Lasting Connections

SELECTION GUIDE

COVERED ELECTRODES FOR (SMAW / MMA)

voestalpine Böhler Welding
www.voestalpine.com/welding

voestalpine
ONE STEP AHEAD.

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.

Our clients benefit from a partner with

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

Within a given AWS classification, various electrodes with different coating types are available on the market.

This selection guide is a tool to support you in the selection of the best performing stick electrode for your application, especially in the case of commodities with several “equal” products to select from.

Specialized in welding consumables for Joining – Böhler Welding also offers a broad range of stick electrodes for standard unalloyed up to high alloyed steel qualities.

Please visit **www.voestalpine.com/welding** for a full overview or contact one of our application engineers.

EN ISO CLASSIFICATION FOR STICK ELECTRODES

EN ISO 2560	Covered electrodes for manual metal arc welding of non-alloyed and fine grain steels.
EN ISO 3580	Covered electrodes for manual metal arc welding of creep resistant steels.
EN ISO 3581	Covered electrodes for manual metal arc welding of stainless and heat resistant steels. (former EN 1600)
EN ISO 14172	Covered electrodes for manual metal arc welding of nickel and nickel alloys.
EN ISO 18275	Covered electrodes for manual metal arc welding of high strength steels. (former EN 757)

EN ISO 2560: **E 42 5 B 4 2 H5**

E – type of welding consumable. Here: Electrode
42 – code for the min. yield strength. Here: 420 MPa
5 – code for the temperature at which 47 J CVN impact toughness is guaranteed. Here: -50 °C
B – type of coating. Here: Basic
4 – code for recovery and type of current. Here: > 105 % < 125 %. typee of current: DC
2 – code for position. Here: all positions except vertical-down
H5 – code for diffusible hydrogen content – in the all weld metal. Here: H_2 < 5 mg/100 g weld metal

AWS CLASSIFICATION FOR STICK ELECTRODES

Unalloyed electrodes	AWS A5.1
AWS A5.1:	**E7018-1H4R** **E –** type of welding consumable. Here: Electrode **70 –** code for the min. tensile strength in [ksi]. Here: 70 ksi (= 480 MPa) **1 –** code for the welding positions. Here: 1 = All positions (2 = flat and horizontal only) **8 –** type of coating and current and polarity. Here: iron powder low hydrogen. Polarity AC or DCEP **-1 –** this electrode meets low temperature impact requirements **H4 –** code for diffusible hydrogen. Here: < 4 mg / 100 g weld metal **R –** code for reduced moisture absorption
HIGH Alloyed electrodes	**AWS A5.4**
AWS A5.4:	**E308L-16** **E –** code for type of welding consumable. Here: Electrode **308 –** code for chemical composition **L –** code for low carbon **-16 –** usability designation: -15 = DCEP only, basic type; -16 (-17) includes arc stabilizing elements (rutile). AC possible

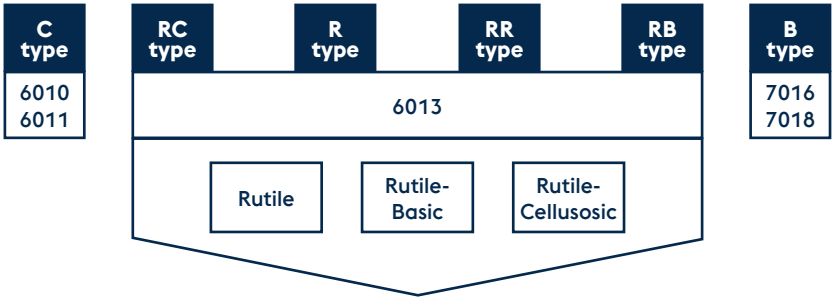
STICK ELECTRODES FOR UNALLOYED STEELS

Comparison of the EN ISO and AWS standards for unalloyed steel gives the approximate range of available stick electrodes.

The difference is the coating type:

C	Cellulosic
RC	Rutile Cellulosic
R / RR	Rutile or Thick Rutile
RB	Rutile Basic
B	Basic

Different coating types acc. to EN ISO



What is the difference?

C – CELLULOSIC TYPE – AWS: E6010 / EN ISO: E 38 3 C 2 1

Mainly for pipeline welding.

The cellulosic coating provides an intensive arc which enables fast vertical-down welding on large pipelines.

This example shows the classification for the steel with the lowest strength level. The highest would be E9010.

