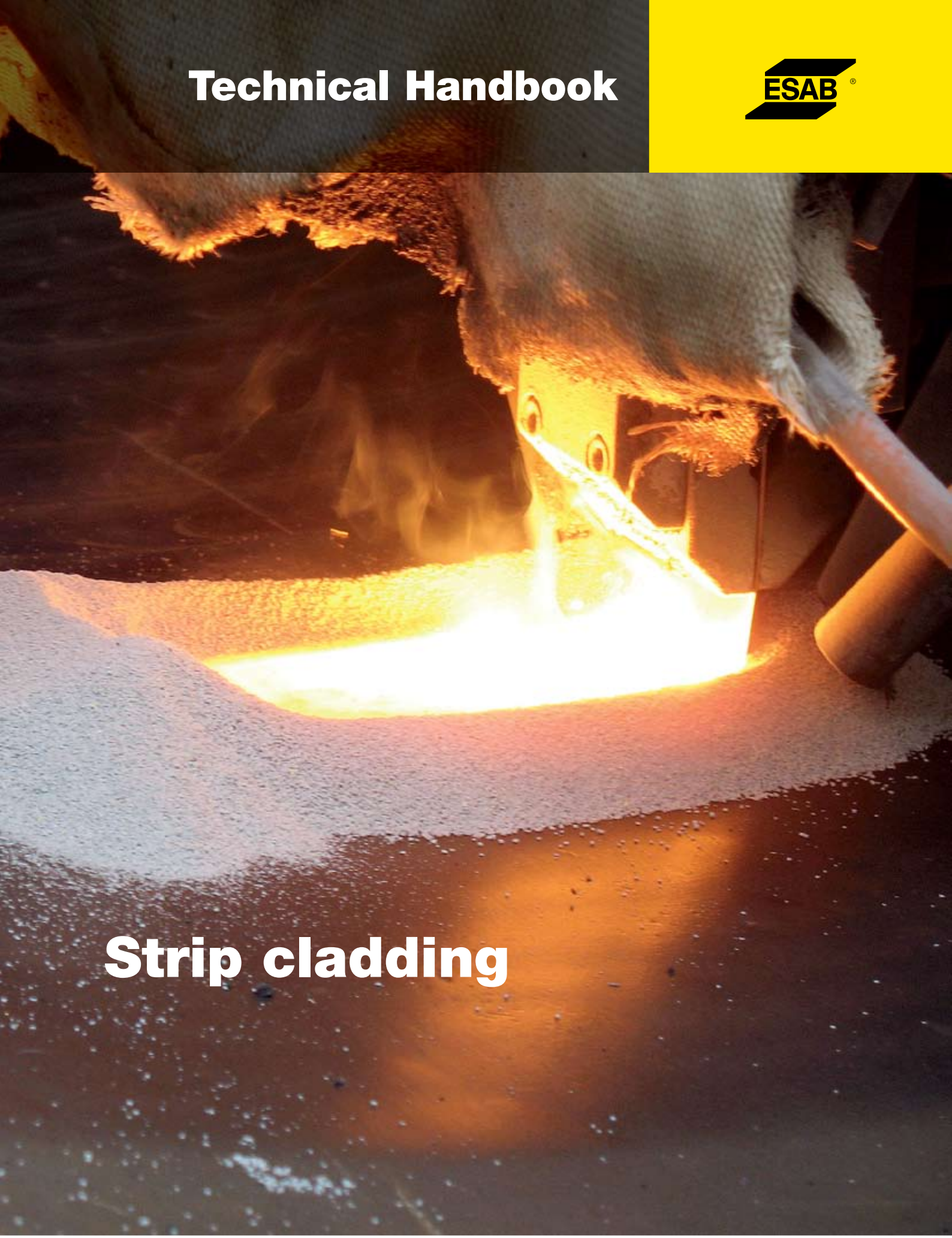
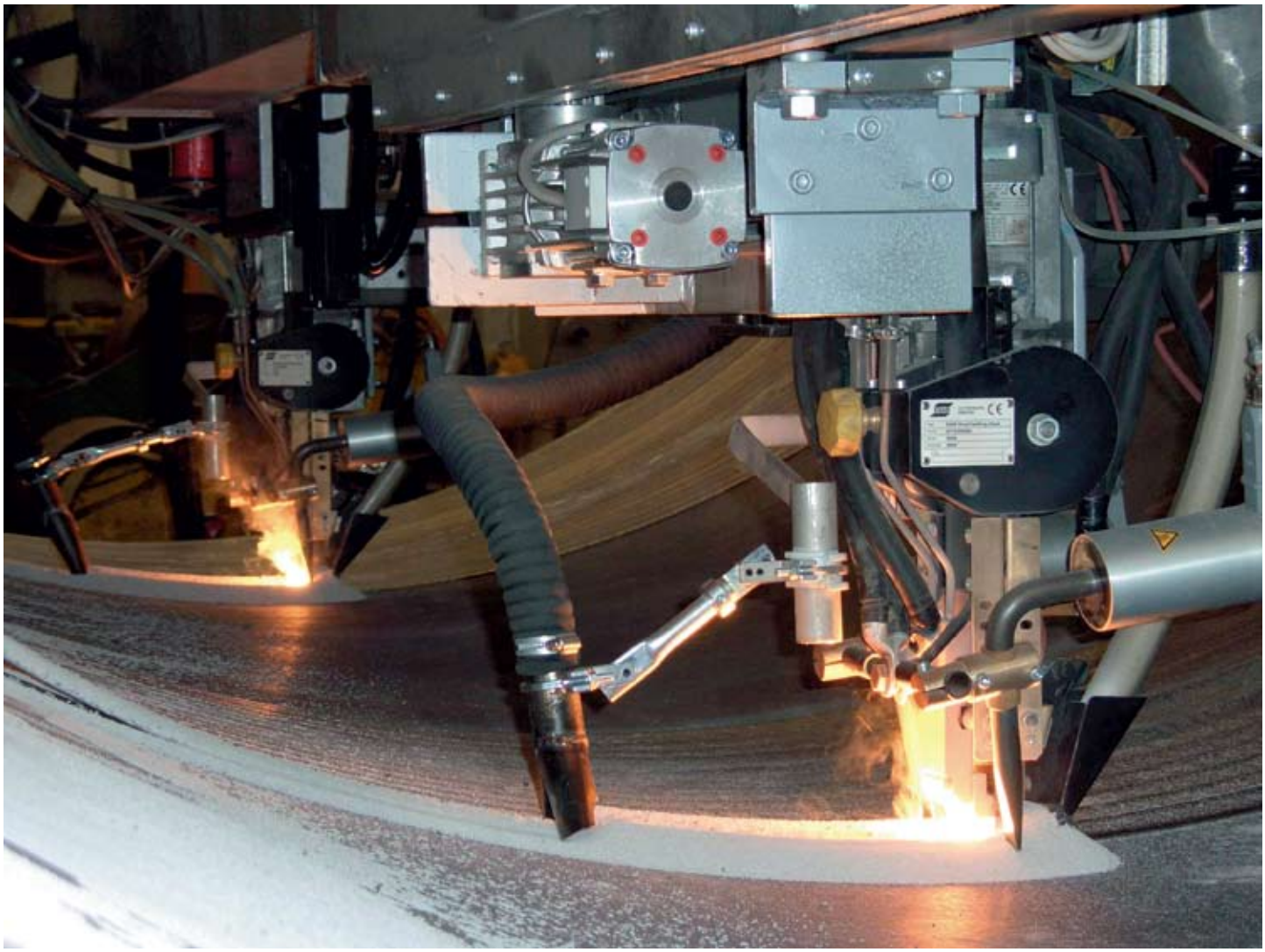
Technical Handbook



Strip cladding

FLUXES AND STRIPS FOR SUBMERGED ARC AND ELECTROSLAG STRIP CLADDING

Contents



ESAB - One solution - one supplier

This brochure presents an overview of ESABs product range of strip cladding consumables. ESAB can offer a complete technical solution including power sources, equipment, strips and fluxes as well as process and metallurgical know-how for strip cladding.

