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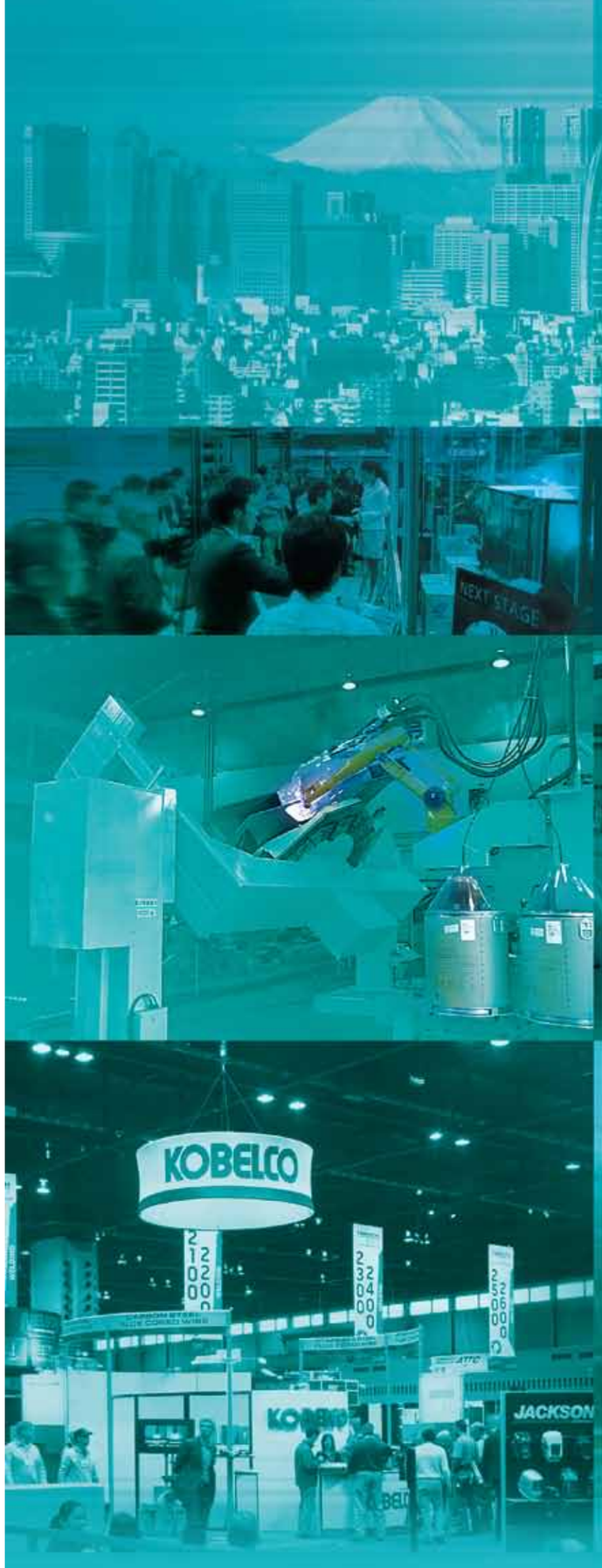
KOBELCO WELDING TODAY

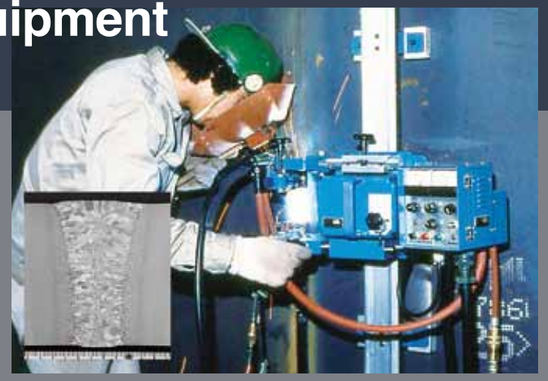
Vol.17
2014 No.1

KOBELCO Puts the Customer First with All-in-One Product and Service



KOBELCO

The SEGARC™ process: achieving efficiency by combining exclusive equipment and flux cored wire



SEGARC™ (Simple Electro-Gas ARC), developed by Kobe Steel, Ltd. in 1974, is an extremely efficient electro-gas arc welding process in the vertical upward position. Even though about 40 years have passed since its debut, it continues to be applied in such fields as shipbuilding, crude oil tank fabrication and steel-frame building construction. It offers the following advantages:

1. The deposition rate is as high as 180 g/min at the current of 380A, resulting in highly efficient welding as shown in Figure 1.
2. The combination of SEGARC-2Z with special flux cored wires provides excellent weldability and superb weld metal properties.
3. Optimum oscillation of welding torch raises one pass welding range to 65 mm plate thickness (See Figure 2)

front side electrode is connected in DC-EP polarity but the root side electrode, in DC-EN.

