böhler welding
by voestalpine

Lasting Connections

BISMUTH-FREE STAINLESS FLUX-CORED WIRES FOR HIGH SERVICE TEMPERATURES

voestalpine Böhler Welding
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ONE STEP AHEAD.

LASTING CONNECTIONS

As a pioneer in innovative welding consumables, Böhler Welding offers a unique product portfolio for joint welding worldwide. More than 2000 products are adapted continuously to the current industry specifications and customer requirements, certified by well-respected institutes and thus approved for the most demanding welding applications.

Our customers benefit from a partner with

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

FLUX-CORED ARC WELDING – THE FLEXIBLE AND PRODUCTIVE WAY TO JOIN STAINLESS STEEL

Böhler Welding flux-cored wires offer a productive and versatile alternative for the welding of stainless steel over SMAW / MMA with stick electrodes or GMAW / MIG with solid wires.

They outperform any other manual arc welding process for stainless steel in terms of welding productivity and feature outstanding weldability and superb weld quality. The rutile slag system gives an excellent bead appearance, while the slag is easily removed.

WHY BISMUTH-FREE?

The flux formulation of stainless steel flux-cored wires usually contains small amounts of bismuth in the form of Bi2O3 to improve slag detachability. The resulting bismuth content in the weld metal is about 180-200 ppm. At service temperatures below roughly 500 °C there are no detrimental effects from bismuth on quality and mechanical properties of the weld, but at higher temperatures segregation of bismuth to the grain boundaries occurs. The following issues have been experienced:

- Reduced ductility at temperatures above 650°C
- Inter-granular cracks at temperatures above 700°C with fracture surface showing presence of bismuth

The vast majority of stainless steel weld deposits are put into service below about 250°C, but within power generation and process industries, extended service can exceed temperatures of 500°C. It is in these weldments that bismuth creates problems, which may also occur when carrying out a post weld heat treatment (PWHT) when weld overlaying carbon steel or after repair of castings.

WHEN NEEDED?

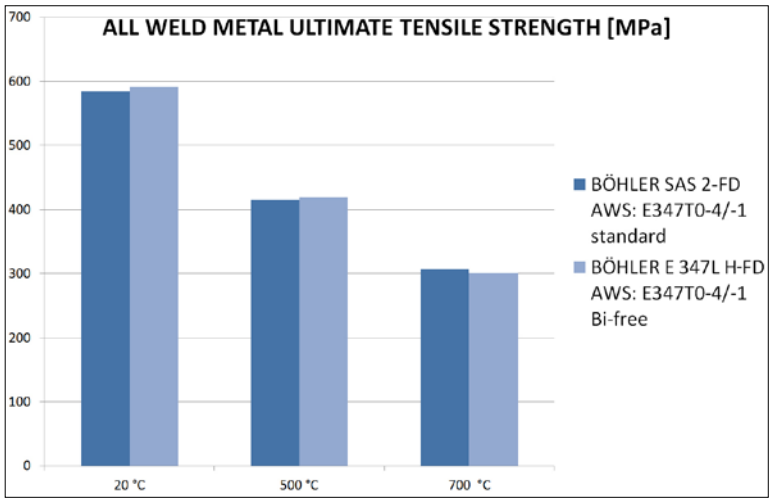
Bi-free stainless cored wires are needed when joining alloys such as 347, 347H, 321, 321H or 308H intended for high temperature service and also when cladding over creep resistant steels.

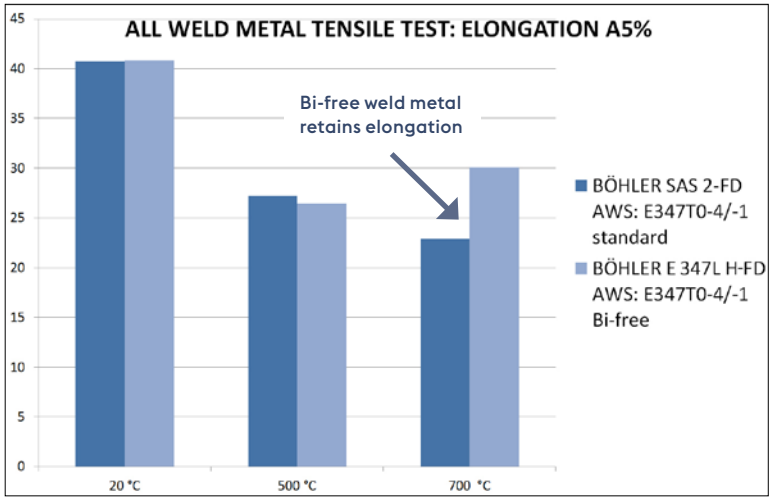
Cladding applications are often found in the petrochemical industry. The operating temperature of petrochemical critical process equipment is usually below 538 °C with the exception of Fluid Catalytic Cracking (FCC) units. These operate at 716 °C. Other units may have service temperatures below 538 °C, but they utilize clad creep resistant steel requiring a post weld heat treatment above this critical temperature.