We supply strip electrodes and suitable fluxes for almost all demanding applications, for example for the chemical, petrochemical, nuclear and pulp and paper industries and also repair and maintenance.

Two cladding processes

ESAB can offer the two most productive systems for surfacing large components which are subjected to corrosion or wear. These are submerged arc and electroslag cladding, using a strip electrode.

Both proceses are characterised by a high deposition rate and low dilution. They are suitable for surfacing flat and curved objects such as heat exchangers, tubes, tube sheets and various pressure vessels.

Submerged arc welding (SAW) is the more frequently used, but if higher productivity and restricted dilution rates are required, then electroslag welding (ESW) is recommended.

Strip cladding processes

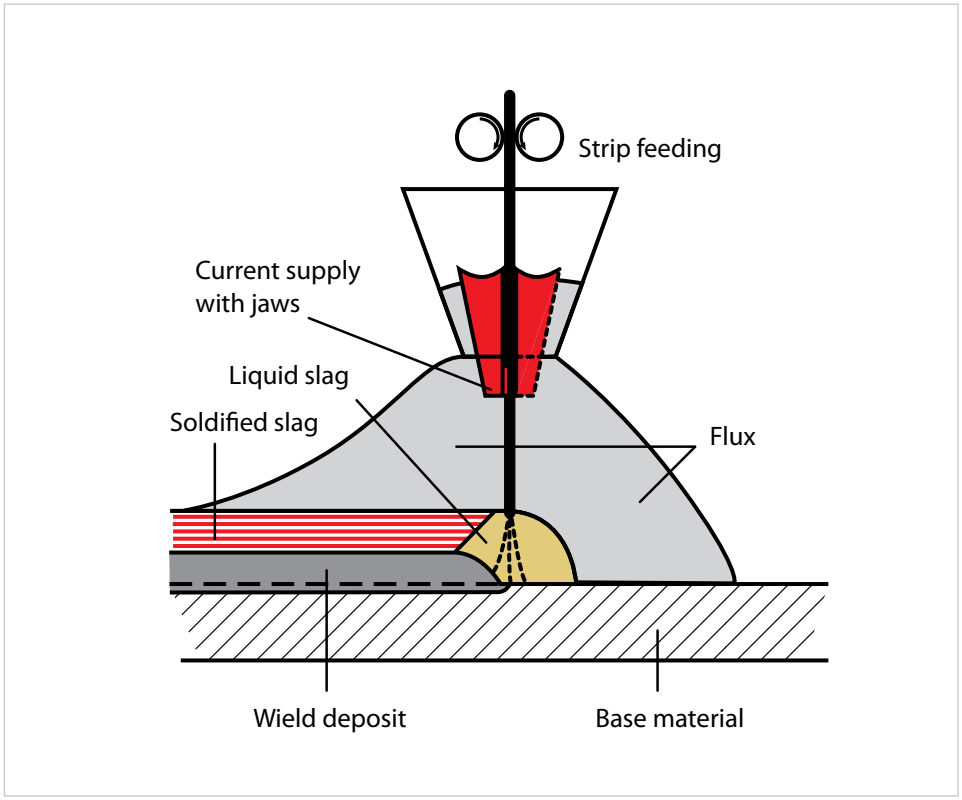


Figure 2: Submerged arc strip cladding

SAW strip cladding

The well-known SAW method has been widely used with strip electrodes since the mid-1960s. A strip electrode, normally measuring 60 x 0.5 mm or 90 x 0.5 mm, is used as the (usually positive) electrode and an electric arc is formed between the strip and the workpiece. Flux is used to form a molten slag to protect the weld pool from the atmosphere and helps to form a smooth weld bead surface.

ESW strip cladding

Electroslag strip cladding is a development of submerged arc strip cladding which has quickly established itself as a reliable high deposition rate process. ESW strip cladding relates to the resistance welding processes and is based on the ohmic resistance heating of a molten electrically conductive slag. There is no arc between the strip electrode and the parent material. The heat generated by the molten slag melts the surface of the base material, and the edge of the strip electrode is submerged in the slag and flux.

The penetration achieved with ESW is less than that with for SAW because the molten slag pool is used to melt the strip and some of the parent material. The temperature of the slag pool is about 2300°C, making it necessary to water-cool the contact jaws.

ESW uses higher welding currents than SAW strip cladding so the welding heads used are more heavy duty.
The following shows the features of ESW compared with the strip cladding process.

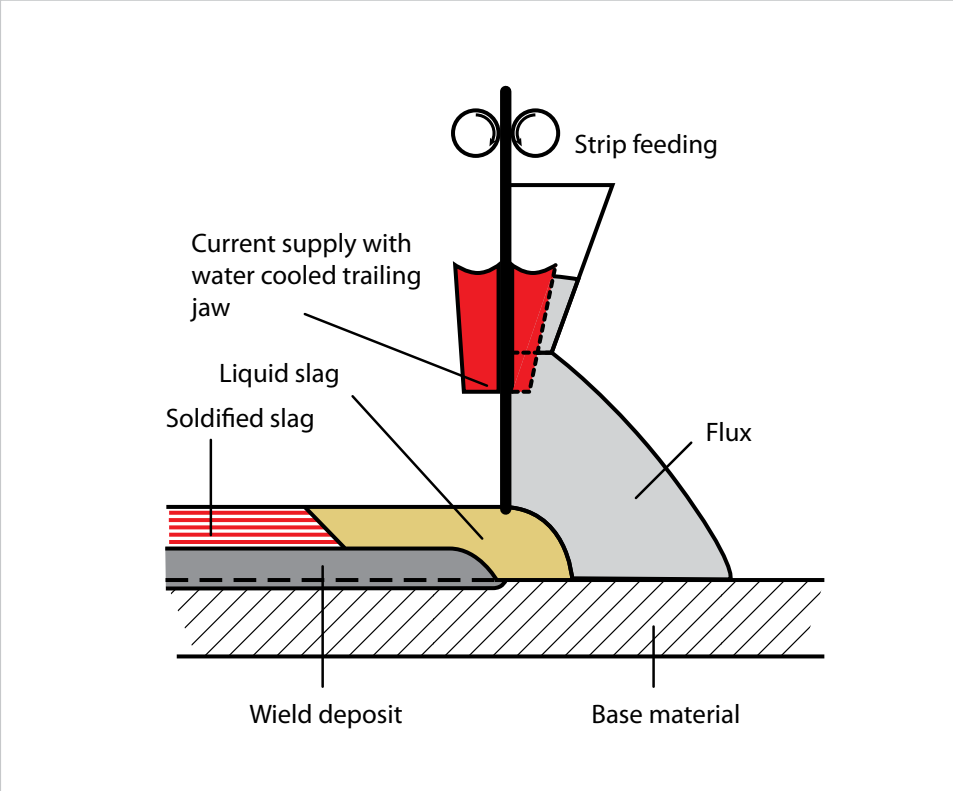


Figure 3: Electro slag strip cladding

- Increased deposition rate of 60% to 80%.
- Only half of the dilution (10%–15%) from the base material due to less penetration.
- Lower arc voltage (24–26 V).
- Higher amperage and current density (About 1000–1250 A with strips of 60 mm width, corresponding to 33–42 A/mm^2). Specially developed fluxes for high productivity purposes can be welded with amperage in excess of 2000 A which corresponds to a current density about 70 A/mm^2.
- Increased welding speed (50%–200%), resulting in a higher area coverage in m^2/h.
- Comparable heat input.
- Lower flux consumption (about 0.5 kg/kg strip).
- The solidification rate of the ESW weld metal is lower, aids de-gassing and increases resistance to porosity. Oxides can rise easier out of the molten pool to the surface; resulting in a metallurgically cleaner weld metal which is less sensitive to hot cracking and corrosion.

