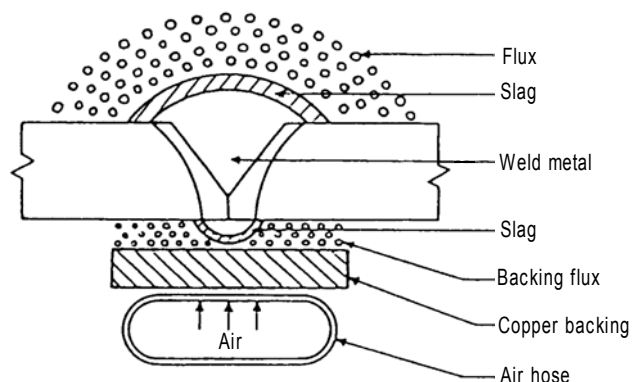


FCB Process

Principles:

FCB is an automatic one-side submerged arc welding process by which a uniform reverse side bead can be obtained. Welding is conducted from the surface side of the welding groove after supplying the backing flux, MF-1R or PFI-50R, on the copper backing and pushing up the copper backing to the reverse side of the groove by the pressurized air hose.



Features:

The combination of the backing flux and copper plate provides better contact onto the reverse side of the groove, which can accommodate a fluctuation of root gap and wide welding conditions to ensure consistent reverse bead without excessive melt through.

Applications:

Plate-to-plate butt welding for shipbuilding

Welding consumables

Type of steel	Flux	Wire	Backing flux	Remarks
General	PFI-50	US-43	PFI-50R or MF-1R	MF-1R is more suitable for thin plate with thickness 20 mm or less.
TMCP	PFI-55E	US-36	PFI-50R or MF-1R	

Note: Redrying conditions of flux: 200~300°Cx1h
(Backing fluxes must not be dried by heating)

Approvals : PFI-50 / US-43 / PFI-50R

Number of wires	AB	LR	NV	BV	NK	Others
Two	○	3A, 3YA	IIIYM	A3, 3YM	○	GL, CCS, CR
Three	○	3A, 3YA	IIIYM	A3, 3YM	○	CCS

○: Subject to satisfactory procedure test by user

Approvals: PFI-55E / US-36 / PFI-50R

Number of wires	AB	LR	NV	BV	NK	Others
Two	○	3A, 3YA	IIIY	A3YM	KAW53	CCS
Three	3*, 3Y*	3A, 3YA	IIIY	A3YM	KAW53	CCS
Four	3*, 3Y*	3Y40A	IIIY	A3YM	KAW53Y40SP	CCS

○: Subject to satisfactory procedure test by user

Packages

Wire: **US-43, US-36**

Dia. (mm)	Type	Weight (kg)
4.8	coil	25
	coil	75
	coil	150
6.4	coil	25
	coil	78
	coil	159

Flux: **PFI-45, PFI-50, PFI-55E**

Mesh size	Type	Weight (kg)
10x48	can	20

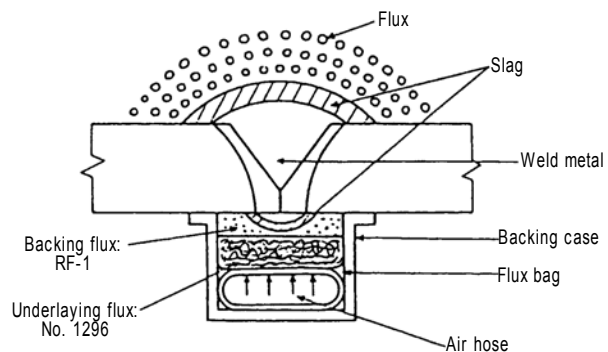
Flux: **PFI-50R, MF-1R**

Mesh size	Type	Weight (kg)
10x65	can	20

RF Process

Principles:

RF is an automatic one-side submerged arc welding process by which a uniform reverse side bead can be obtained. Welding is conducted from the surface side of the welding groove after supplying the backing flux, RF-1, which contains thermosetting resin, on the underlaying flux contained in the flux bag placed in the backing case and pushing up the fluxes onto the reverse side of the groove by the pressurized air hose.



