ESAB high-alloyed welding consumables for ferritic stainless steel exhaust systems.

Translation of an article by Bruno Schwarz and Frank Tessin published in Fenster, the customer magazine of ESAB Germany.

Although today's car fuels are very low in sulphur, a certain amount of sulphur dioxide remains present in the exhaust gases. Together with the condense water, it forms sulphurous or sulphuric acid that deposits in the exhaust system. Ferritic stainless steels resist these acids very well and have a good heat resistance. They are increasingly preferred for exhaust systems instead of austenitic stainless steels. Table 1 gives an overview of the most common ferritic stainless steels.

W-Nr.	Composition	AISI/SAE
1.4002	X6CrAl13	405
1.4003	X2Cr11	-
1.4006	X12Cr13	410
1.4016	X6Cr17	430
1.4511	X3CrNb17	-
1.4512	X2Ti12	409
1.4513	X2CrMoTi17-1	-

Table 1: ferritic stainless steels

Welding

Ferritic stainless steels are in principle sensitive to the heat cycle generated by the welding process. Grain growth and hardening due to martensite formation can reduce the toughness of the steel and increase the risk of cracking in the heat affected zone of the weld. This can be largely avoided, however, by the use of special filler materials and by applying the right welding procedure.

- In general, preheating is needed when the carbon content of the steel is above 0.08% and the thickness of the steel exceeds 3mm.
- Welding should be carried out with the lowest possible heat input (pulsed arc).
- Unstabilised steels require a post weld heat treatment at 700-750 °C to avoid intercristalline corrosion.
- Steels stabilised with titanium or niobium (columbium)do not need a post weld heat treatment.

Ferritic stainless steels can be welded with either austenitic or ferritic filler materials. Very commonly applied is the austenitic filler metal composition 18 8Mn (1.4370/ER 307, see table 2). However, this type of welding consumable is sensitive for corrosion in sulphur containing media and can therefore only be used for exhaust systems when fuels are used with an extremely low sulphur content.

Advantages with regard to fatigue strength and the general corrosion behaviour are provided by ferritic filler materials, such as of the type G13, G17 and G18 (EN440). The thermal expansion coefficient and the carbon content of both the steel and the weld metal are at the same level. Therefore, unfavourable stress peaks along the fusion line are avoided, as well as the diffusion of carbon.

ESAB offers a comprehensive range of filler materials for the welding of ferritic stainless steels, see table 2. A very productive option for specific exhaust applications are the new Arcaloy metal-cored wires for MAG welding. They enable higher deposition rates than common solid MAG wires and the low amount of spatter results in less post weld cleaning.

Hot end of an exhaust system in ferritic stainless steel.

ESAB	Type	Werkstoffnr.	Composition	AWS A5.9
OK Autrod 430LNb	Solid MIG/MAG wire	1.4511mod	G Z 17 L Nb	ER430LNb
OK Autrod 16.80		1.4009	G 13	ER410
OK Autrod 16.81		1.4502	G 17(Ti)	ER430
OK Autrod 16.82		-	G 13(Nb)	ER409Nb
OK Autrod 16.95		1.4370	G 18 8 Mn	ER307
OK Tubrod 15.34	MAG metal-cored wire	1.4370	T 18 8 Mn	ER307
Arcaloy 18 CrCb		-	(T 18 TiNb)	-
Arcaloy 409Ti		-	T 13 Ti	ER409
Arcaloy 409CB		-	T 13 Nb	ER409Nb
Arcaloy 430LCB		1.4511	T 17 (Nb)	ER430
Arcaloy 439Ti		-	(T 18 Ti)	-
OK Tigrod 16.81	TIG rod	1.4502	W 17(Ti)	ER430
OK Tigrod 16.95		1.4370	W 18 8 Mn	ER307

Table 2: ESAB welding consumables for ferritic stainless steels.