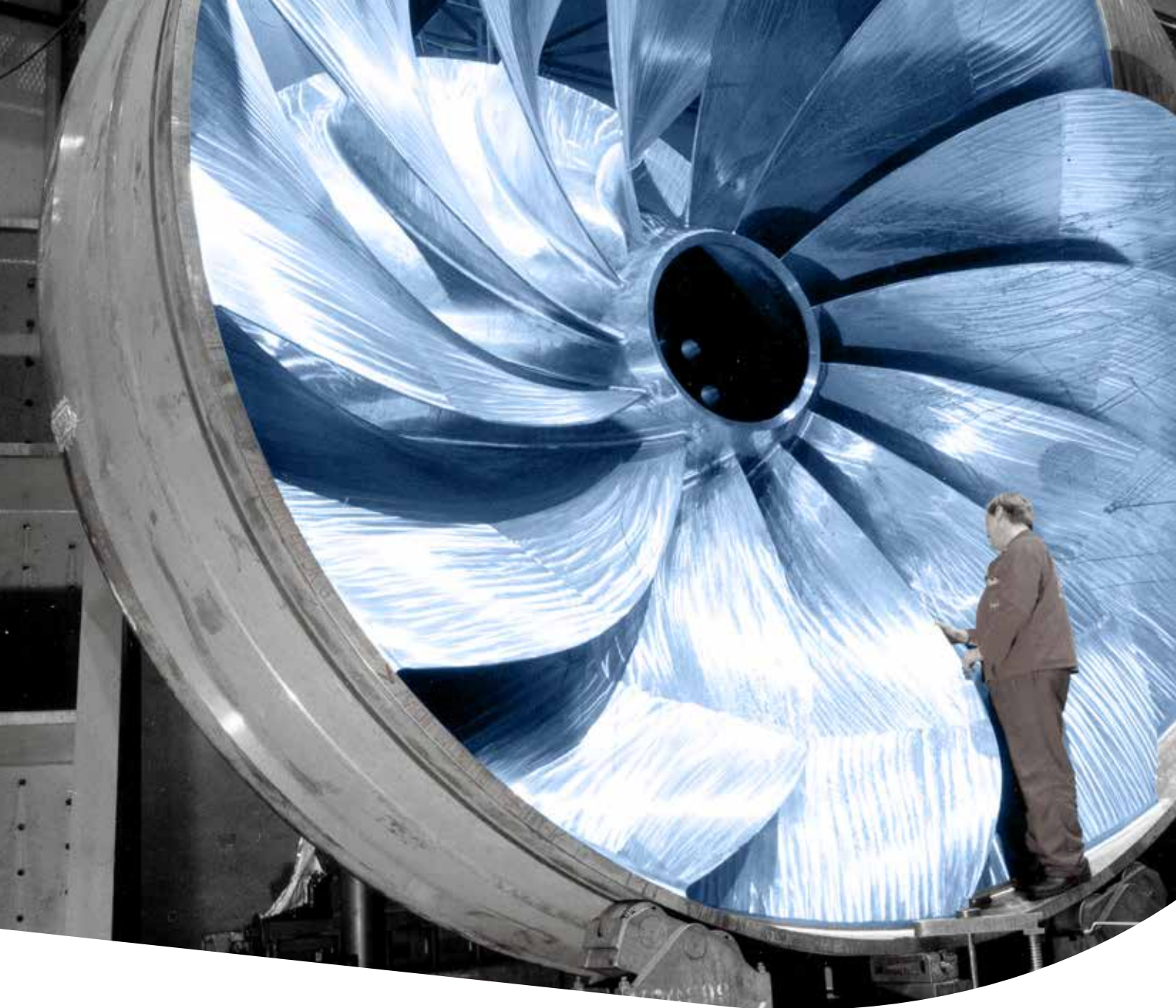


Lasting Connections

# Welding Consumables for the Hydro Power Industry





## Lasting Connections

As a pioneer in welding consumables for the joining of metals, Böhler Welding offers a globally unique and customer-focused portfolio for lasting connections. The extensive range of approximately 2.000 products is continuously aligned with latest industry specifications and customer requirements, certified by leading approval authorities, and thereby accredited for even the most challenging applications.

Böhler Welding provides its customers and partners the highest level of joining expertise. With a large number of joining application engineers with the deepest metallurgical and joining process know-how, Böhler Welding ensures that the branded products are used to the fullest satisfaction of their customers. All Böhler Welding products are constantly controlled by the certified voestalpine Böhler Welding laboratories.



# Specialized Welding Consumables for the Hydro Power Industry

Since decades, Böhler Welding has been a trusted partner and supplier of welding consumables to major fabricators within the hydro power industry. The product range comprises specially designed filler metals for typical hydro power welding applications such as:

- Construction and refurbishment of Francis, Kaplan and Pelton turbines in austenitic or soft martensitic stainless steel
- The repair of casting defects
- The (mechanized) joining of penstocks in normal or high strength steel

The range of filler metals covers all commonly applied welding processes; SMAW, GTAW, GMAW, FCAW and SAW. They are all designed for the productive deposition of high quality welds, meeting the most stringent mechanical and safety requirements in both prefabrication and on-site assembly, for safe and trouble-free plant operation.

Highlights in the range are very productive flux and metal-cored wires for 13%Cr / 4%Ni alloyed soft martensitic stainless steel. Their very low weld metal hydrogen content ensures the best possible protection against the formation of hydrogen cracks while superior CVN impact toughness after commonly applied heat treatments provides a convenient safety margin for high service payload. Applied without heat treatment - e.g. for single layer repair welds - toughness properties are still sufficient. They are easy to operate in all welding positions with minimum spatter, flat and smooth bead profiles with excellent wetting and safe weld penetration.



Böhler Welding consumables are also available in moisture resistant and hermetically sealed packs.



# Selection Guide

## Welding processes

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$R_{p0.2} \geq 690 \text{ MPa}$	BÖHLER FOX V 85	10	BÖHLER Ti 80 T-FD	10	BÖHLER NiCrMo 2.5-IG	11	BÖHLER X 70-IG BÖHLER alform® 700-IG BÖHLER alform® 700-MC BÖHLER X 70-MC	11 12 12 13	Union S 3 NiMoCr / UV422TT LH	13
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## High strength steels $R_{p0.2} > 485 \text{ MPa}$

### BÖHLER FOX EV 65

EN ISO 18275-A: E 55 6 1NiMo B 4 2 H5

AWS A5.5: E8018-GH4R

Welding process: SMAW

#### Characteristics and applications

Basic electrode with high ductility and cold-cracking resistance, for high-strength fine-grained steels. Ductile down to  $-60^\circ\text{C}$ . Resistant to ageing. Easy to handle in all positions, except vertical-down.

Very low hydrogen content (acc. to AWS condition HD  $<4 \text{ ml/100 g}$  weld metal).

BÖHLER FOX EV 65 can be used in sour gas applications (HIC-Test acc. NACE TM-02-84). Test values for SSC-test are available too.

#### Base materials

Constructional steels, pipe- and vessel steels, cryogenic fine-grained steels and special grades

S460N, S460M, S460NL, S460ML, S460Q-S550Q, S460QL-S550QL, S460QL1-S550QL1, P460N, P460NH, P460NL1, P460NL2, L415NB, L415MB-L555MB, L415QB-L555QB,

alform 500 M, alform 550 M, aldur 500 Q, aldur 500 QL, aldur 500 QL1, aldur 550 Q, aldur 550 QL, aldur 550 QL1, GE300, 20MnMoNi4-5, 15NiCuMoNb5-6-4

ASTM A 572 Gr. 65; A 633 Gr. E; A 738 Gr. A; A 852; API 5 L X60, X65, X70, X80, X60Q, X65Q, X70Q, X80Q

#### Typical chemical analysis all weld metal (%)

C	0.06	Ni	0.80
Si	0.30	Mo	0.35
Mn	1.20		

#### Typical mechanical properties all weld metal

$R_{p0.2}$	600 MPa	ISO-V	+20 °C: 180 J
$R_m$	650 MPa		-60 °C: 80 J
$A_5$	25 %		

#### Ø / mm

2.5	3.2	4.0	4.8	5.0
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#### Approvals

TÜV, VG 95132, BV, RMR, ABS, CE

### BÖHLER Ti 60-FD

EN ISO 17632-A: T 50 6 1Ni P M 1 H5

AWS A5.36: E81T1-M21A8-Ni1-H4

Welding process: FCAW

#### Characteristics and applications

Rutile flux cored wire with fast freezing slag for welding low-temperature steels. Outstanding welding properties in all positions. Exceptional mechanical strength and good slag detachability, low spatter, smooth, finely rippled seam surface, notch-free weld toes. Out-of-position welding can be carried out with increased welding current, and therefore very economically with increased deposition rates. For high-quality welding in shipbuilding, for offshore applications and steel structures with high strength requirements, as well as for low-temperature applications down to  $-60^\circ\text{C}$ .

BÖHLER Ti 60-FD can be used in sour gas applications (HIC-Test acc. to NACE TM-02-84). Test values for SSC-test are available too. The wire is CTOD tested.

#### Base materials

General structural steels, pipe and boiler steels, cryogenic fine-grained structural steels and special qualities.

S355JR, S355J0, S355J2, S450J0, S355N-S460N, S355NL-S460NL, S355M-S460M, S355ML-S460ML, S460Q, S500Q, S460QL, S500QL, S460QL1, S500QL1, P355GH, P355NH, P420NH, P460NH, P355N-P460N, P355NH-P460NH, P355NL1-P460NL1, P355NL2-P460NL2, L245NB-L415NB, L245MBL485MB, L360QB-L485QB, aldur 500Q, aldur 500QL, aldur 500QL1

ASTM A 350 Gr. LF2; A 516 Gr. 65, 70; A 572 Gr. 42, 50, 60, 65; A 573 Gr. 70; A 588 Gr. B, C, K; A 633 Gr. A, C, D, E; A 662 Gr. B, C; A 678 Gr. B; A 707 Gr. L2, L3; A 841 Gr. A, B, C; API 5 L X42, X52, X60, X65, X70, X52Q, X60Q, X65Q, X70Q

#### Typical chemical analysis all weld metal (%)

C	0.06	Mn	1.30
Si	0.45	Ni	0.90

#### Typical mechanical properties all weld metal

$R_{p0.2}$	530 MPa	ISO-V	+20 °C: 140 J
$R_m$	590 MPa		-20 °C: 120 J
$A_5$	27 %		-40 °C: 100 J
			-60 °C: 60 J

#### Ø / mm

1.2			
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#### Approvals

TÜV, DB, ABS, LR, BV, CE, DNV GL

## High strength steels $R_{p0.2} > 485 \text{ MPa}$

### BÖHLER NiMo 1-IG

EN ISO 16834-A: W 55 611 Mn3Ni1Mo

AWS A5.28: ER90S-G

Welding process: GTAW

#### Characteristics and applications

GTAW rod for high strength quenched and tempered fine-grained constructional steels. The rod is suited for joint welding in boiler, pressure vessel, pipeline and crane construction as well as in structural steel engineering. Due to the precise addition of micro alloying elements NiMo 1-IG rod features excellent ductility and cracking resistance in spite of its high strength. Good cryogenic impact energy down to  $-60^\circ\text{C}$ , low hydrogen contents in the weld deposit are advantages of this rod.

#### Base materials

Pipe steels and fine grained steels, quenched and tempered fine-grained steels

S460N, S460M, S460NL, S460ML, S460Q-S555Q, S460QL-S550QL, S460QL1-S550QL1, P460N, P460NH, P460NL1, P460NL2, L415NB, L415MB-L555MB, L415QB-L555QB, alform 500 M, alform 550 M, aldur 500 Q, aldur 500 QL, aldur 500 QL1, aldur 550 Q, aldur 550 QL, aldur 550 QL1, 20MnMoNi4-5, 15NiCuMoNb5-6-4

ASTM A 572 Gr. 65; A 633 Gr. E; A 738 Gr. A; A 852; API 5 L X60, X65, X70, X80, X60Q, X65Q, X70Q, X80Q

#### Typical chemical analysis all weld metal (%)

C	0.08	Ni	0.90
Si	0.60	Mo	0.30
Mn	1.80		

#### Typical mechanical properties all weld metal

$R_{p0.2}$	620 MPa	ISO-V	+20 °C: 140 J
$R_m$	700 MPa		-40 °C: 110 J
$A_5$	23 %		-60 °C: $\geq 47 \text{ J}$

#### Ø / mm

2.4			
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#### Approvals

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### BÖHLER NiMo 1-IG

EN ISO 16834-A: G 55 6 M21 Mn3Ni1Mo

AWS A5.28: ER90S-G

Welding process: GMAW

#### Characteristics and applications

Copper coated GMAW wire for high strength, quenched and tempered fine-grained constructional steels. The wire is suited for joint welding in boiler, pressure vessel, pipeline, and crane construction as well as in structural steel engineering. The typical composition of the wire fulfils the requirements of the NORSOK- regulation for „water injection systems“. Due to the precise addition of micro alloying elements, NiMo 1-IG wire features excellent ductility and cracking resistance in spite of its high strength. Good cryogenic impact energy down to  $-60^\circ\text{C}$ , low hydrogen contents in the weld deposit, best feedability and a low copper content.