Features:

- (1) RF-1, a fine particle flux, can accommodate much more distortion in the reverse side of the groove, joint misalignment and dissimilar-thickness transition of the joint to maintain good contact onto the reverse side of the groove, which offers higher suitability for thinner plates.
- (2) RF-1 turns to be a brick by the heat of welding, maintaining close contact onto the reverse side of the groove and thereby assures a uniform reverse bead.
- (3) With a multiple-wire welding machine, one-layer completion welding can be done for steel plates with a thickness of up to approximately 25 mm.

Applications:

Plate-to-plate butt welding for steel structures, ships and bridges, and butt and seam welding of pipes

Welding consumables

Type of steel	Flux	Wire	Backing flux
Mild steel, 490-MPa HT steel	PFH-55E	US-36	RF-1

Note: Redrying conditions of flux; 200~300°Cx1h
(RF-1 must not be dried by heating)

Approvals: PFH-55E / US-36 / RF-1

Number of wires	AB	LR	NV	BV	NK
Two	○	2A, 2YA	II Y(M)	A2M, 2YM	○

○: Subject to satisfactory procedure test by user

Packages

Wire: **US-36**

Dia. (mm)	Type	Weight (kg)
4.8	coil	25
	coil	75
	coil	150
6.4	coil	25
	coil	78
	coil	159

Flux: **PFH-55E**

Mesh size	Type	Weight (kg)
10x48	can	20

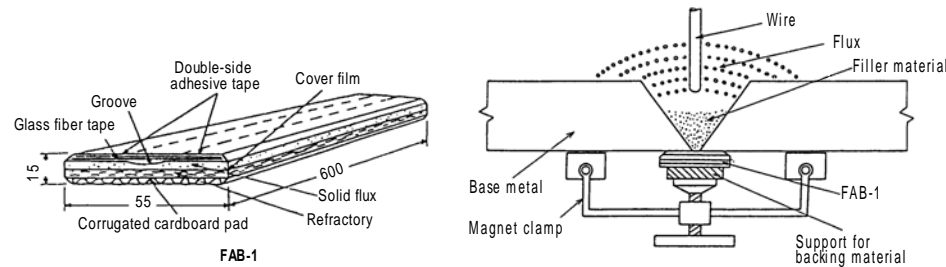
Flux: **RF-1**

Mesh size	Type	Weight (kg)
32xD	can	25

FAB Process

Principles:

FAB is a simplified one-side welding process in which a flexible backing material, FAB-1, is used. The structure of FAB-1 is as shown in the sketch below. It consists of glass fiber tapes for forming a reverse side bead, a solid flux for controlling reverse side bead protrusion, a refractory, a corrugated cardboard pad, a cover film and double-side adhesive tapes. FAB-1 is attached onto the reverse side of the groove with the adhesive tapes and fixed with an aluminum plate and magnetic clamps.



Features:

- (1) FAB features good flexibility to assure smooth contact onto the reverse side of the groove to accommodate much more joint misalignment, distortion and dissimilar-thickness transition of the joint. FAB is also suitable for a joint having a curvature on its reverse side.
- (2) Consistent reverse side beads can be obtained due to a wider tolerance in welding conditions.

Applications:

Curved shell plates, deck plates, bottom plates, tank top plates of ships, steel deck plates of bridges, and other one-side welding applications

Welding consumables

Type of steel	Flux	Wire	Metal powder	Backing material
Mild steel	MF-38	US-36	RR-2	FAB-1
	PFI-52E	US-36	RR-2	FAB-1
490MPa HT steel	MF-38	US-49	RR-2	FAB-1
	PFI-52E	US-36	RR-2	FAB-1

Note: Redrying conditions of flux: **PFI-52E**: 200~300°Cx1h, **MF-38**: 150~350°Cx1h
(**FAB-1** and **RR-2** must not be dried by heating)

Approvals: PFI-52E/US-36/RR-2/FAB-1

Number of wires	AB	LR	NV	BV	NK	Others
Single	○	3A, 3YA	ⅢY	A3YM	KAW53	GL, CR
Tandem	3*, 3Y*	3A, 3YA	ⅢY	A3YM	KAW53	GL, CR

○: Subject to satisfactory procedure test by user

Approvals: MF-38/US-36/RR-2/FAB-1

Number of wires	AB	LR	NV	BV	NK
Single	3*	3A	ⅢM	A3M	KAW3

Packages

Wire: **US-36/US-49**

Dia. (mm)	Type	Weight (kg)
4.8	coil	25
	coil	75
	coil	150
6.4	coil	25
	coil	78
	coil	159