Fluxes for ESW

The ESW-process requires a slag pool with an ohmic resistance behaviour. In comparison to SAW cladding the electrical conductance must be higher to avoid arc flash, which is a disturbance of the process. The composition of the welding flux influences the conductivity, the solidification range and the viscosity of the molten slag. To increase the cladding speed at corresponding high welding currents, it is necessary to use fluxes with high electrical conductivity and low viscosity.

Deposition rate of electroslag strip cladding

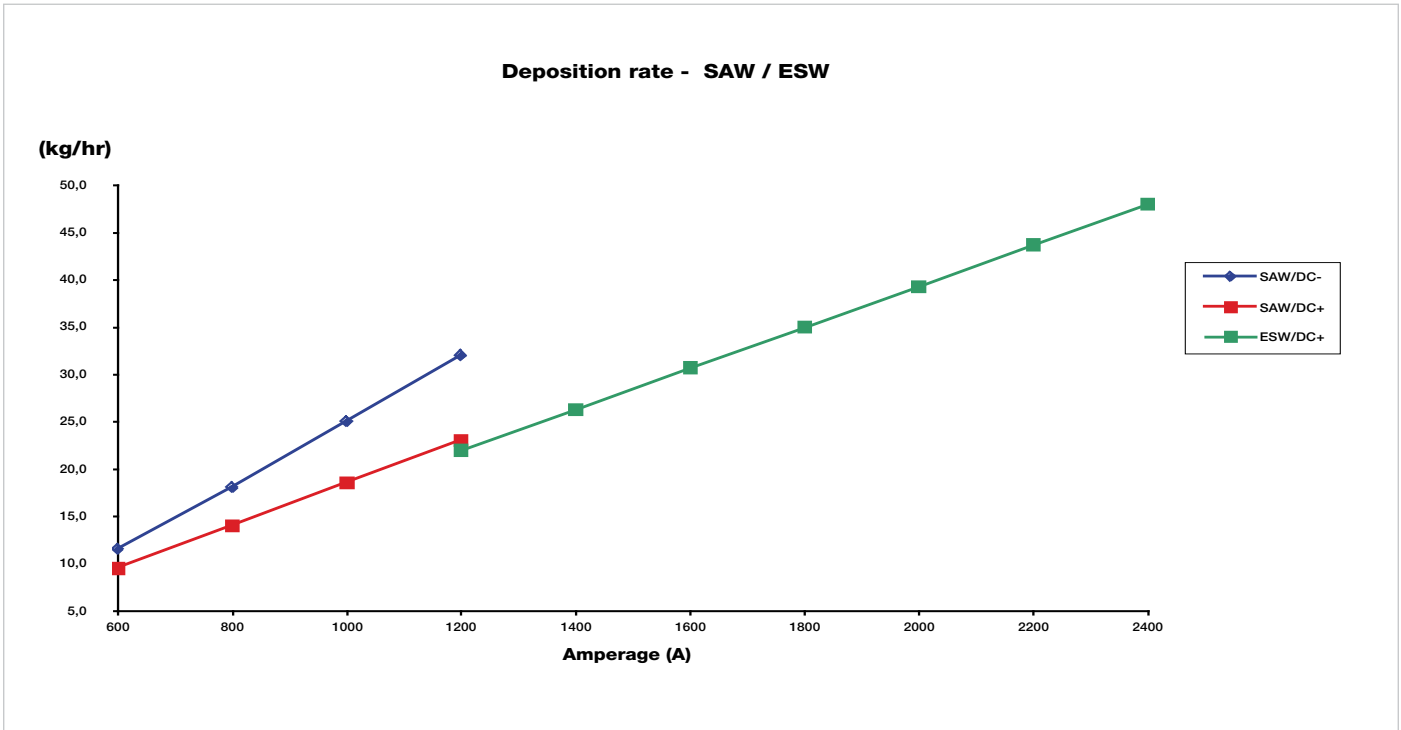
The electroslag strip cladding method was developed in the early seventies to increase productivity by increasing the deposition rate and decreasing the dilution compared with the SAW process.

Due to the properties of ESW often only one layer is needed to fulfill the cladding requirements and further the consumption of consumables is significantly reduced.

ESW can be advantageously used for the productive cladding of a second layer, when the two layer technology is demanded. The first layer, usually a buffer layer, can be deposited with either SAW or ESW.

The unique ESAB OK Flux 10.14 is a high basicity flux used with the electroslag process, designed for single-layer or multi-layer cladding in combination with austenitic strips at very high deposition rates using high power intensity (up to 45 cm/min with 60 x 0.5mm strip).

With the 60 x 0,5 mm strip, the most common size, welding currents up to 2300 A can be used. The difference in deposition rate between the methods is illustrated in the diagram below.



Deposition rate table

Combination	OK Flux 10.05/ OK Band 11.62 SAW	OK Flux 10.10/ OK Band 309LNb ESW	OK Flux 10.14/ OK Band 309LNb High speed ESW
Strip [mm]	60 x 0,5	60 x 0,5	60 x 0,5
Welding process	SAW	ESW	ESW
Current [A]	750	1250	2100
Voltage [V]	26	24	25
Travel speed [cm/min]	10	18	40
Current density [A/mm2]	25	42	70
Arc	yes	no	no
Heat input [kJ/mm]	11,7	11,25	8,6
Bead height [mm]	4,5	4,5	4,5
Bead width [mm]	65	68	65
Dilution [%]	18	9	18
Number of layers	2 (Buffer OK Band 309L)	1	1
Deposition rate [kg/hour]	14	22	51
Flux consumption [kg/kg strip]	0,8	0,6	0,6

Cladding equipment for automation

ESAB supplies various options for strip cladding operations:

- CaB 300/460/600 as carrier.
- Welding control by PEH and PLC or only sequence control by PLC for step and spiral cladding.
- Strip cladding heads for SAW and ESW.
- Compact heads for small ID objects.
- Feed motors air cooled or water cooled.
- Holders for heads providing easy set-up and adjustment for circumferential or longitudinal cladding.
- Manual or automatic hight and side control (joint tracking).

ESW strip cladding of valves for petrochemical plants

Wherever chemical or petrochemical plants exist, pipes and valves are needed to transport fluids or gas and control flows. Over the last decade, the use of noble materials for the entire valve has shifted to the cladding of a forged or cast CMn steel load-bearing bodies with a resistant alloy. The quality of the facing varies with the valve application. In the case of valves for transporting gas, the final layer is grade 316 stainless steel, as it is only subject to corrosion, whereas a final layer of Inconel 625 is a common choice when crude oil mixed with sand is involved, causing both chemical attack and abrasion.

Consumables

The flux/wire combinations used for ESW strip cladding with 316L composition are:

- single layer: OK Flux 10.10/OK Band 309MoL.
- double layers: OK Flux 10.10/OK Band 309MoL for the first pass and OK Flux 10.10/OK Band 316L for the second pass.

The flux/wire combination used for ESW strip cladding with final Inconel 625 composition is:

- OK Flux 10.11/ OK Band NiCrMo3. This combination ensures optimum results in terms of analysis and surface appearance for both single and double layers.

ESW Inconel strip cladding

SAW and ESW strip cladding are two options for cladding vessels with a protective Inconel 625 layer. In the application described here, the client's specification stipulated a minimum of two layers and an Fe content of 5% maximum at the weld overlay surface and 7% maximum at 2 mm sub surface. – the highest requirement within the petrochemical industry, covering both heat and corrosion. Since no overlay thickness was specified, there was the freedom to reach the final composition in the most economic way.