Figure 4 shows a 200-kg carton of DW-S43G, that is supplied to a certain shipyards in Japan in response to their expressed needs for decreasing the frequency of wire replacement, the time spent repairing weld joints, and the amount of FCW scrap.

Figure 1:
Efficiency of the SEGARC™ process

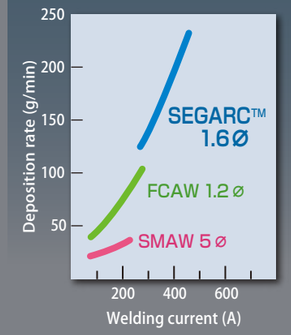
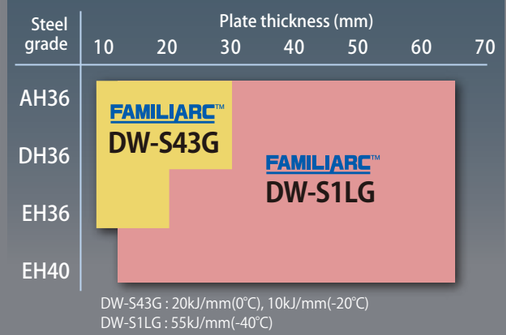
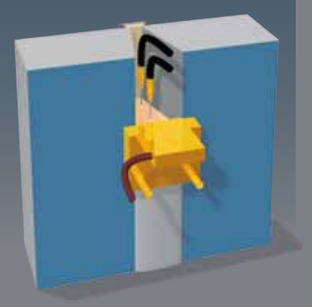


Figure 2:
Applicable steel grades, plate thickness and FCWs



DW-S43G : 20kJ/mm(0°C), 10kJ/mm(-20°C)
DW-S1LG : 55kJ/mm(-40°C)

Figure 3:
Schematic diagram of two etectrode SEGARC™ process



In case of applicable range up to 80 mm thickness, a second electrode has been added to the standard apparatus. A schematic diagram with two electrodes is shown in Figure 3. The procedure is nearly the same as the conventional SEGARC™ process. A water-cooled sliding copper shoe with a shielding gas outlet is placed on the face of the weld joint while a backing material is fixed on the root side. FCWs developed for this process, DW-S50GTF and DW-S50GTR, are used as front side and root side respectively. In order to minimize mutual arc interference, the

In order to meet demands of overseas users for higher levels of efficiency and expedience, SEGARC-2Z may soon be adapted to meet foreign specifications and/or regulations and marketed abroad. However, it is important that interested users confirm beforehand the chemistry of the steel plates as well as the mechanical properties of the corresponding heat affected zones in particular because of the large heat input applied in the SEGARC™ process. Another consideration is the need to carefully manage the storage of welding wire.

Figure 4: 200-kg pack

Comprehensive technological capability and frequent communication are key factors in total welding solutions

A Happy New Year to dearest KWT readers! I am Fusaki Koshiishi, Vice Head of the Welding Business. I would like to express my sinsere gratitude for the kind and continuous support you have given us and our Kobelco products. I have been involved in research and development of welding technology for a long time. Recently I have been visiting China every month to perform one of my duties: managing and controlling the overall Kobelco operations in China.

I am proud of my many years in the welding business because I firmly believe welding is one of the key technologies for building things in such global industries as energy, shipbuilding, automobile, and building construction. And these industries have truly contributed to development all over the world.

We have recently determined our mid- and long-term business vision, which states "we will become the most reliable enterprise for total welding solutions in the world." Accordingly, we will focus our overseas activities to pursue this vision. In order to realize this vision, we must raise our comprehensive technological capabilities while remaining engaged in frequent communication with you so that we can work together to find solutions to your welding-related issues and challenges.

In order to raise our comprehensive technological capabilities, we are focusing on the development of "total welding solution technology," explained in this issue as the Technical Highlight (Pages 3-7). Additionally, we remain committed to developing new and advanced technology that will satisfy your welding needs such as high-performance and high-quality welding consumables, high-functional robotic welding systems and innovative welding processes.

As for mutual communication, direct contact with you is our basic principle. Kobelco staff members as well as our local representatives will visit your countries and your areas as much as possible. At such times, please tell us about your welding needs and difficulties. We'll be happy to listen and discuss anything with you.

Last of all, I wish all of you and your family a happy, prosperous and healthy New Year in 2014.

Fusaki Koshiishi
Vice Head
Welding Business
Kobe Steel, Ltd.

