50 °C). The relatively low Si content makes the welding rod especially suitable for weld joints that are to be later enamelled or galvanised. BÖHLER EML 5 can also be used in sour gas applications (HIC test acc. to NACE TM-02-84).	Steels up to a yield strength of 460 N/mm ² (67 ksi) S235J2G3 - S355J2G3, E360, P235T1-P355T1, P235G1TH, L210, L290MB, P255G1TH, P235GH, P265GH, P295GH, P310GH, P255NH, S235JRS1 - S235J4S, S355G1S - S355G3S, S255N - S385N, P255NH- P385NH, GE200-GE260 ASTM A27 & A36 Gr. all; A214; A242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A570 Gr. 30, 33, 36, 40, 45; A 572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5 L Gr. B, X42 - X60

Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechanical properties	Ø mm	Approvals	Characteristics and applications	Base metals
ER 70 S-2 ER70S-2 ER48S-2	GTAW	C 0.05 Si 0.5 Mn 1.2 Ti + Zr + Al +	YS ≥ 420 N/mm ² TS ≥ 520 N/mm ² EL $\geq 23\%$ CVN ≥ 80 J ≥ 27 J...-29 °C	1.6 2.0 2.4 3.0	-	GTAW welding rod with Al, Ti and Zr additives, specially suited for welding of non-deoxidised and semi-deoxidised steels. Specially suitable for single-pass welds of thin-walled sheets and pipes as well as for root pass welds. For multi-pass welds, or temperature requirements lower than -30 °C, we recommend the Böhler GTAW rod EML 5 (ER 70S-3).	Specially suitable for root pass welds of steels up to a yield strength of 420 N/mm ² (60 ksi) e.g. S235J2G3, E360, P235T1, L210, P255G1TH, P295GH, P310GH, P255NH, S235J4S, S255N, GE260 ASTM e.g. A27 & A36 Gr. all; A 210 Gr.1; A214; A34 Gr.1; A113; A 139
SG 3-P G4Si1 G 46 5 M G0 G4Si1 G 42 4 C G0 G4Si1 ER70S-G ER485S-G	GMAW	C 0.05 Si 0.75 Mn 1.5 Ti +	YS 510 N/mm ² TS 640 N/mm ² EL 25% CVN ≥ 100 J ≥ 47 J...-50 °C		TÜV-D, CE	BÖHLER SG 3-P is a micro-alloyed GMAW solid wire designed for high-quality automated welding of pipelines. An optimum balanced alloying concept ensures good weld metal properties to fulfil the high requirements in the on/offshore pipeline industry. Deposit is extremely crack-resistant and the CVN toughness is available down to -50 °C. The very important quality aspects, prerequisite for uninterrupted feedability of the solid wire e.g. helix of the wire, copper coating, close wire diameter tolerance and precision layer wound spooling are taken into account during the production.	L290MB-L485MB API Spec. 5 L: X42, X46, X52, X56, X60, X65

Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechanical properties	Ø mm	Approvals	Characteristics and applications	Base metals
Wire: EMS 2 S2 EM12K Flux: BB 24 SA FB 1 65 DC H5	SAW	C 0.07 Si 0.25 Mn 1.2	YS 440 N/mm ² TS 520 N/mm ² EL 33% CVN 185 J 140 J...-60 °C	2.0 2.5 3.0 3.2 4.0	TÜV-D Wire: TÜV-D, TÜV-A, DB, ÖBB, KTA 1408.1, SEPROZ, CE	<p>Wire/flux combination universally applicable in shipbuilding, steel construction as well as boiler and tank manufacture. For joint welds of standard and fine-grained constructional steels. The flux reacts metallurgically Mn-neutral. The weld metal exhibits good toughness properties for temperatures down to -60 °C.</p> <p>A clean seam and good wetting characteristics as well as good slag removability and the low hydrogen content of the weld metal (≤ 5 ml/100 g) are other advantages of this wire/flux combination. It is especially suitable for multi-pass welds on thick-walled sheets.</p>	<p>Steels up to a yield strength of 400 N/mm² (60 KSI).</p> <p>S235JR - S335JR, S235J2G3 - S335J2G3, P235T1 - P335T1, P235T2 - P355T2, P235GH, P265GH, S255N, P295GH, P310GH, S235RS1 - S235J4S, S255N - S380N</p> <p>ASTM A36 Gr. all; A 106 Gr. A, B A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45; A572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5L X42-X60</p>
Wire: EMS 2 S2 EM12K Flux: BB 25 SA FB 1 68 AC H5	SAW	C 0.07 Si 0.4 Mn 1.45	YS 450 N/mm ² TS 530 N/mm ² EL 28% CVN 180 J 90 J...-40 °C	2.0 2.5 3.0 3.2 4.0	TÜV-D Wire: TÜV-D, TÜV-A, DB, ÖBB, KTA 1408.1, SEPROZ, CE	<p>This wire/flux combination is universally applicable in shipbuilding, steel construction as well as boiler and tank manufacture. It is suitable for joint welds of standard and fine-grained constructional steels. Combining with the welding flux BÖHLER BB 25 gives a Si and Mn-alloyed weld metal.</p> <p>The weld metal exhibits good toughness properties at low temperatures to -40 °C.</p>	<p>Steels up to a yield strength of 420 N/mm² (60 ksi)</p> <p>S235J2G3-S355J2G3, GE200, GE240, GE260, S235RS1-S235J4S, AH, DH, EH, S255NS380N, P235GH, P265GH, S255N, P295GH, S235G2T, S255GT, S355GT, L210-L360NB, P235G1TH, P255G1TH</p> <p>ASTM A36 Gr. all; A 106 Gr. A, B A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45; A572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5L X42 - X56</p>

Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechanical properties	Ø mm	Approvals	Characteristics and applications	Base metals
Wire: EMS 2 S 2 EM12K Flux: BB 33 M SA AR 197 AC SKM	SAW	C 0.08 Si 0.7 Mn 1.3	YS 540 N/mm ² TS 620 N/mm ² EL 29% CVN 70 J 40 J...-20 °C	2.0 2.5 3.0 3.2 4.0	TÜV-D, TÜV-A Wire: TÜV-D, TÜV-A, KTA 1408.1, DB, ÖBB, SEPROZ, CE	This wire/flux combination is universally applicable in shipbuilding, steel construction as well as boiler and tank manufacture. In combination with the welding flux BÖHLER BB 33 M, suitable for joint welds of standard constructional steels and fine-grained steels with fast welding speeds (> 1.5 m/min). The weld metal exhibits good toughness properties down to -20 °C.	Steels up to a yield strength of 460 N/mm ² (67 ksi) S235J0G3-S355J0G3, GE200, GE240, GE260, S235JR1-S235J0S, AH, DH, EH, S255NS380N, P235GH, P265GH, S255N, P295GH, S235G2T, S255GT, S355GT, L210-L360NB, P235G0TH, P255G0TH ASTM A36 Gr. all; A 106 Gr. A, B A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45; A572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5L X42-X60
Wire: EMS 2 S2 EM12K Flux: BF 16 SF MS 178 AC M	SAW	C 0.04 Si 0.5 Mn 1.3	YS 400 N/mm ² TS 500 N/mm ² EL 29% CVN 90 J 40 J...-20 °C	2.0 2.5 3.0 3.2 4.0	TÜV-D, TÜV-A Wire: TÜV-D, TÜV-A, DB, ÖBB, KTA 1408.1, SEPROZ, CE	This wire/flux combination ensures good universal weldability in building construction with non-alloy steels and thin-walled components. BÖHLER BF 16 is a melt of Si and Mn-alloyed welding flux with high current carrying capacity for DC as well as AC.	Steels up to a yield strength of 380 N/mm ² (50 ksi) S235JR-S335JR, S235J0G3-S335J0G3, P235T1-P335T1, P235T2-P355T2, P235GH, P265GH, S255N, P295GH, P310GH, S235JR1-S235J0S, S255N-S380N ASTM A36 Gr. all; A 106 Gr. A, B A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45; A572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5L X42-X60

Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechani- cal properties	Ø mm	Approvals	Characteristics and applications	Base metals
Wire: EMS 3 S3 EH10K Flux: BB 24 SA FB 1 65 DC H5	SAW	C 0.08 Si 0.30 Mn 1.5	YS ≥ 420 N/mm ² TS ≥ 500 N/mm ² EL $\geq 24\%$ CVN ≥ 130 J ≥ 47 J...-40 °C	4.0	TÜV-D Wire: TÜV-D, TÜV-A, DB, ÖBB, KTA 1408.1, SEPROZ, CE	This wire/flux combination is universally applicable in shipbuilding, steel construction as well as boiler and tank manufacture. It is suitable for joint welds of standard and fine-grained constructional steels. The flux reacts metallurgically Mn-neutral. Good toughness properties to -40 °C. A clean seam and good wetting characteristics as well as good slag removability and the low hydrogen content of the weld metal (≤ 5 ml/100 g) are other advantages of this wire/flux combination. It is especially suitable for multi-pass welds on thick-walled sheets.	Steels up to a yield strength of 420 N/mm ² (60 ksi) S235J2G3 - S355J2G3, GE200, GE240, GE260, S235JR1 - S235J4S, AH, DH, EH, S255N - S380N, P235GH, P265GH, S255N, P295GH, S235G2T, S255GT, S355GT, L210 - L360NB, P235G1TH, P255G1TH
Wire: EMS 3 S3 EH10K Flux: BB 25 SA FB 1 68 AC H5	SAW	C 0.06 Si 0.40 Mn 1.9	YS 520 N/mm ² TS 600 N/mm ² EL 23% CVN 140 J ≥ 47 J...-30 °C	4.0	Wire: TÜV-D, TÜV-A, DB, ÖBB, KTA 1408.1, SEPROZ, CE	This wire/flux combination is universally applicable in shipbuilding, steel construction as well as boiler and tank manufacture. It is suitable for joint welds of standard and fine-grained constructional steels. Combining with the welding flux BÖHLER BB 25 gives a Si and Mn-alloyed weld metal. The weld metal exhibits good toughness properties down to -30 °C.	ASTM A36 Gr. all; A 106 Gr. A, B A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45; A572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5L X42 - X56
Wire: EMS 3 S 3 EH 10K Flux: BB 33 M SA AR 1 97 AC SKM	SAW	C 0.08 Si 0.8 Mn 1.7	YS 550 N/mm ² TS 650 N/mm ² EL 20% CVN 60 J	4.0	Wire: TÜV-D, TÜV-A, KTA 1408.1, DB, ÖBB, SEPROZ, CE	This wire/flux combination is universally applicable in shipbuilding, steel construction as well as boiler and tank manufacture. In combination with the welding flux BÖHLER BB 33 M, suitable for joint welds of standard constructional steels and fine-grained steels with fast welding speeds (> 1.5 m/min).	Steels up to a yield strength of 500 N/mm ² (72 ksi) S235J0G3 - S355J0G3, GE200, GE240, GE260, S235JR1 - S235J0S, AH, DH, EH, S255N - S380N, P235GH, P265GH, S255N, P295GH, S235G2T, S255GT, S355GT, L210 - L360NB, P235G0TH, P255G0TH ASTM A36 Gr. all; A 106 Gr. A, B A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45; A572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5L X42-X60

Unalloyed steels

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechanical properties	Ø mm	Approvals	Characteristics and applications	Base metals
Wire: EMS 3 S3 EH10K Flux: BF 16 SF MS 178 AC M	SAW	C 0.04 Si 0.5 Mn 1.7	YS 410 N/mm ² TS 520 N/mm ² EL 25% CVN 70 J 40 J...-30 °C	4.0	Wire: TÜV-D, TÜV-A, DB, ÖBB, KTA 1408.1, SEPROZ, CE	This wire/flux combination ensures good universal weldability in building construction with non-alloy steels and thin-walled components. BÖHLER BF 16 is a melt of Si and Mn-alloyed welding flux with high current carrying capacity for DC as well as AC. The weld metal exhibits good toughness properties down to -30 °C.	Steels up to a yield strength of 380 N/mm ² (50 ksi) S235JR - S355JR, S235J0G3 - S355J0G3, P235T1-P355T1, P235T2-P355T2, P235GH, P235GH, P265GH, S255N, P295GH, P310GH, S235RS1 - S235J0S, S355N - S420N ASTM A36 Gr. all; A 106 Gr. A, B A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C, D; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45, A572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5L X42 - X52
DMO O IV R60-G	OAW	C 0.12 Si 0.15 Mn 1.0 Mo 0.5	YS 330 N/mm ² TS 470 N/mm ² EL 24% CVN 60 J	2.0 2.5 3.2 4.0	TÜV-D, DB, ÖBB, SEPROZ, CE	Mo-alloyed gas welding wire for non-alloyed and 0.5% Mo-alloyed steels preferred for pipe welds with higher testing requirements. Viscous weld pool. Approved for long-term use for service temperatures to +500 °C.	High temperatur steels, same alloyed 16Mo3, P285NH, P295NH, P255GITH, P295GH ASTM A335 Gr. P1, A36 Gr. all; A283 Gr. B, C, D; A285 Gr. B; A414 Gr. C; A442 Gr. 60; A515 Gr. 60; A516 Gr. 55, 60; A570 Gr. 33, 36, 40

Welding guidelines

Welding guidelines for non-alloy construction materials

An increase of strength in non-alloy steels occurs mainly through the rise in carbon content. From about 0.2% carbon content, the limit of good weldability is reached. A rough estimate of the weldability can be calculated using the carbon equivalent.

$$K = C + \frac{Mn}{6}$$

(simplified formula, only for non-alloy steels)

Using the K-value taken from the chemical composition of the steel, the necessity of preheating can be determined.

K-value	Recommended preheating °C
Up to 0.45	< 100
0.45 ... 0.60	100 ... 250
Over 0.60	250 ... 350 (higher if necessary)

For hardening, the following important influencing variables are not taken into account:

- Steel manufacture process
- Grain size
- Workpiece dimensions (cross-section)
- Workpiece temperature
- Weld seam shape and thickness
- Welding process
- Electrode diameter
- Coating type

Gas shielded arc welding of non-alloy steels

The GMAW welding with solid wires is today the most important process in the working of non-alloy steels. For the inert gas in conventional applications, pure carbon dioxide (CO₂) has established itself as the best compromise solution in regard to welding behaviour, mechanical properties and economy.

For higher demands of weld metal toughness, the use of gas mixtures (e.g. 82% Argon + 18% CO₂) is recommended.

GTAW (TIG) welding is primarily used for root passes and thin-walled sheets.

GMAW welding with flux cored or metal cored wires is increasingly used in positional welding due to the higher welding performance.

Submerged arc welding of non-alloy steels

For sub-arc welds of non-alloy materials, similar criteria apply in regard to the selection of the welding flux as for covered electrodes. Acid fluxes perform similarly to rutile types in regard to welding characteristics and the mechanical properties of the weld metal. Basic fluxes have the same advantages and disadvantages as basic covered electrodes.

Welding technology for non-alloy steels

- Welding consumables are to be selected based on the minimum requirements for the mechanical properties of the base metal.
- For steels with “guaranteed weldability” and wall thicknesses of 20-30 mm (depending on the base metal), preheat to 150 °C and use basic welding consumables.
- For steels with “limited weldability”, preheat according to the K-value (C-equivalent). Use only basic, re-dried welding consumables.
- For non-deoxydised steels, avoid melting the segregation zones and likewise use basic welding consumables.

Dissimilar joints

Unalloyed – unalloyed (e.g. S235 with S355)

Welding consumable is matched for strength to the softer base metal. When determining the coating, filling or flux type, the wall thickness and component rigidity should be considered.

Unalloyed – high strength (e.g. S275 with S690)

Welding consumable is usually matched to the softer base metal. In the case of greatly differing strength properties of the partner material, a welding consumable with a strength lying between the values of the two materials should be considered.

Unalloyed – quenched and tempered steels (e.g. S275 with 25CrMo4)

Quenched and tempered steels have only limited weldability. Types with higher carbon contents should not be used for welded constructions. They require special heat control during welding and heat treatment afterwards. Depending on the combination of materials, non-alloy or low-alloy welding consumables should be considered to suit the weld metal gains increased strength through carburization from the base metal. Dilution should be kept to a minimum. Nickel-based welding consumables are also sometimes used. In exceptional cases, if a subsequent heat treatment is not possible, the use of austenitic CrNi welding consumables can be beneficial.

Processing instructions for covered electrodes

Covered electrode for non-alloy construction materials

Rutile covered electrodes

ADVANTAGES

- Very good start and restart characteristics
- Easy handling with stable arc
- Excellent welding characteristics with direct and alternating current
- Suitable for positional welding
- Easy slag removability
- Low spatter formation
- Good gap bridging ability (root pass welds)
- Elastic coating
- Highly resistant to porosity

DISADVANTAGES

- Not recommended for thick-walled components (> 25-30 mm)
- Low impact strength values at low temperatures
- Toughness for non-alloy and low-alloy types only to ± 0 °C (-10 °C)
- Hydrogen content is high (~ 25 ml/100 g)
- Not recommended for carbon steels with C > 0.2%
- Not recommended for fine-grained constructional steels

Basic covered electrodes

ADVANTAGES

- High impact strength at low temperatures e.g.:
FOX EV 50 -50 °C
FOX EV 60 -60 °C
FOX 2.5 Ni -80 °C
- High purity of weld metal (O₂, N₂, S, P)
- Generally very tough and crack-resistant
- Low hydrogen values (< 5 ml/100 g)
- Suitable for thick-walled constructions
- Suitable for steels with high carbon content (C > 0.2%) or quenched and tempered steels with the correct welding technology (non-alloy and low-alloy types)
- Suitable for fine-grained constructional steels

DISADVANTAGES

- More difficult to weld (trained welders required)
- Highly basic type, only direct current, positive polarity
- Coarse seam surface
- Poorer slag removability
- Vertical down welds only possible with special types (e.g. FOX BVD 85)
- Coating more brittle (high-temperature drying)
- Sensitive to porosity due to high tendency of moisture pick up.