#### Base materials

Fine-grained steels and quenched and tempered fine-grained steels

S460N, S460M, S460NL, S460ML, S460Q-S555Q, S460QL-S550QL, S460QL1-S550QL1, 460N, P460NH, P460NL1, P460NL2, L415NB, L415MB-L555MB, L415QB-L555QB, alform 500 M, alform 550 M, aldur 500 Q, aldur 500 QL, aldur 500 QL1, aldur 550 Q, aldur 550 QL, aldur 550 QL1, 20MnMoNi4-5, 15NiCuMoNb5-6-4

ASTM A 572 Gr. 65; A 633 Gr. E; A 738 Gr. A; A 852; API 5 L X60, X65, X70, X80, X60Q, X65Q, X70Q, X80Q

#### Typical chemical analysis all weld metal (%)

C	0.08	Ni	0.90
Si	0.60	Mo	0.30
Mn	1.80		

#### Typical mechanical properties all weld metal

$R_{p0.2}$	620 MPa	ISO-V	+20 °C: 140 J
$R_m$	700 MPa		-40 °C: 110 J
$A_5$	23 %		-60 °C: $\geq 47 \text{ J}$

#### Ø / mm

0.9	1.0	1.2	
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#### Approvals

TÜV, DB, DNV GL, CE, VG 95132

## High strength steels $R_{p0.2} > 485 \text{ MPa}$

### Union S 3 NiMo 1 / UV 421 TT

EN ISO 26304-A: S556FB S 3 NiMo

AWS A5.23: S 55 6 FB S3Ni1MO

Welding process: SAW

#### Characteristics and applications

UV 421 TT is an agglomerated fluoride-basic flux with high basicity and neutral metallurgical behaviour. It is suitable for single (DC) and tandem (DC and AC) welding. Very good slag detachability also for narrow gap welding. Flux can especially be used for multi-pass butt welding of medium tensile steels. Very good impact toughness of weld metal at low temperatures.

Grain size: EN ISO 14174: 3 – 20 (0.3 – 2.0 mm); Tyler: 8 x 48

Basicity (Boniszewski): Mol-% = 3.5 / Weight-% = 2.6

Main constituents in %:  $\text{SiO}_2 + \text{TiO}_2 = 15$  /  $\text{CaO} + \text{MgO} = 35$  /  $\text{Al}_2\text{O}_3 + \text{MnO} = 20$  /  $\text{CaF}_2 = 26$

#### Base materials

Quenched and tempered fine-grained steels

S460N, S460M, S460NL, S460ML, S460Q - S555Q, S460QL1 - S550QL1, P460N, P460NH, P460NL1, P460NL2, L415NB, L415MB - L555MB, L415QB - L555QB, alform 500 M, alform 550 M, aldur 500 Q, aldur 500 QL, aldur 500 QL1, aldur 550 Q, aldur 550 QL, aldur 550 QL 120MnMoNi4-5, 15NiCuMoNb5-6-4

ASTM A572 Gr. 65; A633 Gr. E; A738 Gr. A; A852; API 5 L X60, X65, X70, X80, X60Q, X65Q, X70Q, X80Q

#### Typical chemical analysis all weld metal (%)

C	0.08	Si	0.25
Mn	1.55	P	≤ 0.015
Ni	0.90	S	≤ 0.012
Mo	0.55		

#### Typical mechanical properties all weld metal

$R_{p0.2}$	560 MPa	ISO-V	+20 °C: 140 J
$R_m$	640 MPa		-20 °C: 120 J
A5	20 %		-40 °C: 70 J
			-60 °C: 47 J

#### Ø / mm

1.6	2.0	2.5	3.0	4.0
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#### Approvals

TÜV



## High strength steels $R_{p0.2} > 620$ MPa

### BÖHLER FOX EV 75

EN ISO 18275-A: E 62 6 Mn2NiCrMo B 4 2 H5

AWS A5.5: E10018-GH4R

Welding process: SMAW

#### Characteristics and applications

Mn-Mo-Ni -alloyed basic electrode with high ductility and cracking resistance for high-strength, quenched and tempered fine-grained constructional steels. Suitable for service temperatures at  $-60$  °C to  $+400$  °C.

Weld metal recovery approx. 120 %. Easy weldability in all positions except vertical-down. Preheat, interpass temperature and post weld heat treatment as required by the base metal.

Very low hydrogen content (acc. AWS condition HD < 4 ml/100 g weld metal).

#### Base materials

Quenched and tempered fine-grained steels up to 620 MPa yield strength and 730 MPa tensile strength

S500Q-S620Q, S500QL-S620QL, S500QL1-S620QL1, L485MB-L555MB, L485QB-L555QB, alform 500 M, alform 550 M, alform 600 M, aldur 550 Q, aldur 550 QL, aldur 550 QL1

ASTM A 572 Gr. 65; A 633 Gr. E; A 738 Gr. A; A 852; API 5 L X70, X80, X70Q, X80Q

#### Typical chemical analysis all weld metal (%)

C	0.05	Cr	0.40
Si	0.40	Ni	2.00
Mn	1.60	Mo	0.40

#### Typical mechanical properties all weld metal

$R_{p0.2}$	700 MPa	ISO-V	$+20$ °C: 140 J
$R_m$	750 MPa		$-60$ °C: $\geq 47$ J
A5	23 %		

#### Ø / mm

2.5	3.2	4.0	5.0
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#### Approvals

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### BÖHLER Ti 75 T-FD

EN ISO 18275-A: T62 4 Mn1.5Ni PM 1 H5

AWS A5.36: E101T1-M21A4-K2-H4

Welding process: FCAW

#### Characteristics and applications

Seamless rutile Ni-Mo alloyed flux cored wire for single- or multilayer welding of carbon, 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, low spatter, fast freezing and easy to remove slag. The exceptional mechanical properties of this wire even at low temperatures as well as the low content of diffusible hydrogen make it especially suitable for off-shore applications.

#### Base materials

S500Q-S620Q, S500QL-S620QL, L485MB-L555MB, L485QB-L555QB, alform 500 M, 550 M, 600 M, aldur 550 Q, aldur 550 QL, aldur 620 M, PAS 460-550

ASTM A 572 Gr. 65; A 633 Gr. E; A 738 Gr. A; A 852; API 5 L X70, X80, X70Q, X80Q

#### Typical chemical analysis all weld metal (%)

C	0.05	Ni	1.50
Si	0.30	Mo	0.30
Mn	1.30	Gas	M21

#### Typical mechanical properties all weld metal

$R_{p0.2}$	670 MPa	ISO-V	$-40$ °C: 90 J
$R_m$	730 MPa		
A5	20 %		

#### Ø / mm

1.0	1.2	1.4	1.6
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#### Approvals

CE
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## High strength steels $R_{p0.2} > 690$ MPa

### BÖHLER FOX EV 85

EN ISO 18275-A: E 69 6 Mn2NiCrMo B 4 2 H5

AWS A5.5: E11018-GH4R

Welding process: SMAW

#### Characteristics and applications

Basic Mn-Ni-Mo-alloyed electrode with high ductility and cracking resistant for high-strength fine-grained constructional steels. Low-temperature ductility at  $-60$  °C and resistant to ageing.

Easy weldability in all positions except vertical-down. Very low hydrogen content (acc. AWS condition HD < 4 ml/100 g).

#### Base materials

Quenched and tempered fine-grained steels up to 690 MPa yield strength

S620Q, S620QL, S690Q, S690QL, S620QL1-S690QL1, alform plate 620 M, 700 M, aldur 620 Q, aldur 620 QL, aldur 620 QL1, aldur 700 Q, aldur 700 QL, aldur 700 QL1

ASTM A 514 Gr. F, H, Q; A 709 Gr. 100 Type B, E, F, H, Q; A 709 Gr. HPS 100W

#### Typical chemical analysis all weld metal (%)

C	0.05	Cr	0.40
Si	0.40	Ni	2.10
Mn	1.70	Mo	0.50

#### Typical mechanical properties all weld metal

$R_{p0.2}$	780 MPa	ISO-V	+20 °C: 110 J
$R_m$	840 MPa		-50 °C: 60 J
A5	20 %		

#### Ø / mm

2.5	3.2	4.0	5.0
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#### Approvals

TÜV, DB, BV, CE

### BÖHLER Ti 80 T-FD

EN ISO 18276-A: T 69 6 Z P M 1 H5

AWS A5.36: E111T1-M21A8-GH4

Welding process: FCAW

#### Characteristics and applications

Seamless rutile, Ni-Mo alloyed, flux cored wire for single- or multilayer welding of high strength steels to be used with Argon-CO<sub>2</sub> shielding gas.

This core wire with its easy to remove and fast freezing slag shows excellent weldability in all positions, excellent bead appearance and very low spatter. The low diffusible hydrogen content of the pure weld metal (2-3 ml/100 g) and the outstanding mechanical properties at low temperatures ( $-60$  °C) make this wire perfectly suitable for offshore applications and crane fabrication.

#### Base materials

Quenched and tempered fine-grained steels up to 690 MPa yield strength

S620Q, S620QL, S690Q, S690QL, S620QL1-S690QL1, alform plate 620 M, 700 M, aldur 620 Q, aldur 620 QL, aldur 620 QL1, aldur 700 Q, aldur 700 QL, aldur 700 QL1

ASTM A 514 Gr. F, H, Q; A 709 Gr. 100 Type B, E, F, H, Q; A 709 Gr. HPS 100W

#### Typical chemical analysis all weld metal (%)

Gas	M21	Mn	1.70
C	0.07	Ni	2.00
Si	0.40	Mo	0.15

#### Typical mechanical properties all weld metal

$R_{p0.2}$	770 MPa	ISO-V	-40 °C: 75 J
$R_m$	800 MPa		-60 °C: 60 J
A5	19 %		

#### Ø / mm

1.0	1.2	1.4	1.6
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#### Approvals

DNV GL, ABS, LR, BV, CE

High strength steels  $R_{p0.2} > 690$  MPa

## BÖHLER NiCrMo 2.5-IG

EN 16834-A: W 69 6 I1 Mn3Ni2.5CrMo

AWS A5.28: ER110S-G

Welding process: GTAW

### Characteristics and applications

GTAW rod for joint welding of high-strength fine-grained constructional steels with stringent requirement on low-temperature toughness down to -60° C e.g. in marine engineering for the manufacture of LPG tankers.

## BÖHLER X 70-IG

EN ISO 16834-A: G 69 5 M21 Mn3Ni1CrMo

AWS A5.28: ER110S-G

Welding process: GMAW

### Characteristics and applications

GMAW wire for the welding of high-strength, TMCP, fine-grained constructional steels with a minimum yield strength of 690 MPa.

Due to the precise addition of micro-alloying elements X 70-IG wire features excellent ductility and cold-cracking resistance in spite of its high strength. Good cryogenic impact energy down to -50 °C.

