

Welding Consumables for Exhaust Systems in Automotive Engineering





Lasting Connections

Creating lasting connections is the most important part of the welding process. Böhler Welding offers a globally unique product portfolio for all conventional arc welding processes and our best-in-class welding consumables ensure lasting connections – even in the most challenging applications and industries.

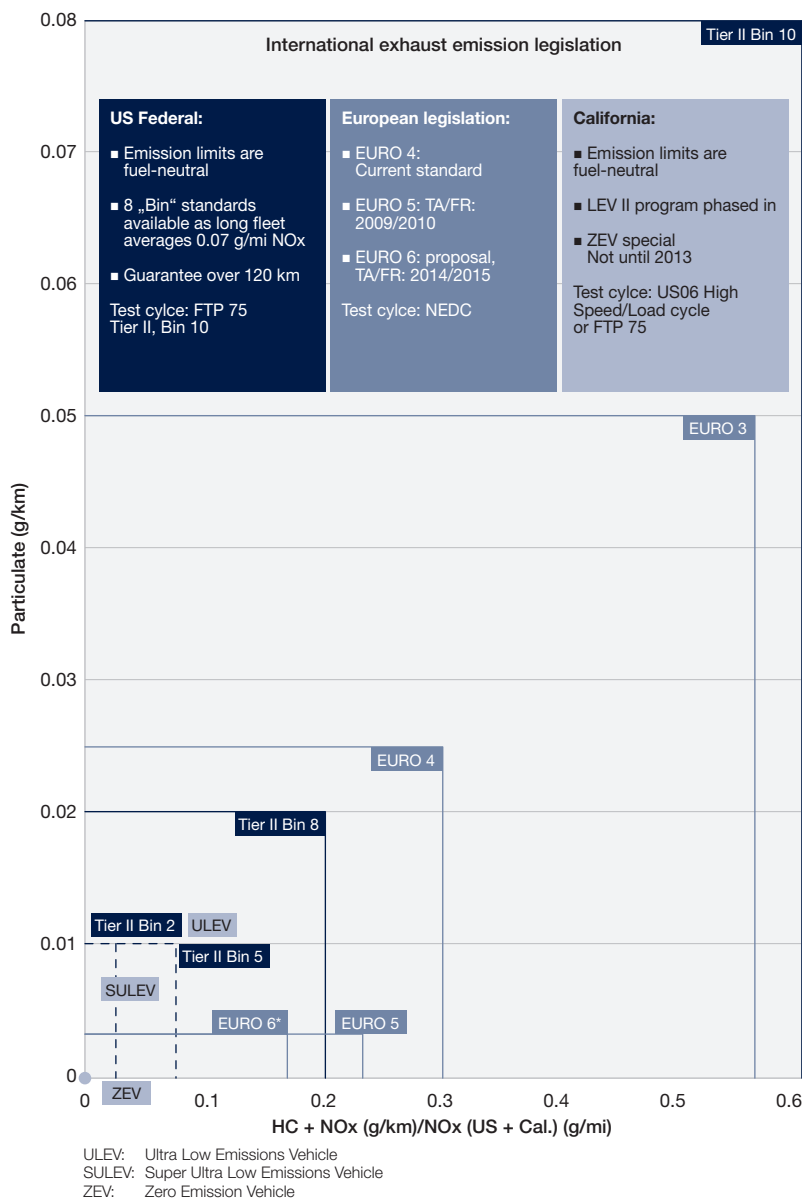
Our range of solid and metal-cored welding wires for the manufacturing of exhaust systems in the automotive industry answer the latest demands placed on materials by ever more stringent international emission legislation – resulting in higher operating temperatures for catalytic converters and overall weight reduction. Our welding consumables are specifically designed for the robotic welding challenges in exhaust system manufacturing, securing short cycle times and minimal downtime, lowest possible reject rates and minimal post weld work.