Cellulosic electrodes

ADVANTAGES

- Suitability for root pass welds
- Vertical down welds
- Stable arc
- Pore-free seams
- High current capacities and welding speeds

DISADVANTAGES

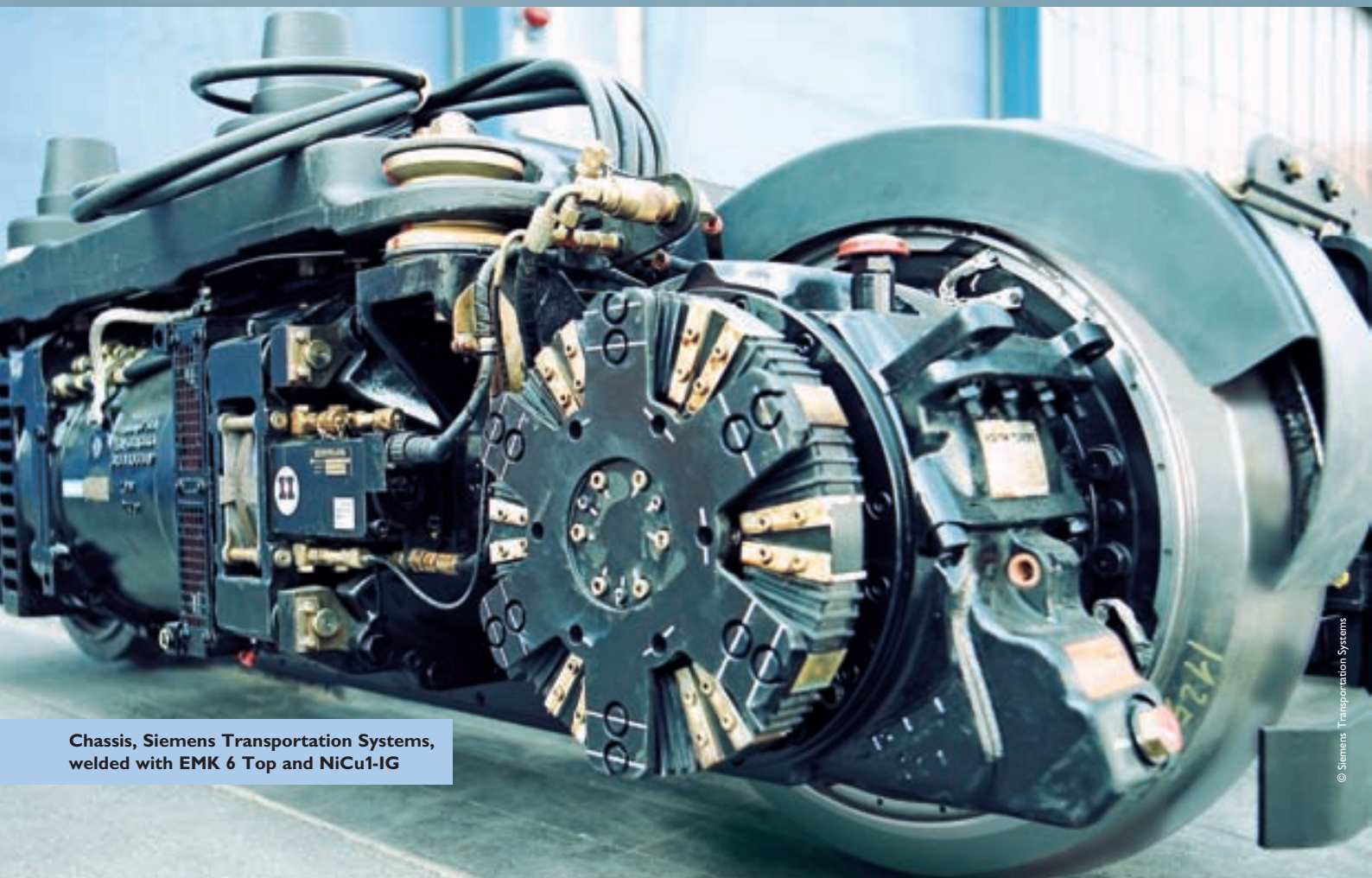
- High hydrogen content
- Preheating required

High-strength fine-grained steels



Rion-Antirion Bridge, welded with BÖHLER FOX EV 65 and BÖHLER NiMo1-IG

© Gefyra SA



Chassis, Siemens Transportation Systems, welded with EMK 6 Top and NiCu1-IG

© Siemens Transportation Systems

High-strength fine-grained steels

Some non-alloy welding consumables made by **BÖHLER WELDING** are also suitable for high-strength base metals. The technical data of these products can be found in the section "Unalloyed materials". Please refer to the selection guide on page 4.

BÖHLER Standard EN AWS	Welding process	Typical analysis	Typical mechani- cal properties	Ø mm	Approvals	Characteristics and applications	Base metals
FOX NiCuCr E 46 4 ZNiCrCu B 42 H5 E 49 18-G A H5 E8018-W2H4R E5518-W2H4R	SMAW	C 0.05 Si 0.4 Mn 0.7 Cr 0.6 Ni 0.6 Cu 0.45	YS 520 N/mm ² TS 570 N/mm ² EL 27% CVN 200 J 130 J...-40 °C PWHT 580 °C/2 h YS 500 N/mm ² TS 550 N/mm ² EL 27% CVN 190 J	2.5 3.2 4.0	RMR	Ni-Cu-Cr-alloyed, basic covered electrodes for weather-resistant constructional steels of similar type, such as CORTEN, PATINAX, CORALDUR and KORALPIN. Excellent mechanical properties with high crack resistance even under rigid clamping. Weld metal recovery approx. 115%. Easy handling in all positions except vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g).	Weather-resistant steels Corten A, Patinax 37, Alcodur 50, Koralpin 52 S235JR, S235RW, S355RW, S355J2G3 Cu ASTM A36, A283 Gr. B, C
NiCu 1-IG G 42 4 M GO G 42 4 C GO ER80S-G ER55S-G	GMAW	C 0.1 Si 0.5 Mn 1.1 Ni 0.9 Cu 0.4	YS 500 N/mm ² TS 580 N/mm ² EL 26% CVN 130 J 50 J...-10 °C ≥ 90 J...-40 °C	1.0 1.2	DB, ÖBB, CE	Ni-Cu alloy solid wire electrode, copper-coated, for metal/inert gas welding on weather-resistant steels, constructional steels and special steels. NiCu 1-IG has good weldability in short arcs at low voltage as well as in spray arcs with higher voltage. The mechanical properties of the weld metal, the resistance to porosity and the bead formation are dependent upon the type of inert gas used and the other welding parameters. Due to the copper alloying, the weld metal features higher resistance to atmospheric corrosion.	
FOX EV 55 E 46 5 B 42 H5 E 49 18-1 A U H5 E7018-1H4R E4918-1H4R	SMAW	C 0.07 Si 0.35 Mn 1.4	YS 500 N/mm ² TS 550 N/mm ² EL 30% CVN 220 J 90 J...-50 °C PWHT 580 °C/2 h YS 470 N/mm ² TS 530 N/mm ² EL 30% CVN 200 J	2.5 3.2 4.0	TÜV-D, TÜV-A, RMR, LTSS, SEPROZ	Basic covered electrodes for high-quality weld joints with excellent strength and toughness characteristics. Crack-resistant, impervious to cold down to -50 °C. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g). Very good weldability in all positions except vertical down. Use in steel construction, boiler and tank manufacture, vehicle manufacture, shipbuilding and machine construction. Also suitable for buffer layers for surfacing of high carbon steels. Also suitable for use in sour gas applications (HIC test acc. to NACE TM-02-84). Values for the SSC test are also available.	Steels up to a yield strength of 460 N/mm ² (67 ksi) S235J2G3 - S355J2G3, S235JR - S355J0, P235T1- P355T1, P235T2 -P355T2, L210 - L415NB, L290MB, P235GTH, P255GTH, P235GH, P265GH, P295GH, S235JRS1 - S235J4S, S355G1S - S355G3S, S255N - S460N, P255NH- P355NH, S255NL - S460NL, S255NL1, GE200-GE300 ASTM A27 & A36 Gr. all; A214; A 242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A570 Gr. 30, 33, 36, 40, 45; A 572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50; API 5 L Gr. B, X42 - X60

