KOBELCO WELDING TODAY

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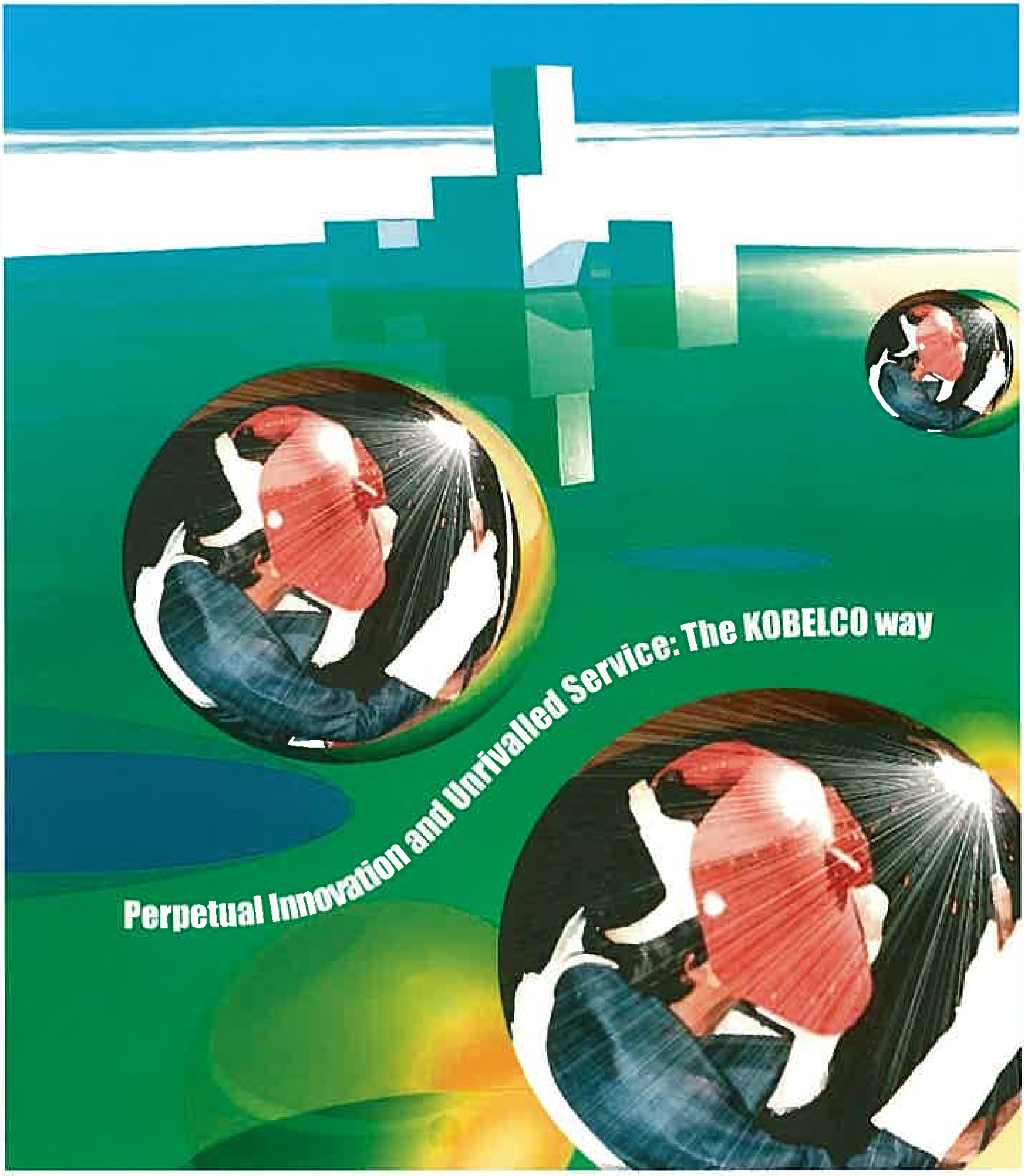
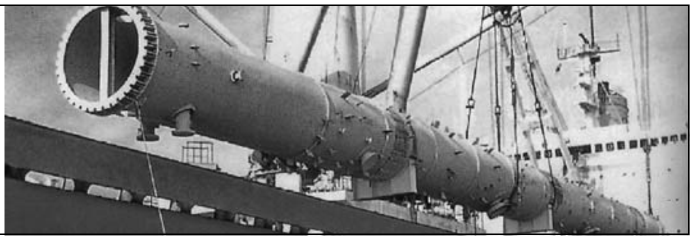


Doosan Mecatec: The globally recognized diversified machinery manufacturer born of century-old roots



The merger of Doosan Machinery B. G. and Hanjung DCM Co., Ltd. established Doosan Mecatec, Co., Ltd. as one of the affiliates of the Doosan Group, and the new organization set sail January 1, 2002. This strategic integration between leading manufacturers in the fields of chemical and petrochemical process equipment and industrial plants as well as power plant equipment enables Doosan Mecatec to enhance productivity and project management capacity by utilizing accumulated expertise in engineering technology, advanced manufacturing and quality assurance.

Their business spans across many fields. One area of business consists of chemical process equipment such as pressure vessels, columns, heat exchangers, and reactors. Another includes machine tools such as CNC lathes, milling machines, machining centers, and industrial robotics. A third line includes plants for such industries as fine/bio chemicals, industrial raw material processes, and environmental businesses. Doosan Mecatec is even in the construction of steel bridges.