Exhaust System Base Material Requirements

Demands placed on motor vehicles are constantly increasing. High performance is required along with energy efficiency and low weight, while more stringent international legislation enforces steadily reduced emissions. Quality and performance of the exhaust system are elementary in modern cars.

To reduce emissions and save weight, there is a trend towards reduced wall thickness and higher operating temperatures for exhaust system components such as catalytic converters and diesel particle filters. They need to be produced efficiently for a long service life. In the manufacturing process, welding consumables

play a crucial role in the dependable, high-speed welding of thin-walled components. Exhaust systems are exposed to extreme mechanical and corrosive loads. They must withstand temperatures from -40 °C to 950 °C and accommodate the resultant stresses. Condensate in the interior and brine from outside mean that the material must be highly corrosion-resistant. This leads to the use of a variety of steel grades.



European and US legislation over the years placing increasingly sharper demands on exhaust emissions from personal cars.

The exhaust system is divided into three sections, each of which is subject to different mechanical, heat and corrosion conditions. Base material and welding consumables must withstand these conditions:

High temperature section

(exhaust manifold, catalytic converter, diesel particle filter):

- High resistance to scaling
- Low embrittlement tendency

Middle section

(pre-silencer, connection pipe):

- High temperature- and corrosion resistance

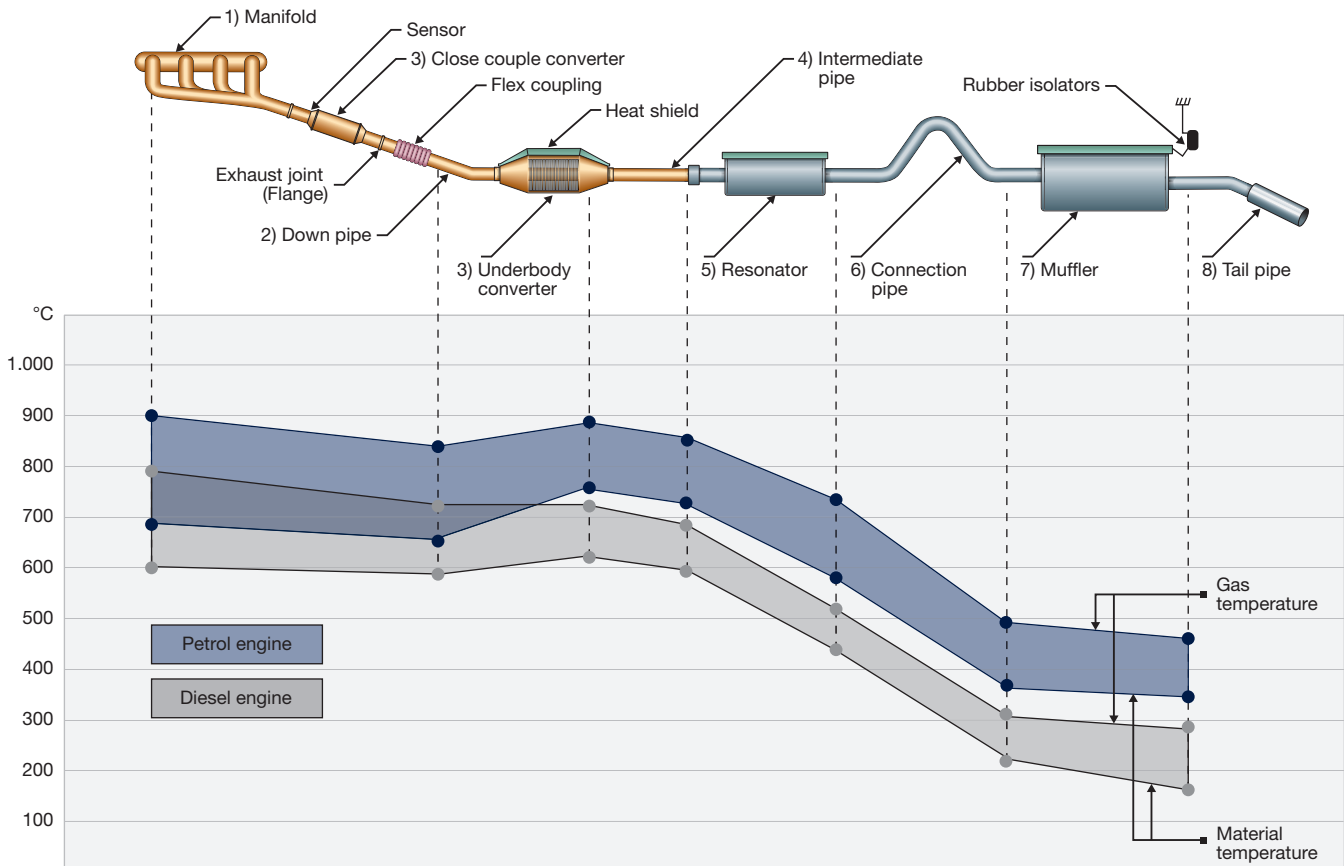
End section

(rear silencer, tail pipe):

- Wet corrosion due to condensate in interior
- Corrosion due to brine from outside



