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KOBELCO WELDING TODAY

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

SINCE 1998

ANNIVERSARY

KOBELCO

Head of the Welding Business reflects upon the publication of KWT's 20th anniversary special issue

Dear KWT readers! My name is Fusaki Koshiishi, Head of the Welding Business. I would like to express my sincere appreciation for your warm and continuous patronage of KOBELCO products. Since KWT was first issued in 1997, 20 years have passed, and we are proud to publish this 20th anniversary special issue. We are also thankful for your kindness at reading KWT for these many years. Looking back at the last two decades in this special issue we see big changes in the world as well as in our welding business environment. In 2008, the Lehman Brothers financial crisis triggered worldwide economic stagnation, while the Great East Japan Earthquake in 2011 led to public opinion turning against nuclear power generation. In fact, energy industries overall, including offshore structures, have declined due to a drop of crude oil prices. However, despite these downward trends, we have pushed forward with globalization, establishing KWQ, in Qingdao, China, for production of FCWs in 2008; KWSH, in Shanghai, China, for sales and marketing activities in 2010; and KWI, India, for sales and marketing activities in 2011.

While our business environment remains severe, there is no change in that welding is at the core of all industries. The history of KOBELCO's welding business started in 1940, with the development of an ilmenite type covered electrode, which was an original product available only in Japan. Two years later, in 1942, we produced the first coating machine in Japan, the EB-17, named for the 17th year of the Showa era on the Japanese calendar. Since then, our welding business has progressed by developing new welding technologies and putting them into practical use in cooperation with domestic as well as overseas customers. The result has been our contribution to society.

When we look at current trends in welding technology by every industry, the need for automation and reducing manpower is increasing. This is true in the Asian shipbuilding industries as it is among steel frame fabricators, where, despite progress in welding automation inside plants, manpower shortages at construction sites are causing hardship. Looking overseas, automated fabrication of multiple-shaped H columns is now indispensable. Car manufactures require faster welding of thin plates, including galvanized steel sheets, and multi-material joining, such as Al/steel in order to reduce a weight. In the construction machinery industry, where robotization is already established, progress is being made in the application of highly efficient welding processes, such as welding with large currents and narrow gap welding, in addition to IoT utilization like the control and monitoring of plural robots in order to increase productivity. And even in energy-related industries, the need for automation has increased in plant construction.

The Welding Business aims to remain the most reliable enterprise for total welding solutions in the world. As mentioned above, there is a strong need for automation and robotization due to labor shortage, the difficulty in passing down expert skills, and the desire for high efficiency in every industry. To respond to these issues, KOBELCO is focusing on developing welding robot functions and controllers, suitable welding processes and procedures, as well as welding wires to be used in combination with robots. For example, our ultimate target for welding wires is to develop one with such excellent feedability it will "never stop welding." Covered electrodes, on the other hand, are still applied around the world, in particular in the ASEAN regions, and we will continue developing new types of covered electrodes together with the Technical Department in TKW, Thailand by applying scientific approaches.

TKW will celebrate its 50th anniversary next year. It was the first overseas production base for the whole of Kobe Steel as well as the first step in globalization for the Welding Business. After TKW, overseas bases were expanded to each country in the ASEAN region, the USA, Korea, Netherlands, China and India. Over the past two decades of publication KWT, we have promoted our overseas business expansion, and even now, under the corporate slogan "the most reliable welding solutions enterprise in the world," we keep on acting to become Asia's No.1. Guiding our drive toward the goal are "quality and technology," "trust and reliability," "pride and responsibility" and "challenging spirit and activity," the attributes that have been cultivated by staff members throughout our long history. Through KWT, we will introduce our products and technologies and inform you of our management philosophy, while cherishing the communication with you. We look forward to working with you in the next two decades.

Fusaki Koshiishi
 Director, Senior Managing
 Executive Officer
 Head of the Welding Business
 Kobe Steel, Ltd.



We will strive to enhance the welding industries while taking our customers' needs into account together with those of our distributors and partners and incorporating them into new and distinctive products and technologies. And finally, we look forward to your continuous patronage of KWT, as we continue to feature the best contents in the magazine.

Koichi (Jay) Sugiyama
 General Manager
 Global Operations and Marketing Department
 Marketing Center
 Welding Business
 Kobe Steel, Ltd.

The relationship of trust never changes

Dear KWT readers! I would like to express my sincere gratitude for your continuous support that has led us to being able to celebrate KWT's 20th anniversary. I am also proud of KOBELCO's successive staff members for their efforts at publishing the magazine over the years.

Incidents that occurred around the world in 1997 (20 years ago) included the Asian currency crisis that impacted the economies in Thailand, Indonesia, Malaysia and Korea; the return of Hong Kong from the UK to China; and the death of Princess Diana, who was popular even in Japan. While the largest-ever El-Nino also occurred in 1997, abnormal weather related to climate change has become more serious over the last 20 years. When I see extreme weather events occurring worldwide, I feel the earth is angry. We all must work together to leave the earth with a rich environment for the younger generations.

