

Lasting Connections

WELDING CONSUMABLES FOR EXHAUST SYSTEMS IN AUTOMOTIVE ENGINEERING



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

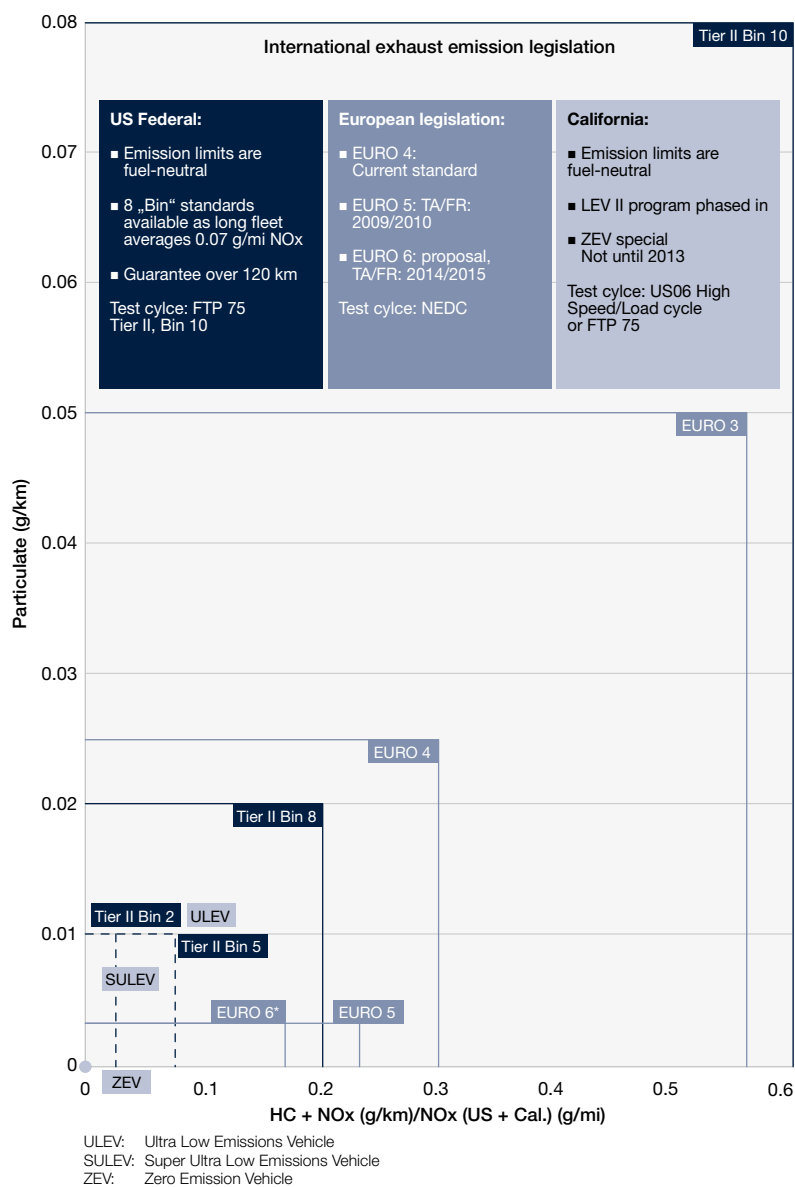
EXHAUST SYSTEM BASE MATERIAL REQUIREMENTS