The company's main manufacturing bases are Changwon Plant I (Shinchon Plant) and Changwon Plant II (Daewon Plant), which were established in 1964. They comprise areas of 198,000 m^2 and 205,204 m^2 respectively in Changwon City, and they employ a total of approximately 600 workers. Both plants acquired the ISO 9001 Quality Assurance System Certificate in 1998 and ASME Stamps (S, H, U, U2) in 1991.

Changwon Plant I (Shinchon Plant) with integrated facilities is located at an ideal place for fabricating huge equipment in Changwon City

Chemical process equipment (CPE) is Doosan Mecatec's main business, comprising approximately 40 to 45% of the firm's total sales for the last four years. Furthermore, 80 to 90% of CPE sales are made up of exports.

A CPE module for the BP Alaska LTS-3 gas project, delivered to the client in June 2003

We strive to provide reliable service with KOBELCO's high quality welding consumables in order to meet Doosan Mecatec's stringent requirements for individual projects. For instance, we have supplied several top quality welding consumables for the BP Alaska LTS-3 gas project: US-521S / PF-200 for SAW, CMA-106N for SMAW, TGS-2CM for GTAW. These welding consumables have shown far better weldability and unsurpassed welds as compared with other suppliers' products, thereby satisfying the client's strict specifications.

This project has been one of the greatest successes in our long lasting customer relationships. We will endeavor to add value and be a leading supplier to Doosan Mecatec by providing quality products with outstanding technical support and quick delivery in cooperation with Kobe Welding of Korea and Kobe Steel, Japan.

Reported by I. S. Choi, OK Trading
Arranged by D. S. Kim, KOSARC

Fruitful Spring after Harsh Winter

Spring has come. In Japan we can enjoy cherry blossoms in April but just for about two weeks or so because cherry blossoms are so short-lived. Japanese cherry trees bloom quickly around early April and are likely to fall fluttering in the strong spring wind. It is not the national flower, but in early spring, ordinary Japanese people seem to act as if it were. During the brief flowering period, crowds of people enjoy blossom viewing outings or picnics under the cherry trees after work, where they may enjoy the beauty of cherry blossoms, while chatting and singing songs over a cup of Japanese rice wine, called "SAKE" (pronounced: Sah-Kae). For me the spring here in Japan with cherry blossoms and fresh leaves is the most attractive season of the year.

In contrast to nature's hopeful season, I regret that my message must again focus on the hopeless forecast of tight deliveries of materials. Like you, I fervently look forward to better deliveries of raw materials as well as relief from the stresses of struggling to assure enough raw materials at reasonable prices. However, it seems that it will take a long time for all industries to be relieved from this problem. As you may know, the problems are mainly due to the rapid growth of the Chinese economy. China's economy continues to grow at a brisk pace. Nobody knows how long the rapid economic expansion will continue, and how big the bad as well as the good effects will be on industries worldwide. In the short-term, it seems many industries have suffered, but I hope China's growth will also provide the global economy with fruitful effects in the long-term. I will do my best to overcome the hard economic winter, looking forward to beneficial economic spring.

Masakazu Tojo
General Manager
International Operations Dept.
Welding Company
Kobe Steel, Ltd.

Canteen in KWT

An extensive menu: Everything looks delicious.

The most favored Seafood and Kernel Lunch

Kobe Welding of Tangshan is in Tangshan City, 200 km northeast of Beijing, in Hebei Province which faces the Bay of Bo Hai. Although Tangshan City is a provincial city with a population of "only" seven million, there are a lot of restaurants that serve the local specialties from many of the various districts of China. At KWT's canteen, too, the dishes that are offered vary daily from Monday to Friday to stimulate the appetites of the employees. At lunch time, when you see young people standing in a long queue, craning their necks for a better look while waiting for their turn to pick up their favorite dishes, you cannot but imagine how delicious they will be. The most popular is "Seafood and Kernel Lunch" shown in the photo. It is mixture of fried shrimp, cashew nuts and cucumbers with comparatively light seasoning. I, too, like it very much.

Reported by Daisuke Hino, KWT

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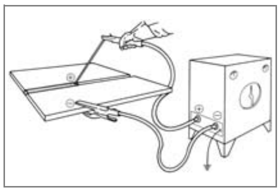
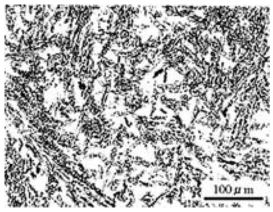
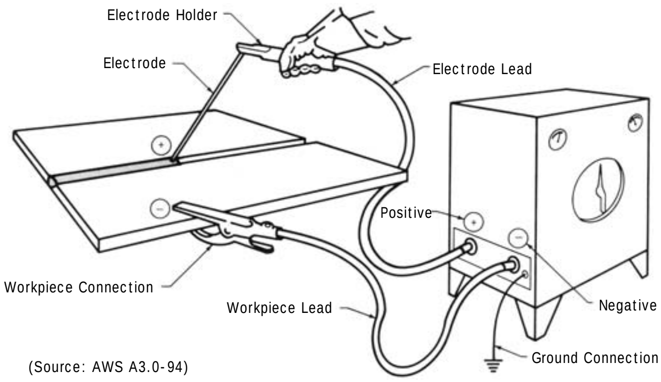




How Electric Polarity Affects Weld Quality in Arc Welding

DCEP AC DCEN AC DCEP AC DCEN AC DCEP



DCEP AC DCEN AC DCEP AC DCEN AC DCEP

The term "polarity" is used to describe the electrical connection of the electrode in relation to the terminal of a power source. With direct current (DC), when the electrode is connected to the positive terminal, the polarity is designated as direct current electrode positive (DCEP). When the electrode is connected to the negative terminal, the polarity is designated as direct current electrode negative (DCEN). When alternating current (AC) is used, the polarity changes every half cycle of 50 or 60 Hz.