Both methods were trial tested for consumable selection and choice of parameters. The trial tests clearly indicated that it was not possible to meet the Fe requirements with SAW strip cladding in two layers. A third layer would have been needed, involving an extra, time-consuming fabrication step and more expensive weld metal. With ESW cladding, however, parameters could be found to fulfill the chemical requirements in two layers due to less dilution with the parent material. Welding parameters were fine-tuned and a welding procedure for the weld overlay of SA516 Gr. 70 (P1 Gr.2) was established and qualified according to ASME Sec. IX and client specification.

ESW cladding with OK Flux 10.11/OK Band NiCrMo-3

Trial	Layer	Thickness	% Fe surface
1	1st	4.9mm	9.05%
2	1st	4.3mm	10.41%
3	1st	4.0mm	11.91%
	1st & 2nd	8.0mm	3.28%
4	1st	3.1mm	11.93%
	1st & 2nd	6.2mm	5.15%

Chemical analyses of the ESW weld overlay (%). Inconel 625 chemistry met at 3.5mm from the fusion line, so 2.5mm sub surface.

C	Ni	Cr	Mo	Fe
0.02	59	22	8.5	4.0

Right: ESW cladding of an Inconel 625 protective layer onto a SA 516 Gr. 70 vessel for the desalination industry. Welding parameters: 1050-1180A, 24-25V, 19.8-21.9cm/min. Strip dimensions OK Band NiCrMo-3: 60 x 0.5mm.

Combinations for SAW and ESW strip cladding

Alloy	Process	Layers	Flux	Strip	Strip	Welding parameters[1]		
		Nr.		**Layer 1[2]**	**Layer 2**	**A**	**V**	**cm/min**
Low alloy	SAW	1	OK Flux 10.31	OK Band 7018		750	28	12
	SAW	2	OK Flux 10.31	OK Band 7018	OK Band 7018	750	28	12
308 L	SAW	2	OK Flux 10.05	OK Band 309L	OK Band 308L	750	28	13
	ESW	1	OK Flux 10.10	OK Band 309L ESW	-	1250	24	16
	ESW	2	OK Flux 10.10	OK Band 309L ESW	OK Band 309L ESW	1250	24	16
	SAW/ESW[3]	2	OK Flux 10.05/10.10	OK Band 309L	OK Band 308L	1250	24	32
	SAW/ESW[3]	2	OK Flux 10.05/10.14	OK Band 309L	OK Band 308L	1250	24	32
316 L	SAW	2	OK Flux 10.05	OK Band 309L	OK Band 316L	750	28	13
	SAW	1	OK Flux 10.06	OK Band 309L[4]	-	1125	27	26
	SAW	1	OK Flux 10.06F	OK Band 309L	-	750	28	12
	ESW	1	OK Flux 10.10	OK Band 309LMo ESW	-	1250	25	16
	ESW	2	OK Flux 10.10	OK Band 309LMo ESW	OK Band 309LMo ESW	1250	25	16
	SAW/ESW[5]	2	OK Flux 10.05/10.10	OK Band 309L	OK Band 316L	1250	24	32
	SAW/ESW[3]	2	OK Flux 10.05/10.14	OK Band 309L	OK Band 316L	2000	26	35
317L	SAW	2	OK Flux 10.05	OK Band 309L	OK Band 317L	750	28	12
347	SAW	2	OK Flux 10.05	OK Band 309L	OK Band 347	750	28	13
	SAW	1	OK Flux 10.05	OK Band 309LNb	-	750	28	12
	ESW	1	OK Flux 10.10	OK Band 309LNb ESW	-	1250	25	16
	ESW	2	OK Flux 10.10	OK Band 309LNb ESW	OK Band 309LNb ESW	1250	24	16
	ESW	1	OK Flux 10.14	OK Band 309LNb	-	2300	24	40
	ESW	1	OK Flux 10.14	OK Band 309LNb[4]	-	2300	24	30
	SAW/ESW[5]	2	OK Flux 10.05/10.10	OK Band 309L	OK Band 347	1250	24	18
	SAW/ESW[5]	2	OK Flux 10.05/10.14	OK Band 309L	OK Band 347	2000	26	35
2209	SAW	2	OK Flux 10.05	OK Band 2209	OK Band 2209	750	28	12
904L	SAW	3	OK Flux 10.05	OK Band 385	OK Band 385	750	28	12
	ESW	1	OK Flux 10.11	OK Band 385		1250	24	18
	ESW	2	OK Flux 10.11	OK Band 385	OK Band 385	1250	24	18
310 MoL	ESW		OK Flux 10.10	OK Band 310MoL	OK Band 310MoL	1250	25	18
410 NiMo	SAW	3	OK Flux 10.07	OK Band 430	OK Band 430[6]	770	25	22
430	SAW	2	OK Flux 10.03	OK Band 430	OK Band 430	750	28	12
Alloy 82	SAW	2	OK Flux 10.16	OK Band NiCr3	OK Band NiCr3	750	28	12
	ESW	2	OK Flux 10.11	OK Band NiCr3	OK Band NiCr3	1200	24	25
Alloy 625	SAW	2	OK Flux 10.16	OK Band NiCrMo3	OK Band NiCrMo3	750	27	13
	SAW	3	OK Flux 10.16	OK Band NiCrMo3	OK Band NiCrMo3[6]	750	27	13
	ESW	2	OK Flux 10.11	OK Band NiCrMo3	OK Band NiCrMo3	1200	24	25
Monel	SAW	2	OK Flux 10.18	OK Band NiCu7	OK Band NiCu7	750	29	14
	SAW	3	OK Flux 10.18	OK Band NiCu7	OK Band NiCu7[6]	750	29	14

1)Strip dimension 60x0.5 if no other information is given.
2)Buffer layer if more than one layer is welded.
3)Results for second layer (Buffer layer cladded by SAW 750A, 28V, 20 cm/min)
4)Strip dimension 90x0.5 mm
5)Results for second layer (Buffer layer cladded by SAW 750A, 28V, 14 cm/min)
6)Second and third layer
7)For each layer