KOBELCO WELDING TODAY No.1 2014

CONTENTS Vol.17

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Total welding solutions: Integrating Kobelco's comprehensive technologies

1 Preface

A solution is the act of or capability for solving problems. When it comes to a welding solution, it means solving customers' welding problems. In the course of helping clients solve problems and addressing their requests, Kobe Steel, Ltd. has been able to develop its highly reputed range of welding consumables, robotic welding systems as well as welding power sources and processes. The basis of all welding solutions arises from the users' needs, as shown in Figure 1.

In the past, however, a welding consumable or a robotic welding system was regarded as the endpoint of welding product development, and it would be up to the customer to adopt the product or combine one final product with another. The total welding solution as envisaged by Kobe Steel seeks to define the entire welding procedure, matching the welding process with the appropriate welding consumable, shielding gas, and power source. Ultimately the goal is to raise the quality of welded structures by improving the efficiency of the welding procedure and reducing costs (Figure 2).

Kobe Steel, Ltd. is one of the few companies in the world that develops and manufactures welding consumables, robotic welding systems and power sources. This enables Kobe Steel to offer its original welding consumables in combination with the most appropriate welding procedures. In this special edition of Kobelco Welding Today, we wish to introduce three new total welding solutions: MX-MIG process, J-Solution™ Zn and Ultra High Current MAG Welding.

Figure 1: Welding solution cycle

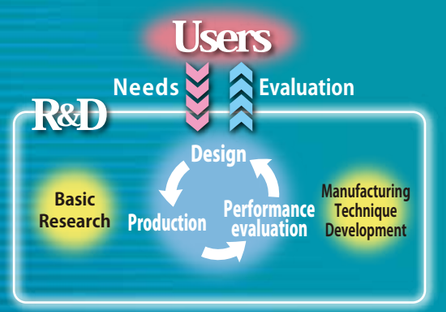
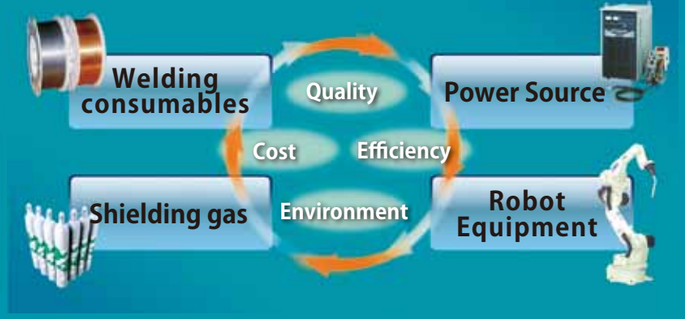


Figure 2: Solution diagram and its factors related to welding procedure



2 MX-MIG process

MX-MIG is a total welding solution that combines the MIG welding process with pure Ar shielding gas, MM-309L flux cored wire (FCW) and an inexpensive, standard welding power source. Ar shielding gas can decrease C content in the weld metal, reduce spatter and fumes, and allow low dilution overlay welding due to shallow penetration, while MM-309L is specially designed to maintain an appropriate amount of oxygen in the molten pool.

The Product Spotlight of Kobelco Welding Today; No. 16-2 introduced MX-MIG as a process for welding in automobiles, in which MM-1S FCW for general carbon steels, is used for lap-fillet weld joints on thin steel plates. This article explains the same process for stainless steels.

MM-309L is 309L FCW for the MX-MIG process. By adjusting the flux, MM-309L is designed to improve bead wetting at the toe area, which can be problematic with pure Ar gas. (See Figure 3 and Figure 4.)

Figure 3: Bead appearance

Figure 4: Macrostructure

2-1. Generation rate of spatter and fumes

As seen in Figure 5 and Figure 6, MM-309L reduces spatter to one-third or less and fume emissions by half that of the conventional DW-309L.

Figure 5: Spatter generation rate

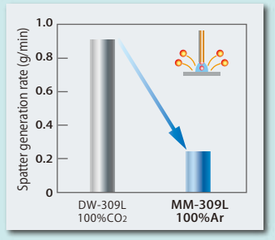
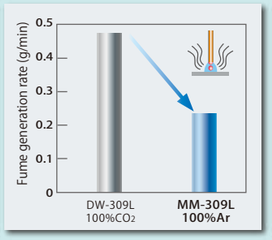


Figure 6: Fume emission rate



2-2. Chemistry and mechanical properties

The chemistry and mechanical properties of MM-309L all deposited metal are shown in Tables 1 and 2 respectively.