In lieu of DCEP and DCEN, electrode polarity can also be termed as DC+ and DC− respectively. You may also be familiar with "reverse polarity" and "straight polarity," but these are considered nonstandard terms today as per the AWS and BS standard. "Electrode positive has sometimes been known in British practice as straight polarity and in American practice as reverse polarity. For this reason both these terms are deprecated," notes the British Standard BS 499 (Welding Terms and Symbols).

SMAW electrode coverings and applications choose polarity

A large variety of covering fluxes for covered electrodes enable the SMAW process to be the most versatile in choice of polarity. As specified in AWS A5.1 for carbon steel electrodes (Table 1), the type of covering determines the proper type of current or polarity. High cellulose type electrodes such as E6010 (KOBE-6010), E7010-P1 (KOBE-7010S), and E8010-P1 (KOBE-8010S) for pipe welding are designed for use with DCEP in order to allow smoother droplet transfer. Titania type electrodes such as E6013 (RB-26), E6019 (B-17) and E7024 (ZERODE-43F) for general applications offer good performance with AC, DCEP or DCEN. Low hydrogen covered electrodes such as E7016 (LB-52) for general applications use either AC or DCEP.

Table 1: Electrode coverings and proper type of current (extracted from AWS A5.1-2004)

AWS class.	Type of covering	Type of current
E6010	High cellulose sodium	DC+
E6013	High titania potassium	AC or DC±
E6019	Iron oxide titania potassium	AC or DC±
E6027	High iron oxide, iron powder	AC or DC− for h-fillet position AC or DC± for flat position
E7016	Low hydrogen potassium	AC or DC+
E7018	Low hydrogen potassium, iron powder	AC or DC+
E7024	Iron powder, titania	AC or DC±
E7028	Low hydrogen potassium, iron powder	AC or DC+
E7048	Low hydrogen potassium, iron powder	AC or DC+

As specified in AWS A5.5, low carbon type Cr-Mo electrodes with low hydrogen coverings such as E7015-B2L (CMB-95), and E8015-B3L (CMB-105) are designed for use with DCEP for better performance. Some specific low hydrogen electrodes such as LB-80UL (E11016-G) for high strength steels and LB-88LT (E11016-G) for low temperature steels are recommended to use AC in order to guarantee strict requirements for strength and impact toughness of weld metal.

Polarity affects the usability, chemistry and mechanical properties of covered electrodes. The effect of polarity varies depending on the type of covering as shown in Table 2. With E6019 electrode, there is almost no change in chemical and mechanical properties of the weld metal. With the E7016 electrode, by contrast, the effect of polarity is significant. That is, the use of DCEP decreases the C and Si content and consequently the tensile strength and 0.2% proof strength of the weld metal as compared to AC. With DCEN, the N content of the weld metal increases markedly when compared with the other polarities. The increase in N content causes a significant decrease in impact toughness and, though not shown in the table, it can degrade the X-ray soundness of the weld metal due to increased amounts of blowhole. In addition, the use of DCEN decreases Si and Mn in the weld metal but increases the tensile strength due to the increase in N. This is why E7016 electrodes are recommended to use with either AC or DCEP but not with DCEN as specified in the AWS standard.

Table 2: Effects of polarity on weld metal chemistry and mechanical properties (1)

Electrode	B-17 (E6019)			LB-52 (E7016)		
Polarity	AC	DCEP	DCEN	AC	DCEP	DCEN
C (%)	0.08	0.08	0.08	0.08	0.07	0.08
Si	0.09	0.10	0.10	0.66	0.61	0.52
Mn	0.59	0.62	0.58	0.94	0.95	0.83
N	0.007	0.008	0.008	0.011	0.010	0.039
0.2%PS (MPa)	392	389	394	480	466	481
TS (MPa)	458	461	466	572	551	589
El (%)	31	29	30	32	33	29
IV at 0°C (J)	117	106	112	215	226	151
IV at −20°C (J)	103	99	105	162	183	85
IV at −40°C (J)	-	-	-	90	116	39

Note (1) Testing methods are per JIS Z 3211 and Z 3212.

Electric polarity also affects the hydrogen content of the weld metal. As shown in Figure 1, the use of DCEP with a low hydrogen electrode, such as LB-62 (E9016-G), results in higher amounts of hydrogen than in using AC over the current range tested.

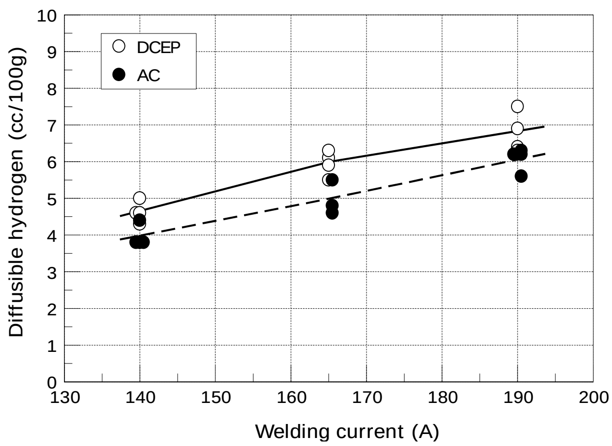


Figure 1: Effect of polarity on diffusible hydrogen in weld metal as a function of welding current