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

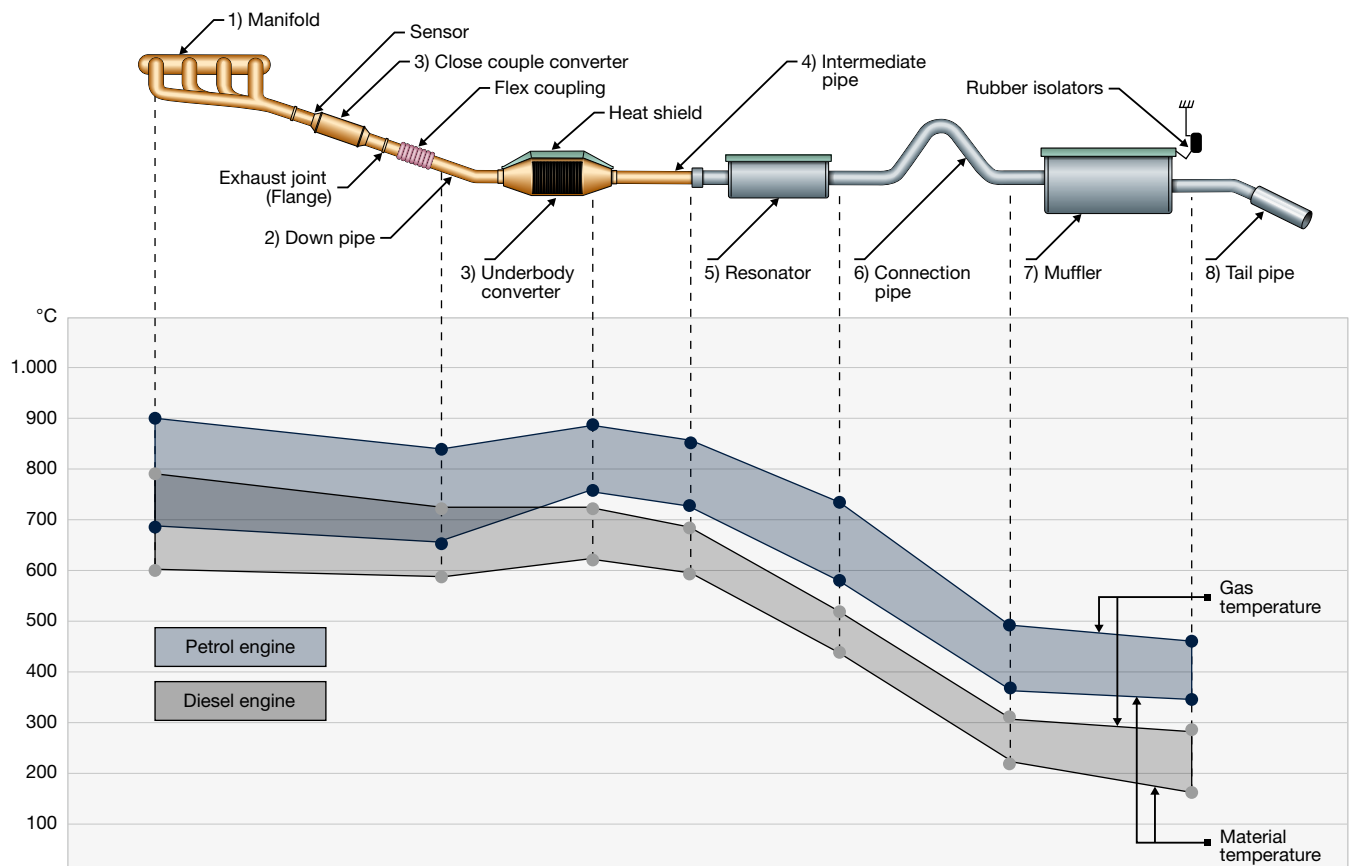
(pre-silencer, connection pipe):

- » High temperature- and corrosion resistance

End section

(rear silencer, tail pipe):

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



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/ Presilencer	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 / X5CrN-iMo17-12-2 / 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

Für weitere Informationen zu unseren Produkten verwenden Sie bitte die Produktsuche auf www.voestalpine.com/welding

Weld seams on an exhaust manifold



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.

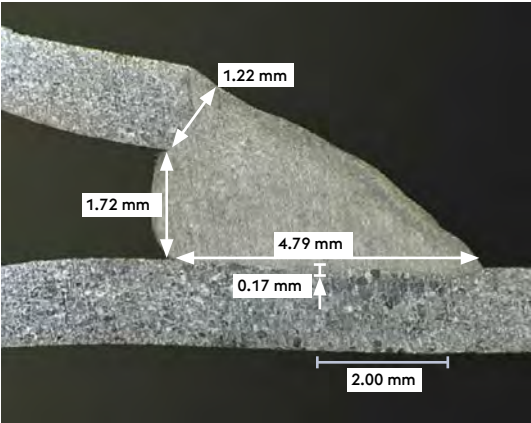
Due to their design – a metal sheath filled with metal powder – Böhler Welding metal-cored wires for exhaust systems have a much higher deposition rate and welding speed than solid wires of the same diameter. They also enter the favorable spray arc droplet transfer mode at much lower wire feed speeds 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.