High-strength fine-grained steels

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechanical properties	Ø mm	Approvals	Characteristics and applications	Base metals
FOX EV 60 E 46 6 1Ni B 42 H5 E 55 18-N2 A U H5 E8018-C3H4R E5518-C3H4R	SMAW	C 0.07 Si 0.4 Mn 1.15 Ni 0.9	YS 510 N/mm ² TS 610 N/mm ² EL 27% CVN 180 J 110 J...-60 °C PWHT 580 °C/2 h YS 480 N/mm ² TS 580 N/mm ² EL 27% CVN 160 J	2.5 3.2 4.0 5.0	TÜV-D, TÜV-A, DNV, RMR, Statoil, LTSS, SEPROZ, CRS, CE	Ni-alloyed, basic covered electrode with excellent mechanical properties, most notably greater toughness and crack resistance for high-strength, fine-grained constructional steels. Suitable for the temperature range -60 °C to +350 °C. Very good impact strength in older condition. Weld metal recovery approximately 115%. Easy handling in all positions except vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g).	Standard constructional steels, pipe and boiler steels, cold-resistant fine-grained constructional steels and special grades. e.g.: E335, S355J2G3, C45, L360NB, L360MB, P310GH, S460N, P460NH, S460NL, S380NL1 - S460NL2, GE300 ASTM A516 Gr. 65, A572 Gr. 55, 60, 65, A633 Gr. E, A612, A618 Gr. 1, A537 Gr. 1-3.
FOX EV 60 PIPE E 50 4 1Ni B 12 H5 E 55 16-G A H5 E8016-G H4R E5516-GH4R	SMAW	C 0.07 Si 0.6 Mn 1.2 Ni 0.9	YS 550 N/mm ² TS 590 N/mm ² EL 29% CVN 170 J 60 J...-46 °C	2.0 2.5 3.2 4.0	VNIIGAZ	BÖHLER FOX EV 60 PIPE is a basic covered electrode which has excellent welding characteristics for vertical pipe seam welding of root passes with negative polarity as well as filler and cap passes with positive polarity. The electrode is likewise well suited for alternating current and can therefore also be used in alternating current welds in building and plant construction. The electrode offers excellent cryogenic CVN toughness down to -40 °C as well as a low hydrogen content of max. 5 ml/100 g in the weld metal. For wall thicknesses of 8 mm or more, a 3.2 mm electrode diameter can be used for root pass welding. The shorter depositing times that can thereby be achieved as well as the longer bead lengths per electrode result in considerable cost savings as compared to the type AWS E 8018 electrodes that are normally used for this.	EN: S235J2G3 - S355J2G3, L210NB - L450NB, L210MB - L450MB, P235GH - P295GH, E295, E335, S355J2G3, C35 - C45, P310GH, S380N - S460N, P380NH - P460NH, S380NL - S460NL, S380NL1 - S460NL2, GE260-GE300 API Spec. 5 L: X42, X46, X52, X56, X60, X65 ASTM A516 Gr. 65, A572 Gr. 55, 60, 65, A633 Gr. E, A612, A618 Gr. 1, A537 Gr. 1-3
FOX EV 63 E 50 4 B 42 H5 E 57 18-G A H5 E8018-GH4R E5518-GH4R	SMAW	C 0.08 Si 0.7 Mn 1.7	YS 580 N/mm ² TS 630 N/mm ² EL 26% CVN 170 J 90 J...-40 °C PWHT 580 °C/2 h YS 560 N/mm ² TS 610 N/mm ² EL 26% CVN 130 J	2.5 3.2 4.0 5.0	TÜV-D, TÜV-A, DB, ÖBB, RMR, SEPROZ, CE	Basic covered electrode for non-alloy and low-alloy steels of higher strength and a carbon content of up to 0.6%. Also suitable for rail joint welding. Tough and crack-resistant weld metal. Weld metal recovery approx. 115%. Good weldability in all positions except vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g).	Standard constructional steels, pipe steels, rail steels S355J2G3, E295 - E360, C35 - C60, S355N - S500N, P315NH - P500NH, GE200 - GE300, R0800 ASTM A225 Gr. C; A517 Gr. A, B, C, E, F, H, J, K, M, P
FOX EV 65 E 55 6 1NiMo B 42 H5 E8018-GH4R E8018-D1H4R (mod.) E5518-GH4R E5518-D1H4R (mod.)	SMAW	C 0.06 Si 0.3 Mn 1.2 Ni 0.8 Mo 0.35	YS 600 N/mm ² TS 650 N/mm ² EL 25% CVN 180 J 80 J...-60 °C PWHT 580 °C/2 h YS 580 N/mm ² TS 630 N/mm ² EL 25% CVN 160 J	2.5 3.2 4.0	TÜV-D, SEPROZ, CE, VNIIST	Basic covered electrode with a high degree of toughness and crack resistance for high-strength, fine-grained constructional steels. Cold-resistant to -60 °C and ageing-resistant. Easy handling in all positions except vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g).	Standard constructional steels, pipe and boiler steels, cold-resistant fine-grained constructional steels and special grades. E295 - E360, 20MnMoNi5-5, 22NiMoCr4-7, P355NL1 - P460NL1, P355NL2 - P460NL2, S380N - S500N, S355NH - S460NH, S380NL - S500NL, S380NL1 - S500NL1, 15NiCuMoNb5S (WB 36), 20MnMoNi5-5, 17MnMoV6-4 (WB 35), 22NiMoCr4-7 ASTM A302 Gr. A-D; A517 Gr. A, B, C, E, F, H, J, K, M, P; A225 Gr. C; A572 Gr. 65

High-strength fine-grained steels

BÖHLER Standard EN AWS	Welding process	Typical analysis	Typical mechani- cal properties	Ø mm	Approvals	Characteristics and applications	Base metals
FOX EV 70 E 55 6 1NiMo B 42 H5 E9018-GH4R E9018-D1H4R (mod.) E6218-GH4R E6218-D1H4R (mod.)	SMAW	C 0.04 Si 0.3 Mn 1.2 Ni 0.9 Mo 0.4	YS 650 N/mm ² TS 700 N/mm ² EL 24% CVN 160 J 70 J...-60 °C PWHT 580 °C/2 h YS 650 N/mm ² TS 700 N/mm ² EL 24% CVN 130 J	3.2 4.0	TÜV-D, SEPROZ, CE	MoNi-alloyed, basic covered electrode with a high degree of toughness and crack resistance for high-strength, fine-grained constructional steels. Suitable for the temperature range of -60 °C to +350 °C Weld metal recovery approx. 115%. Easy handling in all positions except vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g).	High-strength fine-grained steels S380N - S500N, P380NH - S500NH ASTM A517 Gr. A, B, C, E, F, H, J, K, M, P, A225 Gr. C, A633 Gr. E, A572 Gr. 65
FOX EV 70 PIPE E 55 4 Z Mn 2Ni Mo B 12 H5 E9016-GH4R E6216-GH4R	SMAW	C 0.06 Si 0.5 Mn 1.7 Ni 2.2 Mo 0.3	YS 620 N/mm ² TS 680 N/mm ² EL 20% CVN 140 J 55 J...-46 °C	2.5 3.2 4.0	-	BÖHLER FOX EV 70 PIPE is a basic covered electrode which has excellent welding characteristics for vertical pipe seam welding of root passes with negative polarity as well as filler and cap passes with positive polarity. The electrode is likewise well suited for alternating current and can therefore also be used in alternating current welds in building and plant construction. The electrode offers excellent cryogenic CVN toughness down to -40 °C as well as a low hydrogen content of max. 5 ml/100 g in the weld metal. For wall thicknesses of 8 mm or more, a 3.2 mm electrode diameter can be used for root pass welding. The shorter depositing times that can thereby be achieved as well as the longer bead lengths per electrode result in considerable cost savings as compared to the type AWS E9018 electrodes that are normally used for this.	EN: L450MB, L485MB, L555MB API Spec. 5 L: X65, X70, X80
FOX EV 70 Mo E 55 3 MnMo B T 42 H10 E9018-G E9018-D1 (mod.) E6218-G E6218-D1 (mod.)	SMAW	C 0.06 Si 0.4 Mn 1.6 Ni 2.2 Mo 0.5	YS 580 N/mm ² TS 680 N/mm ² EL 22% CVN 150 J 85 J...-30 °C PWHT 650 °C/2 h YS 580 N/mm ² TS 650 N/mm ² EL 23% CVN 160 J 90 J...-30 °C	2.5 3.2 4.0 5.0	TÜV-D, DB, ÖBB, TÜV-A, CE	MnMo-alloyed, basic covered electrodes for high-strength fine-grained constructional steels and heat-resistant steels, e.g. especially suited for 15NiCuMoNb5S. Crack-resistant, ageing-resistant and tough. Very good weldability in all positions except vertical down.	High-strength fine-grained constructional steels, rail steels to R0800 (for joint welding) E295 - E360, C35 - C60, P310GH, 17MnMoV6-4, 15NiCuMoNb5S, S380NS500N, P380NH - S460NH, GE300, 22Mo4 ASTM A225 Gr. C, A302 Gr. A-D, A514 and A517 Gr. A, B, C, E, F, H, J, K, M, P
FOX EV 75 E 62 6 Mn2NiCrMo B 42 H5 E10018-GH4R E10018-MH4R (mod.) E6918-GH4R E6918-MH4R (mod.)	SMAW	C 0.05 Si 0.4 Mn 1.6 Cr 0.4 Ni 2.0 Mo 0.4	YS 700 N/mm ² TS 750 N/mm ² EL 23% CVN 140 J > 47 J...-60 °C PWHT 650 °C/2 h YS 700 N/mm ² TS 750 N/mm ² EL 23% CVN 120 J	3.2 4.0	SEPROZ	MnMoNi-alloyed, basic covered electrode with a high degree of toughness and crack resistance for high-strength, quenched and tempered fine-grained constructional steels. Suitable for the temperature range of -60 °C to +400 °C. Weld metal recovery approx. 120%. Easy handling in all positions except vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g).	Quenched and tempered fine-grained constructional steels to a yield strength of 650 N/mm ² . Quenched and tempered steels to 730 N/mm ² strength S500N, S460NH, S500NL ASTM A225 Gr. C, A 514 und A517 Gr. A, B, C, E, F, H, J, K, M, P, A656, A678 Gr. C