Flux: **PFI-52E**

Mesh size	Type	Weight (kg)
10x48	can	20

Flux: **MF-38**

Mesh size	Type	Weight (kg)
12x65	can	20

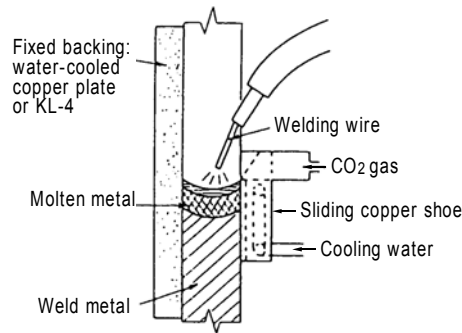
Backing materials: **FAB-1**

Applicable type of joint	Length (mm)	Pieces per carton
Standard joint	600	30
Transition joint	600	25
Mismatch joint	600	30

Electrogas Arc Welding

Principles:

Electrogas arc welding (EGW) is vertical-up butt welding. SEGARC is an automatic vertical welding process suitable for EGW. This process uses SEG-2Z equipment with the combination of a small diameter flux-cored wire, a sliding copper shoe on the front side of a joint, and a fixed backing on the reverse side of a joint.



Features:

- (1) High deposition rates (e.g., 180g/min at 380A) provide high welding efficiency.
- (2) Lightweight, compact-size equipment makes it easy to set up.
- (3) Wire extension can be controlled constant against varied welding conditions.
- (4) Welding line can be located either on the left side (Standard) or, by re-assembling, the right side of the tracking rail.
- (4) With the oscillator (Option), one-pass completion welding can be conducted for plates with a thickness of 32 mm max.
- (5) The carriage can be detached at any place of the tracking rail.

Applications:

- (1) Side shells, bulkheads, hoppers of bulk carriers in shipbuilding
- (2) Box girder webs and I-plate girder webs in bridge construction
- (3) Press flame, storage tanks, large diameter pipes, and other vertical welding lines

Welding consumables and equipments

Type of steel	Wire	Backing material	Shielding gas	Equipment	Polarity
Mild steel & 490MPa HT steel	DWS-43G	KL-4	CO ₂	SEG-2Z	DC-EP
Mild steel & 490MPa HT steel for low temperature service	DWS-1LG	KL-4	CO ₂	SEG-2Z	DC-EP
550 to 610MPa HT steel	DWS-60G	KL-4	CO ₂	SEG-2Z	DC-EP

Example of chemical composition of weld metal (%)

Brand name	C	Si	Mn	P	S	Ni	Mo	Ti
DWS-43G	0.08	0.35	1.63	0.014	0.010	0.02	0.17	0.02
DWS-1LG	0.05	0.25	1.60	0.009	0.007	1.40	0.13	0.05
DWS-60G	0.08	0.32	1.67	0.010	0.008	0.71	0.25	0.03

Example of mechanical properties of weld metal

Brand name	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
DWS-43G	470	600	27	-20°C: 62
DWS-1LG	500	615	25	-60°C: 100
DWS-60G	520	650	26	-20°C: 65

Approvals: DWS-43G (Backing: KL-4)

AB	LR	NV	BV	NK	Others
3A*, 3YA*	2, 2Y1	II Y, MG	AV3, AV3Y	KEW53G(C)	GL, CCS, CR, KR

Approvals: DWS-1LG (Backing: KL-4)

AB	LR	NV	NK	Others
3A*, 3YA*, 3Y400A*	5Y40 ²	II Y, NV2-4L, 4-4L	KEW54Y40G(C), MG	GL

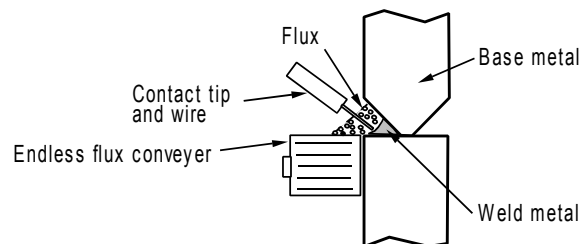
Packages

Dia. (mm)	Type	Weight (kg)
1.6	Spool	20

Horizontal Submerged Arc Welding

Principles:

In horizontal submerged arc welding of butt joints, a welding wire is fed at a certain work angle into a granular flux that is sustained by an endless conveyer tracking along the lower part of a double bevel groove according to welding progress. This welding process was developed to improve welding efficiency to cope with increased storage capacity of cylindrical tanks.