Chemical composition (%)									FN			Deposition rate	
C	Mn	Si	Cr	Ni	Mo	Nb+Ta	N	Other	WRC 92	Overlay thick-ness (mm)	Typical base material	(kg/h)	(m²/h)[7]
0.07	0.15	0.4	0.04	0.06	0.5	-	-	Cu=0.02		3.9	CMn	14	0.43
0.07	0.09	0.34	0.04	0.06	0.6	-	-	Cu=0.02		7.0	CMn	14	0.43
0.02	1.0	0.6	19.0	10.5	-	-	0.03	-	~6	48.5	2.25Cr1Mo	14	0.43
0.03	1.2	0.4	19.0	10.0	-	-	0.05	-	~4	4.5	2.25Cr1Mo	23	0.6
0.02	1.2	0.5	20.0	11.0	-	-	0.05	-	~7	8.6	CMn	23	0.6
0.02	1.2	0.5	19.5	9.9	-	-	0.04		~6	6.5	CMn		
0.02	1.3	0.5	19.2	9.9	-	-	0.05	-	~6	6.5	CMn		
0.02	1.1	0.7	18.0	13.0	2.5	-	0.02	-	~7	8.5	CMn	14	0.43
0.035	0.8	0.6	18.4	11.0	2.5	-	0.05	-	~7	3	CMn	21	0.6
0.03	0.8	0.6	19.0	12.0	2.5	-	0.05	-	~7	5	CMn	16	0.45
0.02	1.1	0.4	18.0	12.5	2.8	-	0.04	-	~6	4.5	2.25Cr1Mo	23	0.6
0.02	1.3	0.5	19.0	13.0	3.0	-	0.04	-	~8	8.6	2.25Cr1Mo	23	0.6
0.025	1.3	0.6	18.0	12.0	2.0	-	0.04	-	~3	7.5	CMn		
0.025	1.3	0.5	18.0	11.9	2.0	-	0.04	-	~3	7.0	CMn		
0.02	1.1	0.6	18.5	13.0	2.7	-	0.04		~8	8.2	CMn	16	0.45
0.02	1.1	0.7	19.0	10.5	-	0.4	0.03	-	~8	8.2	2.25Cr1Mo	14	0.43
0.03	1.1	0.6	19.0	10.0	-	0.4	0.04	-	~9	4.5	CMn	14	0.43
0.03	1.3	0.5	19.0	10.0	-	0.4	0.05	-	~4	4.5	2.25Cr1Mo	23	0.6
0.02	1.3	0.5	20.5	11.0	-	0.4	0.05	-	~9	8.6	2.25Cr1Mo	23	0.6
0.06	1.6	0.5	19.0	10.0	-	0.6	0.02	-	~5	5.0	CMn	31	1.3
0.04	1.7	0.4	20.0	11.0	-	0.6	0.02	-	~9	5.2	CMn	51	1.8
0.015	1.3	0.4	19.0	11.0	-	0.5	0.04	-	~6	9.0	2.25Cr1Mo		
0.01	1.3	0.4	19.0	10.5	-	0.4	0.05	-	~7	8.0	2.25Cr1Mo		
0.02	1.1	0.8	22.0	8.0	3.0	-	0.15	-	~35	8.2	CMn	13	0.38
0.02	1.1	0.6	19.0	24.0	4.6	-	0.06	Cu=1.3	-	12.0	CMn	14	0.43
0.02	1.4	0.5	19.0	24.0	4.3	-	0.06	Cu=1.3	-	4.5	CMn	22	0.65
0.02	1.4	0.5	20.0	25.0	4.5	-	0.06	Cu=1.4	-	8.6	CMn	22	0.65
0.02	2.8	0.4	24.0	22.0	2.0	-	0.14	-	-	8.6	CMn	22	0.61
0.05	0.15	0.6	13.0	4.0	1.0	-	-	HB=410	-	12.0	CMn	12	0.35
0.06	0.2	0.8	16.6	0.1	-	-		HB=260	-	9.0	CMn	14	0.32
0.02	3.0	0.5	20.0	Balance	-	2.5	-	Fe=3.0	-	9.0	CMn	17	0.47
0.02	0.03	0.5	21.0	Balance	8.1	3.2	0.01	Fe=4.0		7.0	CMn	23	0.7
0.01	1.1	0.2	21.0	Balance	8.0	2.8	-	Fe=4.0	-	9.0	CMn	17	0.47
0.01	1.2	0.2	21.0	Balance	8.4	2.8	-	Fe=1.7		11.5		17	0.47
0.02	0.05	0.5	21.0	Balance	8.0	3.2	-	Fe=4.0	-	7.0	CMn	23	0.7
0.015	3.2	1.1	-	Balance	-	-	-	Cu=26.0Fe=6.5Ti=0.3		8.0	CMn	14	0.44
0.013	3.5	1.1	-	Balance	-	-	-	Cu=28.0Fe=2.4Ti=0.31		11.5	CMn	14	0.44

Fluxes and strips for SAW and ESW strip cladding

FLUX	EN 760	Description
SAW		
OK Flux 10.03	SA CS 2 Cr DC	For strip cladding with ferritic e.g. 430 alloys strips.
OK Flux 10.05	SA Z 2 DC	Standard flux for strip cladding with austenitic strips.
OK Flux 10.06	SA CS 2 CrNiMo DC	For cladding with EQ309L strip (0,5x90 mm) giving 316L material in one layer.
OK Flux 10.06F	SA CS 2 CrNiMo DC	For cladding with EQ309L strip (0,5x60 mm) giving 316L material in one layer.
OK Flux 10.07	SA CS 2 NiMo DC	For cladding with 17Cr-strip producing 14Cr 4Ni 1Mo overlay.
OK Flux 10.16	SA AF 2 DC	For strip cladding and joining with Ni-base materials
OK Flux 10.18	SA CS 2 DC	For strip cladding with Monel type of strips primarily with NiCu7-strip.
OK Flux 10.31	SA CS 3 Mo DC	For strip cladding with unalloyed CMn-steel strips.
OK Flux 10.92	SA CS 2 Cr DC	For strip cladding and joining of stainless steels.
ESW		
OK Flux 10.10	(~SA FB 2 DC)	Standard ES cladding flux for austenitic stainless strips. Suitable for ferritic strips also.
OK Flux 10.11	(~SA FB 2 DC)	For ES high speed cladding with stainless and Ni-base strips.
OK Flux 10.12	(~SA FB 2 DC)	For ES outside cladding of round objects with stainless strips.
OK Flux 10.14	(~SA FB 2 DC)	For very high speed ES cladding with austenitic stainless strips.

Strips for Submerged Arc Strip Cladding and Electroslag Strip Cladding

OK Band	EN ISO		AWS/SFA		C	Si	Mn	Cr	Ni	Mo	N	others	FN(WRC 92)
7018		Low alloy			0.1	0.1	0.5						
308L	14343:	B 19 9 L	A5.9:	EQ308L	0.015	0.3	1.8	20.0	10.5		0.06		12
347	14343:	B 19 9 Nb	A5.9:	EQ347	0.02	0.4	1.8	19.5	10.0		0.06	Nb=0.5	11
316L	14343:	B 19 12 3 L	A5.9:	EQ316L	0.02	0.4	1.8	18.5	13.0	2.9	0.06		8
2209	14343:	B 22 9 3 N L	A5.9:	EQ2209	0.015	0.4	1.5	23.0	9.0	3.2	0.15		50
309L	14343:	B 23 12 L	A5.9:	EQ309L	0.015	0.4	1.8	23.5	13.5		0.06		13
309LNb	14343:	B 23 12 L Nb	A5.9:		0.02	0.3	2.1	24.0	12.5		0.06	Nb=0.8	22
317L	14343:	B 18 15 3 L	A5.9:	EQ317	0.02	0.5	1.5	19.0	14.0	3.8	0.05		
310MoL	14343:	B 25 22 2 N L	A5.9:	(EQ310MoL)	0.02	0.2	4.5	25.0	22.0	2.1	0.13		0
385	14343:	B 20 25 5 Cu L	A5.9:	EQ385	0.02	0.4	1.8	20.0	25.0	4.5	0.05	Cu=1.5	0
309L ESW	14343:	B 21 11 L	A5.9:		0.015	0.2	1.8	21.0	11.5		0.06		11
309LNb ESW	14343:	B 21 11 L Nb	A5.9:		0.015	0.2	1.8	21.0	11.0		0.06	Nb=0.6	15
309LMo ESW	14343:	(B 23 12 2 L)	A5.9:		0.015	0.2	1.8	20.5	13.5	2.9	0.06		13
430	14343:	B 17	A5.9:		0.04	0.4	0.7	17.0			0.06		
NiCr3	14343:	B Ni6082 (NiCr20Mn3Nb)	A5.14:	ERNiCr-3	< 0.1	0.2	3.0	20.0	≥67.0		0.05	Nb=2.5, Fe≤3.0	
NiCrMo3	14343:	B Ni6625 (NiCr22Mo9Nb)	A5.14:	ER NiCrMo-3	< 0.1	0.1	0.3	22.0	≥58.0	9.0	0.05	Nb=4.0, Fe≤2.0	
NiCrMo13	14343:	B Ni6059 (NiCr23Mo16)	A5.14:	ERNiCrMo-13	< 0.01	0.1	0.5	23.0	≥56.0	15.5		Fe≤1.5	
NiCu7	14343:	B Ni4060 (NiCu30Mn3Ti)	A5.14:	ERNiCu-7	< 0.1	1.0	3.0		67.0			Cu=29,Ti=2.5 Fe≤2.0	

Fluxes for SAW strip cladding

OK Flux 10.03

Basicity index
1.0

Density
~ 1.0 kg/dm³

Grain size
0.25-1.4 mm

Slag type
Neutral

Polarity
DC+

Alloy transfer
Cr compensating

Classifications & approvals	Typical chemical composition all weld metal (%)								
OK Flux 10.03	**C**	**Si**	**Mn**	**Cr**	**Ni**	**Mo**	**N**	**FN**	**Others**
EN 760: SA CS 2 Cr DC									
With OK Band 430	*2rd layer cladded with OK Band 430 0.5x60 mm.								
EN ISO 14343: B 17	0.06	0.8	0.2	16.6	0.1				HB=260

OK Flux 10.03 is a neutral slightly Cr compensating agglomerated flux designed for submerged strip cladding cladding with an AWS EQ430 strip producing an overlay weld metal with hardness around 260 HB. It has good welding characteristics gives a smooth bead appearance and easy slag removal. For cladding on shafts, pistons, continuous cast rolls and other parts of repair and maintenance segment or applications that demand a ferritic or martensitic weld metal.