High-strength fine-grained steels

BÖHLER Standard EN AWS	Welding process	Typical analysis	Typical mechani- cal properties	Ø mm	Approvals	Characteristics and applications	Base metals
FOX EV 85 E 69 6 Mn2NiCrMo B 42 H5 E11018-GH4R E11018-MH4R (mod.) E7618-GH4R E7618-MH4R	SMAW	C 0.05 Si 0.4 Mn 1.7 Cr 0.4 Ni 2.1 Mo 0.5	YS 780 N/mm ² TS 840 N/mm ² EL 20% CVN 110 J 60 J...-60 °C PWHT 580 °C/2 h YS 750 N/mm ² TS 800 N/mm ² EL 20% CVN 80 J	2.5 3.2 4.0 5.0	TÜV-D, DB, ÖBB, SEPROZ, CE	MnMoNi-alloyed, basic covered electrode with a high degree of toughness and crack resistance for high-strength, fine-grained constructional steels. Cold-resistant to -60 °C and ageing-resistant. Easy handling in all positions except vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g).	High-strength, fine-grained constructional steels to a yield strength of 720 N/mm ² . Quenched and tempered steels to 790 N/mm ² strength S620 QL-S690QL, S620QL1, S690QL1, N-AXTRA 56, 63, 70
FOX EV 85 M - E11018-MH4R E7618-MH4R	SMAW	C 0.05 Si 0.2 Mn 1.5 Cr 0.3 Ni 2.2 Mo 0.35	YS ≥ 680 N/mm ² TS ≥ 760 N/mm ² EL ≥ 20% CVN ≥ 100 J ≥ 27 J...-50 °C	3.2 4.0 5.0	-	Basic covered electrode with a high degree of toughness and crack resistance for high-strength, fine-grained constructional steels. Cold-resistant to -50 °C and ageing-resistant. Easy handling in all positions except vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g).	
FOX EV 100 E 89 4 Mn2NiCrMo B 42 H5 E12018-G E8318-GH4R	SMAW	C 0.06 Si 0.35 Mn 1.7 Cr 0.7 Ni 2.5 Mo 0.4 V 0.7	YS ≥ 890 N/mm ² TS ≥ 980 N/mm ² EL 15% CVN ≥ 47 J ≥ 47 J...-40 °C	3.2 4.0 5.0	CE	Basic covered electrode with a high degree of toughness and crack resistance for high-strength, fine-grained constructional steels. Cold-resistant to -60 °C and ageing-resistant. Easy handling in all positions except vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100 g).	Quenched and tempered fine-grained constructional steels to a yield strength of 890 N/mm ² . Quenched and tempered low-alloy steels to 1,000 N/mm ² tensile strength XABO 890
FOX 2.5 Ni E 46 8 2Ni B 42 H5 E8018-C1H4R E5518-C1H4R	SMAW	C 0.04 Si 0.3 Mn 0.8 Ni 2.4	YS 490 N/mm ² TS 570 N/mm ² EL 30% CVN 180 J 110 J...-80 °C PWHT 580 °C/2 h YS 470 N/mm ² TS 550 N/mm ² EL 30% CVN 200 J	2.5 3.2 4.0 5.0	TÜV-D, ÖBB, DB, ABS, BV, DNV, GL, LR, Statoil, WIVWEB, SEPROZ, RINA, CE	Basic covered, 2.5% Ni-alloyed electrode for non-alloy and Ni-alloyed fine-grained constructional steels. Tough, crack-resistant weld metal for low temperature applications down to -80 °C. Best weldability in all positions except for vertical down. Low hydrogen content (under AWS conditions HD < 4 ml/100 g).	Cold-resistant constructional and Ni-steels, cold-resistant special shipbuilding steels 12Ni14, 14Ni6, 13MnNi6-3, G12Ni14, S255N - S460N, S255NH - S460NH, S255NL - S460NL, S255NL1 - S460NL1 ASTM A633 Gr. E, A572 Gr. 65, A203 Gr. D, A333 a., A334 Gr. 3, A350 Gr. LF3
DMO-IG W MoSi W 46 3 W2Mo ER70S-A1 (ER80S-G) ER49S-A1 (ER55S-G)	GTAW	C 0.1 Si 0.6 Mn 1.2 Mo 0.5	YS 520 N/mm ² TS 630 N/mm ² EL 27% CVN 200 J ≥ 47 J...-30 °C PWHT 620 °C/1 h YS 480 N/mm ² TS 570 N/mm ² EL 26% CVN 230 J	1.6 2.0 2.4 3.0 3.2	TÜV D, TÜV A, DB, BV, DNV, KTA 1408.1, ÖBB, CRS, CE	GTAW welding rod for welding in the construction of boilers, pressure tanks, pipelines, cranes and steel. High-quality, very tough and crack-resistant weld metal, resistant to ageing. Suitable for the temperature range of -30 °C to +500 °C (+550 °C). Very good welding and flow behaviour.	Heat-resistant steels and steel cast of similar types, ageing-resistant steels and steels resistant to caustic cracking e.g.: S355J2G3, L415NB, L415MB, P310GH, 16Mo3, 17MnMoV6-4, 22NiMoCr4-7, 20MnMoNi5-5, 15NiCuMoNb5S, 20MnMoNi4-5, GE300, 22Mo4, S460N, P460NH ASTM A335 Gr. P1; A182M Gr. F1; A204M Gr. A, B, C; A250M Gr. T1; A217 Gr. WC 1
SG 8-P G3Ni1 G 42 5 M G3Ni1 ER80S-G ER55S-G	GMAW	C 0.06 Si 0.7 Mn 1.5 Ni 0.9 Ti +	YS 500 N/mm ² TS 590 N/mm ² EL 24% CVN 150 J 80 J...-50 °C	0.9 1.0 1.2	DNV	Micro-alloyed GMAW solid wire designed for high quality automated welding of pipelines. Additional applications: Steel tanks and machine construction. Very good cryogenic CVN toughness down to -50 °C, excellent ductility and high crack resistance. Excellent welding and flow characteristics and best feedability.	API 5 L: X42 - X70 (X80) EN 10208-2: L290MB - L485MB DIN 17172: StE290TM - StE480.7TM

High-strength fine-grained steels

BÖHLER Standard EN AWS	Welding process	Typical analysis	Typical mechani- cal properties	Ø mm	Approvals	Characteristics and applications	Base metals
Ni 1-IG W3Ni1 ER80S-Ni1 (mod.) ER55S-Ni1 (mod.)	GTAW	C 0.07 Si 0.7 Mn 1.4 Ni 0.9	YS 500 N/mm ² TS 600 N/mm ² EL 25% CVN 150 J 90 J...-50 °C	1.6 2.0 2.4 3.0 3.2	-	Ni-alloyed GTAW welding rod for high-quality weld joints of e.g. pipelines in the offshore industry. Excellent toughness characteristics down to -50 °C:	High-strength steels to S500N Pipe steels: L290MB - L485MB, API Spec. 5 L: X52, X56, X60, X65,
2.5 Ni-IG W2Ni2 (rod) W 46 8 W2Ni2 ER80S-Ni2 ER55S-Ni2 G2Ni2 (wire) G 46 8 M G2Ni2 G 46 6 C G2Ni2 ER80S-Ni2 ER55S-Ni2	GTAW GMAW	C 0.08 Si 0.6 Mn 1.0 Ni 2.4	YS 510 N/mm ² TS 600 N/mm ² EL 26% CVN 280 J ≥ 47 J...-80 °C	2.0 2.4 3.0	TÜV-D, TÜV-A, BV, GL, Statoil, CE, SEPROZ	GTAW welding rod and GMAW wire electrode, 2.5% Ni-alloyed for high-strength weld joints of cold-resistant, fine-grained constructional steels and nickel-alloy steels of e.g. storage tanks and pipeline systems for use at low temperatures. The weld metal features especially good cryogenic toughness down to -80 °C and resistance to ageing. The GMAW wire electrode exhibits very good welding and flow behaviour as well as excellent feeding characteristics, high productivity and is also suitable for use in robotic welding.	Cold-resistant constructional and Ni-steels, cold-resistant special shipbuilding steels 12Ni14, 14Ni6, 13MnNi6-3, G12Ni14, S255N - S460N, S255NH - S460NH, S255NL - S460NL, S255NL1 - S460NL1 ASTM A633 Gr. E, A572 Gr. 65, A203 Gr. D, A333 a., A334 Gr. 3, A350 Gr. LF3
NiMo 1-IG G 55 6 M Mn3Ni1Mo G 55 4 C Mn3Ni1Mo ER90S-G ER62S-G	GTAW GMAW	C 0.08 Si 0.6 Mn 1.8 Ni 0.9 Mo 0.3	YS 620 N/mm ² TS 700 N/mm ² EL 23% CVN 140 J ≥ 47 J...-60 °C (80% Ar/20% CO ₂) YS 590 N/mm ² TS 680 N/mm ² EL 22% CVN 120 J ≥ 47 J...-40 °C (100% CO ₂)	(0.9) 1.0 1.2	DB, ÖBB, GL, SEPROZ, CE	Copper-coated wire electrode and GTAW rod for welding of high-strength, quenched and tempered fine-grained constructional steels. Due to the precise addition of micro-alloying elements, the BÖHLER NiMo1-IG wire results in a weld metal with excellent ductility and high crack resistance. Good cryogenic toughness down to -60 °C, low hydrogen content, best feedability and good copper bonding as well as low overall copper content are other features of this wire. For joint welding in steel construction, tank manufacture, pipeline and machine construction. The chemical composition meets the NORSOK regulations regarding Ni-content for water injection systems.	Pipe steels and fine-grained constructional steels, quenched and tempered fine-grained steels S380N - S500N, S380NL - S500NL, S500NC - S550NC, N-A-XTRA 56-70, BHV 70, PAS 600, HSM 600, 20MnMoNi5-5 ASTM A517 Gr. A, B, C, E, F, H, J, K, M, P, A225 Gr. C, A633 Gr. E, A572 Gr. 65 API Spec. 5L: X70, X80
NiCrMo 2.5-IG G 69 6 M Mn3Ni2.5CrMo G 69 4 C Mn3Ni2.5CrMo ER110S-G ER76S-G	GTAW GMAW	C 0.08 Si 0.6 Mn 1.4 Cr 0.3 Ni 2.5 Mo 0.4	YS 810 N/mm ² TS 910 N/mm ² EL 18% CVN 120 J ≥ 47 J...-60 °C (80% Ar/20% CO ₂) YS 780 N/mm ² TS 890 N/mm ² EL 17% CVN 70 J ≥ 47 J...-40 °C (100% CO ₂)	1.0 1.2	DB, ÖBB, ABS, BV, DNV, GL, LR, SEPROZ, CE	Copper-coated wire electrode and GTAW rod for joint welding of quenched and tempered fine-grained constructional steels demanding greater cryogenic toughness (to -60 °C depending on the inert gas), e.g. in shipbuilding for the manufacture of LPG tankers.	Quenched and tempered fine-grained constructional steels demanding great cryogenic toughness N-A-XTRA 65-70, USS-T 1 etc.
Wire: 3 NiCrMo 2.5-UP S 3Ni2.5CrMo EM4 (mod.) Flux: BB 24 SA FB 1 65 DC H5	SAW	C 0.06 Si 0.3 Mn 1.5 Cr 0.5 Ni 2.2 Mo 0.5	YS 740 N/mm ² TS 850 N/mm ² EL 20% CVN 120 J ≥ 47 J...-60 °C	3.0 4.0	-	Wire/flux combination particularly suitable for high-strength, fine-grained constructional steels. The combination exhibits good cryogenic toughness. The weld metal is suitable for subsequent quenching and tempering. The flux reacts metallurgically Mn-neutral. The weld metal exhibits good toughness properties at low temperatures down to -60 °C. A clean seam and good wetting characteristics as well as good slag removability and the low hydrogen content of the weld metal (≤ 5 ml/100 g) are other advantages of this wire/flux combination. It is especially suitable for multi-pass welds on thick-walled sheets. Depending on the starting temperature, yield strengths of approximately 470-600 N/mm ² can be achieved.	