Table 1: Typical chemistry (%)

C	Si	Mn	P	S	Ni	Cr	Mo	FNW*1
0.02	0.77	1.23	0.013	0.002	13.7	24.5	0.02	17.7

Note: *1 FNW: Ferrite content according to WRC diagram

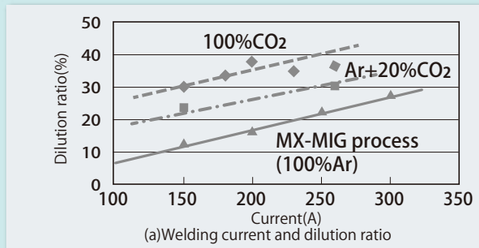
Table 2: Typical mechanical properties

0.2%PS	TS	El	vE(-20℃)	vE(-196℃)
427MPa	563MPa	36%	40J	21J

2-3. Low dilution overlay welding

The pure Ar gas used for the MX-MIG process increases the arc range and reduces the energy density over the molten pool surface, thus allowing shallow penetration of the base metal, as shown in Figure 7(c). Figure 7(a) shows the influence of the shielding gas and welding current on the base metal dilution ratio. The base metal dilution ratio of the MX-MIG process is below 20% at 200A and below 30% at 300A.

Figure 7: Penetration shape and base metal dilution ratio



It is clear that the MX-MIG process allows low dilution overlay welding even with high current/high deposition welding and thus reduces the number of welding passes as well as working time.

2-4. Overlay welding

Overlay welding was carried out with DW-309L and MM-309L, using a welding speed of 30 cm/min for three passes in one layer and by changing the welding current as shown in Table 3. It shows that the chemistries of both the overlay weld metal and the first layer are equivalent to those of 308L stainless steel even at 250A.

Table 3: Chemistry of overlay-weld metal (%)

Product name	Welding current	C	Si	Mn	Ni	Cr	N	FNS*1
DW-309L	150A	0.06	0.62	1.26	9.1	17.7	0.021	3.0
	200A	0.06	0.57	1.28	8.8	17.3	0.019	2.3
	250A	0.06	0.53	1.31	8.7	17.2	0.020	1.1
	300A	0.07	0.50	1.26	8.6	16.9	0.019	1.0
MM-309L	200A	0.03	0.74	1.19	12.4	22.2	0.021	9.5
	250A	0.04	0.71	1.21	11.2	20.2	0.019	6.9
	300A	0.05	0.69	1.22	10.5	18.7	0.019	3.6

Note: *1 FNS: Ferrite content according to Schaeffler diagram

MM-309L resulted in shallow base metal penetration〔as seen in Figure 8(b)〕as well as excellent bead appearance and slag removal.

Figure 8: Bead appearance and penetration shape

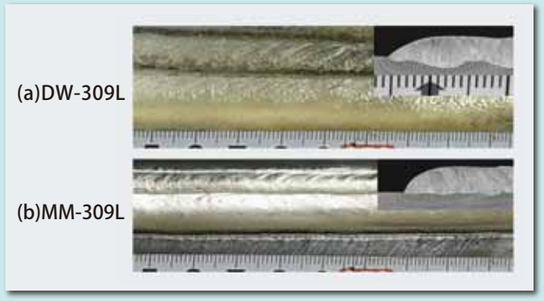


Figure 9: Microstructure change of overlay-weld metal

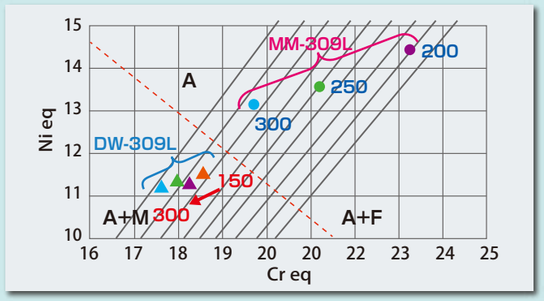


Figure 9 is a DeLong Diagram based on Table 3. In the case of DW-309L, all four results indicate a mixed austenitic and martensitic microstructure (A+M) that could crack at the hardened zone. On the other hand, the all results obtained with MM-309L show a mixed austenitic and ferritic structure (A+F) that would enable high current welding. Using MM-309L for overlay welding, one may weld a first layer with a high current range like 300A, while raising welding efficiency as high as 1.6 times, compared with the conventional process that applies a low current below 200 A.

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3 J-Solution™ Zn

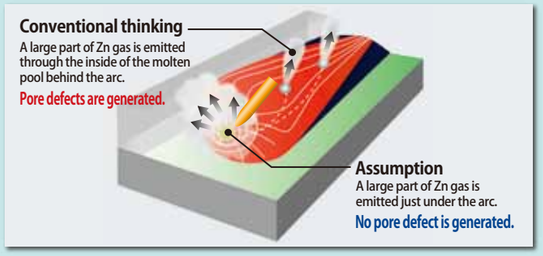
To prevent rust in automobiles, manufacturers utilize galvanized steel. Unfortunately poor weldability is a well-known drawback of galvanized steel sheet. The zinc (Zn), plated on the sheet surface, evaporates during welding, causing pore defects such as pits (open holes on the weld metal surface) and blowholes (defects inside weld metals) to occur. And another weak point is the increase of spatter because the evaporated Zn gas blows off molten droplets as well as the molten pool itself.