### Base materials

Quenched and tempered fine-grained steels with high requirements for low-temperature toughness

S620Q, S620QL, S690Q, S690QL, S620QL1-S690QL1, alform plate 620 M, 700 M, aldur 620 Q, aldur 620 QL, aldur 620 QL1, aldur 700 Q, aldur 700 QL, aldur 700 QL1

ASTM A 514 Gr. F, H, Q ; A 709 Gr. 100 Type B, E, F, H, Q ; A 709 Gr. HPS 100W

### Base materials

High-strength fine-grained steels

S620Q, S620QL, S690Q, S690QL, N-A-XTRA M 700, alform® plate 620 M, alform® 700 M, alform® plate 700 M, aldur 620 Q, aldur 620 QL, aldur 700 Q, aldur 700 QL

ASTM A 514 Gr. F, H, Q; A 709 Gr. 100 Type E, F, H, Q ; A 709 Gr. HPS 100W

### Typical chemical analysis all weld metal (%)

C	0.08	Cr	0.30
Si	0.60	Ni	2.50
Mn	1.40	Mo	0.40

### Typical mechanical properties all weld metal

$R_{p0.2}$	750 MPa	ISO-V	+20 °C: 160 J
$R_m$	830 MPa		-40 °C: 80 J
A5	22 %		-60 °C: ≥ 47 J

### Ø / mm

2.4			
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### Approvals

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### Typical chemical analysis all weld metal (%)

C	0.10	Ni	1.30
Si	0.60	Mo	0.25
Mn	1.60	V	0.10
Cr	0.25		

### Typical mechanical properties all weld metal

$R_{p0.2}$	800 MPa	ISO-V	+20 °C: 190 J
$R_m$	900 MPa		-50 °C: ≥ 47 J
A5	19 %		

### Ø / mm

1.0	1.2		
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### Approvals

TÜV, DB, ABS, BV, DNV GL, CE
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## High strength steels $R_{p0.2} > 690$ MPa

### BÖHLER alform® 700-IG

EN ISO 16834-A: G 79 5 M21 Mn4Ni1,5CrMo

AWS A5.28: ER110S-G

Welding process: GMAW

#### Characteristics and applications

Medium alloy solid wire electrode for shielded arc welding of quenched and tempered fine grained structural steels. Outstanding tough weld metal at low temperature when deposited with gas mixture. Good deformability; outstanding mechanical properties even at higher heat input per unit length of weld. Good resistance to cold-cracking due to high purity of the wire surface. For use in crane and vehicle manufacturing.

#### Base materials

High strength steels like S690Q, S690QL, aldur 700Q, 700QL, alform® 700 M (wire is especially balanced for this plate steel)

ASTM A 514 Gr. F, H, Q; A 709 Gr. 100 Type E, F, H, Q; A 709 Gr. HPS 100W

#### Typical chemical analysis all weld metal (%)

C	0.09	Cr	0.30
Si	0.70	Ni	1.85
Mn	1.70	Mo	0.60

#### Typical mechanical properties all weld metal

$R_{p0.2}$	≥ 790 MPa	ISO-V	+20 °C: ≥ 90 J
$R_m$	880 – 1080 MPa		-50 °C: ≥ 47 J
A5	≥ 16 %		

#### Ø / mm

1.0	1.2		
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#### Approvals

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### BÖHLER alform® 700-MC

EN ISO 18276-A: T 69 6 Mn2NiCrMo M M 1 H5

AWS A5.36: E110T15-M21A8-K4-H4

Welding process: GMAW

#### Characteristics and applications

The BÖHLER alform® 700-MC metal cored wire manufactured with seamless laser technology, is developed for shielded arc welding of thermo mechanically produced fine grained structural steels. A balanced metallurgy combined with a very precise production technology results in high strength combined with very good toughness behaviour and excellent welding performance. This tubular wire possesses higher rigidity – as a result it offers exact ignition and excellent feeding characteristic. Due to the manufacturing technology, this metal cored wire ensures low diffusible hydrogen content of < 2 ml/100 g weld metal. This metal cored wire is designed for welding under mixed gas (Ar + CO<sub>2</sub>) in PA and PB position. Good results were also achieved after using alternative gases, 8 – 10 % CO<sub>2</sub> + Ar and vertical down welding position. This filler material is used for high strength steel constructions, crane and vehicle manufacturing, for ship building, offshore applications and also for penstocks.

#### Base materials

S690 and higher strength grades, thermo mechanically treated fine grain steels up to 690 MPa.

S690Q, S690QL, aldur 700Q, aldur 700QL, alform® 700 M (wire is especially balanced for this plate steel).

ASTM A 514 Gr. F, H, Q; A 709 Gr. 100 Type E, F, H, Q; A 709 Gr. HPS 100W

#### Typical chemical analysis all weld metal (%)

C	0.07	Si	0.70
Mn	1.60	Cr	0.35
Ni	2.00	Mo	0.30

#### Typical mechanical properties all weld metal

$R_{p0.2}$	770 MPa	ISO-V	-40 °C: 130 J
$R_m$	830 MPa		-60 °C: 85 J
A5	18 %		

#### Ø / mm

1.0	1.2	1.6	
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#### Approvals

TÜV, DB, DNV GL, CE

High strength steels  $R_{p0.2} > 690$  MPa

## BÖHLER X 70-MC

EN ISO 18276-A: T 69 6 Mn2NiCrMo M M 1 H5

AWS A5.36: E110T15-M21A8-K4-H4

Welding process: GMAW

### Characteristics and applications

The BÖHLER X 70-MC metal cored wire is developed for shielded arc welding of fine grained high strength structural steels. Good metallurgical results with high strength combined with very good toughness behaviour and excellent welding performance. Due to the manufacturing technology, this metal cored wire ensures low diffusible hydrogen content of <4 ml/100 g weld metal. This metal cored wire is designed for welding under mixed gas (Ar + CO<sub>2</sub>) in PA and PB-position. Good results were also achieved after using alternative gases CO<sub>2</sub>, 8-10 % CO<sub>2</sub> + Ar and different welding positions (PG). This filler material is used for high strength steel constructions, crane and vehicle manufacturing, for ship building, offshore applications and also for penstocks.

### Base materials

S690 and higher strength steels grades, up to 690 MPa. S690Q, S690QL S700Q, S700QL,

ASTM A 514 Gr. F, H, Q ; A 709 Gr. 100 Type E, F, H, Q;  
A 709 Gr. HPS 100W

### Typical chemical analysis all weld metal (%)

C	0.07	Si	0.70
Mn	1.60	Cr	0.35
Ni	2.00	Mo	0.30

### Typical mechanical properties all weld metal

$R_{p0.2}$	770 MPa	ISO-V	-40 °C: 130 J
$R_m$	830 MPa		-60 °C: 85 J
A5	19 %		

### Ø / mm

1.0	1.2		
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### Approvals

TÜV, DB, DNV GL, CE

## Union S 3 NiMoCr / UV 421 TT

EN ISO 26304-A: S 69 6 FB SZ3Ni2,5CrMo

AWS A5.23: F11A8-EG-F6

Welding process: SAW

### Characteristics and applications

UV 421 TT is an agglomerated fluoride-basic flux with high basicity and neutral metallurgical behavior. It is suitable for single (AC or DC) and tandem (DC and AC) welding. Very good slag detachability also for narrow gap welding. Flux can especially be used for multi-pass butt welding of medium and high tensile steels. Very good impact toughness of weld metal at low temperatures.

Humidity (1050 °C): max. 0.1 % H<sub>2</sub>O

Diffusible Hydrogen content acc. to EN ISO 3690: HD max. 5 ml/100 g

Grain size: EN ISO 14174: 3 – 20 (0.3 – 2.0 mm); Tyler: 8 x 48

Main constituents in %: SiO<sub>2</sub> + TiO<sub>2</sub> = 15 / CaO + MgO = 35 / Al<sub>2</sub>O<sub>3</sub> + MnO = 20 / CaF<sub>2</sub> = 25

### Base materials

Fine grained structural steels, especially for HT steels with yield strength up to 690 MPa.

### Typical chemical analysis all weld metal (%)

C	0.08	S	≤ 0.012
Si	0.20	Cr	0.32
Mn	1.60	Ni	2.00
P	≤ 0.015	Mo	0.58

### Typical mechanical properties all weld metal

$R_{p0.2}$	690 MPa	ISO-V	+20 °C: 120 J
$R_m$	770 MPa		-20 °C: 80 J
A5	17 %		-40 °C: 60 J
			-60 °C: 47 J

### Ø / mm

3.0	4.0		
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### Approvals

ABS, BV, DB, DNV GL, LR, TÜV, WIWEB, CE

## Stainless Steel soft-martensitic

### BÖHLER FOX CN 13/4

EN ISO 3581-A: E 13 4 B 6 2

AWS A5.4: E410NiMo-15

Welding process: SMAW

#### Characteristics and applications

Basic electrode, low-hydrogen, suited for similar soft martensitic and martensitic-ferritic rolled, forged and cast steels. Mainly used in the construction of hydro turbines, compressors. Resistant to corrosion from water, steam and sea water atmosphere. Thanks to an optimum balance of alloying components the weld deposit yields very good ductility, toughness and cracking resistance despite of its high strength. Excellent operating characteristics, easy slag removal, smooth bead appearance and low hydrogen weld metal (HD ≤ 5 ml/100 g). Metal recovery approx. 130 %. Positional weldability is offered up to ø 3.2 mm electrodes.

#### Base materials

1.4317 GX4CrNi13-4, 1.4313 X3CrNiMo13-4, 1.4407 GX5CrNiMo13-4, 1.4414 GX4CrNiMo13-4  
ACI Gr. CA 6 NM, S41500

#### Typical chemical analysis all weld metal (%)

C	0.035	Cr	12.2
Si	0.30	Ni	4.50
Mn	0.50	Mo	0.50

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	680 MPa	ISO-V	+20 °C: 32 J
R <sub>m</sub>	910 MPa		-20 °C: 60 J
A5	17 %		-60 °C: 55 J

#### Ø / mm

2.5	3.2	4.0	5.0
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#### Approvals

TÜV, CE

### BÖHLER FOX CN 13/4 SUPRA

EN ISO 3581-A: E 13 4 B 4 2

AWS A5.4: E410NiMo-15

Welding process: SMAW

#### Characteristics and applications

Basic electrode, core wire alloyed, low-hydrogen suited for welding similar soft-martensitic and martensitic-ferritic rolled, forged, and cast steels. Mainly used in the construction of hydro turbines, compressors. Resistant to corrosion from water, steam and sea water atmosphere. Thanks to an optimum balance of alloying components the weld deposit yields very good ductility, toughness and cracking resistance despite of its high strength. Excellent slag removability, smooth bead appearance and low hydrogen weld metal (HD ≤ 5 ml/100 g).

#### Base materials

1.4317 GX4CrNi13-4, 1.4313 X3CrNiMo13-4, 1.4407 GX5CrNiMo13-4, 1.4414 GX4CrNiMo13-4  
ACI Gr. CA 6 NM, S41500

#### Typical chemical analysis all weld metal (%)

C	0.03	Cr	12.20
Si	0.30	Ni	4.50
Mn	0.60	Mo	0.50

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	680 MPa	ISO-V	+20 °C: 35 J
R <sub>m</sub>	930 MPa		-20 °C: 60 J
A5	18 %		-60 °C: 55 J

#### Ø / mm

3.2	4.0		
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#### Approvals

TÜV, CE



## Stainless Steel soft-martensitic

### BÖHLER CN 13/4 PW-FD

EN ISO 17633-A: T 13 4 P M21/C1 1 (H5)

AWS A5.22: E410NiMoT1-4/1 (H4)

Welding process: FCAW

#### Characteristics and applications

Rutile flux-cored wire of T 13 4 P / E410NiMoT1 type for welding of 13Cr4Ni soft martensitic stainless steels such as EN 1.4313 / UNS S41500. Results in very low weld metal hydrogen content (HD of 1-3 ml/100 g) and high weld metal impact toughness after post-weld heat treatment. Fast freezing slag offers excellent weldability and slag control in all positions. Easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter. Increased travel speeds as well as self-releasing slag with little demand for cleaning and pickling provide considerable savings. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion.

#### Base materials

1.4313 X3CrNiMo13-4, 1.4317 GX4CrNi13-4, 1.4407 GX5CrNiMo13-4, 1.4414 GX4CrNiMo13-4  
ACI Grade CA 6 NM, UNS S41500

#### Typical chemical analysis all weld metal (%)

C	0.03	Cr	12.00
Si	0.70	Ni	5.00
Mn	0.90	Mo	0.50

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	790 MPa	ISO-V	+20 °C: 50 J
R <sub>m</sub>	920 MPa		-20 °C: 45 J
A5	17 %		-50 °C: 40 J

annealed: 600 °C/2 h

#### Ø / mm

1.6			
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#### Approvals

TÜV, CE

### BÖHLER CN 13/4-IG

EN ISO 14343-A: W 13 4

AWS A5.9: ER410NiMo (mod.)