High-strength fine-grained steels

BÖHLER Standard EN AWS	Welding process	Typical analysis	Typical mechani- cal properties	Ø mm	Approvals	Characteristics and applications	Base metals
X 70-IG G 69 5 M Mn3Ni1CrMo ER110S-G ER76S-G	GMAW	C 0.1 Si 0.6 Mn 1.6 Cr 0.25 Ni 1.3 Mo 0.25 V 0.1	YS 800 N/mm ² TS 900 N/mm ² EL 19% CVN 190 J ≥ 47 J...-50 °C	1.0 1.2	TÜV-D, TÜV-A, DB, ÖBB, ABS, BV, DNV, GL, LR, RMR, SEPROZ, CE	Copper-coated wire for welding of high-strength, quenched and tempered fine-grained constructional steels with a minimum yield strength of 690 N/mm ² . Also suitable for GTAW hot wire welding for e.g. penstocks. Due to the precise addition of micro-alloying elements, the BÖHLER X 70-IG wire features excellent ductility and crack resistance in spite of its high strength. Good cryogenic CVN to -50 °C.	High-strength fine-grained steels S690Q, L690M, N-A-XTRA 70, USS-T1, BH 70 V, HY 100, Pass 700, HSM 700 ASTM A514 Gr. F
X 90-IG G 89 6 M Mn4Ni2CrMo ER120S-G ER83S-G	GMAW	C 0.1 Si 0.8 Mn 1.8 Cr 0.35 Ni 2.25 Mo 0.6	YS 915 N/mm ² TS 960 N/mm ² EL 20% CVN 130 J ≥ 47 J...-60 °C (80% Ar/20% CO ₂)	1.0 1.2	TÜV-D, TÜV-A, DB, ÖBB, SEPROZ, GL, CE	Copper-coated wire for welding of high-strength, quenched and tempered fine-grained constructional steels with a minimum yield strength of 890 N/mm ² . Due to the precise addition of micro-alloying elements, the BÖHLER X 90-IG wire features excellent ductility and crack resistance in spite of its high strength. Good cryogenic CVN to -60 °C.	High-strength fine-grained steels S890Q, XABO 90, OX 1002
EMK 7 G4Si1 (wire) G 46 4 M G4Si1 G 46 4 C G4Si1 ER70S-6 ER48S-6	GMAW	C 0.11 Si 1.0 Mn 1.8	YS 470 N/mm ² TS 600 N/mm ² EL 26% CVN 120 J ≥ 47 J...-40 °C (80% Ar/20% CO ₂) PWHT 600 °C/2 h YS 470 N/mm ² TS 530 N/mm ² EL 27% CVN 190 J (80% Ar/20% CO ₂)	1.0 1.2	TÜV-D, DB, ÖBB, CE	Solid wire electrode for welding construction parts with high strength requirements. Smooth and stable arc with minimal spatter loss, also good weldability in short arc ranges and for positional welding. Use small wire diameters for vertical down seams.	Steels up to a yield strength of 460 N/mm ² (67 ksi) S235J2G3 - S355J2G3, E360, P235T1-P355T1, P235G1TH, P255G1TH, P235GH, P265GH, P295GH, P310GH, P255NH, S235JRS1 - S235J4S, S355G1S - S355G3S, S255N - S460N, P255NH- P460NH, GE200-GE260
EMK 8 G 46 4 M G4Si1 G 46 4 C G4Si1 ER70S-6 ER48S-6	GMAW	C 0.07 Si 1.0 Mn 1.7	YS 470 N/mm ² TS 600 N/mm ² EL 26% CVN 120 J 50 J...-40 °C (80% Ar/20% CO ₂) PWHT 600 °C/2 h YS 470 N/mm ² TS 530 N/mm ² EL 27% CVN 190 J (80% Ar/20% CO ₂)	0.8 1.0 1.2	TÜV-D, DB, ÖBB, ABS, DNV, GL, LR, SEPROZ, CE	Solid wire electrode with universal application in tank, boiler and building construction. Practically spatter-free material transfer using mix gases or CO ₂ . Optimally suited for welding thick-walled components due to high current carrying capacity. Use small wire diameters for vertical down seams. This solid wire electrode is also available in the TIME version and is especially suited for robotic welding.	ASTM A27 & A36 Gr. all; A106 Gr. A, B A214; A242 Gr. 1-5; A266 Gr. 1, 2, 4; A283 Gr. A, B, C, D; A285 Gr. A, B, C; A299 Gr. A, B; A328; A366; A515 Gr. 60, 65, 70; A516 Gr. 55; A556 Gr. B2A; A570 Gr. 30, 33, 36, 40, 45; A572 Gr. 42, 50; A606 Gr. all; A607 Gr. 45; A656 Gr. 50, 60; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A841; A851 Gr. 1, 2; A935 Gr. 45; A936 Gr. 50
Ti 60-FD T 50 6 1Ni P M 1 H5 E81T1-Ni1MH8	FCAW	C 0.06 Si 0.45 Mn 1.2 Ni 0.85	YS > 500 N/mm ² TS > 560 N/mm ² EL > 19% CVN > 120 J > 47 J...-60 °C (80% Ar/20% CO ₂)	1.2 1.6	LR	Rutile flux cored wire electrodes with fast freezing slag for welding cold-resistant steels. Excellent welding properties in all positions. Excellent mechanical properties, easy slag removal, low spatter loss, smooth, finely rippled bead surface, high x-ray safety, dent-free seam joints. The product performs to the highest productivity with significant time and cost savings when used for positional welding. For high-quality welds in shipbuilding, for offshore applications and construction with high strength requirements as well as for low temperature applications to -60 °C.	Standard constructional steels, pipe and boiler steels, cold-resistant fine-grained constructional steels and special grades. E295, E335, S355J2G3, C35 - C45, L210 - L360NB, L210MB - L360MB, P310GH, S380N - S460N, P380NHP460NH, S380NL - S460NL, S380NL1 - S460NL2, GE260-GE300 Shipbuilding steels with yield strengths up to 460 N/mm ² , including cold-resistant types ASTM A516 Gr. 65, A572 Gr. 55, 60, 65, A633 Gr. E, A612, A618 Gr. I, A537 Gr. 1-3.

High-strength fine-grained steels

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechanical properties	Ø mm	Approvals	Characteristics and applications	Base metals
Wire: 3 NiMo 1-UP S 3Ni1Mo EF3 (mod.) Flux: BB 24 SA FB 1 65 DC H5	SAW	C 0.09 Si 0.25 Mn 1.65 Ni 0.9 Mo 0.55	YS 580 N/mm ² TS 650 N/mm ² EL 21% CVN 180 J 60 J...-40 °C	4.0	TÜV-D Wire: TÜV-D, CE	Wire/flux combination for the welding of high-strength and low temperature resistant steels. The flux reacts metallurgically Mn-neutral. The wire/flux combination results in very good low temperature values down to -40 °C. Excellent slag removability, smooth weld seams, good wetting characteristics and extremely low hydrogen content (≤ 5 ml/100 g) are additional quality features. This combination is well suited for multi-pass welds on thick-walled components.	Pipe steels and fine-grained constructional steels, quenched and tempered fine-grained steels S380N - S500N, S380NL - S500NL, S500NC - S550NC, N-A-XTRA 56-70, BHV 70, PAS 600, HSM 600, 20MnMoNi5-5 ASTM A517 Gr. A, B, C, E, F, H, J, K, M, P, A225 Gr. C, A633 Gr. E, A572 Gr. 65 API Spec. 5L: X70, X80
Wire: Ni 2-UP S2Ni2 ENi2 Flux: BB 24 SA FB 1 65 DC H5	SAW	C 0.07 Si 0.25 Mn 1.15 Ni 2.2	YS ≥ 480 N/mm ² TS ≥ 580 N/mm ² EL ≥ 24% CVN ≥ 130 J ≥ 47 J...-60 °C	3.0	Wire: TÜV-D, TÜV-A, KTA 1408.1, DB, ÖBB, SEPROZ, CE	Wire/flux combination for the joint welding of cold-resistant constructional and nickel-alloy steels. The weld metal (untreated and stress-relieved) features excellent cryogenic toughness down to -60 °C and resistance to ageing. A clean seam and good wetting characteristics as well as good slag removability and the low hydrogen content of the weld metal (≤ 5 ml/100 g) are additional features of this combination. It is especially suitable for multi-pass welds on thick-walled sheets. The flux is notable for reacting metallurgically Mn-neutral.	Cold-resistant constructional and Ni-steels, cold-resistant special shipbuilding steels 12Ni14, 14Ni6, 13MnNi6-3, G12Ni14, S255N - S460N, S255NH - S460NH, S255NL - S460NL, S255NL1 - S460NL1 ASTM A633 Gr. E, A572 Gr. 65, A203 Gr. D, A333 a., A334 Gr. 3, A350 Gr. LF3

Welding guidelines

General information on high-strength fine-grained construction steels

With non-alloy constructional steels, the strength is primarily achieved by raising the carbon content, whereby the limit for good weldability is reached earlier.