In order to improve weldability, the latest visualizing technology was used to examine the mechanism of Zn gas generation. As a result, Kobe Steel and Daihen have together developed a solution involving Kobe Steel's new solid wire and Daihen's current-wave control as well as a new type of shielding gas. Named J-Solution™ Zn, this process resists porosity and reduces spatter.

3-1. Mechanism of Zn gas generation

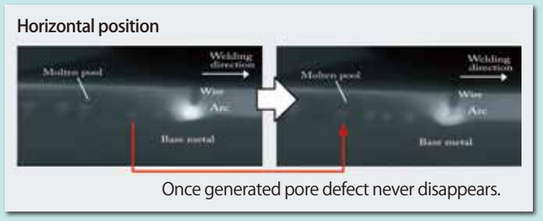
It has been assumed that Zn gas can generate pits and blowholes if it is emitted into the molten pool right behind the arc but not if it evaporates as it is emitted from just under the arc. Figure 10 indicates the conventional thinking and the assumption in this regard.

Figure 10: How pore defects are generated



This assumption has recently been studied by observing a moving picture of Zn gas behavior in the molten pool during welding. An X-ray transmission, high-speed moving picture camera was used under the cooperation of the Joining and Welding Research Institute, Osaka University, and proved that the assumption was correct. As shown in Figure 11, Zn gas that remained in the molten pool instead of evaporating from under the arc caused pore defects. On the other hand, when Zn gas largely evaporated from under the arc, pore defects were not generated at all.

Figure 11: Pore defect behavior in the molten pool, observed through X-ray transmission photograph



When Zn gas evaporates from just under the arc, bubbles do not form in the molten pool and pore defects are avoided. Accordingly it is now clear that the amount of pressure applied to the molten pool right under the arc is the dominant factor allowing Zn gas to evaporate quickly.

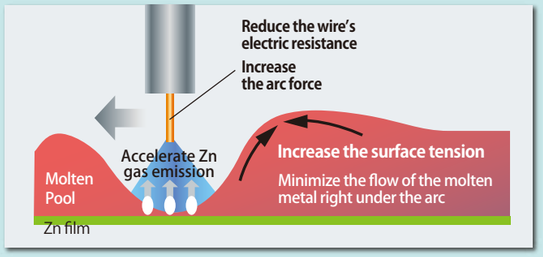
3-2. Improvement of porosity resistance

As explained, depressing the molten pool right under the arc is essential to improve porosity resistance. In order to learn how to do this more effectively, all three elements of gas shielded arc welding - welding consumable, shielding gas and welding power source - were examined and the results incorporated into J-Solution™ Zn, which significantly reduces porosity.

3-2-1. FAMILIARC™ MIX-Zn solid wire

In order to exert sufficient pressure on the molten pool just under the arc, the flow of the molten pool right under the arc must be minimized. The factors influencing this flow are the surface tension of molten pool and the arc force (See Figure 12). For J-Solution™ Zn, the surface tension of the molten pool was increased by reformulating the welding wire chemistry, and the arc force was raised by minimizing the welding wire's electric resistance; thus high current welding that maintains the wire's melting rate has become possible.

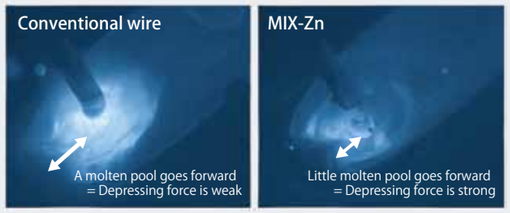
Figure 12: Influential factors depressing the molten pool



MIX-Zn solid wire was developed to optimize surface tension as well as to apply a higher current with the same deposition amount by reducing the wire's electric resistance.

The photos in Figure 13 of molten pools just under the arc with conventional solid wire and MIX-Zn show that MIX-Zn depresses the molten pool and prevents gravity from moving it forward.

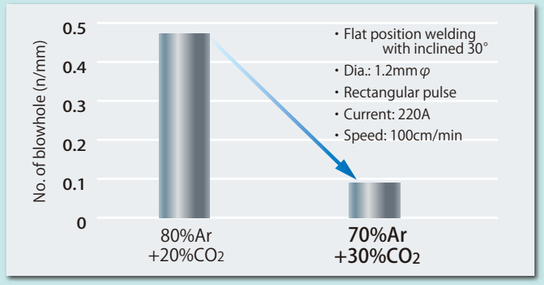
Figure 13: Molten pool shape (flat position welding with an electrode inclined 30°)



3-2-2. Shielding gas

Whereas pulsed MAG welding generally applies Ar+20%CO_2 gas, which reduces spatter through spray transfer, J-Solution™ Zn process has adopted Ar+30%CO_2 gas because of its effect on the arc force that allows tension on the surface of the molten pool to be maintained while also keeping spatter low. The mere 10% increase of CO_2 gas has a remarkable effect on porosity resistance, as seen in Figure 14.