Weld seams on an exhaust manifold



Example of an exhaust system with thermal histograms for petrol and diesel engines.
 Source: International Journal of Recent Development in Engineering and Technology.
 Materials for Automotive Exhaust System by S. Rajadurai, M. Afnas, S. Ananth and S. Surendhar, Sharda Motor Industries Ltd.

Component	Ferritic base material		Austenitic base material	
	Euro Norm, Nom., acc. EN 10027-2 AISI/ASTM/UNS	Recommended filler material	Norm, Nom., acc. EN 10027-2 AISI/ASTM/UNS	Recommended filler material
1) Manifold	1.4509 / X2CrTiNb18 / 430 1.4511 / X3CrNb17 / 430 Nb	BÖHLER CAT 430L Cb Ti BÖHLER CAT 430L Cb	1.4828 / X15CrNiSi20-12 / 309 1.4828 / 309 (mod.)	BÖHLER FF-IG
2) Down pipe	1.4509 / X2CrTiNb18 / 430 1.4512 / X2CrTi12 / 409	BÖHLER CAT 430L Cb Ti Thermanit 409 Cb	1.4828 / X15CrNiSi20-12 / 309	BÖHLER FF-IG BÖHLER A 7-MC
3) Catalytic converter	1.4509 / X2CrTiNb18 / 430 1.4511 / X3CrNb17 / 430 Nb	BÖHLER CAT 430L Cb Ti BÖHLER CAT 430L Cb	1.4828 / X15CrNiSi20-12 / 309	BÖHLER FF-IG BÖHLER A 7-MC
4) Intermediate pipe	1.4509 / X2CrTiNb18 / 430 1.4512 / X2CrTi12 / 409	BÖHLER CAT 430L Cb Ti Thermanit 409 Cb	1.4301 / X5CrNi18-10 / 304	BÖHLER A 7-MC BÖHLER EAS 2-IG (Si)
5) Resonator/Pre-silencer	1.4512 / X2CrTi12 / 409 1.4510 / X3CrTi17 / 439	BÖHLER CAT 439L Ti Thermanit 409 Cb	1.4301 / X5CrNi18-10 / 304 1.4541 / X6CrNiTi18-10 / 347	BÖHLER EAS 2-IG (Si) BÖHLER SAS 2-IG (Si)
6) Connection pipe	1.4512 / X2CrTi12 / 409	Thermanit 409 Cb	1.4301 / X5CrNi18-10 / 304	BÖHLER EAS 2-IG (Si)
7) Muffler	1.4512 / X2CrTi12 / 409	Thermanit 409 Cb	1.4301 / X5CrNi18-10 / 304 1.4541 / X6CrNiTi18-10 / 347	BÖHLER EAS 2-IG (Si) BÖHLER SAS 2-IG (Si)
8) Tail pipe	1.4509 / X2CrTiNb18 / 430	BÖHLER CAT 430L Cb Ti	1.4301 / X5CrNi18-10 / 304 1.4401 / X5CrNiMo17-12-2 / 316	BÖHLER EAS 2-IG (Si) BÖHLER EAS 4 M-IG (Si)