Welding process: GTAW

#### Characteristics and applications

GTAW rod of low-carbon type 13Cr4Ni suited for soft-martensitic steels like 1.4313 / CA 6 NM. Designed with precisely tuned alloying composition creating a weld deposit featuring very good ductility, CVN toughness and cracking resistance despite its high strength.

For applications like hydro- and steam turbines, corrosion resistant against water and steam.

#### Base materials

1.4317 GX4CrNi13-4, 1.4313 X3CrNiMo13-4, 1.4407 GX5CrNiMo13-4, 1.4414 GX4CrNiMo13-4  
ACI Gr. CA6NM

#### Typical chemical analysis all weld metal (%)

C	0.01	Cr	12.30
Si	0.70	Ni	4.70
Mn	0.70	Mo	0.50

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	750 MPa	ISO-V	+20 °C: 150 J
R <sub>m</sub>	830 MPa		-60 °C: ≥ 32 J
A5	21 %		

annealed: 600 °C/8 h

#### Ø / mm

2.0	2.4		
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#### Approvals

TÜV, CE

## Stainless Steel soft-martensitic

### BÖHLER CN 13/4-IG

EN ISO 14343-A: G 13 4

AWS A5.9: ER410NiMo (mod.)

Welding process: GMAW

#### Characteristics and applications

GMAW solid wire of low-carbon type 13Cr-4Ni suited for soft-martensitic steels like 1.4313 / CA 6 NM. Designed with precisely tuned alloying composition creating a weld deposit featuring very good ductility, CVN toughness and cracking resistance despite its high strength. For applications like hydro- and steam turbines, corrosion resistant against water and steam.

#### Base materials

1.4317 GX4CrNi13-4, 1.4313 X3CrNiMo13-4, 1.4407 GX5CrNiMo13-4, 1.4414 GX4CrNiMo13-4  
ACI Gr. CA 6 NM

#### Typical chemical analysis all weld metal (%)

C	0.01	Cr	12.20
Si	0.65	Ni	4.80
Mn	0.70	Mo	0.50

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	760 MPa	ISO-V	+20 °C: 150 J
R <sub>m</sub>	890 MPa		-20 °C: ≥ 47 J
A5	17 %		-60 °C: ≥ 32 J

annealed: 580° C/8 h

#### Ø / mm

1.2			
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#### Approvals

CE

### BÖHLER CN 13/4-MC

EN ISO 17633-A: T 13 4 M M12 2

AWS A5.22: EC410NiMo (mod.)

Welding process: GMAW

#### Characteristics and applications

Metal-cored wire of T 13 4 M / EC410NiMo type for welding of 13Cr-4Ni soft martensitic stainless steels such as EN 1.4313 / UNS S41500. Applications are for instance turbine components in the hydropower industry. Easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter. The wire shows good wetting behavior and results in a smooth surface. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. It is easily used in all welding positions. Additionally, precise alloy adjustment ensures very good weld metal impact toughness after heat treatment. The diffusible hydrogen content is extra low with maximum 4 ml/100 g to prevent cold-cracking.

#### Base materials

1.4313 X3CrNiMo13-4, 1.4317 GX4CrNi13-4, 1.4407 GX5CrNiMo13-4, 1.4414 GX4CrNiMo13-4  
ACI Grade CA 6 NM, UNS S41500.

#### Typical chemical analysis all weld metal (%)

C	0.022	Si	0.70
Mn	0.90	Cr	12.00
Ni	4.60	Mo	0.60

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	760 MPa	PWHT	580 °C/8 h
R <sub>m</sub>	900 MPa	ISO-V	+20 °C: 68 J
A5	16 %		-20 °C: 62 J

#### Ø / mm

1.2	1.6		
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#### Approvals

TÜV, LR, CE

## Stainless Steel soft-martensitic

### BÖHLER CN 13/4-MC (F)

EN ISO 17633-A: T 13 4 M M20 2

AWS A5.22: EC410NiMo (mod.)

Welding process: GMAW

#### Characteristics and applications

Metal-cored wire of T 13 4 M / EC410NiMo type for welding and repair welding of cast 13Cr-4Ni soft martensitic stainless steels such as EN 1.4407. Applications are for instance turbine components in the hydropower industry. Easy handling and high deposition rate result in high productivity with excellent welding performance and very low spatter. The wire shows good wetting behavior and results in a smooth surface. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. It is easily used in all welding positions. Additionally, precise alloy adjustment ensures very good weld metal impact toughness after heat treatment. The diffusible hydrogen content is extra low with maximum 4 ml/100 g to prevent cold-cracking. Significant gains in productivity can be realized by higher deposition rates and reduced post weld grinding as compared to GMAW using solid wires.

#### Base materials

1.4313 X3CrNiMo13-4, 1.4317 GX4CrNi13-4, 1.4407 GX5CrNiMo13-4, 1.4414 GX4CrNiMo13-4  
ACI Gr. CA6NM

#### Typical chemical analysis all weld metal (%)

C	0.023	Cr	12.20
Si	0.70	Ni	4.60
Mn	0.90	Mo	0.60

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	745 MPa	ISO-V	+20 °C: 55 J
R <sub>m</sub>	900 MPa		-20 °C: 50 J
A5	16 %	PWHT	600 °C/2 h

#### Ø / mm

1.2	1.6		
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#### Approvals

CE

### BÖHLER CN 13/4-UP // BB 203

EN ISO 14343-A: S 13 4

AWS A5.9: ER410NiMo (mod.)

Welding process: SAW

#### Characteristics and applications

Sub-arc wire/flux combination for welding similar soft-martensitic steels like 1.4313 / CA 6 NM.

BÖHLER CN 13/4-UP // BB 203 yields a weld deposit featuring very good ductility and CVN toughness as well as high cracking resistance.

BÖHLER BB 203 is a fluoride-basic, agglomerated flux providing good operating characteristics, smooth beads and a low hydrogen weld metal (HD ≤ 5 ml/100 g). For information regarding this sub-arc welding flux see our detailed data sheet.

#### Base materials

1.4317 GX4CrNi13-4, 1.4313 X3CrNiMo13-4, 1.4407 GX5CrNiMo13-4, 1.4414 GX4CrNiMo13-4  
ACI Gr. CA 6 NM

#### Typical chemical analysis all weld metal (%)

C	0.015	Cr	11.80
Si	0.65	Ni	4.70
Mn	0.70	Mo	0.50

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	≥ 500 MPa	ISO-V	+20 °C: ≥ 50 J
R <sub>m</sub>	≥ 750 MPa		PWHT 600 °C/2 h
A5	≥ 15 %		

#### Ø / mm

3.0			
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#### Approvals

CE



## Stainless Steel soft-martensitic

### BÖHLER FOX CN 16/6 M-HD

EN ISO 3581-A: E Z16 6 Mo B 6 2

AWS: –

Welding process: SMAW

#### Characteristics and applications

Basic electrode, high efficiency, for welding of soft martensitic forged and cast steels. The high chromium content enhances the corrosion resistance in water, steam and sea atmosphere. Main applications are found in turbines, pumps- and combustion building. Popular in hydro turbine engineering.

The electrode shows very good features in regard to arc stability, weld puddle control, slag detachability and seam cleanliness. Suitable for all positions except vertical down (positional welding up to  $\varnothing$  3.2 mm). Metal recovery approx. 135 %. Low hydrogen is an essential and necessary prerequisite of this product.

#### Base materials

Soft-martensitic forge steels and cast steels, same-alloyed  
1.4405 GX4CrNiMo16-5-1, 1.4418 X4CrNiMo16-5-1

#### Typical chemical analysis all weld metal (%)

C	0.03	Cr	15.50
Si	0.30	Ni	5.80
Mn	0.60	Mo	1.20

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	640 MPa	ISO-V	+20 °C: 48 J
R <sub>m</sub>	920 MPa		
A5	16 %		

#### Ø / mm

2.5	3.2	4.0	5.0
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#### Approvals

CE

## Stainless steels – Austenitic

### BÖHLER FOX EAS 4 M

EN ISO 3581-A: E 19 12 3 L B 2 2
AWS A5.4: E316L-15
Welding process: SMAW

#### Characteristics and applications

Basic electrode, core wire alloyed stainless steel. Preferably used for 1.4435/316L steel grades.

BÖHLER FOX EAS 4 M is designed to produce high quality weld deposits with reliable toughness values down to -196 °C. Sound welds together with very good root pass and positional welding characteristics. Good gap bridging ability, easy weld pool and slag control. Easy slag removal even in narrow preparations result in clean bead surfaces with minimum post weld cleaning. Ideal electrode for welding on site. Electrodes are packed in hermetically sealed tins and have a moisture resistant coating. Good resistance to inter-granular corrosion. Maximum application temperature: 400 °C.

#### Base materials

1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-13-3, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4583 X10CrNiMoNb18-12, 1.4409 GX2CrNiMo 19-11-2

UNS S31603, S31653; AISI 316L, 316Ti, 316Cb

Typical chemical analysis all weld metal (%)			
C	0.03	Cr	18.80
Si	0.40	Ni	11.80
Mn	1.20	Mo	2.70

Typical mechanical properties all weld metal			
R <sub>p0.2</sub>	460 MPa	ISO-V	+20 °C: 90 J
R <sub>m</sub>	600 MPa		-120 °C: ≥ 32 J
A5	38 %		-196 °C: ≥ 27 J

Ø / mm			
2.5	3.2	4.0	

#### Approvals

TÜV, DNV GL, CE

### BÖHLER FOX EAS 4 M-A

EN ISO 3581-A: E 19 12 3 L R 3 2
AWS A5.4: E316L-17
Welding process: SMAW

#### Characteristics and applications

Rutile electrode, core wire alloyed, stainless steel. Preferably used for 1.4435/316L steel grades.

BÖHLER FOX EAS 4 M-A is an acknowledged world leader, noted for its superior welding characteristics and metallurgy. It can be used on AC or DC. Other advantages include high current capacity, minimum spatter formation, self-releasing slag, smooth and clean weld profile, safety against formation of porosity due to moisture resistant coating and packaging in hermetically sealed tins. The fully alloyed core wire ensures the most reliable corrosion resistance. Good resistance to inter-granular corrosion. Maximum application temperature: 400 °C.

#### Base materials

1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-13-3, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4583 X10CrNiMoNb18-12, 1.4409 GX2CrNiMo 19-11-2

UNS S31603, S31653; AISI 316L, 316Ti, 316Cb

Typical chemical analysis all weld metal (%)			
C	0.03	Cr	18.80
Si	0.80	Ni	11.50
Mn	0.80	Mo	2.70

Typical mechanical properties all weld metal			
R <sub>p0.2</sub>	460 MPa	ISO-V	+20 °C: 70 J
R <sub>m</sub>	600 MPa		-120 °C: ≥ 32 J
A5	36 %		

Ø / mm					
1.5	2.0	2.5	3.2	4.0	5.0

#### Approvals

TÜV, DB, ABS, DNV GL, LR, CWB, CE

## Stainless steels – Austenitic

### BÖHLER EAS 4 M-FD

EN ISO 17633-A: T 19 12 3 L R M21/C1 3

AWS A5.22: E316LT0-4/-1

Welding process: FCAW

#### Characteristics and applications

Rutile flux-cored wire of T 19 12 3 L R / E316LT0 type for welding of stainless steels such as EN 1.4435 / 316L. Easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter formation. Increased travel speeds as well as self-releasing slag with little demand for cleaning and pickling provide considerable savings in time and money. The wire shows good wetting behavior and results in a finely rippled surface pattern. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. Suitable for service temperatures from -120 °C to 400 °C. Good resistance to inter-granular corrosion. For higher temperatures a niobium-stabilized consumable such as BÖHLER SAS 4-FD is required.

BÖHLER EAS 4 M-FD Ø 0.9 mm is well suitable for welding of sheet metal from 1.5 mm and BÖHLER EAS 4 M-FD Ø 1.2 mm can be used for wall thicknesses ≥ 3 mm. For welding in vertical-up and overhead positions, BÖHLER EAS 4 M PW-FD is recommended.