Böhler Welding products:

BÖHLER FOX CEL	AWS: E6010	EN ISO: E 38 3 C 2 1	Standard welding of hot pass, filler and cap
BÖHLER FOX CEL +	AWS: E6010	EN ISO: E 38 2 C 2 1	Especially for welding root passes
Phoenix CEL 70	AWS: E6010	EN ISO: E 42 2 C 2 5	Welding of hot pass, filler passes and cap. Higher toughness and a more fluid weld pool.

Background: the cellulosic coating creates an exothermic reaction which provides the intensive arc with deep penetration and allows a high welding speed.

RC – RUTILE-CELLULOSIC TYPE – AWS: E6013 / EN ISO: E 38 0 RC 1 1

Electrodes for a variety of steel constructions on site

The thin coated rutile/celullosic cover provides:

- Very good arc striking behaviour
- Very intensive arc
- Good penetration
- Easy to weld in all positions

Böhler Welding products:

BÖHLER FOX OHV	AWS: E6013	EN ISO: E 38 0 RC 1 1
BÖHLER FOX KE	AWS: E6013	EN ISO: E 38 0 RC 1 1
Phoenix 6013	AWS: E6013	EN ISO: E 42 0 RC 1 1
Phoenix Blau	AWS: E6013	EN ISO: E 42 0 RC 1 1

RC – RUTILE-CELLULOSIC TYPE – AWS: E6013 / EN ISO: E 38 0 RC 1 1

The characteristics of these electrodes are ideal for outdoor welding under adverse conditions. They can be used anywhere; even with simple welding equipment. Due to the intensive arc, they can be used to weld zinc-coated material or plates with paint or primer residuals.

BÖHLER FOX OHV
BÖHLER FOX KE
Phoenix 6013

- » Low spatter formation
- » Better bead appearance
- » Higher flexibility for welding positions
- » Vertical-up welds

Phoenix Blau

- » More intensive arc
- » Higher zinc coating thickness on the plate
- » Better penetration
- » Vertical-down welds

R/RR – RUTILE TYPE – AWS: E6013 / EN ISO: E 42 0 RR 1 2

Electrodes for smooth and clean beads with good appearance (RR – Types)
Very easy to handle, in most welding positions. Mainly RR – types are on the market

Böhler Welding products:

BÖHLER FOX ETI	AWS: E6013	EN ISO: E 42 0 RR 1 2
BÖHLER FOX SUM	AWS: E6013	EN ISO: E 38 0 RR 1 2
Phoenix Grün T	AWS: E6013	EN ISO: E 42 0 RR 1 2
Phoenix SH Blau	AWS: E6013	EN ISO: E 42 0 RR 1 2

- Good arc striking behaviour
- Fine rippled weld bead surface
- Very good slag detachability – mostly self-releasing slag
- Extremely smooth weld beads
- Minimum spatter

R/RR – RUTILE TYPE – AWS: E6013 / EN ISO: E 42 0 RR 1 2

Choose the Böhler Welding product which is best suited for your specific needs:

Electrode type (Ø 3.2 mm)	AC welding on simple equipment	Re-striking behaviour (cold cond.) *	Spatter formation for bead on plate welds	Spatter formation for fillet welds	Possibility for vertical-down welding	Arc intensity
BÖHLER FOX ETI	2	2	2	1	Ø 2.5 mm only	2
BÖHLER FOX SUM	2	2	1	1	Ø 2.5 mm only	2
Phoenix Grün T	1	1	1	3	1	1
Phoenix SH Blau	3	1	1	3	Ø 2.5 mm only	1
Ranking: 1-excellent; 2-good; 3-OK						

Footnote:
* the higher the electrode coating temperature the better the re-striking characteristics – investigation was done with „cold“ electrodes

RB – RUTILE-BASIC TYPE – AWS: E6013 / EN ISO: E 38 2 RB 1 2

These electrodes combine the very easy weldability of rutile types with improved mechanical properties of basic coated electrodes.

These elektrodes offer:

- Good characteristics for root pass welding
- All-positional weldability
- Good CVN impact toughness down to -20 °C
- Suitability for several applications

Böhler Welding products:

BÖHLER FOX SPE	AWS: E6013 (mod.)	EN ISO: E 38 2 RB 1 2
Phoenix SH Gelb R	AWS: E6013	EN ISO: E 38 2 RB 1 2

RB – RUTILE-BASIC TYPE – AWS: E6013 / EN ISO: E 38 2 RB 1 2

These electrodes are perfect for the welding of tubes in the vertical-up position, giving sound welds with good mechanical properties. Slag is easy to remove.