For instance, main critical process equipment, such as hydro-treating, hydro-cracking and hydro-desulpharization reactors as well as effluent heat exchangers are constructed from CRA clad grade 11, grade 22 or grade 22V, needing PWHT. Some areas, such as the inside of nozzles and fittings, cannot be covered by clad plates and/or strip cladding and need separate overlay welding. This can be efficiently done using the FCAW process.

Flux-cored wires can be efficiently used for completing claddings inside nozzles, fittings and weld overlay build-up of internal supports. Example of uncovered areas to be restored on a dished-end.

THE BÖHLER WELDING RANGE OF BISMUTH-FREE STAINLESS CORED WIRES





Comparison between Bi-containing and Bi-free 347 type weld metal. At high temperatures, the Bi-free weld metal retains its elongation properties.

Böhler Welding offers two series of bismuth-free stainless steel cored wires. These have the same weldability and slag detachability as bismuth alloyed stainless cored wires. Low-temperature CVN impact toughness and lateral expansion are also at the same level.

The two series are:
» All-positional rutile FCW for joining
» Flat-horizontal rutile FCW for joining and cladding

All-positional rutile cored wires feature excellent weldability in all positions. They are used for joining high-temperature resistant stainless steel. The fast freezing slag system allows relatively high amperes in positional welding.

Flat-horizontal rutile cored wires are optimized to maximize the parameters, and consequently are used for high deposition rate, in flat-horizontal positions. They are ideal for cladding low-alloyed, creep resistant steels but can be used also for joining high-temperature resistant stainless steel when welding in flat position.

Both type of wires are easy to operate – both in manual and mechanized welding– and show excellent welding characteristics with conventional non-pulse power sources.

The weld deposit is scaling resistant and- because of the controlled low delta ferrite content - highly resistant to sigma phase embrittlement.

The wires are developed for use in M21 (Ar + 18% CO_2) shielding gas, but they are also suitable when welding in 100% CO_2.

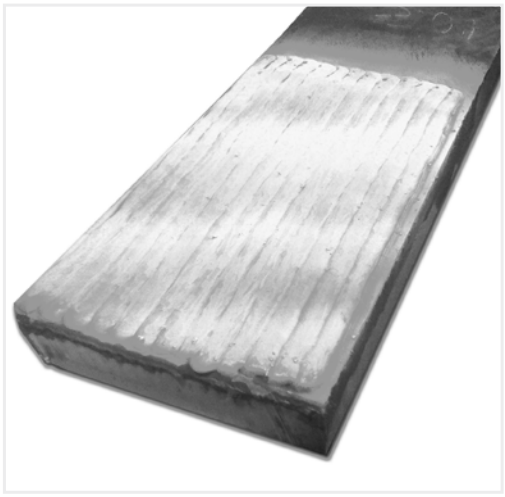
They are welder-friendly and operate with a powerful penetrating spray arc and minimum spatter formation. Productivity advantages over solid wire pulse arc welding are easily obtained, while using simple non-pulse power sources.

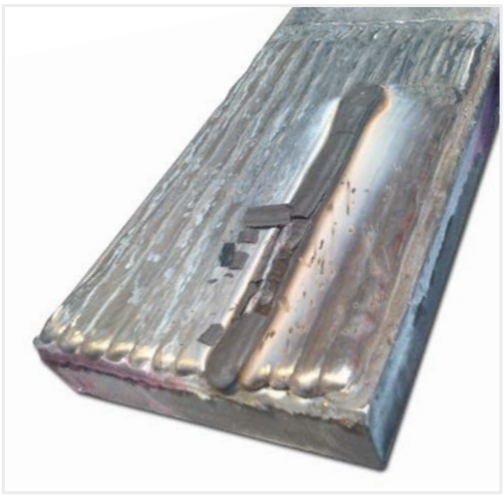
Additional cost efficiency is realized through the use of cheaper shielding gases, good wetting (less grinding), little oxidation (less pickling), and safe penetration and smooth and clean welds (less repair and cleaning).