SAW can use AC, DCEP or DCEN but the performance changes

Particular combinations of SAW wire and flux may be used with AC, DCEP or DCEN. The performance, however, varies between polarities. As shown in Figure 2, the deposition rate is highest with DCEN, lowest with DCEP and in the middle with AC for fluxes tested. Figure 3 shows that the amount of slag generated during welding is highest with DCEN, lowest with AC and in the middle with DCEP for every flux. Figure 4 shows the flux consumption ratio (the ratio of the amount of slag obtained in Figure 3 to the amount of deposition rate obtained in Figure 2). With DCEP, it is higher than with AC by roughly 10-30% depending on the type of flux. That is, the mass of flux compositions (e.g. SiO_2 and MnO) that react with the molten metal becomes larger, thereby decreasing C, and increasing Si, Mn and O in the weld metal. As shown in Table 3, marked differences can be recognized between DCEP and AC as to C, Si, Mn, O, and consequently 0.2%PS, TS and IV. This is why careful choice of wire and flux combination is significant taking into account the polarity of the power source to be used when the quality requirement for the weld metal is strict.

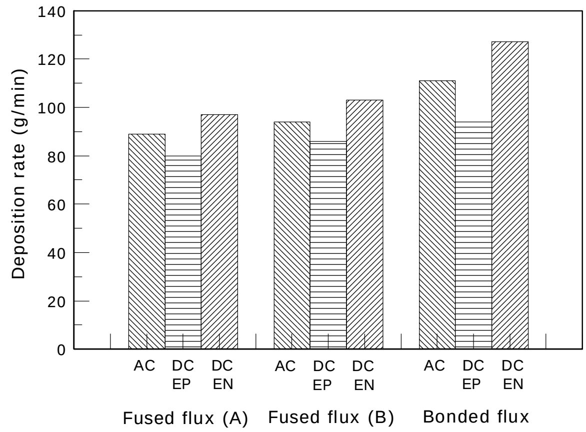


Figure 2: Effect of polarity on deposition rate with fused and bonded fluxes

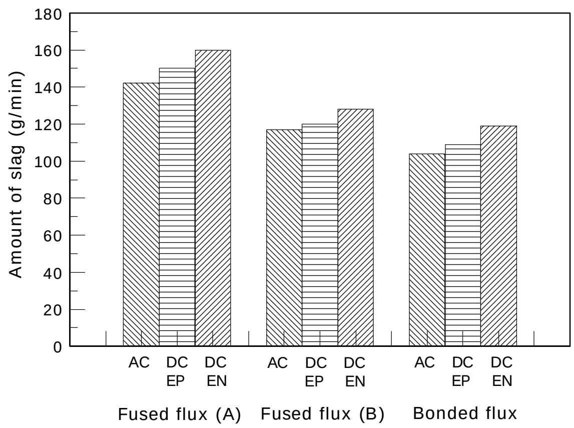


Figure 3: Effect of polarity on amount of slag with fused and bonded fluxes

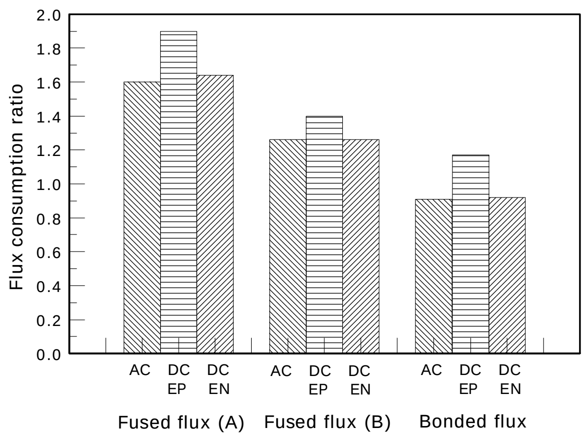


Figure 4: Effect of polarity on flux consumption ratio with fused and bonded fluxes

Table 3: Effect of polarity on chemical and mechanical properties of SAW weld metal with fused flux (MF-38) and solid wire (US-36) for mild steel and 490MPa high strength steel (as-welded condition)

Polarity	AC	DCEP
C (%)	0.07	0.05
Si	0.30	0.35
Mn	1.61	1.67
P	0.017	0.018
S	0.005	0.006
O	0.067	0.098
0.2%PS (MPa)	462	411
TS (MPa)	565	512
El (%)	30	33
RA (%)	70	69
IV at −40°C (J)	93	74

How to select AC- or DC-spec. SMAW and SAW filler metals

Most filler metals suitable for AC may be used with DC, unless the quality requirement is strict. When requirements are strict, the matter is treated seriously, even when a particular filler metal is classified per the AWS standard as an AC-or-DCEP type. This is because, as discussed above, the polarity of welding current affects the chemical composition (C, Si, Mn, and O in particular), and thus the mechanical properties, of the weld metal.

Kobe Steel has long been producing a wide range of filler metals for various applications. Among them are specific filler metals such as those for high strength steel, low temperature steel and Cr-Mo steel filler metals, which sometimes become critical in terms of meeting quality guarantees due to stringent customer requirements for specific applications. These applications include offshore structures and oil refinery equipment. To satisfy the strict quality requirements, AC- or DC-spec. filler metals should be selected as per Tables 4 and 5 for high strength steel and low temperature steel and Table 6 for heat-resistant low-alloy steel.

The DC-spec. filler metals have been developed particularly for overseas markets where, unlike in the domestic market, DC power sources are often used. These filler metals have a high reputation for excellent performance comparable to the AC-spec. filler metals.