While global crude steel production, which mirrors demand for welding consumables, reached about 800 million tons in 1997, it nearly doubled in quantity to about 1.6 billion tons in 2016. The rise was caused by a nearly eight-fold increase of production in China. And the remarkable progress of China still drives the world economy. Just ten years after 1997, the iPhone appeared, greatly changing our work and lifestyles. The development of IT technology has continued to bring us a wide range of high quality digital tools at a speed beyond our imagination.

By contrast, there is one thing that we have never changed even after a long time: the Welding Business's deep respect for the relationship of trust we maintain with our customers and partners more than anything else. This attitude is the base of remaining "the most reliable total welding solutions enterprise" and will never change. In the future as well, while listening to KWT readers' voices, we will walk together with you.

As time flows on, the importance of welding has increased further, and our customers' requirements have diversified. Our mission ranges across such areas as the improvement of fuel efficiency in cars and merchant vessels, which is influenced by climate change, the expansion of clean energy applications, including LNG, and the promotion of automated welding with IT technology installed.



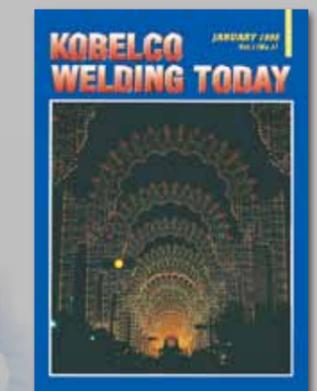
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1998 Vol.1-1 first issue

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THE KOBELCO ARC over the Last Decade

The swing from active to sluggish market (2008 ~ 2010)

In the years leading up to 2008, the world economy remained strong, thanks to booming economic growth in developing nations, including China. These trends were mirrored in the welding industry, and demand for welding consumables in the shipbuilding and energy industries increased. Due to increasing demand for crude oil and other natural resources, commodity prices continuously increased, leading to ever more construction of such facilities as offshore structures for exploration and production of oil or natural gas as well as crude oil tankers, storage tanks and oil refineries. Indeed, many industries that enrich human lives prospered, including automobiles and construction of power plants, infrastructure and commercial and residential buildings.

In many industries, demand increased not only for welding consumables but also for greater production capacity and automated production systems, and KOBELCO was in good position to supply both. Having developed and supplied automatic welding technologies to Japanese shipyards and related industries since the 1970s, KOBELCO now supplied them to new overseas markets.

These exports included RF™ (Figure 1) and FCB™ (Figure 2) equipment for one side welding processes long utilized in Japanese shipyards for panel joining; processes such as SEGARC™ (Figure 3), for automatic vertical welding of heavy plates, and TRIFARC™ (Figure 4), which allows highly efficient horizontal fillet welding; and the ARCMAN™ robotic welding systems for construction

machinery and steel frame construction. Used together with exclusively-developed welding consumables, these technologies delivered superb performance within their respective circumstances.

However, following the Beijing Olympic and the financial crisis caused by the subprime mortgage problem, this favorable business climate cooled. Enthusiasm for investment slowed, resource prices dropped, and the world economy quickly went into recession. However, while at first it seemed the adjustment phase would last long, the world economy slowly began showing signs of recovery in 2010, thanks to continued growth in the BRICS and other developing nations.

Around this time, the following new trademarks were adopted for KOBELCO's welding consumables:

FAMILIARC™: ("FAMILIAR" + "ARC") is used for mild steel and high tensile strength steel below 590MPa.

TRUSTARC™: ("TRUST" + "ARC") is used for 590MPa or higher tensile strength steel, low temperature and heat resistant steels.

PREMIARC™: ("PREMIUM" + "ARC") is used for high alloy steel, stainless steel and non-ferrous metal.

In 2008, the new trademarks were incorporated into new product names; for example, RB-26 became FAMILIARC™ RB-26; CMA-106 became TRUSTARC™ CM-A106; and DW-308LP became PREMIARC™ DW-308LP.

One of the above trademarks is displayed on each KOBELCO welding consumable. In this article, the trademarks will be abbreviated as **F**, **T**, and **P**, respectively.

The re-emergence of developing nations (2011 ~ 2013)

In March 2011, the Great East Japan Earthquake and the tsunami that followed caused unprecedented damage. The Japanese economy that had been suffering in the aftermath of the financial crisis was damaged further. Many scars still remain.

By contrast, while instability caused by the European and American debt problems hampered the recovery of the world economy, easy-money policies and economic stimulus measures implemented in many countries resulted in an expansion of demand, increased prices for energy and natural resources, and an upturn of business worldwide.

As in the years prior to 2008, the oil and gas industries grew significantly. Construction of offshore structures, oil refineries, ships and ship-related buildings boomed, particularly in developing countries. Fabricators in both industrialized countries and developing nations saw their orders rise.