BÖHLER FOX SPE

- Root pass welding
- Good differentiation of slag and weld-pool
- Thin-walled tubes
- Narrow gap welding

Phoenix SH Gelb R

- Vertical-up welding
- High bending angle of the electrode
- Very small working areas

AWS: E7018 – BASIC COATED ELECTRODES FOR UNALLOYED STEELS

This basic coated group of electrodes meets the upper end of the requirements for welding unalloyed steel.

Higher quality requests and higher mechanical properties in terms of strength and impact toughness can be satisfied.

However, significant differences are found in characteristics and application of individual electrodes. Classification suffixes show whether the electrode has improved impact toughness or a low-hydrogen weld metal.

They consist of three main types:

- Standard type for joining (or sometimes maintenance) of unalloyed steels
- The A1 type for creep resistant steels for elevated temperature applications, e. g. in thermal power plants
- The G type including 1 % Ni, for low-temperature and sour gas applications.
  It is a typical mixed type, suited for creep resistant as well as higher toughness applications.

AWS: E7018 – STANDARD TYPE

General purpose electrode for normal temperature applications in unalloyed steel. Different types are reflected by the classification:

Böhler Welding products:

BÖHLER FOX 7018	AWS: E7018-H4R	EN ISO: E 42 4 B 4 2 H5	impact @ -40 °C, moisture resistant coating and low-hydrogen weld metal
Phoenix 120 K	AWS: E7018-1	EN ISO: E 42 5 B 3 2 H5	impact @ -50 °C, high recovery, Ø 5.0 and 6.0 mm allow high current settings
BÖHLER FOX EV 50	AWS: E7018-1H4R	EN ISO: E 42 5 B 4 2 H5	impact @ -50 °C, moisture resistant coating and low-hydrogen weld metal
BÖHLER FOX EV 55	AWS: E7018-1H4R	EN ISO: E 46 5 B 4 2 H5	higher strength, impact @ -50 °C, moisture resistant coating and low-hydrogen weld metal

AWS: E7018 – A1 TYPE FOR CREEP RESISTANT STEELS

Also a 7018 type, but mostly used for creep resistant materials, including 0.5 % Mo (16Mo3 steel grades).
Can also be used for higher strength steel, due to the addition of Mo.

Therefore, they are often classified according to two EN ISO standards: 2560-A for unalloyed steels and 3580-A for creep resistant steels.

Böhler Welding products:

BÖHLER FOX DMO Kb	AWS: E7018-A1H4	EN ISO 2560-A: E 42 4 B 4 2 H5 EN ISO 3580-A: E Mo B 4 2 H5 – low-hydrogen weld metal

This product is for creep resistant steels up to 500 °C, but also meets toughness requirements down to -40 °C.

AWS: E7018 – G TYPE

The classification –G is also a 7018 type, but with deviations from the standard.
Böhler Welding provides a 1 % Ni product for high strength, low temperature applications.

Böhler Welding products:

BÖHLER FOX 1 Ni	AWS: E7018-GH4R	EN ISO: E 46 6 1Ni B 4 2 H5
BÖHLER FOX 7018 G	AWS: E7018-GH4R	EN ISO: E 46 6 1Ni B 4 2 H5
Moisture resistant coating and low-hydrogen weld metal.		

Due to the addition of 1 % Ni, these products have a service temperature range from -60 °C up to 350 °C.
They yield an average CVN impact toughness of 100 J @ -60 °C, all weld metal.

AWS: E7018 – MAINTENANCE & REPAIR

These two products are classified according to AWS as 7018. Both are designed for maintenance and repair of unalloyed steels.

UTP Maintenance products:

UTP 614 Kb	AWS: E7018	EN ISO: E 42 3 B 3 2 H10	high recovery of 120 %
UTP 613 Kb	AWS: ~ E7018-1H4R	EN ISO: E 42 5 B 4 2 H5	impact @ -50 °C, moisture resistant coating and low diffusible hydrogen

*This product does not exactly meet the AWS standard, therefore it is marked with the ~sign.

UTP Maintenance is specialized in repair, maintenance and cladding – offering customers and partners Tailor-Made Protectivity™

AWS: 7015 AND 7016

Less common than E7018, but also used for welding a variety of unalloyed steels.

Both are basic types. The reason for the different classification is more or less market driven; sometimes one of these special classifications is required.