GMAW and FCAW wires use mostly DCEP

The vast majority of gas metal arc welding (GMAW) and flux cored arc welding (FCAW) applications use DCEP. This condition yields a stable arc, smooth metal transfer, relatively low spatter, good weld bead appearance and deep penetration for a wide range of welding currents. In contrast, with DCEN, the molten droplet size tends to increase and the droplet transfer becomes irregular, thereby increasing large grain spatter. However, some specific flux-cored wires, e.g. DWA-51B (AWS A5.20 E71T-5MJ), with basic type cored flux are available specifically for DCEN, which offers better impact toughness and crack resistibility in all position welding. Self-shielding flux-cored wires use DCEN, DCEP or AC according to the manufacturer's specification for individual brands.

Table 4: Quick guidance to proper SMAW filler metals for high strength and low temperature steel (1)

TS (MPa)		490 min	520 min	550 min	610 min	670 min	770 min
YS (MPa)		350 min	400 min	420 min	500 min	550 min	690 min
IV (J)		35 min	40 min	42 min	50 min	55 min	69 min
Service temperature (°C)	−20	LB-52 (AC/DCEP, AW/SR) LB-52A (AC/DCEP, AW/SR)	LB-57 (AC/DCEP, AW/SR)	LB-62UL (AC/DCEP, AW/SR) LB-62 (AC/DCEP, AW/SR)	LB-62UL (AC/DCEP, AW/SR) LB-62 (AC/DCEP, AW/SR)	LB-106 (AC/DCEP, AW)	LB-80UL (AC, AW)
	−40	LB-7018-1 (DCEP, AW) LB-52LT-18 (DCEP, AW/SR)	NB-1SJ (AC/DCEP, AW/SR) LB-52NS (AC, AW)	NB-1SJ (AC, AW/SR) LB-62L (AC/DCEP, AW/SR)	LB-65L (DCEP, AW/SR) LB-62L (AC, AW/SR)	LBY-75 (AC, AW)	LB-88LT (AC, AW)
	−60	NB-1SJ (AC/DCEP, AW/SR) LB-52NS (AC/DCEP, AW/SR)					

Note (1) SR stands for stress relieved. AW stands for as-welded.

Table 5: Quick guidance to proper SAW filler metals for high strength and low temperature steel

<table>
<tr><td colspan="2">TS (MPa)</td><td>490 min</td><td>520 min</td><td>550 min</td><td>610 min</td><td>670 min</td><td>770 min</td></tr>
<tr><td colspan="2">YS (MPa)</td><td>350 min</td><td>400 min</td><td>420 min</td><td>500 min</td><td>550 min</td><td>690 min</td></tr>
<tr><td colspan="2">IV (J)</td><td>35 min</td><td>40 min</td><td>42 min</td><td>50 min</td><td>55 min</td><td>69 min</td></tr>
<tr><td rowspan="3">Service temperature (°C)</td><td>−20</td><td>MF-300 /
US-36
(AC, AW/SR)</td><td colspan="2">MF-300 /
US-49A
(AC, AW/SR)</td><td>MF-300 /
US-40
(AC, AW)</td><td rowspan="3">PFH-80AK /
US-255
(AC, AW)</td><td rowspan="3">PFH-80AS /
US-80LT
(DCEP, AW)
PFH-80AK /
US-80LT
(AC, AW)</td></tr>
<tr><td>−40</td><td rowspan="2">PFH-55AS /
US-36J
(DCEP, AW/SR)
PFH-55LT /
US-36
(AC, AW/SR)</td><td>PFH-55S /
US-49A
(AC, AW/SR)</td><td>PFH-55S /
US-49A
(AC, AW/SR)
PFH-80AK /
US-56B
(DCEP, AW)</td><td>PFH-55S /
US-40
(AC, AW)
PFH-80AK /
US-56B
(AC/DCEP, AW)</td></tr>
<tr><td>−60</td><td>PFH-55AS /
US-36J
(DCEP, AW)
PFH-55LT /
US-36
(AC, AW)
PFH-55LT /
US-36J
(AC, AW/SR)</td><td>PFH-55LT /
US-36J
(AC, AW)</td><td>PFH-80AK /
US-56B
(AC, AW)
PFH-55S /
US-2N
(AC, AW/SR)</td></tr>
</table>

Table 6: Quick guidance to proper SMAW and SAW filler metals for heat-resistant low-alloy steel

Steel type	ASTM ASME steel grade		SMAW		SAW	
	Plate	Pipe Tube				
Mn-Mo Mn-Mo-Ni	A302Gr.B,C,D A533Type A,B,C,D	-	BL-96 BL-106	AC/DCEP AC/DCEP	MF-27/US-56B PF-200/US-56B PF-200/US-63S	AC AC AC
0.5Mo	A204Gr.A,B,C	A209Gr.T1 A335Gr.P1	CMA-76	AC/DCEP	MF-38 / US-40 MF-38 / US-49 MF-38 / US-A4	AC AC AC
1Cr-0.5Mo 1.25Cr-0.5Mo	A387Gr.12 Cl.1,2 A387Gr.11 Cl.1,2	A213Gr.T11,12 A335Gr.P11,12	CMA-96 CMA-96MB CMA-96MBD CMB-95 CMB-98	AC/DCEP AC DCEP DCEP AC/DCEP	MF-29A / US-511 PF-200 / US-511N PF-200D / US-511ND	AC AC DCEP
2.25Cr-1Mo	A387Gr.22 Cl.1,2	A213Gr.T22 A335Gr.P22	CMA-106 CMA-106N CMA-106ND CMB-105 CMB-108	AC/DCEP AC DCEP DCEP AC/DCEP	MF-29A / US-521 PF-200 / US-521S PF-200D / US-521S	AC AC DCEP
2.25Cr-1Mo-V	A542Type D Cl.4a A832Gr.22V	-	CMA-106H CMA-106HD	AC DCEP	PF-500 / US-521H PF-500D / US-521HD	AC DCEP
Low C 2.25Cr-W-V-Nb	-	SA213Gr.T23 SA335Gr.P23	CM-2CW	AC/DCEP	-	-
5Cr-0.5Mo	A387Gr.5 Cl.1,2	A213Gr.T5 A335Gr.P5	CM-5	AC/DCEP	PF-200S / US-502	AC
9Cr-1Mo	A387Gr.9 Cl.1,2	A213Gr.T9 A335Gr.P9	CM-9	AC/DCEP	-	-
9Cr-1Mo-V-Nb	A387Gr.91 Cl.2	A213Gr.T91 A335Gr.P91	CM-9Cb CM-96B9	AC/DCEP DCEP	PF-200S / US-9Cb	AC