OK Flux 10.05

Basicity index
1.1

Density
~ 0.7 kg/dm³

Grain size
0.25-1.6mm

Slag type
Slightly Basic

Polarity
DC+

Alloy transfer
none

Classifications & approvals	Typical chemical composition all weld metal (%)								
OK Flux 10.05	**C**	**Si**	**Mn**	**Cr**	**Ni**	**Mo**	**N**	**FN**	**Others**
EN 760: SA Z 2 DC									
With OK Band 309L									
EN 14343: B 23 12 L AWS/SFA 5.9: EQ309L									
TÜV									
With OK Band 308L*	*2nd layer. First layer welded with OK Band 309L								
EN 14343: B 19 9 L AWS/SFA 5.9: EQ308L	0.02	0.6	1.0	19.0	10.5	-	0.03	6	
With OK Band 347*	*2nd layer. First layer welded with OK Band 309L								
EN 14343: B 19 9 Nb AWS/SFA 5.9: EQ347	0.02	0.7	1.1	19.0	10.5	-	0.03	8	Nb=0.35
With OK Band 316L*	*2nd layer. First layer welded with OK Band 309L								
EN 14343: B 19 12 3 L AWS/SFA 5.9: EQ316L	0.02	0.7	1.1	18.0	13.0	2.5	0.02	7	

Aluminate basic, agglomerated flux designed for submerged strip cladding with Cr, CrNi, CrNiMo stabilised stainless strips of the AWS EQ300 type and duplex. OK Flux 10.05 is ESAB standard flux for internal overlay welding on mild or low alloyed steel. It has good welding characteristics gives a smooth bead appearance and easy slag removal.

OK Flux 10.06, OK Flux 10.06F

Basicity index
1.0

Density
~ 1.2 kg/dm³

Grain size
0.25-1.4mm

Slag type
Neutral

Polarity
DC+

Alloy transfer
Cr, Ni and Mo-alloying

Classifications & approvals	Typical chemical composition all weld metal (%)								
OK Flux 10.06, OK Flux 10.06F	**C**	**Si**	**Mn**	**Cr**	**Ni**	**Mo**	**N**	**FN**	**Others**
EN 760: SA CS 2 CrNiMo DC									
With OK Band 309L*	*1rd layer cladded with OK Band 309L 0,5x60 mm and OK Flux 10.06F.								
EN 14343: B 23 12 L AWS/SFA 5.9: EQ309L	0.035	0.6	0.8	18.4	11.0	2.5	0.05	7	
With OK Band 309L*	*1rd layer cladded with OK Band 309L 0,5x90 mm and OK Flux 10.06.								
EN 14343: B 23 12 L AWS/SFA 5.9: EQ309L	0.03	0.6	0.8	19.0	12.0	2.5	0.05	7	

Neutral Cr, Ni and Mo-alloying agglomerated flux designed for submerged strip cladding at high welding speed with an AWS EQ309L strip, producing a 316L overlay weld metal in one layer e.g. for internal overlay welding of a paper fibre digester drums.
OK Flux 10.06F is especially designed for cladding with 60 mm wide strip, OK Flux 10.06 for 90 mm wide strip.

OK Flux 10.07

Basicity index
1.0

Density
~ 1.0 kg/dm³

Grain size
0.25-1.4mm

Slag type
Neutral

Polarity
DC+

Alloy transfer
Ni and
Mo-alloying

Classifications & approvals	Typical chemical composition all weld metal (%)								
	C	Si	Mn	Cr	Ni	Mo	N	FN	Others
EN 760: SA CS 3 NiMo DC									
With OK Band 430*	*3rd layer cladded with OK Band 430 0.5x60 mm.								
EN 14343: B 17	0.05	0.6	0.15	13.0	4.0	1.0			HB=410

Neutral Ni and Mo-alloying agglomerated flux designed for submerged strip cladding with an AWS EQ430 strip producing an overlay weld metal of 14Cr-4Ni-1Mo and a hardness of 370-420 HB . Especially suitable for cladding on continuous cast rolls. It produces a ferritic weld metal with an enhanced toughness and cracking resistance during service.

OK Flux 10.16

Basicity index
2.4

Density
~ 1.2 kg/dm³

Grain size
0.25-1.4mm

Slag type
Basic

Polarity
DC+

Alloy transfer
None

Classifications & approvals	Typical chemical composition all weld metal (%)									Typical mechanical properties all weld metal			
	C	Si	Mn	Cr	Ni	Mo	N	FN	Other	$R_{p\,0.2}$ (MPa)	Rm (MPa)	A4/A5 (%)	CVN (°C/J)
EN 760: SA AF 2 DC													
TÜV													
With OK Band NiCrMo3*	*2nd layer on mild steel												
EN 18274: S Ni6625 (NiCr22Mo9Nb) AWS/SFH 5.14 ER NiCrMo-3	0.01	0.2	1.1	21	Bal.	8	0.026		Nb+Ta=2.8 Fe=4.0				
With OK Band NiCr3*	*2nd layer on mild steel												
EN 18274: S Ni6082 (NiCr20Mn3Nb) AWS/SFH 5.14 ERNiCr-3	0.02	0.5	3.0	20	Bal.				Nb=2.5 Fe=3.0				

OK Flux 10.16 is am agglomerated, non-alloying flux for submerged arc welding - specially designed for welding and cladding with Ni-base alloyed wires and strips. The well balanced flux composition minimises silicon transfer from the flux to the weld metal, reducing the risk of hot cracking. OK Flux 10.16 is suitable for submerged arc strip cladding with all grades of Ni-based strips. For chemical and petrochemical plants, offshore construction, marine equipment, pressure vessels, storage tanks, etc.

OK Flux 10.18

Classifications & approvals | Typical chemical composition all weld metal (%)

		C	Si	Mn	Cu	Ni	Ti	Fe	FN	Others
Basicity index 1.0	EN 760: SA CS 2 DC									
	With OK NiCu7	*3nd layer on mild steel								
Density ~ 1.2 kg/dm³	EN 760: SA CS 2 DC EN ISO 18274: B Ni4060 (NiCu30Mn3Ti) AWS/SFA 5.14: ERNiCu-7	0.013	1.1	3.5	28.0	Bal.	0.31	2.4		

Grain size 0.25-1.6 mm

Slag type Neutral

Polarity DC+

Alloy transfer Moderately silicon alloying

OK Flux 10.18 is a neutral moderately silicon alloying agglomerated flux designed for strip cladding with Monel type of strips. The flux is primarily suitable for strip cladding with OK Band NiCu7 or with CuNi30 strip uses OK Band NiCu7 as buffer layer. This flux either 60mm or 90mm x 0.5mm strips gives good welding characteristics, a smooth bead appearance and easy slag removal. For desalinaiton plants, chemical processing industry, petrochemical industry, pressure vessels and other applications.