#### Base materials

1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4409 GX2CrNiMo19-11-2, 1.4429 X2CrNiMoN17-12-3, 1.4432 X2CrNiMo17-12-3, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-12-3, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4583 X10CrNiMoNb18-12

UNS S31600, S31603, S31635, S31640, S31653; AISI 316L, 316Ti, 316Cb

#### Typical chemical analysis all weld metal (%)

C	0.03	Cr	19.00
Si	0.70	Ni	12.00
Mn	1.50	Mo	2.70

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	410 MPa	ISO-V	+20 °C: 55 J
R <sub>m</sub>	560 MPa		-120 °C: 35 J
A5	34 %		

#### Ø / mm

1.2	1.6		
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#### Approvals

TÜV, DB, CWB, DNV GL, LR, CE

### BÖHLER EAS 4 PW-FD

EN ISO 17633-A: T 19 12 3 L P M21/C1 1

AWS A5.22: E316LT1-4/-1

Welding process: FCAW

#### Characteristics and applications

Rutile flux-cored wire of T 19 12 3 L P / E316LT1 type for welding of stainless steels such as EN 1.4435 / AISI 316L. The fast freezing slag offers excellent weldability and slag control in all positions. Easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter formation. Increased travel speeds as well as self-releasing slag with little demand for cleaning and pickling provide considerable savings in time and money. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. Suitable for service temperatures from -120 °C to 400 °C. Good resistance to inter-granular corrosion. For flat and horizontal welding positions (1G, 1F and 2F) BÖHLER EAS 4 M-FD is recommended.

#### Base materials

1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4409 GX2CrNiMo19-11-2, 1.4429 X2CrNiMoN17-12-3, 1.4432 X2CrNiMo17-12-3, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-12-3, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4583 X10CrNiMoNb18-12

UNS S31600, S31603, S31635, S31640, S31653; AISI 316L, 316Ti, 316Cb

#### Typical chemical analysis all weld metal (%)

C	0.03	Cr	19.00
Si	0.70	Ni	12.00
Mn	1.50	Mo	2.70

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	430 MPa	ISO-V	+20 °C: 65 J
R <sub>m</sub>	560 MPa		-120 °C: 40 J
A5	34 %		

#### Ø / mm

0.9	1.2	1.6	
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#### Approvals

TÜV, DB, CWB, LR, DNV GL, ABS, CE

## Stainless steels – Austenitic

### BÖHLER EAS 4 M-IG

EN ISO 14343-A: W 19 12 3 L

AWS A5.9: ER316L

Welding process: GTAW

#### Characteristics and applications

GTAW rod of type W 19 12 3 L / ER316L engineered to a very precise analysis to create a weld deposit of high purity, superior hot-cracking and corrosion resistance.

CVN toughness down to -196 °C. Good resistance to inter-granular corrosion. Maximum application temperature: 400 °C.

#### Base materials

1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-13-3, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4583 X10CrNiMoNb18-12, 1.4409 GX2CrNiMo 19-11-2

UNS S31603, S31653; AISI 316L, 316Ti, 316Cb

#### Typical chemical analysis all weld metal (%)

C	≤ 0.02	Cr	18.50
Si	0.50	Ni	12.30
Mn	1.80	Mo	2.80

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	470 MPa	ISO-V	+20 °C: 140 J
R <sub>m</sub>	610 MPa		-196 °C: ≥ 32 J
A5	38 %		

#### Ø / mm

0.8	1.0	1.2	
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#### Approvals

TÜV, DB, DNV GL, CE

### BÖHLER EAS 4 M-IG (Si)

EN ISO 14343-A: G 19 12 3 L Si

AWS A5.9: ER316LSi

Welding process: GMAW

#### Characteristics and applications

GMAW solid wire of type G 19 12 3 L Si / ER316LSi designed for first class welding, good wetting and feeding characteristics. Good resistance to inter-granular corrosion. Maximum application temperature: 400 °C.

Low temperature service down to -196 °C.

#### Base materials

1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-13-3, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4583 X10CrNiMoNb18-12, 1.4409 GX2CrNiMo19-11-2

UNS S31603, S31653; AISI 316L, 316Ti, 316Cb

#### Typical chemical analysis all weld metal (%)

C	0.02	Cr	18.40
Si	0.80	Ni	12.40
Mn	1.70	Mo	2.80

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	430 MPa	ISO-V	+20 °C: 120 J
R <sub>m</sub>	580 MPa		-196 °C: ≥ 32 J
A5	38 %		

#### Ø / mm

0.8	1.0	1.2	
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#### Approvals

TÜV, DB, DNV GL, CE

## Stainless steels – Austenitic

### BÖHLER EAS 4 M-MC

EN ISO 17633-A: T 19 12 3 L M M12 2

AWS A5.22: EC316L

Welding process: GMAW

#### Characteristics and applications

Austenitic metal-cored wire of T 19 12 3 L / EC316L type for welding matching and similar, stabilized or non-stabilized, corrosion resistant austenitic CrNi(Mo) steels. Easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter formation. The wire shows good wetting behavior and results in a smooth surface. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. This makes the metal-cored wire less sensitive to edge misalignment and variation in gap width. Suitable for service temperatures from –196 °C to 400 °C.

#### Base materials

1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2,  
1.4409 GX2CrNiMo19-11-2, 1.4429 X2CrNiMoN17-12-3,  
1.4432 X2CrNiMo17-12-3, 1.4435 X2CrNiMo18-14-3,  
1.4436 X3CrNiMo17-12-3, 1.4571 X6CrNiMoTi17-12-2,  
1.4580 X6CrNiMoNb17-12-2, 1.4583 X10CrNiMoNb18-12

UNS S31600, S31603, S31635, S31640, S31653; AISI 316L, 316Ti, 316Cb

#### Typical chemical analysis all weld metal (%)

C	0.025	Cr	18.80
Si	0.60	Ni	12.20
Mn	1.40	Mo	2.70

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	410 MPa	ISO-V	+20 °C: 75 J
R <sub>m</sub>	560 MPa		–196 °C: 35 J
A5	34 %		

#### Ø / mm

1.2	1.6		
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#### Approvals

TÜV, CE

### Thermanit GE-316L / Marathon 431

EN ISO 14343-A: S 19 12 3 L

AWS A5.9: ER316L

Welding process: SAW

#### Characteristics and applications

Thermanit GE-316L / Marathon 431 is a wire/flux combination for welding of stainless steel grades like 1.4435 / 316L. Suited for service temperatures from –120 °C to +400 °C.

Marathon 431 is an agglomerated basic flux that ensures good welding properties with nice bead appearance and good slag detachability. For more information regarding this sub-arc welding flux see our detailed data sheet.

#### Base materials

1.4401 – X5CrNiMo17-12-2, 1.4404 – X2CrNiMo17-12-2,  
1.4435 – X2CrNiMo18-14-3, 1.4436 – X3CrNiMo17-13-3,  
1.4571 – X6CrNiMoTi17-12-2, 1.4580 – X6CrNiMoNb17-12-2,  
1.4583 – X10CrNiMoNb18-12, 1.4409 – GX2CrNiMo 19-11-2

UNS S31603, S31653; AISI 316L, 316Ti, 316Cb

#### Typical chemical analysis all weld metal (%)

C	0.012	Cr	18.00
Si	0.60	Ni	12.20
Mn	1.20	Mo	2.80

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	> 350 MPa	ISO-V	+20 °C: > 70 J
R <sub>m</sub>	> 550 MPa		–120 °C: > 60 J
A5	> 30 %		

#### Ø / mm

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#### Approvals

TÜV, CE

## Stainless steels – Special applications

### BÖHLER FOX A 7

EN ISO 3581-A: E 18 8 Mn B 2 2

AWS A5.4: E307-15 (mod.)

Welding process: SMAW

#### Characteristics and applications

Basic electrode for joint welding of dissimilar joints, problematic steels and for repair and maintenance. Very popular electrode for numerous applications. The weld metal offers exceptionally high ductility and elongation together with outstanding cracking resistance. There is no fear of embrittlement when operating down to service temperatures of  $-110\text{ }^{\circ}\text{C}$  or above  $+500\text{ }^{\circ}\text{C}$ . The scaling resistance goes up to  $+850\text{ }^{\circ}\text{C}$ . When working at service temperatures above  $+650\text{ }^{\circ}\text{C}$  please contact the supplier. The weld metal can be post weld heat treated without any problems. The deposit will work-harden and offers good resistance against cavitation. Ductility is good even after high dilution when welding problematic steels or when subjected to thermal shock or scaling. An excellent alloy providing cost effective performance.

#### Base materials

For fabrication, -repair and maintenance.

Dissimilar joints, tough buffer and intermediate layers prior to hardfacing, 14 % manganese steels, 13-17 % Cr heat resistant steels, armour plates, high carbon and quenched & tempered steels, surfacing of gears, valves, turbine blades etc.

#### Typical chemical analysis all weld metal (%)

C	0.09	Si	0.70
Mn	6.50	Cr	18.60
Ni	8.80		

#### Typical mechanical properties all weld metal

$R_{p0.2}$	460 MPa	ISO-V	$+20\text{ }^{\circ}\text{C}$ : 90 J
$R_m$	660 MPa		$-110\text{ }^{\circ}\text{C}$ : $\geq 32\text{ J}$
A5	35 %		

#### Ø / mm

2.5	3.2	4.0	5.0	6.0
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#### APPROVALS

TÜV, DB, DNV GL, CE

### BÖHLER FOX A 7-A

EN ISO 3581-A: E Z18 9 MnMo R 3 2

AWS A5.4: E307-16 (mod.)

Welding process: SMAW

#### Characteristics and applications

Rutile basic coated electrode, for joint welding of dissimilar joints, problematic steels and for repair and maintenance. Very popular electrode for numerous applications. The weld metal offers exceptionally high ductility and elongation together with outstanding cracking resistance. There is no fear of embrittlement when operating down to service temperatures of  $-100\text{ }^{\circ}\text{C}$  or above  $500\text{ }^{\circ}\text{C}$ . The scaling resistance goes up to  $850\text{ }^{\circ}\text{C}$ . When working at service temperatures above  $650\text{ }^{\circ}\text{C}$  please our application department. The weld metal can be post weld heat treated without any problems. The deposit will work-harden and offers good resistance against cavitation. Ductility is good even after high dilution when welding problematic steels or when subjected to thermal shock or scaling. An excellent alloy providing cost effective performance. BÖHLER FOX A 7-A is suitable for both AC and DC.

#### Base materials

For fabrication, repair and maintenance!

Dissimilar joints, tough buffer and intermediate layers prior to hardfacing, 14 % manganese steels, 13 – 17 % chromium heat resistant steels up to  $850\text{ }^{\circ}\text{C}$ , armour plates, high carbon and quenched & tempered steels, surfacing of gears, valves, turbine blades etc.

#### Typical chemical analysis all weld metal (%)

C	0.10	Cr	19.50
Si	1.50	Ni	8.50
Mn	4.00	Mo	0.70

#### Typical mechanical properties all weld metal

$R_{p0.2}$	520 MPa	ISO-V	$+20\text{ }^{\circ}\text{C}$ : 75 J
$R_m$	720 MPa		$-100\text{ }^{\circ}\text{C}$ : ( $\geq 32\text{ J}$ )
A5	35 %		

#### Ø / mm

2.5	3.2	4.0	5.0
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#### Approvals

TÜV, CE



## Stainless steels – Special applications

### BÖHLER A 7-FD

EN ISO 17633-A: T 18 8 Mn R M21/C1 3

AWS A5.22: E307T0-G (mod.)

Welding process: FCAW

#### Characteristics and applications

Rutile flux-cored wire of T 18 8 Mn R / E307T0 type for welding and cladding in flat and horizontal position. One of the most universal alloys and for some applications a cost-efficient alternative to E312 or E309L. For tough buffer and intermediate layers for cladding of rails and switches, valve seats and in hydropower plants. Good resistance to embrittlement when operating at service temperatures from –60 °C up to 650 °C. Easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter formation. Increased travel speeds as well as self-releasing slag with little demand for cleaning and pickling provide considerable savings in time and money. The wire shows good wetting behavior and results in a finely rippled surface pattern. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. Used for fabrication, repair and maintenance. The weld deposit offers high ductility and elongation, also after high dilution with problematic steels. The weld metal work-hardens and offers good resistance to cavitation. The weld metal is resistant to scaling up to 850 °C, but at temperatures above 500 °C there is not sufficient resistance to sulfurous combustion gases.

For welding in vertical-up and overhead positions, BÖHLER A 7 PW-FD is recommended.

#### Base materials

Dissimilar joints, tough buffer and intermediate layers prior to hardfacing, 14 % Mn steels, 13 – 17 % Cr and heat resistant Cr and austenitic steels up to 850 °C, armor plates, high carbon and quenched and tempered steels, surfacing of gears, valves, turbine blades, etc. For joint welding of unalloyed / low alloyed or Cr steels with high-alloyed Cr and CrNi steels. Welding of austenitic high manganese steels and with other steels.