Features:

- (1) Good slag removal and glossy bead appearance
- (2) Good weld metal impact property
- (3) Insensitive to rust and dirt and excellent resistibility to pockmark and porosity
- (4) Good X-ray soundness
- (5) DC polarity is recommended for better fusion and bead shape

Applications:

Horizontal joints of side shells of cylindrical tanks

Welding consumables

Type of steel	Flux	Wire	Polarity
Mild steel & 490MPa HT steel	MF-33H	US-36	DC-EP
550 to 610MPa HT steel	MF-33H	US-49	DC-EP
Mild steel & 490MPa HT steel for low temperature service	MF-33H	US-49A	DC-EP

Note: Redrying conditions of flux; 150~350°Cx1h

Example of chemical composition of weld metal (%) (DC-EP)

Flux	Wire	C	Si	Mn	P	S	Mo
MF-33H	US-36	0.07	0.18	1.48	0.013	0.005	—
MF-33H	US-49	0.05	0.17	1.28	0.010	0.006	0.45
MF-33H	US-49A	0.07	0.24	1.47	0.013	0.009	0.22

Example of mechanical properties of weld metal (DC-EP)

Flux	Wire	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	
MF-33H	US-36	421	512	33	-51°C:114	-20°C:128
MF-33H	US-49	506	585	27	-51°C: 40	-
MF-33H	US-49A	464	560	30	-51°C: 46	-

Packages

Wire: **US-36, US-49, US-49A**

Dia. (mm)	Type	Weight (kg)
3.2	coil	25
	coil	75
4.8	coil	25
	coil	78

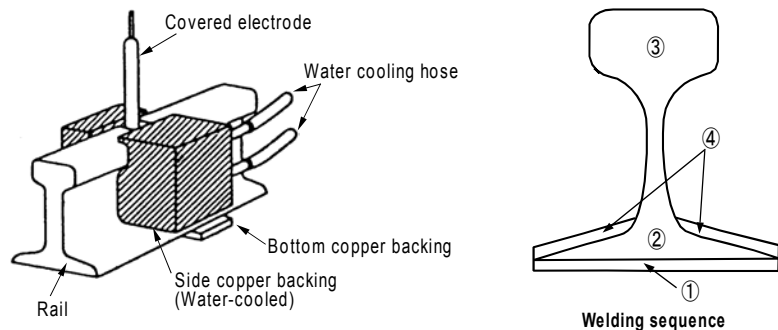
Flux: **MF-33H**

Mesh size	Type	Weight (kg)
12x150	can	25

Enclosed Arc Welding

Principles:

With the enclosed arc welding process, welding is continuously progressed in a square groove enclosed by joining components and cooling jigs, using low hydrogen type covered electrodes without removing the slag in the groove during welding.



Features:

- (1) Simple, square groove can be used.
- (2) Highly efficient because it is no need to break the arc to remove slag during welding, a large diameter electrode can be used, and narrow groove can be used.

Applications:

Rails for rail roads and crane rails

Welding consumables

Place to be applied	Welding sequence	Brand Name	Polarity	Remarks
Bottom part of a rail	①,②,④	LB-116	AC, DC-EP	Preheating temp: 400~500°C
Top part of a rail	③	LB-80EM	AC, DC-EP	Postweld heating temp: 650~710°Cx 20 min

Note: Redrying conditions: 350~400°Cx1h

Example of chemical composition of all-weld metal (%) (AC)

Brand name	C	Si	Mn	P	S	Ni	Cr	Mo
LB-116	0.08	0.63	1.50	0.010	0.006	1.83	0.28	0.43
LB-80EM	0.08	0.69	1.93	0.010	0.006	-	0.52	0.38

Example of mechanical properties of all-weld metal (AC)

Brand name	TS (MPa)	EI (%)
LB-116	830	24
LB-80EM	820	24

Packages of LB-116

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	17
3.2	350	5	20	30
4.0	400	5	20	54
5.0	400	5	20	86

Packages of LB-80EM

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
4.0	450	5	20	58
5.0	450	5	20	90
6.0	450	5	20	131