Band-Overlaying:

What Overlaying with Strip Electrode Offers

The overlaying with a strip electrode, so-called "Band-Overlaying," features the use of thin, wide strip electrodes in combination with fluxes instead of wire electrodes for submerged arc welding (SAW) and electroslag welding (ESW) as illustrated in Figure 1. Strip electrodes can utilize two melting modes, depending on the combination of strip electrode and flux: SAW mode and ESW mode. In the former, arc heat melts the strip and flux, while in the latter, Joule resistance heat of the molten slag generated during welding melts the strip.

Both modes efficiently produce a very flat, wide bead corresponding to the width of the strip used, with shallow, uniform penetration into the base metals, compared to the conventional SAW as seen in the Figure 2. The ESW mode provides smaller penetration with better bead shape, resulting in much better corrosion resistance even for the first layer in comparison with the SAW mode. However, SAW mode offers faster welding speeds than the ESW mode. Thus, Band-Overlaying is most suitable for corrosion-resistant overlaying of such stainless steels as 304(L), 316(L) and 347(L), which can be used for shells of oil refining equipment, various kinds of chemical plants and nuclear power plants as illustrated in Figure 3.

As Band-Overlaying adopts direct current for both modes, magnetic blow may cause uneven beads and undercut depending on the position of power cables for the welding head. Earthing has to be duly located at two or more positions. An electromagnetically controlling head, as shown in Figure 4 is another countermeasure to prevent these kinds of defects.

In order to efficiently obtain satisfactory welding results, you should pay attention to the following points:

(1) Thickness of the overlay: 4 to 5 millimeters
(2) Lap of weld: Around 7 millimeters
(3) Welding position: Flat or 0.5-1.0 degrees upwardly inclined
(4) Flux burden height: 15-30 mm
(5) Electrode extension: 35-40 mm

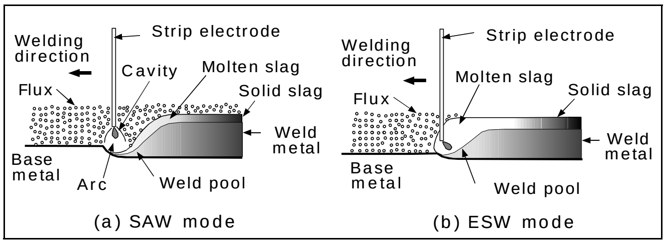


Figure 1: Concept of Band-Overlaying with strip electrode

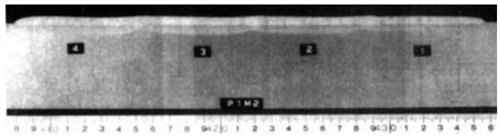


Figure 2: Macrostructure of Band-Overlay weld

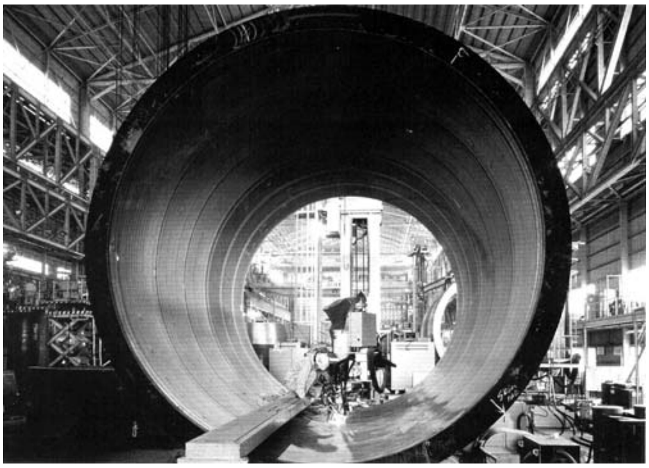


Figure 3: Band-Overlaying of the inside of a shell

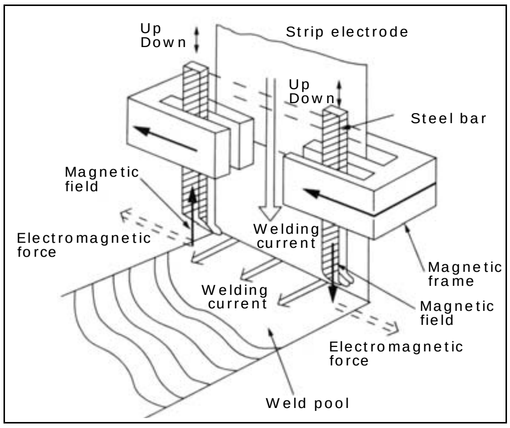


Figure 4: Electro-magnetically controlling welding head for Band-Overlaying

Table 1: Examples of standard welding parameters of Band-Overlaying (DCEP, ESW)

Strip size (0.4T x W mm)	Current (A)	Volt (V)	Speed (cm/min)	Flux burden height (mm)
25	400	25	14	15-25
50	800	25	14	15-25
75	1200	25	14	15-30
150	2400	25	14	15-30

Duplex Stainless Steel Flux Cored Wires, DW-329A and DW-329AP, are Now Spotlighted in the Technologically Demanding Fields

Such technologically demanding welding application as chemical tankers, pulp mills, and offshore structures are the typical fields where DW-329A and DW-329AP shine in flux cored arc welding (FCAW) of duplex stainless steel.