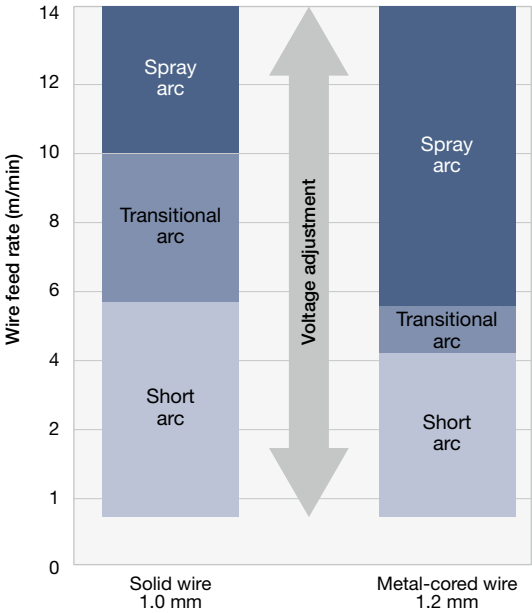
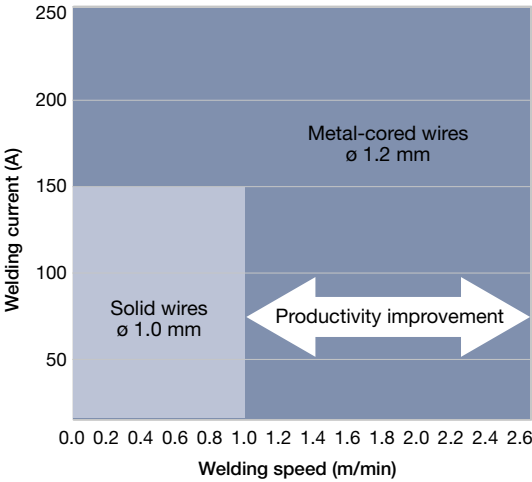
Product feature	User benefit
Spray arc starts at low welding current	Shorter cycle times – more production output; Avoid lack of fusion – less repair rate
Spray arc starts at low welding current	Low spatter, good penetration – less rejects and less post weld cleaning
Travel speeds up to 2.5m/min possible	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

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

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 (Doppelimpulslichtbogen)





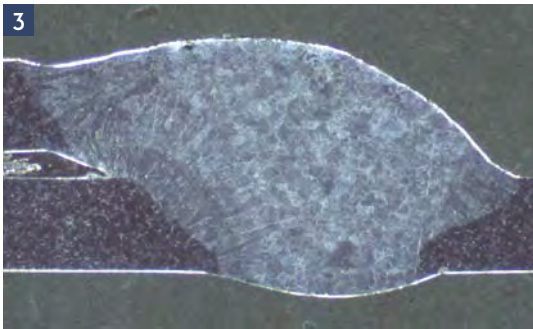
Short arc

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.



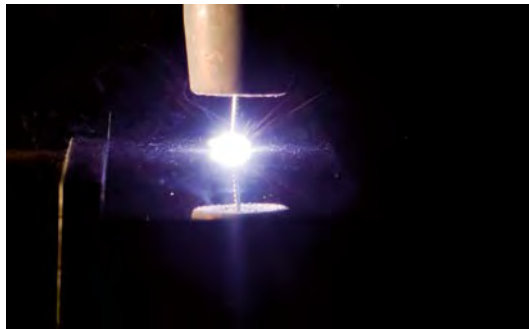
Spray arc

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.



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



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We are a leader in the welding industry with over 100 years of experience, more than 50 subsidiaries and more than 4,000 distribution partners around the world. Our extensive product portfolio and welding expertise combined with our global presence guarantees we are close when you need us. Having a profound understanding of your needs enables us to solve your demanding challenges with Full Welding Solutions - perfectly synchronized and as unique as your company.



Lasting Connections – Perfect alignment of welding machines, consumables and technologies combined with our renowned application and process know-how provide the best solution for your requirements: A true and proven connection between people, products and technologies. The result is what we promise: Full Welding Solutions for Lasting Connections.



Tailor-Made Protectivity™ – The combination of our high-quality products and application expertise enables you to not only repair and protect metal surfaces and components. Our team of engineers, experienced in your specific applications, offer you customized solutions resulting in increased productivity for your demanding challenge. The result is what we promise: Tailor-Made Protectivity™.



In-Depth Know-How – As a manufacturer of soldering and brazing consumables, we offer proven solutions based on 60 years of industrial experience, tested processes and methods, made in Germany. This in-depth know-how makes us the internationally preferred partner to solve your soldering and brazing challenge through innovative solutions. The result is what we promise: Innovation based on in-depth know-how.

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