OK Flux 10.31

Classifications & approvals | Typical chemical composition all weld metal (%)

		C	Si	Mn	Cr	Ni	Mo	N	FN	Others
Basicity index 1.0	EN 760: SA CS 3 Mo DC									
	With OK Band 7018*	*1st layer on non alloy plate. The weld metal analysis performed under various welding conditions and up to 3 layers does not significantly change the deposit analysis.								
Density ~ 1.0 kg/dm³		0.07	0.4	0.15	0.05	0.06	0.5			H=2.7 ml/100 g HB=150

Grain size 0.25-1.6 mm

Slag type Neutral

Polarity DC+

Alloy transfer Mo-alloying

OK Flux 10.31 is a neutral, agglomerated, slighltly molybdenium alloyed flux for strip cladding with unalloyed CMn-steel strips. Weld metal in one layer on non-alloyed plate shows that the flux adds nominally about 0,4% Mo. Maximum hydrogen content is 3.0 ml/100 g of weld metal. The flux gives very good weldability and excellent slag detachability with no slag residuals. For repair and maitenance of shafts, pistons, repairing of production mistakes, buffer layers, storage tanks and others.

OK Flux 10.92

Classifications & approvals | Typical chemical composition all weld metal (%)

		C	Si	Mn	Cr	Ni	Mo	N	FN	Other
Basicity index 1.0	EN 760: SA CS 2 DC									
	TÜV									
Density ~ 1.0 kg/dm³	**With OK Band 308L***									
	EN ISO 14343: B 19 9 L AWS/SFA 5.9 EQ308L	0.02	1.0	0.7	20.6	9.8			12	
Grain size 0.25-1.6mm	**With OK Band 347***									
	EN ISO 14343: B 19 9 Nb AWS/SFA 5.9 EQ347	0.02	1.3	0.7	20.6	9.5			15	Nb=0.5
Slag type Neutral	**With OK Band 316L***									
	EN ISO 14343: B 19 12 3 L AWS/SFA 5.9 EQ316L	0.02	0.9	0.7	18.5	12.3	2.8		8	

Polarity DC+

Alloy transfer Cr compensating

*Third layer on 2.5Cr1Mo steel

OK Flux 10.92 is a neutral, agglomerated, Cr-compensating flux designed for strip cladding, butt and fillet welding of stainless and corrosion resistant steel types with AWS ER300 types of wire. Works well on DC current for single layer and multi layer welding of unlimited plate thickness. Good welding characteristics and easy slag removal. When used for strip cladding with austenitic stainless welding strips, OK Flux 10.92 gives a smooth bead appearance. For chemical and petrochemical plants, offshore construction, pressure vessels, storage tanks, chemical tankers, power generation, nucleair, pulp and paper, civil construction, transport industries etc.

Fluxes for ESW strip cladding

OK Flux 10.10

Basicity index
4.0

Density
~ 1.0 kg/dm³

Grain size
0.15-1.0mm

Slag type
High Basic

Polarity
DC+

Alloy transfer
none

Classifications & approvals	Typical chemical composition all weld metal (%)								
	C	Si	Mn	Cr	Ni	Mo	N	FN	Others
EN 760: ~SA FB 2 DC									
TÜV									
With OK Band 309L ESW*	* 1rd layer, welded on 2.25Cr1Mo steel								
EN 14343: B 21 11 L	0.03	0.4	1.2	19.0	10.0		0.05	4	
With OK Band 309LNb ESW*	* 1rd layer, welded on 2.25Cr1Mo steel								
EN 14343: B 21 11 L Nb	0.03	0.5	1.3	19.0	10.0		0.05	4	Nb=0.4
With OK Band 309LMo ESW*	* 1rd layer, welded on 2.25Cr1Mo steel								
EN 14343: (B 23 12 L)	0.02	0.4	1.1	18.0	12.5	2.8	0.04	6	

High basic, agglomerated flux designed for electroslag strip cladding with the austenitic stainless strips especially produced for electroslag process e.g. OK Band 309L ESW. It is flux for high productive strip cladding. Can be used for single or multi layer cladding. However, require special welding head and a power source of at least 1200 A.

OK Flux 10.11

Basicity index
5.4

Density
~ 1.0 kg/dm³

Grain size
0.2-1.0mm

Slag type
Very High Basic

Polarity
DC+

Alloy transfer
none

Classifications & approvals	Typical chemical composition all weld metal (%)								
	C	Si	Mn	Cr	Ni	Mo	N	FN	Others
EN 760: ~SA FB 2 DC									
OK Band NiCrMo3*	*1st layer on mild steel								
EN 18274: B Ni6625 (NiCr22Mo9Nb) AWS/SFA 5.14: ER NiCrMo-3	0.02	0.5	0.05	21.0	Bal.	8.0			Nb+Ta=3.2, Fe=4.0
OK Band NiCrMo3**	**2nd layer on mild steel								
EN 18274: S Ni6082 (NiCr20Mn3Nb) AWS/SFA 5.14: ER NiCrMo-3	0.02	0.5	0.03	21.0	Bal.	8.1	0.01	4	Nb+Ta=3.2, Fe=4

High basic, agglomerated flux designed for electroslag strip cladding with the stainless, fully austenitic and Ni-based strips. Can be used for single or multi layer cladding with higher welding speed.

Classifications & approvals | Typical chemical composition all weld metal (%)

OK Flux 10.12		C	Si	Mn	Cr	Ni	Mo	N	FN**	Others
Basicity index 2.7	EN 760: (~SA FB 2 DC)									
Density ~ 1.0 kg/dm^3	**With OK Band 309LNb ESW***	*1st layer on mild steel								
Grain size 0.2-1.0 mm	EN 14343: B 21 11 L Nb	0.02	0.45	1.41	20.0	10.6	0.01	0.01	10	Nb=0.44
Slag type Very High Basic										
Polarity DC+										
Alloy transfer None										

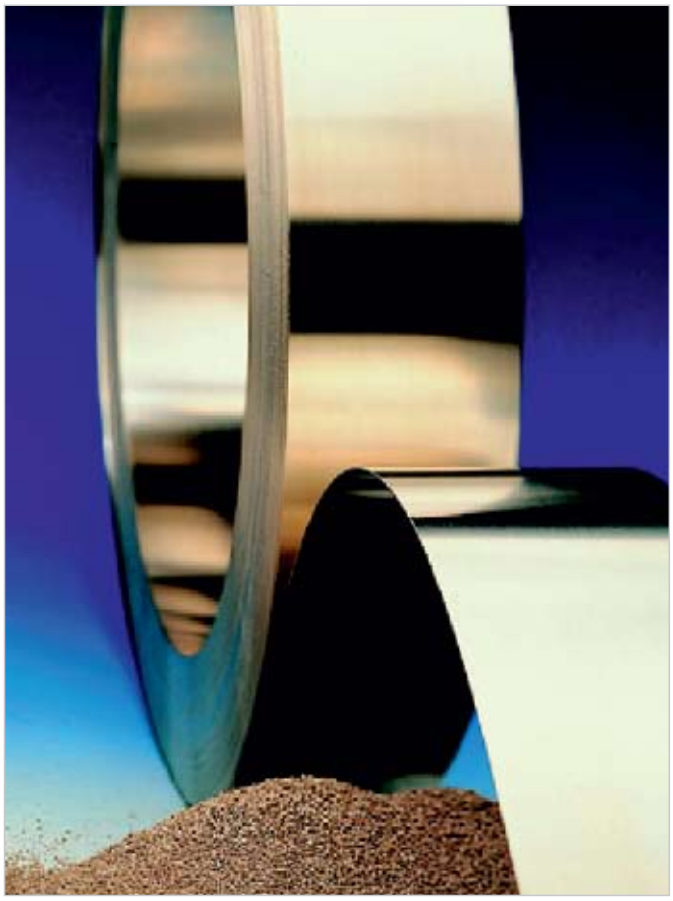
OK Flux 10.12 is high basic flux designed for electroslag strip cladding of round objects with stainless strips It delivers a fast freezing slag, best suitable for cladding of cylinders and rollers with lower diameters. The flux is giving shiny bead finish and smooth overlaps. For cladding on shafts, pistons, and other parts of repair and maintenance segment.