#### Typical chemical analysis all weld metal (%)

C	0.10	Cr	18.80
Si	0.80	Ni	9.00
Mn	6.80		

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	385 MPa	ISO-V	+20 °C: 60 J
R <sub>m</sub>	605 MPa		–60 °C: 35 J
A5	33 %		

#### Ø / mm

1.2	1.6		
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#### Approvals

TÜV, CE

### BÖHLER A 7 PW-FD

EN ISO 17633-A: T 18 8 Mn P M21/C1 2

AWS A5.22: E307T1-G (mod.)

Welding process: FCAW

#### Characteristics and applications

Rutile flux-cored wire of T 18 8 Mn P / E307T1 type for welding and cladding in flat and horizontal position. One of the most universal alloys and for some applications a cost-efficient alternative to E312 or E309L. For tough buffer and intermediate layers for cladding of rails and switches, valve seats and in hydropower plants. Good resistance to embrittlement when operating at service temperatures from –100 °C up to 650 °C. The fast freezing slag offers excellent weldability and slag control in all positions. Easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter formation. Increased travel speeds as well as self-releasing slag with little demand for cleaning and pickling provide considerable savings in time and money. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. The weld deposit offers high ductility, elongation and resistance to hot-cracking, also after high dilution with problematic steels. The weld metal work-hardens and offers good resistance to cavitation. The weld metal is resistant to scaling up to 850 °C, but at temperatures above 500 °C there is not sufficient resistance to sulfurous combustion gases. For flat and horizontal welding positions (1G, 1F and 2F) BÖHLER A 7-FD is recommended.

#### Base materials

Dissimilar joints, tough buffer and intermediate layers prior to hardfacing, 14 % Mn steels, 13 – 17 % Cr and heat resistant Cr and austenitic steels up to 850 °C, armor plates, high carbon and quenched and tempered steels, surfacing of gears, valves, turbine blades, etc. For joint welding of unalloyed / low alloyed or Cr steels with high-alloyed Cr and CrNi steels. Welding of austenitic high manganese steels and with other steels.

#### Typical chemical analysis all weld metal (%)

C	0.10	Cr	18.80
Si	0.80	Ni	9.00
Mn	6.80		

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	420 MPa	ISO-V	+20 °C: 65 J
R <sub>m</sub>	630 MPa		–100 °C: 35 J
A5	39 %		

#### Ø / mm

1.2			
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#### Approvals

TÜV, CE

## Stainless steels – Special applications

### BÖHLER A 7 CN-IG

EN ISO 14343-A: W 18 8 Mn

AWS A5.9: ER307 (mod.)

Welding process: GTAW

#### Characteristics and applications

GTAW rod of type W 18 8 Mn / ER307 for numerous applications. The weld metal offers exceptionally high ductility and elongation together with outstanding cracking resistance. There is no fear of embrittlement when operating down to service temperatures of  $-110\text{ }^{\circ}\text{C}$  or above  $+500\text{ }^{\circ}\text{C}$ . The scaling resistance goes up to  $+850\text{ }^{\circ}\text{C}$ . When working at service temperatures above  $+650\text{ }^{\circ}\text{C}$  please contact the supplier. The weld metal can be post weld heat treated without any problems. The deposit will work-harden and offers good resistance against cavitation. Ductility is good even after high dilution when welding problematic steels or when subjected to thermal shock or scaling. An excellent alloy providing cost effective performance. Very good welding and wetting characteristics.

#### Base materials

For fabrication, repair and maintenance!

Dissimilar joints, tough buffer and intermediate layers prior to hardfacing, 14 % manganese steels, 13 – 17 % chromium and heat resistant steels up to  $+850\text{ }^{\circ}\text{C}$ , armour plates, high carbon and quenched & tempered steels, surfacing of gears, valves, turbine blades etc.

#### Typical chemical analysis all weld metal (%)

C	0.07	Cr	19.20
Si	0.70	Ni	8.80
Mn	6.80		

#### Typical mechanical properties all weld metal

$R_{p0.2}$	460 MPa	ISO-V	$+20\text{ }^{\circ}\text{C}$ : 120 J
$R_m$	650 MPa		$-110\text{ }^{\circ}\text{C}$ : $\geq 32\text{ J}$
A5	38 %		

#### Ø / mm

1.6	2.0	2.4	3.0
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#### Approvals

TÜV, DB, DNV GL, VG 95132, CE

### BÖHLER A 7 CN-IG

EN ISO 14343-A: G 18 8 Mn

AWS A5.9: ER307 (mod.)

Welding process: GMAW

#### Characteristics and applications

GMAW wire of type G 18 8 Mn / ER307 for numerous applications.

The weld metal offers exceptionally high ductility and elongation together with outstanding cracking resistance. There is no fear of embrittlement when operating down to service temperatures of  $-110\text{ }^{\circ}\text{C}$  or above  $+500\text{ }^{\circ}\text{C}$ . The scaling resistance goes up to  $+850\text{ }^{\circ}\text{C}$ . When working at service temperatures above  $+650\text{ }^{\circ}\text{C}$  please contact the supplier.

The weld metal can be post weld heat treated without any problems. The deposit will work-harden and offers good resistance against cavitation. Ductility is good even after high dilution when welding problematic steels or when subjected to thermal shock or scaling. An excellent alloy providing cost effective performance.

Very good feeding, welding and wetting characteristics.

#### Base materials

For fabrication, repair and maintenance!

Dissimilar joints, tough buffer and intermediate layers prior to hardfacing, 14 % manganese steels, 13 – 17 % chromium and heat resistant steels up to  $+850\text{ }^{\circ}\text{C}$ , armour plates, high carbon and quenched & tempered steels, surfacing of gears, valves, turbine blades etc.

#### Typical chemical analysis all weld metal (%)

C	0.08	Cr	19.20
Si	0.90	Ni	9.00
Mn	7.00		

#### Typical mechanical properties all weld metal

$R_{p0.2}$	430 MPa	ISO-V	$+20\text{ }^{\circ}\text{C}$ : 110 J
$R_m$	640 MPa		$-110\text{ }^{\circ}\text{C}$ : $\geq 32\text{ J}$
A5	36 %		

#### Ø / mm

0.8	1.0	1.2	1.6
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#### Approvals

TÜV, DB, CE, DNV GL

## Stainless steels – Special applications

### BÖHLER A 7-MC

EN ISO 17633-A: T 18 8 Mn M M12 1

AWS A5.22: EC307 (mod.)

Welding process: GMAW

#### Characteristics and applications

Austenitic metal-cored wire of T 18 8 Mn / EC307 type for numerous applications. The corrosion resistance is on par with T 19 9 L R / E308LT0. The easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter formation. The wire shows good wetting behavior and results in a smooth surface. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. This makes the metal-cored wire less sensitive to edge misalignment and variation in gap width. This is for instance utilized for robotic welding of exhaust systems in the automotive industry. Used for fabrication, repair and maintenance. The weld deposit offers exceptionally high ductility and elongation, also after high dilution with problematic steels. The resistance to cracking is excellent also when subject to thermal shock. The weld metal work-hardens and offers good resistance to cavitation. Good resistance to embrittlement when operating at service temperatures from –110 °C up to 650 °C. The weld metal is resistant to scaling up to 850 °C, but at temperatures above 500 °C there is not sufficient resistance to sulfurous combustion gases.

#### Base materials

Dissimilar joints, tough buffer and intermediate layers prior to hardfacing, 14 % Mn steels, 13 – 17 % Cr and heat resistant Cr and austenitic steels up to 850 °C, armor plates, high carbon and quenched and tempered steels, surfacing of gears, valves, turbine blades, etc. For joint welding of unalloyed / low alloyed or Cr steels with high-alloyed Cr and CrNi steels. Welding of austenitic high manganese steels and with other steels.

#### Typical chemical analysis all weld metal (%)

C	0.10	Cr	18.80
Si	0.60	Ni	9.20
Mn	6.30		

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	380 MPa	ISO-V	+20 °C: 75 J
R <sub>m</sub>	580 MPa		-90 °C: 35 J
A5	42 %		

#### Ø / mm

1.2	1.6		
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#### Approvals

TÜV, DB, CE

### BÖHLER FOX CN 23/12-A

EN ISO 3581-A: E 23 12 L R 3 2

AWS A5.4: E309L-17

Welding process: SMAW

#### Characteristics and applications

Rutile electrode of type E 23 12 L / 309L providing increased delta ferrite contents (FN ~17) in the weld deposit for safe and cracking resistant dissimilar joint welds and surfacing. BÖHLER FOX CN 23/12-A is noted for its superior welding characteristics and metallurgy. It can be used on AC and DC. Other advantages include high current carrying capacity, minimum spatter formation, self releasing slag, smooth and clean weld profile, safety against formation of porosity due to the moisture resistant coating and packaging in hermetically sealed tins. Operating temperature from –60 °C to 300 °C and for weld claddings up to 400 °C.

#### Base materials

Dissimilar joint welds of and between high-strength, mild steels and low-alloyed QT-steels, stainless, ferritic Cr- and austenitic Cr-Ni- steels, manganese steels. Surfacing: for the first layer of corrosion resistant weld surfacing on ferritic-pearlitic steels in boiler and pressure vessel parts up to fine-grained steel S500N, as well as of high temperature steels like 22NiMoCr4-7 acc. SEW- Werkstoffblatt 365, 366, 20MnMoNi5-5 and G18NiMoCr3-7.

#### Typical chemical analysis all weld metal (%)

C	0.02	Cr	23.20
Si	0.70	Ni	12.50
Mn	0.80		

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	460 MPa	ISO-V	+20 °C: 55 J
R <sub>m</sub>	570 MPa		-60 °C: ≥ 32 J
A5	40 %		

#### Ø / mm

2.5	3.2	4.0	5.0
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#### Approvals

TÜV, DB, ABS, BV, LR, DNV GL, CWB, CE

## Stainless steels – Special applications

### BÖHLER CN 23/12-IG

EN ISO 14343-A: W 23 12 L

AWS A5.9: ER309L

Welding process: GTAW

#### Characteristics and applications

GTAW rod of type W 23 12 L / ER309L. This is a standard alloy for welding dissimilar joints with an average ferrite content 16 FN.

BÖHLER CN 23/12-IG is designed for very good welding and wetting characteristics when welding dissimilar joints. Suitable for service temperatures between -120 °C and +300 °C.

### BÖHLER CN 23/12-IG

EN ISO 14343-A: G 23 12 L

AWS A5.9: ER309L

Welding process: GMAW

#### Characteristics and applications

GMAW wire of type G 23 12 L / ER309L. This is a standard alloy for welding dissimilar joints with an average ferrite content 16 FN.

BÖHLER CN 23/12-IG is designed for very good welding, wetting and feeding characteristics when welding dissimilar joints. Suitable for service temperatures between -80 °C and +300 °C.

#### Base materials

Dissimilar joint welds: of and between high-strength, mild steels and low-alloyed QT-steels, stainless, ferritic Cr- and austenitic Cr-Ni- steels, manganese steels.

Surfacing: for the first layer of corrosion resistant weld surfacing on ferritic-pearlitic steels in boiler and pressure vessel parts up to fine-grained steel S500N, as well as of high temperature steels like 22NiMoCr4-7 acc. SEW-Werkstoffblatt 365, 366, 20MnMoNi5-5 and G18NiMoCr3-7.

#### Base materials

Dissimilar joint welds: of and between high-strength, mild steels and low-alloyed QT-steels, stainless, ferritic Cr- and austenitic Cr-Ni- steels, manganese steels.

Surfacing: for the first layer of corrosion resistant weld surfacing on ferritic-pearlitic steels in boiler and pressure vessel parts up to fine-grained steel S500N, as well as of high temperature steels like 22NiMoCr4-7 acc. SEW-Werkstoffblatt 365, 366, 20MnMoNi5-5 and G18NiMoCr3-7.