PRODUCT OVERVIEW OF BI-FREE FLUX-CORED WIRES

	Product Name	Mechanical properties, all weld metal, typical values							
		Condi-tion	Rp0.2 (MPa)	Rm (MPa)	A5 (%)	CVN (J) +20°C	-60°C	-120°C	-196°C
All-positional rutile FCW	**BÖHLER E 308 H PW-FD** EN ISO 17633-A: T Z 19 9 H P M21 1 | T Z 19 9 H P C1 1 EN ISO 17633-B: TS 308H-F M21 1 | TS 308H-F C1 1 AWS A5.22: E308HT1-4 | E308HT1-1	AW (as welded)	370 (>350)	560 (>550)	45 (>25)	90 (>32)			
	BÖHLER E 309L H PW-FD EN ISO 17633-A: T23 12 L P M21 1 EN ISO 17633-B: TS 309L F M21 1 | TS 309L-F C1 1 AWS A5.22: E309LT1-4 | E309LT1-1	AW	390 (>350)	530 (>520)	35 (>30)	80 (>47)	60 (>32)		
	BÖHLER E 347 H PW-FD EN ISO 17633-A: T 19 9 Nb P M21 1 AWS A5.22: E347HT1-4 | E347HT1-1	AW	410 (>350)	580 (>550)	38 (>25)	95 (>47)		55 (>32)	35
Flat-horizontal rutile FCW	**BÖHLER E 308 H-FD** EN ISO 17633-A: T Z 19 9 H R M21 3 | T Z 19 9 H R C1 3 EN ISO 17633-B: TS 308H-F M21 0 | TS 308H-F C 1 0 AWS A5.22: E308HT0-4 | E308HT0-1	AW	360 (>350)	560 (>550)	45 (>25)	85 (>32)			
	BÖHLER E 309L H-FD EN ISO 17633-A: T 23 12 L R M21 3 | T 23 12 L R C1 3 EN ISO 17633-B: TS 309L-F M21 0 | TS 309L-F C1 0 AWS A5.22: E309LT0-4 | E309LT0-1	AW	390 (>320)	530 (>520)	35 (>25)	65 (>47)	45 (>32)		
	BÖHLER E 347L H-FD EN ISO 17633-A: T 19 9 Nb R M21 3 | T 19 9 Nb R C1 3 EN ISO 17633-B: TS 347L-F M21 0 | TS 347L-F C1 0 AWS A5.22: E347T0-4 | E347T0-1	AW	420 (>350)	580 (>550)	35 (>25)	90 (>47)		50 (>32)	35

TWO-LAYER CLADDING ON BASE MATERIAL 10CRMO 9 10 (ASTM A387 GR. 22)





Chemistry at the surface of the 1st and 2nd layer

	C	Si	Mn	Cr	Mo	Ni	Nb	Ferrite measured*
1st layer	0.048	0.53	1.30	19.8	0.15	10.3	0.004	8–9 FN
2nd layer	0.034	0.59	1.49	19.3	0.08	10.2	0.39	6.5–7.5 FN

Undiluted chemistry of the wires

	C	Si	Mn	Cr	Mo	Ni	Nb	Ferrite measured*
BÖHLER E 309L H-FD	0.030	0.6	1.3	23.0	0.04	12.2	0.01	15 FN
BÖHLER E 347L H-FD	0.030	0.6	1.3	18.8	0.04	10.5	0.45	5–9 FN

* with Fisher Ferritscope MP30

Welding Parameter	
1st Layer BÖHLER E 309L H-FD 2nd Layer BÖHLER E 347L H-FD	
Interpass-Temperature:	max. 150°C
Shielding gas:	Ar + 18% CO_2
Amperage:	230 - 240 A
Wire feed speed:	12m/min
Overlapping:	~50%

JOIN! voestalpine Böhler Welding

With over 100 years of experience, voestalpine Böhler Welding is the global top address for the daily challenges in the areas of joint welding, repair, hardfacing and cladding as well as brazing. Customer proximity is guaranteed by more than 43 subsidiaries in 25 countries, with the support of 2,300 employees, and through more than 2,000 distribution partners worldwide. 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 – As a pioneer in innovative welding consumables, Böhler Welding offers a unique product portfolio for joint welding worldwide. More than 2000 products are adapted continuously to the current industry specifications and customer requirements, certified by well-respected institutes and thus approved for the most demanding welding applications. As a reliable partner for customers, "lasting connections" are the brand's philosophy in terms of both welding and people.

Tailor-Made Protectivity™ – UTP Maintenance ensures an optimum combination of protection and productivity with innovative and tailor-made solutions. Everything revolves around the customer and their individual requirements. That is expressed in the central performance promise: Tailor-Made Protectivity™.

In-Depth Know-How – As a leading brand of soldering and brazing consumables, Fontargen Brazing offers proven solutions based on 50 years of industrial experience, tried and tested processes and methods. This In-Depth Know-How has made Fontargen Brazing an internationally preferred partner for every soldering and brazing task.

The Management System of voestalpine Böhler Welding Group GmbH, Peter-Mueller-Strasse 14-14a, 40469 Duesseldorf, Germany has been approved by Lloyd's Register Quality Assurance to: ISO 9001:2015, ISO 14001:2015, OHSAS 18001:2007, applicable to: Development, Manufacturing and Supply of Welding and Brazing Consumables.
More information: www.voestalpine.com/welding

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