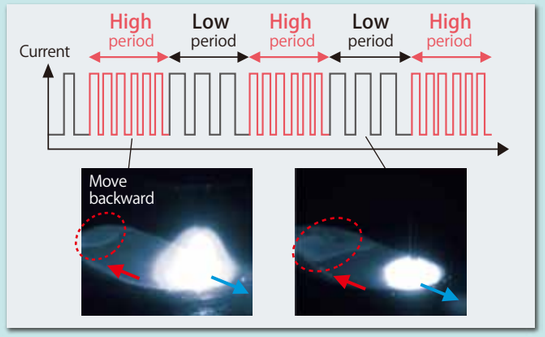
Figure 14: Effect of shielding gas composition against porosity resistance



3-2-3. Pulse wave function

The low frequency-superimposed pulse wave (pulse wave function) is applied in order to either strengthen or weaken the arc force, as seen in Figure 15. The periodic change of current produce a pulse wave that sways the molten pool forward and backward, which allows Zn gas to be emitted as the molten pool begins to thin.

Figure 15: Theory of pulse wave function



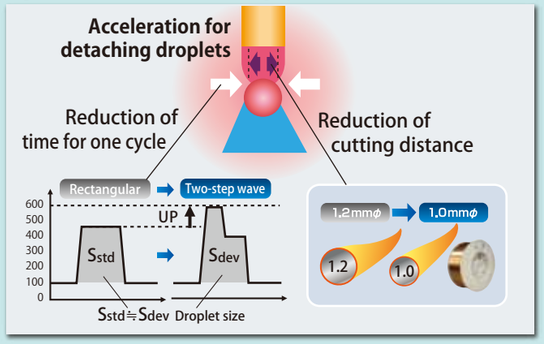
3-3. Reduction of spatter

In theory, the application of Ar+30%CO_2 as well as Zn gas emissions can make spatter generation worse. However, the intensity of spatter generation depends on the speed and stability of the molten droplets as they detach from the wire end. Here are two methods that can keep spatter to a minimum.

3-3-1. DP400R welding power source

The first method for removing droplets from the wire end is to produce an electro-magnetic pinch effect by maintaining the welding current. As shown in Figure 16, a two-step pulse wave control is applied. The first peak current is set high to constrict the droplet while the second peak current, set low, causes it to detach slowly from the wire end, resulting in the stable transfer of small sized droplets.

Figure 16: Method of reducing spatter



3-3-2. Thin diameter wire

The second method for removing droplets from the wire end is to utilize 1.0 mm wire instead of the conventional 1.2 mm. As for efficiency, 1.0 mm diameter is sufficient from a welding speed below 120cm/min, which is common in welding galvanized steel sheets up to 3 mm in thickness. Figure 17 clearly shows the reduction of spatter with the thinner diameter wire.

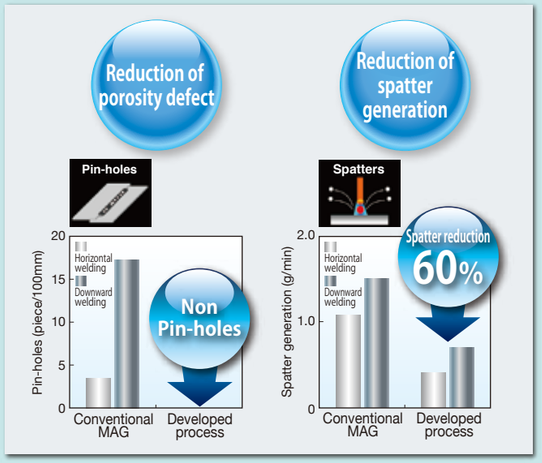
Figure 17: Effect of reducing spatter

Conventional process	J-Solution™ Zn
Gas : Ar+20%CO_2	Gas : Ar+30%CO_2
Diameter: 1.2mmΦ	Diameter: 1.0mmΦ
Pulse wave: Conventional rectangular	Pulse wave: 2-step pulse wave

In summary, J-Solution™ Zn represents a new concept in welding procedures that both improves porosity resistance and reduces spatter. While both aims may appear incompatible in a conventional method (i.e. decreasing porosity may increase spatter), the combination of 1.0 mm MIX-Zn, chemically formulated for galvanized steel sheets; Digital-Pulse DP400R, with added new control software and parameter; and Ar+30%CO_2 shielding gas allows both issues to be solved together.