Böhler Welding products:

Phoenix K 50	AWS: E7015	EN ISO: E 42 4 B 4 2	» if AWS E 7015 is required
Phoenix K 50 R Mod	AWS: E7016	EN ISO: E 42 3 B 4 2	» pipeline root pass welding on DCEP
BÖHLER FOX EV Pipe	AWS: E7016-1	EN ISO: E 42 4 B 4 1	» especially designed for pipeline welding
BÖHLER FOX EV 47	AWS: E7016-1H4R	EN ISO: E 38 4 B 4 2 H5	» impact @ -40 °C, moisture resistant coating and low diffusible hydrogen. DC polarity only.
Phoenix K 90 S	AWS: E7016	EN ISO: E 46 4 B 3 2 H5	» higher strength, welding on AC and DC

STAINLESS STEEL ELECTRODES – TYPICAL COMMODITIES

hese stick electrodes are generally known by their AWS classification which indicates the chemical composition of the weld metal.

Three standard types are used for welding the most common austenitic stainless steel grades and for joining these with unalloyed steel.

AWS 308 – 309 – 316

Also used frequently are electrode types according to **AWS E 347** and **AWS E 307**

The most commonly applied heat resistant stainless steels are welded with electrodes according to **AWS E 308 H** and **AWS E 347 H**

BASE MATERIALS FOR WHICH THESE STAINLESS STEEL ELECTRODES ARE SUITED

The typical austenitic stainless steels for which these electrode types are used are commonly applied in the chemical, petrochemical and food industry, but also for stainless constructions, fences and many other stainless steel applications.

They are designated in the AISI standard e.g. as 304L or 316L, as well as by EN material numbers such as 1.4301, 1.4306, 1.4401 or 1.4404.

The AWS 309L electrode type is mostly used for joining dissimilar types of stainless steel or for joining unalloyed steel and stainless steel. Another use is the cladding of unalloyed steel.

STAINLESS STEEL ELECTRODES – TYPICAL COMMODITIES – AWS E308L

Böhler Welding products for austenitic stainless steels type AISI 304L (EN 1.4301, 1.4306):

Rutile type		
BÖHLER AWS E308L-16	AWS: E308L-16	No EN classification only for AWS driven markets
BÖHLER AWS E308L-17	AWS: E308L-17	EN ISO: E 19 9 L R 3 2
BÖHLER FOX EAS 2-A	AWS: E308L-17	EN ISO: E 19 9 L R 3 2

BÖHLER FOX EAS 2-A comes with a wide range of approvals, including a special version for vertical down welding:

BÖHLER FOX EAS 2-VD	AWS: E308L-17	EN ISO: E 19 9 L R 1 5

STAINLESS STEEL ELECTRODES – TYPICAL COMMODITIES – AWS E308L

Böhler Welding products for austenitic stainless steels type AISI 304L (EN 1.4301, 1.4306):

Basic type			
BÖHLER FOX EAS 2	AWS: E308L-15	EN ISO: E 19 9 L B 2 2	
BÖHLER FOX EAS 2 (LF)	AWS: E308L-15	EN ISO: E 19 9 L B 2 2	Low ferrite content for cryogenic applications down to -196 °C (e. g. LNG plants)

STAINLESS STEEL ELECTRODES – AWS E308 FOR HEAT RESISTANT STEELS

Böhler Welding products:

BÖHLER FOX CN 18/11	AWS: E308-15	EN ISO: E 19 9 B 4 2	Basic type
BÖHLER FOX E 308 H	AWS: E308H-16	EN ISO: E 19 9 H R 4 2	Rutile-basic type high carbon
Thermanit ATS 4	AWS: E308H-15	EN ISO: E 19 9 H B 2 2	Basic type high carbon

These products are designed to meet requirements for heat resistant stainless steels with a higher carbon content. For joining of heat resistant base materials up to 700 °C for turbine and pressure vessels in thermal power plants.

STAINLESS STEEL ELECTRODES – TYPICAL COMMODITIES – AWS E316L

Böhler Welding products for austenitic stainless steels type AISI 316L (EN 1.4401, 1.4404):

Rutile type		
BÖHLER AWS E316L-16	AWS: E316L-16	No EN classification only for AWS driven markets
BÖHLER AWS E316L-17	AWS: E316L-17	EN ISO: E 19 12 3 L R 3 2
BÖHLER FOX EAS 4 M-A	AWS: E316L-17	EN ISO: E 19 12 3 L R 3 2

BÖHLER FOX EAS 4 M-A comes with a wide range of approvals, including a special version for vertical down welding:

BÖHLER FOX EAS 4 M-VD	AWS: E316L-17	EN ISO: E 19 12 3 L R 1 5

STAINLESS STEEL ELECTRODES – TYPICAL COMMODITIES – AWS E316L

Böhler Welding products for austenitic stainless steels type AISI 316L (EN 1.4401, 1.4404):

Basic type			
BÖHLER FOX EAS 4 M	AWS: E316L-15	EN ISO: E 19 12 3 L B 2 2	
BÖHLER FOX EAS 4 M (LF)	AWS: E316L-15	EN ISO: E Z19 12 3 L B 2 2	Low ferrite content for cryogenic applications down to -196 °C (e. g. LNG plants)

STAINLESS STEEL ELECTRODES – AWS E309 / E309L / E309LMo

These types are commonly used for welding dissimilar joints as well as for the cladding of unalloyed plates. E309LMo consumables are used for Mo-alloyed CrNi-steels for a higher corrosion resistance.

Böhler Welding products:

Avesta 309 AC/DC	AWS: E309-17	EN ISO: E Z 23 12 R	Rutile type, high carbon
BÖHLER FOX CN 23/12-A	AWS: E309L-17	EN ISO: E 23 12 L R 3 2	Rutile type without Mo
BÖHLER FOX CN 23/12 Mo-A	AWS: E309LMo-17	EN ISO: E 23 12 2 L R 3 2	Rutile type Mo alloyed

Avesta 309 AC/DC a high carbon type which is mostly used for creep resistant and high temperature applications and for dissimilar joints.

STAINLESS STEEL ELECTRODES – TYPE AWS E307

This alloy type has a very wide field of application. It is used for the welding of dissimilar joints as well as for buffer layers prior to hardfacing on 14 % Mn steels or heat resistant 13-17 % Cr steels or for armour plates.

Böhler Welding products:

BÖHLER FOX A 7	AWS: E307-15	EN ISO: E 18 8 Mn B 2 2	Basic coated
BÖHLER FOX A 7-A	AWS: E307-16 (mod.)	EN ISO: E Z18 9 MnMo R 3 2	Rutile coated
Avesta 307 AC/DC	AWS: E307-17	EN ISO: E 18 9 MnMo R	Rutile coated

STAINLESS STEEL ELECTRODES – AWS E347

These steels and welding consumables are stabilized austenitic stainless grades.

voestalpine Böhler Welding offers a low carbon version (C ≤ 0.03 %) as well as a higher carbon version (C ≥ 0.05 %) for creep resistant applications.

Böhler Welding products:

BÖHLER FOX SAS 2	AWS: E347-15	EN ISO: E 19 9 Nb B 2 2	Basic type, low carbon
BÖHLER FOX SAS 2-A	AWS: E347-17	EN ISO: E 19 9 Nb R 3 2	Rutile type, low carbon
BÖHLER FOX E 347 H	AWS: E347-15	EN ISO: E 19 9 H R 4 2	Rutile-basic type, high carbon

BÖHLER FOX E 347 H is designed to meet requirements for creep resistant stainless CrNi-steels with a higher carbon content. For the joining of creep resistant base materials above 400 °C for turbine and pressure vessels in thermal power plants. Specially designed for welding AISI 347H. Controlled ferrite content of 3-8 FN.

046/2018/EN/GL

JOIN!
voestalpine Böhler Welding

With over 100 years of experience, voestalpine Böhler Welding is the global innovator for the daily welding challenges in joining, wear and corrosion protection as well as brazing.

Customer proximity is guaranteed by more than 40 subsidiaries in 25 countries, with the support of 2,200 employees, and through more than 1,000 distribution partners worldwide. And with individual consultation by our application technicians and welding engineers, we make sure that our customers master the most demanding welding challenges. voestalpine Böhler Welding offers three specialized and dedicated brands to cater our customers' and partners' requirements.

Lasting Connections – More than 2,000 products for joint welding in all conventional arc welding processes are united in a product portfolio that is unique throughout the world. Creating Lasting Connections is the brand's philosophy in welding and between people.

Tailor-Made Protectivity™ – Decades of industry experience and application know-how in the areas of repair of cracked material, anti-wear and cladding, combined with innovative and custom-tailored products, guarantee customers an increase in the productivity and protection of their components.

In-Depth Know-How – Through deep insight into processing methods and ways of application, Fontargen Brazing provides the best brazing and soldering solutions based on proven products with German technology. The expertise of this brand's application engineers has been formulated over many years of experience from countless application cases.

voestalpine Böhler Welding
www.voestalpine.com/welding

voestalpine
ONE STEP AHEAD.