The requirement for using lighter steel sections, yet with the same reliable weldability, led to the development of high-strength, weldable, fine-grained constructional steels.

Higher strengths are achieved through special alloying techniques and heat treatments. Fine-grained constructional steels can be subdivided according to their manufacture into three main groups:

- **Normalized fine-grained constructional steels**
- **Quenched and tempered fine-grained constructional steels**
- **Thermomechanically treated fine-grained constructional steels**

While the properties of the first two steel groups can be achieved through a heat treatment performed after rolling, a specific heat treatment is incorporated into the rolling procedure for the thermomechanically treated steels. This allows high-strength steels to be manufactured above all with a very low carbon content as well as minimal proportions of other alloying elements.

This ensures high strength properties despite a low alloy content and excellent toughness at low temperatures combined with very good weldability.

Welding technology for high-strength fine-grained constructional steels

In general, it should be considered that with increasing minimum yield strength values of the steels and with higher product wall thicknesses, greater care must be taken in the processing. An essential requirement for successful application of the high-strength, fine-grained constructional steels is a weldable and appropriately stress-bearing construction.

Appropriate temperature control should be used.

Based on experience, this is most easily achieved with manual arc welding, inert gas welding or sub-arc welding. For a high-strength weld joint, criteria for maintaining the mechanical properties or for avoiding cold cracks are primarily to be considered.

In the interest of preventing cold cracking, only those welding consumables should be used which, as compared to the base metal, do not result in an unnecessarily high strength and do have a sufficiently low hydrogen content in the weld metal.

Crack resistance

The cold-cracking behaviour of weld joints is determined by the chemical composition of the base metal and the weld metal, the product thickness, the hydrogen content of the weld metal, the heat input during welding and the residual stress of the weld construction.

A very effective measure for avoiding cold cracking is preheating. For joint and tack welding under normal conditions, preheating temperatures between 50 – 250 °C are used. To determine the preheating temperature of fine-grained constructional steels, the carbon equivalent can be employed.

Carbon equivalent – CET (SEW 088)

The reference values of the web thickness for preheating before welding under normal conditions, depending on the carbon equivalent of the base metal.

Carbon equivalent CET %	Web thickness mm
0.18	60
0.22	50
0.26	40
0.31	30
0.34	20
0.38	12
0.40	8

If the web thicknesses in the table above are exceeded for a particular CET value, preheating is necessary. The preheated area should be approximately 100 mm wide on either side of the seam. If the component temperature lies under +5 °C, preheating should always be performed. In addition to the CET value, the preheating temperature also depends on the plate thickness, the hydrogen content and the heat input and should be specified by the steel manufacturer.

Welding technology for high-strength fine-grained constructional steels

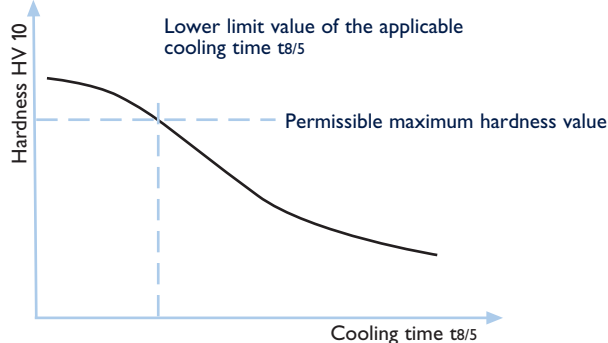
Cooling time $t_{8/5}$

Of decisive importance for the mechanical properties of a weld joint is the temperature-time profile during welding.

This is particularly influenced by the component thickness, the seam shape, the heat input and preheating temperature as well as the layer sequence. In identifying the temperature-over-time profile during welding, one generally selects the cooling time $t_{8/5}$. This is the time during which the cooling of a weld bead traverses the temperature range from 800 to 500 °C.

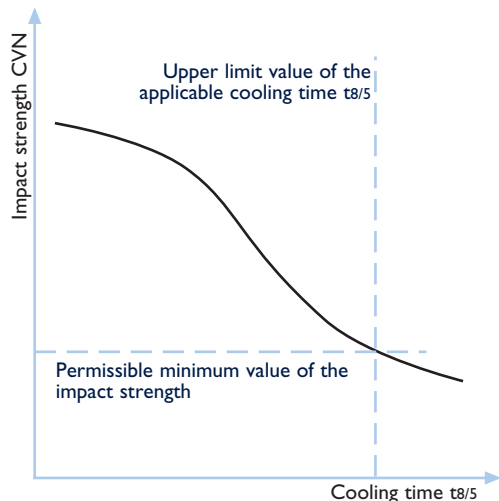
This cooling time is of decisive importance for the resulting joint and its properties (hardness, strength and toughness) in the heat-affected zone (HAZ) of the weld connection. The hardness in the HAZ decreases with increasing cooling time $t_{8/5}$ – see Figure 1.

Figure 1



Increasing the values of the cooling time $t_{8/5}$ results in reduced impact strength in the HAZ – see Figure 2.

Figure 2



To maintain the required mechanical values of a high-strength weld joint, welding conditions must be selected that neither exceed nor fall short of the critical cooling times. Basic data in regard to the upper and lower limits of the cooling time $t_{8/5}$ can be obtained from the steel manufacturer.

Heat input

An essential criteria in the welding of high-strength, fine-grained constructional steels is the heat input, which in particular has a considerable influence on the cooling time $t_{8/5}$. In order to remain within the upper and lower limits of the required cooling time $t_{8/5}$, the heat input should be correspondingly adapted to these specifications.

The heat input is the thermal energy per bead length unit during welding and is calculated from the formula:

$$W = K_2 \cdot E \text{ (KJ/cm)}$$

K_2 = thermal efficiency

Submerged arc wire welding = 1,0

Manual metal-arc welding = 0,8

MIG/MAG welding = 0,8

E = energy input per unit length

The energy delivered is defined as the electrical energy applied per bead length unit during welding.

$$E = \frac{I \cdot U \cdot t}{l \cdot 100} \text{ (KJ/cm)}$$

E = energy input per unit length

I = the amperage A

U = the arc voltage in V

t = the welding time in s

l = the bead length in cm

Dissimilar joints

High strength – non-alloy (e.g. S690 with S275)

Welding consumable is usually matched to the softer base metal. In the case of greatly differing strength properties of the partner material, a welding consumable with a strength lying between the values of the two materials should be considered.

High strength – high strength (e.g. S460 with S690)

Welding consumables are usually matched to the softer base metal. In the case of greatly differing strength properties of the partner material, a welding consumable with a strength lying between the values of the two materials should be considered. If there are special requirements, e.g. in regard to low temperature toughness, these should also be considered when selecting the welding consumable.