Classifications & approvals | Typical chemical composition all weld metal (%)

OK Flux 10.14		C	Si	Mn	Cr	Ni	Mo	N	FN	Others
Basicity index 4.4	EN 760: Not applicable									
Density ~ 1.0 kg/dm^3	**With OK Band 309LNb ***	* 1rd layer, welded on mild steel.								
Grain size 0.2-1.0mm	EN 14343: B 23 12 L Nb	0.06	0.5	1.6	19.0	10.0		0.02	5	Nb=0.6
Slag type High Basic										
Polarity DC+										
Alloy transfer none										

High basic, agglomerated flux designed for electroslag strip cladding with the austenitic stainless strips especially strip OK Band 309LNb. It is flux for very high productive strip cladding, up to about 35 cm/min. Can be used for single or multi layer cladding. However, require water cooled welding head and a power source of at least 2400 A.

Flux and strip packages



ESAB strip electrodes are delivered in a cold rolled condition on 25 kg or 50 kg and 100 – 200 kg coils with an inner diameter of 300 mm. The standard thickness is 0,5 mm and widths normally 30, 60 or 90 mm.
Other coil weight or strip dimensions are available on request.

ESAB delivers fluxes in 25 kg bags, but some types are available in 20 kg bags. Each bag has a polyethylene inlay to prevent the flux from moisture pick-up from the surrounding atmosphere. The palettes used to transport the flux bags are also protected against moisture by wrapping with shrink foil.

For a more robust package ESAB can supply fluxes in steel buckets containing 25 or 30 kg. These have a soft rubber band in the lid which makes them moisture tight.

The coils and bags are labelled with all information according to EN and AWS norms.

Strip cladding heads

ESAB is a traditional supplier of strip cladding heads for submerged strip cladding, e.g. the A6S type, and for electroslag strip cladding e.g. the ESW - S60 or ESW - S90 heads. The unique cladding heads SAW/ESW - S60 and SAW/ESW - S90 are suited for both submerged arc and electroslag cladding. Developed for use with the ESAB A6 motor and PEH control box. For all other motors, gear boxes and control units it is necessary to trial and adapt if necessary.

Technical data

Type	A6S	ESW – S60	ESW – S90
Welding process	SAW	ESW	ESW
Allowed strip width	30-100 mm	30-60 mm	60-90 mm
Dimension	220x400x250 mm	230x400x360 mm	300x400x400 mm
Weight	15 kg	18 kg	18 kg
Water cooling	No	Pressure 4-6 bar	Pressure 4-6 bar

Type	SAW / ESW – S60	SAW / ESW – S90
Welding process	SAW/ESW	SAW/ESW
Allowed strip width	30-60 mm	60-90 mm
Dimension	260x270x400 mm	300x400x400 mm
Weight	14 kg	18 kg
Water cooling	Pressure 4-6 bar	Pressure 4-6 bar

Magnetic steering system

The system is intended for stainless electroslag strip cladding in order to get a more consistent and straight welding pool. The magnets are placed on either side of the welding head to provide the desired magnetic flow. This is recommended for strips over 60 mm.

Type	ESMD 300
Connection voltage	230V, 50Hz
Dimension	280x370x185 mm
Weight	17 kg

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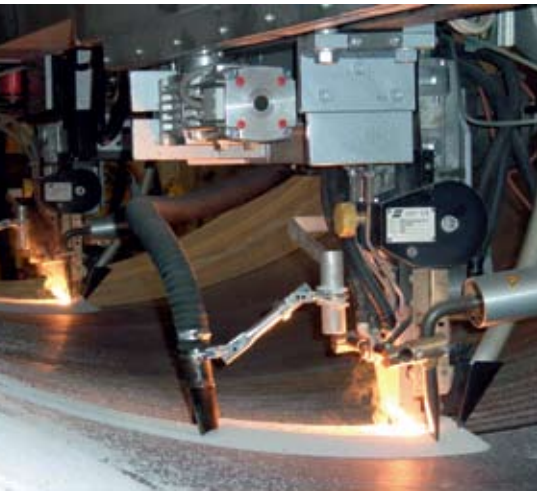
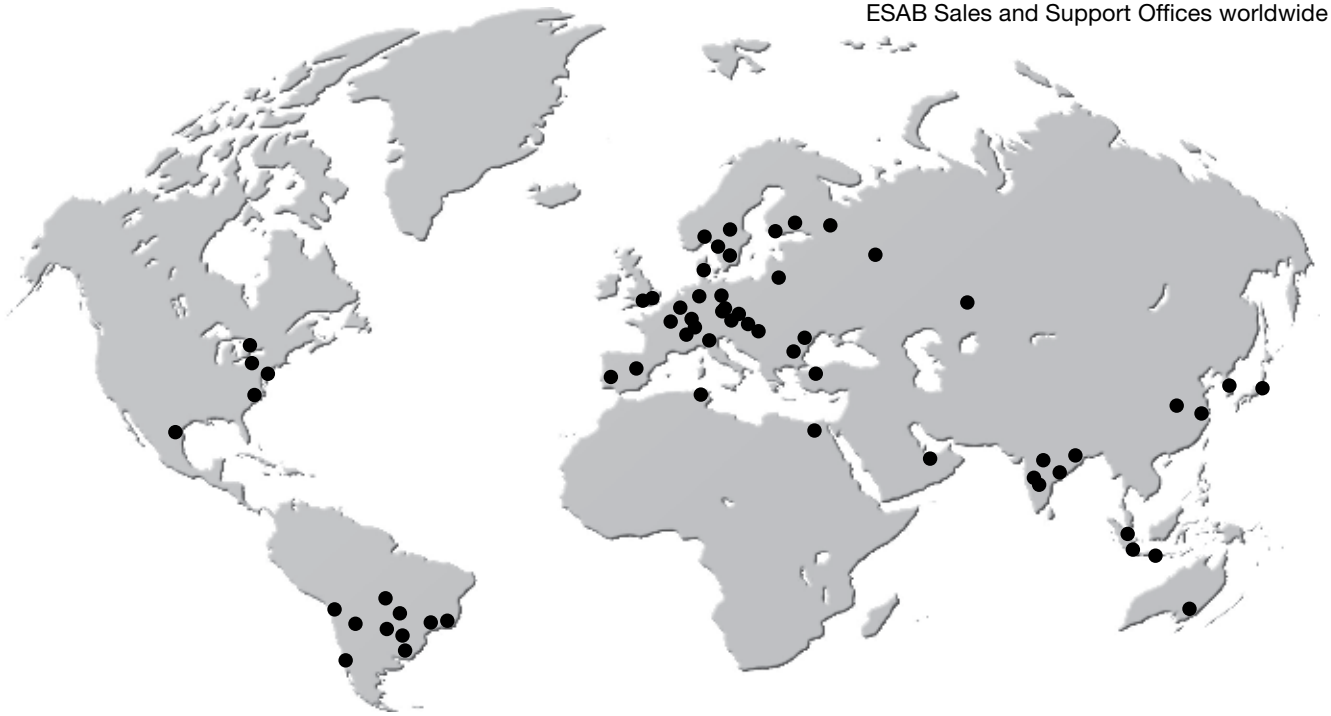


Since 1904, ESAB has been a pioneer in the welding and cutting business. By continuously improving and developing our products and methods, we meet the challenges of technological advance in every sector we operate in.

Our focus on quality issues has always been strong. Quality is an on-going process that is at the heart of all our production processes and facilities worldwide. With world leadership comes worldwide applications
experience and expertise.

Multinational manufacturing of welding consumables and equipment brings ESAB quality and innovation closer to our customers. ESAB customers enjoy full and personal access to an unrivaled resource of technical and applications knowledge, service and support. With local representation all over the world, together with a network of independent distributors, ESAB brings practical expertise and solutions to challenges involving materials, welding, cutting and overall productivity at local level.

ESAB Sales and Support Offices worldwide



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