What is Duplex Stainless Steel?

Duplex stainless steel is known for combining the superior stress-corrosion crack resistance of ferritic stainless steel with the ductility, toughness and weldability of austenitic stainless steel. To establish this sophisticated characteristic, duplex stainless steel features a binary microstructure consisting of approx. 50% ferrite and 50% austenite (Figure 1) and a compositional balance of Cr, Ni, Mo and N. It also features yield strength that is two times higher than the 300-series austenitic stainless steels. Because duplex stainless steel has good weldability in terms of hot and cold crack resistance, users can follow almost the same welding procedure as that for austenitic stainless steels. Chemical plant machinery, oil and natural gas drilling pipes and pipelines, chemical tankers, and water gates are typical applications for duplex stainless steels.

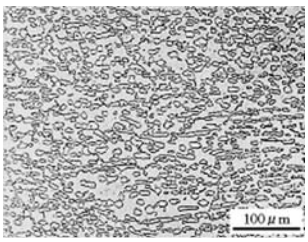


Figure 1: An example of duplex stainless steel microstructure which exhibits distributed austenite (brighter areas) in the ferrite matrix (darker areas)

The Unsurpassed Performance of KOBELCO Duplex Stainless Flux-Cored Wires

Among several KOBELCO brands for duplex stainless steel, DW-329A (AWS A5.22 E2209T0-1/-4) and DW-329AP (AWS A5.22 E2209T1-1/-4) enjoy high reputations worldwide due to excellent performance in usability, mechanical properties and corrosion resistance.

Both brands resemble each other in terms of type of flux (rutile-based flux), suitable shielding gases (CO_2 and Ar/CO_2 mixtures), mechanical properties and chemical composition. However, their applicable welding positions are different: DW-329A is suitable for flat and horizontal fillet welding only, while DW-329AP is excellent in out-of-position welding. DW-329AP features the chemical composition and mechanical properties listed in Table 1 and the microstructure in Figure 2.

Table 1: Typical chemical and mechanical properties of DW-329AP (1.2 mmΦ) weld metal and AWS requirements (1)

Properties \ Brand and AWS	DW-329AP	Requirements of AWS A5.22 E2209T1-4
C (wt%)	0.024	0.04 max
Si	0.55	1.0 max
Mn	0.89	0.5-2.0
P	0.018	0.04 max
S	0.005	0.03 max
Cu	0.06	0.5 max
Ni	9.68	7.5-10.0
Cr	22.96	21.0-24.0
Mo	3.28	2.5-4.0
N	0.14	0.08-0.20
PRE (2)	36.0	-
FNW (3)	40.5	-
0.2% PS (MPa)	617	-
TS (MPa)	808	690 min
El (%)	31	20 min
RA (%)	48	-

(1) Shielding gas: 80%Ar-20%CO_2
(2) PRE = Cr + 3.3Mo + 16N
(3) FNW: Ferrite Number per WRC Diagram-1992

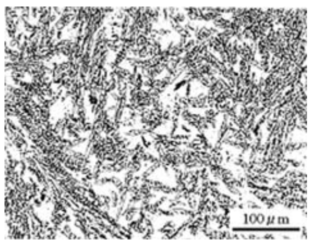


Figure 2: A typical austenite-ferrite binary microstructure of DW-329AP weld metal (the brighter areas show austenite, and the darker areas show ferrite

PRE or Pitting Resistance Equivalent is used as the pitting index to evaluate the resistance to pitting corrosion. With a higher PRE value, the pitting corrosion resistance can be improved. The WRC chemistry-phase diagram is commonly used for estimating the ferrite number related to the ferrite content of duplex stainless steel weld metals.

DW-329AP weld metal possesses sufficient notch toughness or absorbed energies as shown in Figure 3. However, as the testing temperature decreases, the absorbed energy decreases. This is a noticeable disadvantage when compared with austenitic stainless steel weld metals. Therefore, duplex stainless steel weld metals are not suitable for cryogenic temperature applications.

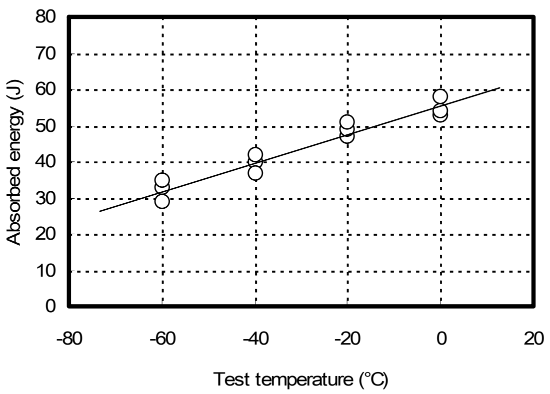


Figure 3: Charpy impact absorbed energies of DW-329AP (1.2 mmΦ) weld metal at low temperatures with 80%Ar-20%CO_2 shielding

Duplex stainless steel is superior in the resistance to pitting corrosion (defined as extremely localized corrosion, resulting in holes in the metal) in chloride-involved applications. DW-329AP weld metal features, as shown in Table 2, excellent resistance to pitting corrosion due to its elaborate chemistry design.