Multi-purpose electrodes

BÖHLER Standard EN AWS	Welding process	Typical analysis	Typical mechani- cal properties	Ø mm	Approvals	Characteristics and applications	Base metals
FOX CEL E 38 3 C 21 E 43 10 A U E6010 E4310	SMAW	C 0.12 Si 0.14 Mn 0.5	YS 450 N/mm ² TS 520 N/mm ² EL 26% CVN 110 J 45 J...-40 °C	2.5 3.2 4.0 5.0	TÜV-D, TÜV-A, DNV, Statoil, SEPROZ, PDO, VNIIST, GdF, CE	Cellulosic covered electrode for vertical down welding of the root, hot passes, filler and cap passes on large pipelines. Particularly suitable for welding of root passes. Great economy as compared to vertical up welding, also in combination with basic vertical down electrodes. FOX CEL features a very intensive, fine-droplet depositing behaviour, as well as good toughness characteristics. Impervious to weathering, high protection against the formation of root notches. HIC and SSC resistance tested acc. to NACE TM 02-84 or TM 01-77.	S235JR, S275JR, S235J2G3, S275J2G3, S355J2G3, P235GH, P265GH, P355T1, P235T2 - P355T2, L210NB - L415NB, L290MB - L415MB, P235G1TH, P255G1TH Root passes to L555NB, L555MB API Spec. 5 L: A, B, X 42, X 46, X 52, X 56, Root passes to X 80
FOX CEL+ E 38 2 C 21 E 43 10 A E6010 E4310	SMAW	C 0.17 Si 0.15 Mn 0.6	YS 450 N/mm ² TS 520 N/mm ² EL 25% CVN 105 J ≥ 27 J...-30 °C	2.5 3.2 4.0	-	Cellulosic covered electrode for vertical down welding in pipeline construction as well as in pipeline construction generally. Especially suitable for root pass welding (up and down) using DC positive polarity. Böehler FOX CEL+ enables good gap bridging, good root penetration behaviour due to an intensive, fine-droplet material transfer, high welding speeds as well as protection against root wormhole formation (piping).	S235JR, S275JR, S235J2G3, S275J2G3, S355J2G3, P235GH, P265GH, P355T1, P235T2 - P355T2, L210NB - L415NB, L290MB - L415MB, P235G1TH, P255G1TH Root passes to L555NB, L555MB API Spec. 5 L: A, B, X 42, X 46, X 52, X 56, Root passes to X 80
DMO-IG G MoSi ER70S-A1 (ER80S-G) ER49S-A1 (ER55S-G)	GMAW	C 0.1 Si 0.6 Mn 1.2 Ni 0.5	YS 50 N/mm ² TS 620 N/mm ² EL 25% CVN 150 J ≥ 47 J...-40 °C	0.8 1.0 1.2	TÜV-D, TÜV-A, DB, ÖBB, SEPROZ, CE	Solid wire electrode, copper-coated for welding in the construction of boilers, pressure tanks, pipelines, cranes and steel. High-quality, very tough and crack-resistant weld metal, resistant to ageing. Impervious to cold down to -40 °C. Approved for long-term use for service temperatures to +550 °C. Excellent gliding ability and feeding characteristics of the wire electrode. Good copper bonding with low overall copper content. Very good welding and flow behaviour.	Heat-resistant steels and steel cast of similar types, ageing-resistant and resistant to caustic cracking Steels 16Mo3, S355J2G3, L320 - L415NB, L320 MB - L415MB, P255G1TH, P235GH, P265GH, P295GH, P310GH, P255NH, 17MnMoV6-4, 22NiMoCr4-7, 20MnMoNi5-5, 15NiCuMoNb5, 20MnMoNi4-5, GE240 - GE300, 22Mo4, S255N - S460N, P255NH - P460NH ASTM A335 Gr. P1; A161-94 Gr. T1 A A182M Gr. F1; A204M Gr. A, B, C; A250M Gr. T1; A217 Gr. WC1
FOX BVD 85 E 46 5 1Ni B 45 E 55 48-G A E8018-G E8045-P2 E5518-G E5545-P2	SMAW	C 0.05 Si 0.4 Mn 1.1 Ni 0.9	YS 510 N/mm ² TS 560 N/mm ² EL 27% CVN 170 J ≥ 47 J...-50 °C	3.2 4.0 5.0	TÜV-D, GdF, SEPROZ, CE	Basic covered vertical down electrode for high-quality weld connections on large pipelines as well as in building construction. In pipeline construction, suitable for filler and cap welding. Especially crack-resistant weld metal with excellent toughness down to -50 °C. Very low hydrogen content in the weld metal. Results in a 80% to 100% increase in deposition rate as compared to vertical up welding. Due to its good welding characteristics, this electrode allows easy processing even under difficult welding conditions. Specially treated igniting ends provide the highest protection against start porosity. HIC and SSC resistance tested acc. to NACE TM 02-84 or TM 01-77.	S235J2G3 - S355J2G3, L290NB - L450NB, L290MB - L450MB, P235GH - P295GH API Spec. 5 L: A, B, X 42, X46, X 52, X 56, X 60, X 65

Multi-purpose electrodes

BÖHLER STANDARD EN AWS	Welding process	Typical analysis %	Typical mechani- cal properties	Ø mm	Approvals	Characteristics and applications	Base metals
FOX BVD 90 E 55 5 Z2Ni B 45 E 9018-G E9045-P2 E6218-G E6245-P2	SMAW	C 0.05 Si 0.3 Mn 1.2 Ni 2.2	YS 600 N/mm ² TS 650 N/mm ² EL 27% CVN 170 J ≥ 47 J...-50 °C	3.2 4.0 5.0	TÜV-D, GdF, Statoil, SEPROZ, CE, NAKS, VNIIST	Basic covered vertical down electrode for high-quality weld joints on large pipelines as well as in building construction. In pipeline construction, suitable for filler and cap welding. Especially crack-resistant weld metal with excellent toughness. Due to its good welding characteristics, this electrode allows easy processing even under difficult welding conditions. Specially treated igniting ends provide the highest protection against start porosity. Very low hydrogen content in the weld metal. Results in a 80% to 100% increase in deposition rate as compared to vertical up welding.	EN: L485MB, L555MB API Spec. 5 L: X 70, X 80

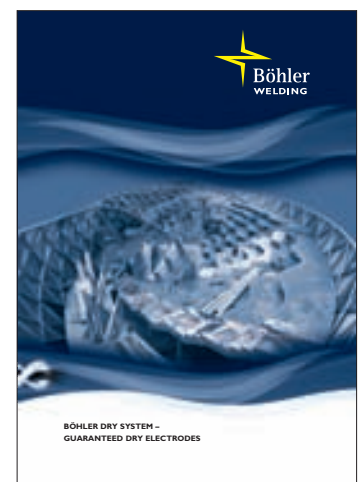
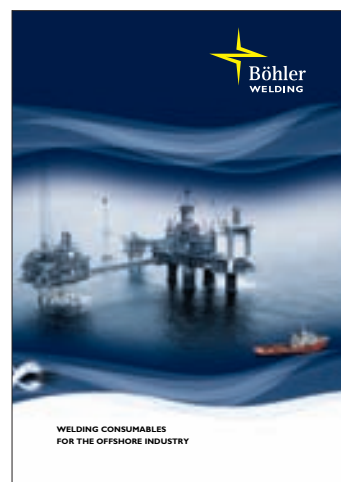
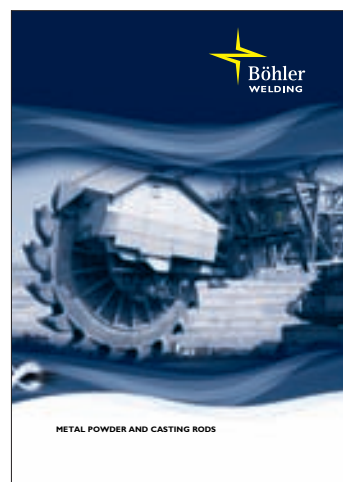
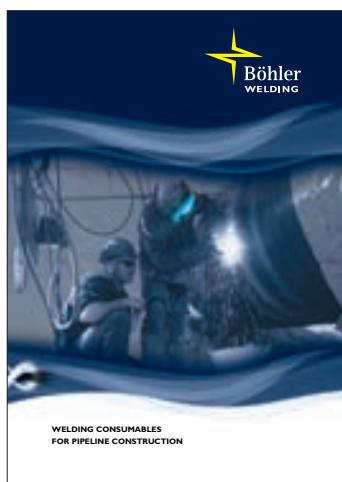
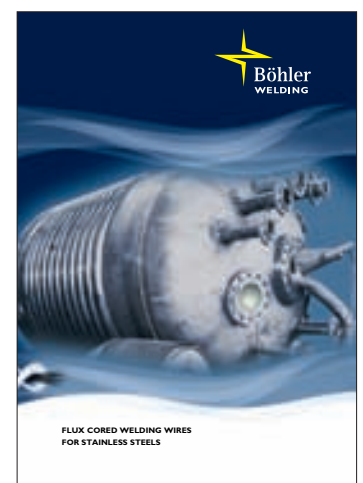
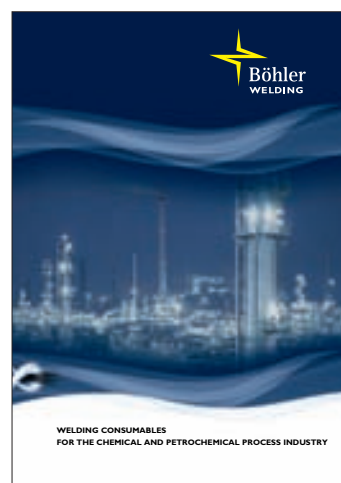
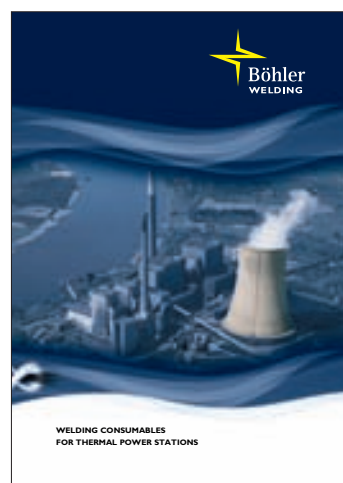
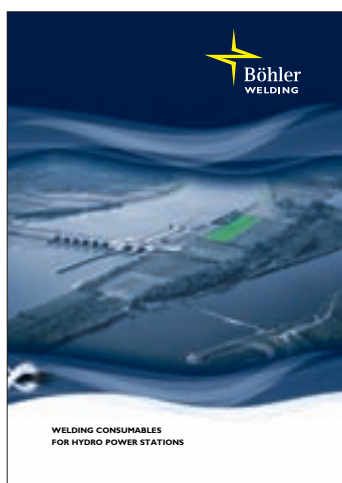
Cutting / gouging electrode

BÖHLER Standard EN AWS	Welding process	Typical analysis %	Typical mechani- cal properties	Ø mm	Approvals	Characteristics and applications	Base metals
FOX NUT	SMAW			3.2 4.0	-	Special electrode for gouging of various materials without oxygen. Fast cutting speed, can be used in all positions. Suitable for chamfering of edges, for furrow and groove cutting as well as joint-groove cutting of defective welds and the opening of cracks prior to welding.	

Additional brochures

Additional brochures on welding consumables made by BÖHLER WELDING for selected industries are available in several language versions.

Further information can be obtained from BÖHLER WELDING sales partners Partners or on the world wide web under www.boehler-welding.com



The specifications in regard to the type and application of our products are only for the user's information. The data specified for the mechanical properties always refer to the weld metal alone under observance of the applicable standards. In the weld joint, the weld metal properties are influenced, among other factors, by the base metal, the welding position and the welding parameters. A guarantee of suitability for a certain type of application requires an explicit written agreement in each individual case.

Subject to modifications.

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