If changing the gas composition to Ar+30%CO_2 or the wire diameter to 1.0mm is not easy, MIX-GZn is available with Ar+20%CO_2 gas. While such excellent results as described above cannot be expected, the results will be far better than those obtained via the conventional procedure.

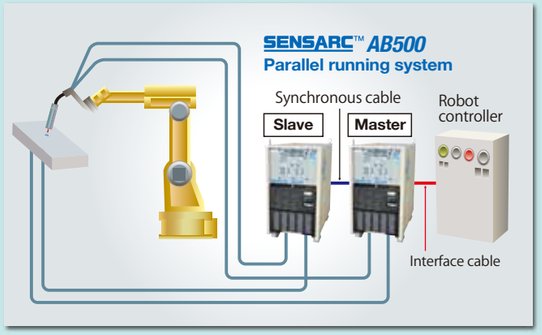
Figure 18: Effect of J-Solution™ Zn



4 Ultra High Current MAG Welding Process

Combined with FCW and two power sources, Ultra High Current MAG Welding provides a total welding solution for mid-thick plate welding. The process was introduced in the Product Spotlight of Kobelco Welding Today, No.16-3. Here we analyze arc stability with a welding current over 500A and describe the system's specifications as well as the test results of butt joint welding. A diagram and specifications are shown in Figure 19 and Table 4, respectively.

Figure 19: Schematic diagram of Ultra High Current MAG Process



4-1. FAMILIARC™ MX-A100D

In conventional high current MAG welding with a solid wire, rotating transfer of the droplet can cause heavy spatter. In contrast, MX-A100D FCW minimizes spatter. Because the outer steel sheath melts first and the inner flux remains in a columnar state, spray transfer occurs at the wire end instead of rotating transfer (See Figure 20).

Figure 20: Droplet transfer

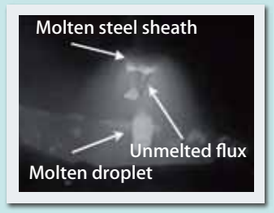


Table 4: Specification

Manipulator		ARCMAN™ MP
Power source SENSARC™ AB500 Parallel system	Rated output current	700A
	Usage rate	100%
	Load voltage	55V
Wire feeding rate		Max. 30.0m/min
Welding torch RTW601	Rated current	600A
	Usage rate	100%
	Cooling method	Water
Welding wire	Product name	MX-A100D
	Diameter	1.4mmΦ
	Deposition rate	Max. 300g/min
Shielding gas		Ar+20%CO_2

4-2. SENSARC™ AB500

The AB500 power source is designed to provide periodic low current by controlling the waveform of the welding current and the arc voltage, resulting in a stable arc voltage equal to the arc length - even under conditions of ultra high current welding.

4-3. Butt joint properties

Figure 21 shows the macrostructure and Table 5, the butt joint properties of the conventional process and Ultra High Current MAG Process.

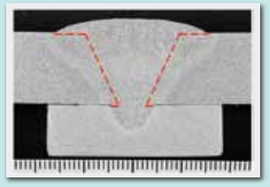
Table 5: Comparison of butt joint properties

	Conventional process *1				Developed process		
Layer *2	1	2	3	4	1	2	3
Welding current (A)	320	360	360	360	530	530	390
Deposition rate (g/min)	88	101	101	101	255	255	153
Welding speed (cm/min)	32.0	28.0	24.0	19.0	48.0	37.0	25.0
Ratio of weld efficiency	1				1.8		

Note: *1: MAG welding with solid wire (dia.:1.4mmΦ)
*2: One pass/ layer welding
3: Groove shape: 50° single V, 5mm root gap, 16mm thick

An additional advantage of this process is the reduction of nitrogen (N_2) in the weld metal because the stable spray transfer even at high current range reduces the intrusion of atmospheric N_2.

Figure 21: Macrostructure



5 Postscript

This article has explored three total welding solutions that consist of dynamic combinations of welding consumables, welding systems, shielding gas and welding power sources. Kobe Steel will continue to pursue solutions to the problems that hinder welders and package the best of them into Kobelco's total welding solutions.

KOBELCO WELDING TODAY
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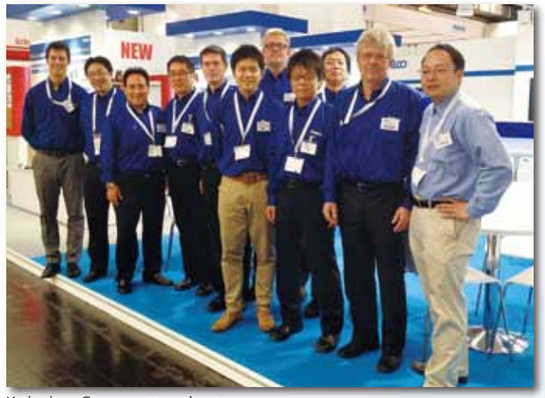
Essen Fair, Germany, 2013; An impressive focus on the energy industry

Fruitful business communication



Kobelco Group attendants

The 18th Essen International Trade Fair was held in Essen, Germany, from September 16 to 21, 2013, and the Kobelco group took part. According to the organizers, 55,000 visitors gathered at the Essen Fair.