Selection of Welding Consumables Based on Requirements

The selection of the right combination of base material and welding consumable is closely linked to the area of use. It depends on which effect is most important; corrosion or high temperature and the related tendency of some materials to become brittle. Some materials are exposed to high temperatures and corrosion. This combination quickly pushes the base material and the welding consumable to the limits. With the right selection of welding consumable and welding method it is possible to improve these critical conditions considerably. Exhaust systems, like many components in automotive engineering, are assembled in automated robotic cells. The clear aim is high productivity: shorter

process times, low reject rates and minimum welding defects paired with as little reworking (cleaning, weld repairs) as possible. These aims pose great challenges for the welding consumable. High welding speeds require low, even feed force and a high tolerance range. Very good general welding properties are also required, including clean, regular weld seams which meet the high quality demanded in automotive engineering. The welding consumable naturally needs to meet mechanical and chemical requirements as well.

Product table

Product	EN Classification	AWS Classification	Typical Chemical Composition (%)									
			C	Si	Mn	Cr	Ni	Mo	Nb	Ti		
Solid wires	BÖHLER EAS 2-IG (Si)	G 19 9 L Si	ER308LSi	≤0.02	0.8	1.7	20.0	10.2				
	BÖHLER SAS 2-IG (Si)	G 19 9 Nb Si	ER347Si	0.035	0.8	1.3	19.4	9.7			+	
	BÖHLER EAS 4 M-IG (Si)	G 19 12 3 L Si	ER316LSi	0.02	0.8	1.7	18.4	12.4	2.8			
	BÖHLER A 7 CN-IG	G 18 8 Mn	ER307 (mod.)	0.08	0.9	7.0	19.2	9.0				
	BÖHLER FF-IG	G 22 12 H	ER309 (mod.)	0.1	1.1	1.6	22.5	11.5				
	BÖHLER FA-IG	G 25 4		0.07	0.8	1.2	25.7	4.5				
	Thermanit 409 Cb	G Z13 Nb L	ER409Nb	≤0.05	0.6	0.6	11.5				≥10xC	
	BÖHLER CAT 439L Ti-IG	G Z18 Ti L	ER439	0.03	0.8	0.8	18.0					> 12xC
	BÖHLER CAT 430L Cb-IG	G Z18 L Nb	ER430 (mod.)	0.02	0.5	0.5	18.0				> 12xC	
	BÖHLER CAT 430L Cb Ti-IG	G ZCr 18 NbTi L	ER430Nb (mod.)	0.02	0.5	0.5	18.0				> 12xC	0.4
Metal-cored wires	BÖHLER A 7-MC	T 18 8 Mn MM1	EC307 (mod.)	0.1	0.6	6.3	18.8	9.2				
	BÖHLER FF-MC	T 22 12 H M M13 1	EC309 (mod.)	0.07	0.6	0.6	20.5	10.5	0.16			(FN 5-9)
	BÖHLER CAT 439L Ti-MC	T Z17 Ti L M M12 1	EC439	0.02	0.5	0.7	18.5					0.85
	BÖHLER CAT 430L Cb-MC	T Z17 Nb L M M12 1	EC439Nb	0.02	0.5	0.7	18.5				0.65	0.12
	BÖHLER CAT 430L Cb Ti-MC	T Z17 Nb Ti L M M12 1	EC430G	0.02	0.5	0.7	18.5				0.55	0.35

For more details on our products please consult our product search on www.voestalpine.com/welding