Table 2: Results of pitting corrosion testing of DW-329AP (1.2 mmΦ) weld metal with 80%Ar-20%CO_2 shielding (1)

Testing condition	Corrosion loss (g/m^2-hr)	Judgement
20°C x 24hr	0.005	No pitting
25°C x 24hr	0.032	No pitting

(1) Testing method: ASTM G48 Practice A
Specimen size: 10T x 15W x 35L (mm)

Figure 4 and Table 3 show the weld joint properties of DW-329AP exhibiting sound macrostructure, sufficient tensile strength and ductility. These test results were obtained in joint welding testing with the 20-mm thick duplex stainless steel base metal of UNS S31803 (0.025C, 0.47Si, 1.43Mn, 5.51Ni, 21.98Cr, 2.96Mo, 0.16N)

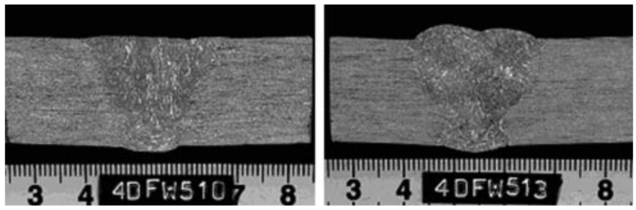
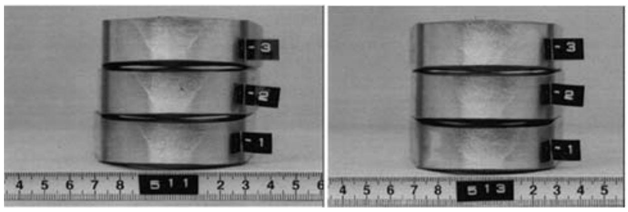


Figure 4: Macrostructure of DW-329AP one-sided weld joints in flat welding (left) and vertical-up welding (right) with ceramic backing and 80%Ar-20%CO_2 shielding

Table 3: Results of tension and side bend testing of DW-329AP (1.2 mmΦ) weld Joints with 80%Ar-20%CO_2 shielding

	Welding position	1G	3G
Tension	Specimen size (mm)	20T x 25W	20T x 25W
	Tensile strength (MPa)	735	723
	Fracture location	Base metal	Base metal
Bend	Specimen size (mm)	9.5T x 20W	9.5T x 20W
	Bending radius	19R-180 deg.	19R-180 deg.
	Appearance (1)	Left below	Right below
	Judgement	Acceptable	Acceptable

(1) Appearance of specimens after testing



Tips for successful welding of duplex stainless steel

(1) CONTROL HEAT INPUT at an appropriate level and keep the interpass temperature lower than 150°C to prevent hot cracks and degradation in corrosion resistance of the weld. The hot crack resistance of duplex stainless filler metal is far better than 310- and 625-type weld metals but a little inferior to 308L- and 316L-type weld metals. Excessively low or high heat input can degrade the corrosion resistance of the weld.

(2) USE NO PREHEAT because the cold crack resistance of duplex stainless steel welds is excellent due to very low diffusible hydrogen as compared to carbon steel welds.

(3) USE HIGHER PRE filler metals or nitrogen-bearing (1-2%) Ar shielding gases for root pass GTAW (which is followed by FCAW for filling passes) in pipes to obtain good resistance to pitting corrosion for the root pass weld.

Hello from Singapore!

Yasunori Nakai
Manager
Business Development Dept.
KWS

Time flies. This is my second experience to work for KOBELCO based in foreign country. It was six years ago when I came back from KWAI (How are you doing guys?) in the USA and now I am in Singapore. No words can express my appreciation for the customers whom I fortunately have had great relationships with wherever or whenever I have traveled on business. (Unfortunately, I have never been to Korea or China). It is now my pleasure to support you as the manager of the Business Development Department with my co-workers here at Kobe Welding Singapore (KWS). Our famous RB-26 (E6013), B-14 (E6019) and LB-52 (E7016) are ready for you at the factory here, along with other items from Kobe Steel, Japan. If you had any requests for KOBELCO welding consumables, please let us know anytime. We will do my best. Have a nice WELDING!

Good Experiences at KWS

After working for Kobe Welding Singapore (KWS) for four and half years, I came back to my old place of work, the International Operations Department (IOD) of the Welding Company of Kobe Steel in December, 2004. I would like to express my heart-felt gratitude for the goodwill extended to me while I was stationed in Singapore from users and distributors who are also readers of Kobelco Welding Today.

Though I had been in charge of the Singaporean market for four years before I began to work for KWS, my stay of four and half years in Singapore was a continual experience of new discoveries and surprises every day, both officially and privately. Indeed, it was a period that let me realize anew the importance of going out into the field, seeing the fabrication workshops, and of thinking after seeing real-world welding practices with my own eyes.

Back in the IOD, I am again in charge of the ASEAN and Middle Eastern markets. This time, since I am in Japan, the transactions between you and me will be indirect, but I will try to make the most of my experiences at KWS to overcome the present economical difficulties together with you. Even though I may not be able to see you physically as often as when I was at KWS, I will be always with you in my mind. Please receive me warmly when I visit you next time.

How are you!

Kazuyuki Harada
IOD, KSL

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