At the Kobelco group display, such key products as DW-A70L and DW-N625P for pipeline welding.

If I were asked for my impression of this Essen Fair, I would say a major focus was on the energy industry - particularly the pipeline-related processes.
At the Kobelco booth, we experienced a wonderful cultural exchange with some users from Brazil.

They delighted us by making Caipirinha, a Brazilian cocktail based on Cachaça, a spirit made from sugarcane, which they brought from their country.
Our meeting was rather lively as a result, and we toasted our mutual and future cooperation in business.

We will be happy to meet our KWT readers in next Essen Fairs. Until then, "Auf wiedersehen (good-bye)!"

Reported by
Masaki Sugimoto,
Manager,
International Sales and Marketing Section,
Marketing Department of the Welding Business

Texas: One of America's most vigorous states





Dear KWT readers! My name is Norisuke (Nick) Miyauchi. I was assigned to Kobelco Welding of America Inc. (KWAI) as president in May 2013. It is my first experience working abroad, where I have been involved in both sales and sales planning of welding consumables as well as robotic welding systems.

In the USA, our most active markets have been the auto and construction industries as well as the energy and drilling rig industries. We aim to penetrate the Kobelco brand deeply into these markets so as to expand our business together with that of our local distributors in each district.

Last year, KWAI took part in the FABTECH 2013, which was held in Chicago. We enjoyed meeting old friends as well as potential customers and look forward to seeing all of them again at FABTECH 2014 in Atlanta.


Posing with members of WWS Inc. (the trading firm)

Texas is home to such major cities as Houston, Dallas and San Antonio, famous for the movie of the Alamo.

Because these cities have been heavily influenced by the shale gas boom, their populations have increased sharply and, consequently, so have housing and building construction as well as traffic jams.

However, once we leave these cities, we can still feel the large size of the American landscape in the endlessly extending plains, the picturesque scenery of cattle grazing on the range and also the pickup trucks driving along to broadcasts of country music.

Also popular in Texas are professional sports such as American football, baseball, basketball and ice hockey. People living in Houston, Dallas and San Antonio love to cheer for their home teams.

Texas today is one of the most vigorous parts of the United States. I encourage you to visit Texas; you can wear a "taste of Texas" costume (cowboy hat and boots) and enjoy a huge Texas steak. "Go Texan!"


Mr. Miyauchi in the "taste of Texas" costume

KOBELCO WELDING TODAY
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People in Thailand: Really cheerful and amazing





Dear KWT readers! I am Yoshiyuki Hasegawa, Managing Director of Kobe MIG Wire (Thailand) Co., Ltd. (KMWT). I was assigned here as Managing Director in November 2011, right in the middle of the heavy floods that caused many factories to disappear under the water. It was our good luck that KMWT did not suffer much from those floods.

This year flooding returned to every region in Thailand, and we worried that our products stored in regional warehouses would suffer water damage. I feel like the floods are one of the annual events in this country.

Floods are not the only events that may surprise Japanese in Thailand. One good example is shown in the photograph below: a scene from KMWT's Energy Week.

Activities related to safety or energy conservation held in factories in Japan tend to be taken very seriously, but when they are held in Thailand, they take on an atmosphere of a merry festival. During Energy Week, employees wore the same polo shirts and decorated the premises on the opening day.


Excellent piece of work at the Board Contest during KMWT's Safety Week

At lunch time during Energy Week, the employees played a number of different games and got very excited. I suppose that the excitement expressed by Thai people is one of the bright features of Thailand, although I, as a foreigner, sometimes ask "isn't it a waste of energy?"

Another example of creativity can be seen in the photo from the Board Contest, held during KMWT's Safety Week.

All of KMWT's employees can take part in the Board Contest. Waste materials are used to make a sculpture. Don't you think the one in the picture is an excellent piece of work? Such masterpieces (?) are then displayed in various parts of the factory during Safety Week. You may wonder whether such a Board Contest achieves the original purpose of increasing awareness about safety or whether they can balance the energy needed for their jobs with that spent on the board contest. However, I am very much surprised at their enthusiasm for the contest and, at the same time, at their skill with their hands.

I would like all KWT readers to visit Thailand at least once and see for yourself how cheerful and amazing Thai people really are.

Posing at the stage on the opening day of Energy Week are KMWT staff members