Böhler Welding Metal-Cored Wires – Higher Welding Speed and Better Gap Bridging

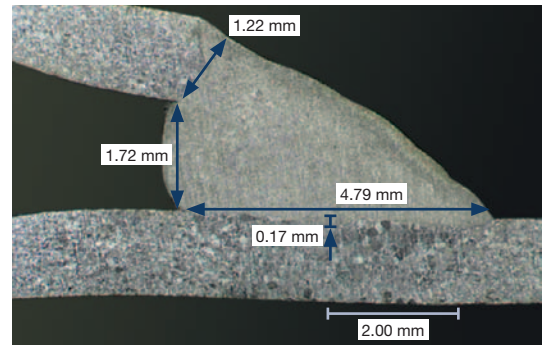
The Böhler Welding range of metal-cored wires has been developed in co-operation with automotive engineers to ensure that the products meet the specific requirements of robotic welding of exhaust systems. The wires have been developed for the high speed welding of thin-walled plate and feature arc stability, good weld penetration and good gap bridging properties with different arc types. The wider penetration profile is beneficial to avoid lack of fusion defects and associated rejects and repairs – particularly important for this industry.

Due to their design – a metal sheath filled with metal powder – Böhler Welding metal-cored wires for exhaust systems have a much higher deposition rate and welding speed than solid wires of the same diameter. They also enter the favorable spray arc droplet transfer mode at much lower wire feed speeds and reduce the unfavorable transitional (globular) mode. Because of these properties, it is easy to find suitable welding parameters for the majority of exhaust welding applications while the wires are tolerant for gap width.

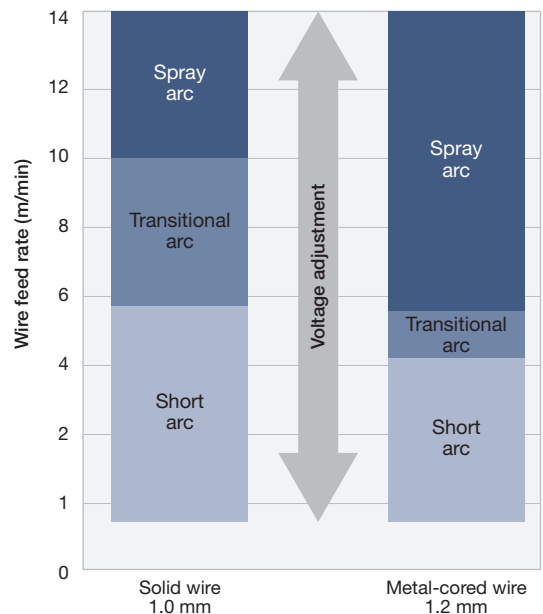
The Böhler Welding range of metal-cored wires has been expanded to weld ferritic and austenitic material grades used for different parts of the exhaust system. More details are found in the product table.

Significant cost savings

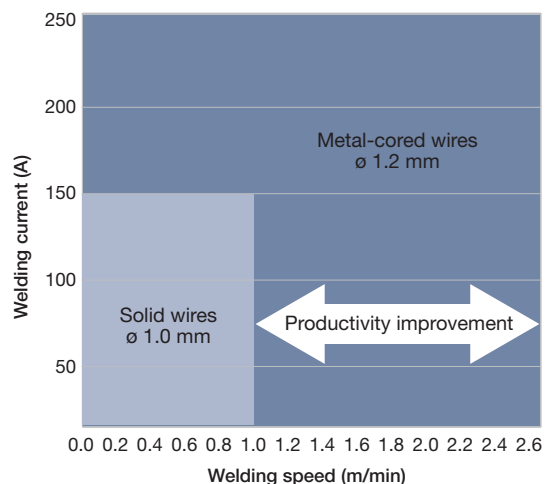
Böhler Welding metal-cored wires offer cost savings in terms of higher production output, increased weld quality, less rejects and less post weld repairs and cleaning.