#### Typical chemical analysis all weld metal (%)

C	≤ 0.02	Cr	23.50
Si	0.50	Ni	13.20
Mn	1.70		

#### Typical chemical analysis all weld metal (%)

C	≤ 0.02	Cr	23.50
Si	0.50	Ni	13.20
Mn	1.70		

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	440 MPa	ISO-V	+20 °C: 150 J
R <sub>m</sub>	580 MPa		-120 °C: ≥ 32 J
A5	34 %		

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	420 MPa	ISO-V	+20 °C: 90 J
R <sub>m</sub>	570 MPa		-80 °C: ≥ 32 J
A5	32 %		

#### Ø / mm

1.6	2.0	2.4	3.2
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#### Ø / mm

0.8	1.0	1.2	
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#### Approvals

TÜV, DNV GL, CE, DB

#### Approvals

TÜV, DB, DNV GL, CE

## Stainless steels – Special applications

### BÖHLER CN 23/12-FD

EN ISO 17633-A: T 23 12 L R M21/C1 3

AWS A5.22: E309LT0-4/-1

Welding process: FCAW

#### Characteristics and applications

Rutile flux-cored wire of T 23 12 L R / E309LT0 type for welding of dissimilar joints of Cr and CrNi(Mo) steels and unalloyed or low-alloyed steels, as well as weld cladding of unalloyed or low-alloyed base metals preferably in flat or horizontal position. Ferrite measured with Fischer Feritescope 14 – 22 FN. Easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter formation. Increased travel speeds as well as self-releasing slag with little demand for cleaning and pickling provide considerable savings in time and money. The wire shows good wetting behavior and results in a finely rippled surface pattern. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. Suitable for service temperatures from –60 °C to 300 °C.

BÖHLER CN 23/12-FD Ø 0.9 mm is well suitable for welding of sheet metal from 1.5 mm and BÖHLER CN 23/12-FD Ø 1.2 mm can be used for wall thicknesses ≥ 3 mm. For welding in vertical-up and overhead positions, BÖHLER CN 23/12 PW-FD is recommended.

#### Base materials

Primarily used for surfacing (buffer layer) unalloyed or low-alloyed steels and when joining non-molybdenum-alloyed stainless and carbon steels. Joints and dissimilar joints between austenitic steels such as EN 1.4301 X5CrNi18-10, 1.4306 X2CrNi19-11, 1.4308 GX5CrNi19-10, 1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4408 GX5CrNiMo19-11-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-12-3, 1.4541 X6CrNiTi18-10, 1.4550 X6CrNiNb18-10, 1.4552 GX5CrNiNb19-11, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4581 GX5CrNiMoNb19-11-2, 1.4583 X10CrNiMoNb18-12, 1.4948 X6CrNi18-10 UNS S30400, S30403, S30809, S31600, S31603, S31635, S32100, S34700, S31640

AISI 304, 304L, 316, 316L, 316Ti, 321, 347 or dissimilar joints between austenitic and heat resistant steels such as 1.4713 X10CrAlSi7, 1.4724 X10CrAlSi13, 1.4742 X10CrAlSi18, 1.4826 GX40CrNiSi22-10, 1.4828 X15CrNiSi20-12, 1.4832 GX25CrNiSi20-14, 1.4837 GX40CrNiSi25-12 with ferritic steels to pressure boiler steels P295GH and fine grained structural steels to P355N, ship building steel grades A – E, AH 32 – EH 36, A40 – F40, etc.

#### Typical chemical analysis all weld metal (%)

C	0.03	Cr	23.00
Si	0.70	Ni	12.50
Mn	1.40		

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	400 MPa	ISO-V	+20 °C: 55 J
R <sub>m</sub>	540 MPa		-60 °C: 45 J
A5	33 %		

#### Ø / mm

1.2	1.6		
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#### Approvals

TÜV, DB, CWB, DNV GL, LR, CE, BV, CE

### BÖHLER CN 23/12 PW-FD

EN ISO 17633-A: T 23 12 L P M21/C1 1

AWS A5.22: E309LT1-4/-1

Welding process: FCAW

#### Characteristics and applications

Rutile flux-cored wire of T 23 12 L P / E309LT1 type for welding of dissimilar joints of Cr and CrNi(Mo) steels and unalloyed or low-alloyed steels, as well as weld cladding of unalloyed or low-alloyed base metals. Ferrite measured with Fischer Feritescope 14 – 22 FN. The fast freezing slag offers excellent weldability and slag control in all positions. Easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter formation. Increased travel speeds as well as self-releasing slag with little demand for cleaning and pickling provide considerable savings in time and money. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. Suitable for service temperatures from –60 °C to 300 °C. For flat and horizontal welding positions (1G, 1F and 2F) BÖHLER CN 23/12-FD is recommended.

#### Base materials

Primarily used for surfacing (buffer layer) unalloyed or low-alloyed steels and when joining non-molybdenum-alloyed stainless and carbon steels.

Joints and dissimilar joints between austenitic steels such as EN 1.4301 X5CrNi18-10, 1.4306 X2CrNi19-11, 1.4308 GX5CrNi19-10, 1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4408 GX5CrNiMo19-11-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-12-3, 1.4541 X6CrNiTi18-10, 1.4550 X6CrNiNb18-10, 1.4552 GX5CrNiNb19-11, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4581 GX5CrNiMoNb19-11-2, 1.4583 X10CrNiMoNb18-12, 1.4948 X6CrNi18-10 UNS S30400, S30403, S30809, S31600, S31603, S31635, S32100, S34700, S31640

AISI 304, 304L, 316, 316L, 316Ti, 321, 347 or dissimilar joints between austenitic and heat resistant steels such as 1.4713 X10CrAlSi7, 1.4724 X10CrAlSi13, 1.4742 X10CrAlSi18, 1.4826 GX40CrNiSi22-10, 1.4828 X15CrNiSi20-12, 1.4832 GX25CrNiSi20-14, 1.4837 GX40CrNiSi25-12 with ferritic steels to pressure boiler steels P295GH and fine grained structural steels to P355N, ship building steel grades A – E, AH 32 – EH 36, A40 – F40, etc.

#### Typical chemical analysis all weld metal (%)

C	0.03	Cr	23.00
Si	0.70	Ni	12.50
Mn	1.40		

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	420 MPa	ISO-V	+20 °C: 65 J
R <sub>m</sub>	540 MPa		-20 °C: 55 J
A5	36 %		-60 °C: 50 J

#### Ø / mm

0.9	1.2	1.6	
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#### Approvals

TÜV, DB, ABS, LR, DNV GL, CWB, BV, CE

## Stainless steels – Special applications

### BÖHLER CN 23/12-MC

EN ISO 17633-A: T 23 12 L M M12 2

AWS A5.22: EC309L

Welding process: GMAW

#### Characteristics and applications

Austenitic metal-cored wire of T 23 12 L / EC309L type for welding dissimilar joints between high-alloyed Cr and corrosion resistant austenitic CrNi(Mo) steels and mild or low-alloyed steels. The easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter formation. The wire shows good wetting behavior and results in a smooth surface. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. This makes the metal-cored wire less sensitive to edge misalignment and variation in gap width. Suitable for service temperatures from -120 °C to 300 °C.

#### Base materials

Primarily used for surfacing (buffer layer) unalloyed or low-alloyed steels and when joining non-molybdenum-alloyed stainless and carbon steels. Joints and dissimilar joints between austenitic steels such as EN 1.4301 X5CrNi18-10, 1.4306 X2CrNi19-11, 1.4308 GX5CrNi19-10, 1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4408 GX5CrNiMo19-11-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-12-3, 1.4541 X6CrNiTi18-10, 1.4550 X6CrNiNb18-10, 1.4552 GX5CrNiNb19-11, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4581 GX5CrNiMoNb19-11-2, 1.4583 X10CrNiMoNb18-12, 1.4948 X6CrNi18-10 UNS S30400, S30403, S30809, S31600, S31603, S31635, S32100, S34700, S31640; AISI 304, 304L, 316, 316L, 316Ti, 321, 347 or dissimilar joints between austenitic and heat resistant steels such as 1.4713 X10CrAlSi7, 1.4724 X10CrAlSi13, 1.4742 X10CrAlSi18, 1.4826 GX40CrNiSi22-10, 1.4828 X15CrNiSi20-12, 1.4832 GX25CrNiSi20-14, 1.4837 GX40CrNiSi25-12 with ferritic steels to pressure boiler steels P295GH and fine grained structural steels to P355N, ship building steel grades A – E, AH 32 – EH 36, A40 – F40, etc.

#### Typical chemical analysis all weld metal (%)

C	0.025	Cr	23.00
Si	0.60	Ni	12.50
Mn	1.40		

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	400 MPa	ISO-V	+20 °C: 90 J
R <sub>m</sub>	540 MPa		-120 °C: 70 J
A5	32 %		

#### Ø / mm

1.2	1.6		
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#### Approvals

CE

### BÖHLER FOX CN 23/12 Mo-A

EN ISO 3581-A: E 23 12 2 L R 3 2

AWS A5.4: E309L Mo-17

Welding process: SMAW

#### Characteristics and applications

Rutile electrode of type E 23 12 2 L / 309MoL providing increased delta ferrite contents (FN ~20) in the weld deposit for safe and cracking resistant dissimilar joint welds as well as claddings or root passes of clad steel. BÖHLER FOX CN 23/12 Mo-A is noted for its superior welding characteristics and metallurgy. It can be used on AC and DC. Other advantages include high current carrying capacity, minimum spatter formation, self releasing slag, smooth and clean weld profile, safety against formation of porosity due to the moisture resistant coating and packaging in hermetically sealed tins. Operating temperature from -10 °C to 300 °C and for weld surfacing (1st layer) up to 400 °C.

#### Base materials

Dissimilar joint welds: mild steels and low-alloyed constructional and QT-steels among themselves or among each other; unalloyed as well as low-alloyed boiler or constructional steels with stainless Cr-, CrNi- and CrNiMo-steels; ferritic-austenitic joint welds in boiler and pressure vessel parts. Weld surfacing: for the first layer of corrosion resistant surfacing on P235GH, P265GH, S255N, P295GH, S355N - S500N; for the first layer of corrosion resistant weld claddings on high temperature quenched and tempered fine-grained steels acc. AD-Merkblatt HPO, class 3.

#### Typical chemical analysis all weld metal (%)

C	0.02	Cr	23.00
Si	0.70	Ni	12.50
Mn	0.80	Mo	2.70

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	580 MPa	ISO-V	+20 °C: 55 J
R <sub>m</sub>	720 MPa		-20 °C: 45 J
A5	27 %		

#### Ø / mm

2.0	2.5	3.2	4.0	5.0
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#### Approvals

TÜV, ABS, DNV GL, BV, LR, CE



## Stainless steels – Special applications

### BÖHLER CN 23/12 Mo-FD

EN ISO 17633-A: T 23 12 2 L R M21/C1 3

AWS A5.22: E309LMoT0-4/1

Welding process: FCAW

#### Characteristics and applications

Austenitic stainless steel CrNiMo rutile flux-cored wire of T 23 12 2 L R / E309LMoT0 type for welding and cladding preferably in flat and horizontal position. The corrosion resistance is superior to E316L type fillers. Primarily designed for welding dissimilar joints between stainless steels and low-alloyed steels. It can also be used for overlay welding, providing an 18Cr-8Ni-2Mo deposit from the very first layer and for joining of various steels. The wire offers high safety against hot-cracking even at high dilution. Alloying with molybdenum increases the corrosion resistance and weld metal strength. Easy handling and high deposition rates result in high productivity with excellent welding performance, very low spatter formation and a smooth surface. Increased travel speeds as well as self-releasing slag with little demand for cleaning and pickling provide considerable savings in time and money. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. Suitable for service temperatures from -60 °C to 300 °C.

BÖHLER CN 23/12 Mo-FD Ø 0.9 mm is well suitable for welding of sheet metal from 1.5 mm and BÖHLER CN 23/12 Mo-FD Ø 1.2 mm can be used for wall thicknesses ≥ 3 mm. For welding in vertical-up and overhead positions, BÖHLER CN 23/12 Mo PW-FD is recommended.