Good gap bridging properties from Böhler Welding metal-cored wires



Use of the metal-cored wire enables considerably higher welding speeds



Product feature	User benefit
Spray arc starts at low welding current	Shorter cycle times – more production output; Avoid lack of fusion – less repair rate
Spray arc starts at low welding current	Low spatter, good penetration – less rejects and less post weld cleaning
Travel speeds up to 2.5m/min possible	Shorter cycle times – more production output
Good weld penetration, excellent wetting behavior	Avoidance of fusion defects – less rejects and less post weld repair
Good gap bridging	Tolerant for fit-up – less rejects and less post weld repair
No weaving	Increased welding speed

Development Test on a Robot System

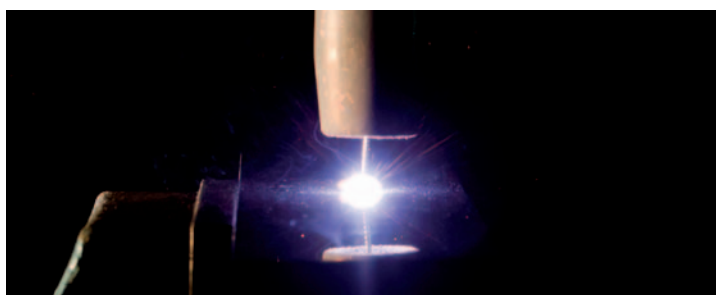
These photographs show samples from a series of tests carried out on the robot system during the development of the wires. The samples comprise two approx. 1.2 mm thick sheet plates which were welded along the overlap. Different feed speeds and arc types were used to simulate the different requirements. The results show that excellent joints were produced with all settings.

Sample No.	Arc type	Current intensity (A)	Voltage (V)	Wire feed (m/min)	Welding speed (m/min)
1	Short arc	121	12.5	2.8	1.0
2	Spray arc	225	19.6	6.7	2.4
3	DFPM*	211	13.4	7.2	1.8

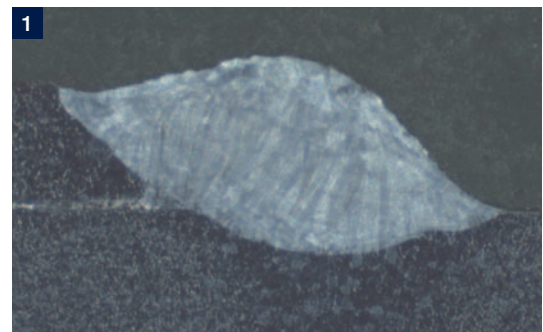
* Double frequency pulse mode



BÖHLER CAT 430L Cb Ti-MC, uncleaned welding samples



Double frequency pulse mode arc with BÖHLER CAT 430L Cb Ti-MC



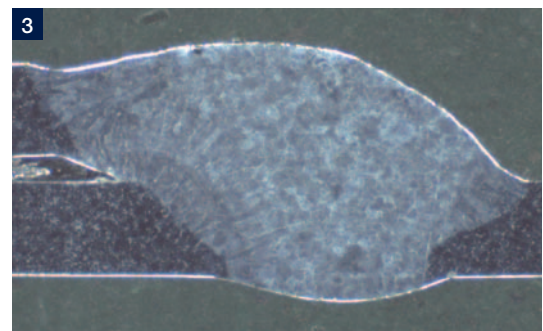
Short arc

The short arc enables gap-bridging with different gap widths. In combination with the metal-cored wire, a very good weld fluidity is achieved even at high welding speeds. If low wire feed rates are required, the metal-cored wire enables a stable short arc with smooth weld toes and no notch formation.



Spray arc

The spray arc is often selected because it is the fastest and therefore usually the most economical choice in combination with the metal-cored wire.



Fronius CMT (Cold Metal Transfer)

Modern power source characteristics and “cold welding processes” can offer further optimizations. Benefits of the metal-cored wire are also evident here.

voestalpine Böhler Welding

Welding know-how joins steel

With over 100 years of experience, voestalpine Böhler Welding is the global top address for the daily challenges in the areas of joint welding, 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. 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 for 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.

Böhler Welding

Global Segment Management
welding.transportation@voestalpine.com
www.boehler-welding.com