#### BASE MATERIAL

Joints and dissimilar joints between austenitic stainless steels such as EN 1.4301 X5CrNi18-10, 1.4306 X2CrNi19-11, 1.4308 GX5CrNi19-10, 1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4408 GX5CrNiMo19-11-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-12-3, 1.4541 X6CrNiTi18-10, 1.4550 X6CrNiNb18-10, 1.4552 GX5CrNiNb19-11, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4581 GX5CrNiMoNb19-11-2, 1.4583 X10CrNiMoNb18-12, 1.4948 X6CrNi18-10, UNS S30400, S30403, S30809, S31600, S31603, S31635, S32100, S34700, S31640, S31653, AISI 304, 304L, 304LN, 302, 321, 347, 316, 316L, 316Ti, 316Cb or duplex stainless steels such as 1.4162 X2CrNiMoN21-5-1, 1.4362 X2CrNiN23-4, 1.4462 X2CrNiMoN22-5-3, UNS S32101, S32304, S31803, S32205; LDX 2101®, SAF 2304, SAF 2205 or dissimilar joints between austenitic and heat resistant steels 1.4713 X10CrAlSi7, 1.4724 X10CrAlSi13, 1.4742 X10CrAlSi18, 1.4826 GX40CrNiSi22-10, 1.4828 X15CrNiSi20-12, 1.4832 GX25CrNiSi20-14, 1.4837 GX40CrNiSi25-12 with ferritic steels to pressure boiler steels P295GH and also fine grained structural steels to P355N, shipbuilding steels grade A – E, AH 32 – EH 36, A40 – F40, etc.

Dissimilar joint welds – overlay welding the first corrosion resistant surface layer on P235GH, P265GH, S255N, P295GH, S355N – S500N; and high-temperature quenched and tempered fine-grained steels.

#### Typical chemical analysis all weld metal (%)

C	0.03	Cr	23.00
Si	0.60	Ni	12.50
Mn	1.40	Mo	2.70

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	520 MPa	ISO-V	+20 °C: 50 J
R <sub>m</sub>	700 MPa		-60 °C: 36 J
A5	28 %		

#### Ø / mm

0.9	1.2	1.6	
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#### Approvals

TÜV, DB, ABS, DNV GL, LR, CWB, CE

### BÖHLER CN 23/12 Mo PW-FD

EN ISO 17633-A: T 23 12 2 L P M21/C1 1

AWS A5.22: E309LMoT1-4/1

Welding process: FCAW

#### Characteristics and applications

Austenitic stainless steel CrNiMo rutile flux-cored wire of T 23 12 2 L P / E309LMoT1 type. The corrosion resistance is superior to E316L type fillers. Primarily designed for welding dissimilar joints between stainless steels and low-alloyed steels. It can also be used for overlay welding, providing an 18Cr-8Ni-2Mo deposit from the very first layer and for joining of various steels. The fast freezing slag offers excellent weldability and slag control in all positions. Easy handling and high deposition rates result in high productivity with excellent welding performance and very low spatter formation. Increased travel speeds as well as self-releasing slag with little demand for cleaning and pickling provide considerable savings in time and money. The wide arc ensures even penetration and side-wall fusion to prevent lack of fusion. Provides high resistance to hot-cracking even at high dilution. Alloying with molybdenum increases the corrosion resistance and weld metal strength. Suitable for service temperatures from -60 °C to 300 °C. For flat and horizontal welding positions (1G, 1F, 2F) BÖHLER CN 23/12 Mo-FD is recommended.

#### Base materials

Joints and dissimilar joints between austenitic stainless steels such as EN 1.4301 X5CrNi18-10, 1.4306 X2CrNi19-11, 1.4308 GX5CrNi19-10, 1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4408 GX5CrNiMo19-11-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNiMo17-12-3, 1.4541 X6CrNiTi18-10, 1.4550 X6CrNiNb18-10, 1.4552 GX5CrNiNb19-11, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4581 GX5CrNiMoNb19-11-2, 1.4583 X10CrNiMoNb18-12, 1.4948 X6CrNi18-10, UNS S30400, S30403, S30809, S31600, S31603, S31635, S32100, S34700, S31640, S31653, AISI 304, 304L, 304LN, 302, 321, 347, 316, 316L, 316Ti, 316Cb or duplex stainless steels such as 1.4162 X2CrNiMoN21-5-1, 1.4362 X2CrNiN23-4, 1.4462 X2CrNiMoN22-5-3, UNS S32101, S32304, S31803, S32205; LDX 2101®, SAF 2304, SAF 2205 or dissimilar joints between austenitic and heat resistant steels 1.4713 X10CrAlSi7, 1.4724 X10CrAlSi13, 1.4742 X10CrAlSi18, 1.4826 GX40CrNiSi22-10, 1.4828 X15CrNiSi20-12, 1.4832 GX25CrNiSi20-14, 1.4837 GX40CrNiSi25-12 with ferritic steels to pressure boiler steels P295GH and also fine grained structural steels to P355N, shipbuilding steels grade A – E, AH 32 – EH 36, A40 – F40, etc.

Dissimilar joint welds – overlay welding the first corrosion resistant surface layer on P235GH, P265GH, S255N, P295GH, S355N – S500N; and high-temperature quenched and tempered fine-grained steels.

#### Typical chemical analysis all weld metal (%)

C	0.03	Cr	23.00
Si	0.70	Ni	12.50
Mn	1.40	Mo	2.70

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	540 MPa	ISO-V	+20 °C: 65 J
R <sub>m</sub>	705 MPa		-60 °C: 44 J
A5	28 %		

#### Ø / mm

0.9	1.2		
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#### Approvals

TÜV, BV, LR, DNV GL, CE

## Stainless steels – Special applications

### BÖHLER CN 23/12 Mo-IG

EN ISO 14343-A: W 23 12 2 L
AWS A5.9: ER309LMo (mod.)
Welding process: GTAW

#### Characteristics and applications

GTAW rod of type W 23 12 2 L / ER309LMo (mod.) for surfacing low-alloy steels and welding dissimilar joints between duplex and stainless steels with low-alloy steels. When used for surfacing the composition is more or less equal to that of ASTM 316 from the first run.

BÖHLER CN 23/12 Mo-IG is designed for very good welding and wetting characteristics and ensuring high resistance against hot-cracking. Suitable for service temperatures between -40 °C and +300 °C.

#### Base materials

Dissimilar joint welds of and between high-strength, mild steels and low-alloyed QT-steels with duplex, stainless, ferritic Cr- and austenitic Cr-Ni-Mo steels.

Surfacing: for the first layer of corrosion resistant weld surfacing on ferritic-pearlitic steels in boiler and pressure vessel parts up to fine-grained steel S500N, as well as of high temperature steels like 22NiMoCr4-7 acc. SEW-Werkstoffblatt 365, 366, 20MnMoNi5-5 and G18NiMoCr3-7.

#### Typical chemical analysis all weld metal (%)

C	0.014	Cr	21.50
Si	0.35	Ni	15.00
Mn	1.50	Mo	2.70

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	470 MPa	ISO-V	+20 °C: 140 J
R <sub>m</sub>	640 MPa		-40 °C: 90 J
A5	34 %		

#### Ø / mm

1.6	2.0	2.4	
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#### Approvals

TÜV, CE

### BÖHLER CN 23/12 Mo-IG

EN ISO 14343-A: G 23 12 2 L
AWS A5.9: ER309LMo (mod.)
Welding process: GMAW

#### Characteristics and applications

GMAW solid wire of type G 23 12 2 L / ER309LMo (mod.) for surfacing low-alloy steels and welding dissimilar joints between duplex and stainless steels with low-alloy steels. When used for surfacing the composition is more or less equal to that of ASTM 316 from the first run.

BÖHLER CN 23/12 Mo-IG is designed for very good welding and wetting characteristics and ensuring high resistance against hot-cracking. Suitable for service temperatures between -40 °C and +300 °C.

#### Base materials

Dissimilar joint welds of and between high-strength, mild steels and low-alloyed QT-steels with duplex, stainless, ferritic Cr- and austenitic Cr-Ni-Mo steels.

Surfacing: for the first layer of corrosion resistant weld surfacing on ferritic-pearlitic steels in boiler and pressure vessel parts up to fine-grained steel S500N, as well as of high temperature steels like 22NiMoCr4-7 acc. SEW-Werkstoffblatt 365, 366, 20MnMoNi5-5 and G18NiMoCr3-7.

#### Typical chemical analysis all weld metal (%)

C	0.014	Cr	21.50
Si	0.35	Ni	15.00
Mn	1.50	Mo	2.70

#### Typical mechanical properties all weld metal

R <sub>p0.2</sub>	470 MPa	ISO-V	+20 °C: 75 J
R <sub>m</sub>	640 MPa		-40 °C: 65 J
A5	31 %		

#### Ø / mm

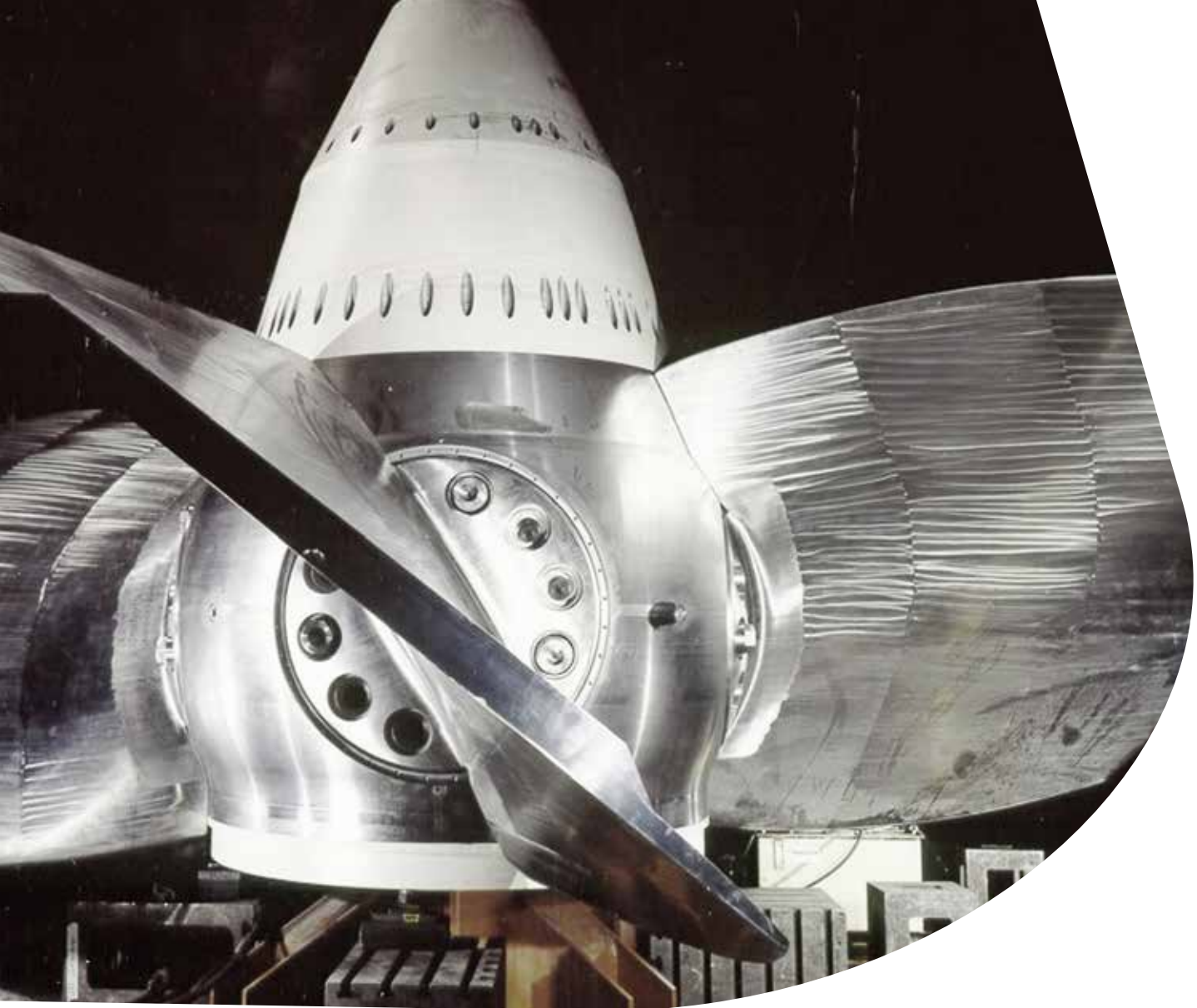
1.2			
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#### Approvals

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## Notes





Kaplan turbine made of 13Cr 4Ni stainless steel S 41500, 1.4313

## References



Close up view on a Francis turbine.



Spiral case of the hydropower plant Goldisthal, Germany





Penstock Kaprun, Austria. MCE staff control the fully mechanized GTAW hot wire process



Prefabrication of the Penstock Kaprun, Austria Steel grade S 690 Q, STM A514 Gr.F



Prefabrication of the Penstock Kaprun, Austria Steel grade S 690 Q, ASTM A514 Gr.F





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