Once again, KOBELCO's efficient and time-tested welding technologies attracted customers while at the same time the company introduced new product lines and high value-added products into the market. For example, new products for pipeline construction included **T** DW-A70L, which offers stable mechanical properties and excellent workability for welding API 5L X80; **P** DW-N625P for all position welding of clad pipes; and flux cored wires (FCWs) for pipes under sour gas environments. Other new product lines were developed for low temperature services. The welding consumables for 9%Ni steels, used in Japan to construct natural gas storage tanks and transportation equipment, seemed to meet the needs of the times as their use spread widely in many regions.

On the other hand, this period also saw increasing consolidation in the welding industry, through M & A and other trends, due to an expectation of long-term unstable demand. However, even under such trying circumstances, KOBELCO continued to sell consumables, by meeting market needs and offering unique technical capabilities,

and introduced new product lines developed for a range of industries. This is the well-known and renowned "KOBELCO Way."

The challenge of new environments (2014 ~ 2017)

In the second half of 2014, weak demand in developing nations helped trigger a decrease in worldwide energy demand, leading to a drop in crude oil prices that had exceeded 100 US\$/barrel. With North American shale gas production adding to the glut, the fall in oil prices was sharp and swift. Even in 2017, crude oil prices remained low at about 50 US\$/barrel, as advancements in drilling technologies ensured further cost reductions in shale gas production. The prices of other resources followed nearly the same path. In many places, regional conflicts as well as corruption and scandals accelerated economic stagnation. As a result, fiscal austerity measures were introduced in many countries, causing even more instability.

On the other hand, in Japan, the easy-money policy as well as demand for construction in response to earthquake damage and preparation for the Tokyo Olympics helped to improve employment and corporate performance. However, long lasting deflationary concerns were not dispelled due to uneasiness about the future. Despite demand in the short term, the declining birthrate and aging society have meant that high efficiency and manpower saving have become essential on a long-term basis.

KOBELCO's robotic welding technologies, developed over the years with corresponding welding consumable, are expected to play an important role. The ARCMAN™ series of welding robots and CB-type controllers are now capable of high quality welding on medium-thick to heavy plates and offer excellent operability. In addition, the digitally controlled SENSARC™ AB500 welding power source provides highly efficient tandem welding, and the REGARC™ process (Figure 5) enables low spattering and efficient GMAW even with CO2 shielding gas by controlling the welding current and arc voltage waveforms.

Figure 1: RF™ equipment for one side welding



Figure 2: FCB™ equipment for one side welding



Figure 3: Welding site of SEGARC™ process



Figure 4: Welding site of TRIFARC™ process



Figure 5: Welding site of REGARC™ process



Figure 6: Application of robotic welding system for hull assembly in shipbuilding



These technologies have been applied not only in Japan but also in overseas regions where construction demand is high, such as North America, East Asia, Southeast Asia, and South Asia. Even in the field of shipbuilding, the need for automation was so high that a robotic welding system for hull assembly (Figure 6) was developed and applied in 2017 for the first time. KOBELCO's strengths lie in supplying total welding solutions to users with particular needs in a diverse range of industries.

KOBELCO's recent history overseas
— China —

In China, KOBELCO increased sales of welding consumables and equipment by meeting local needs when demand for construction and energy rose during the build up to such large-scale events as the Beijing Olympics in 2008 and the Shanghai World Expo in 2010.

Since KOBELCO WELDING OF TANGSHAN CO., LTD. (KWT) (Figure 7) was established as a production base of solid wires in 2002 (Figure 8), it has contributed to the operations of customers, especially car and construction machinery manufacturers.

Japanese-affiliated as well as local producers have given high marks to **F** MG-51T for thin plates and **F** MG-50CH for heavy plates. As a producer of highly reputed solid wires in pail-packs for automatic welding, such as the large-sized ARROW PACK, KWT was able to increase packed wire production lines when demand for automatic welding increased. Also popular with customers have been the SE series solid wires with no-Cu coating (Figure 9) that are exported from Japan and feature smooth wire feeding and a reduced environmental load.

In order to keep up with the growing shipbuilding industry and to manufacture made-in-China welding consumables for shipyards, KOBELCO WELDING OF QINDAO CO., LTD. (KWQ) (Figure 10) was established as a supply base of FCWs in 2008. Since then it has been

contributing to development of local industries. The range of products manufactured in KWQ (Figure 11) has been expanded to meet the users' needs, including FCWs for low temperature services.

KOBELCO's sales organizations have been reorganized to respond to the diverse needs in the Chinese market. In 2010, KOBELCO WELDING OF SHANGHAI CO., LTD. (KWSH) (Figure 12) was established as a sales company, and in 2014, a China KOBELCO "Shin-Yo-Kai" (sales and distribution network) (Figure 13) was organized in the same manner as those in Japan and Thailand, which have proven to be successful over the years. The "Shin-Yo-Kai" networks are an effective means of supplying KOBELCO consumables and providing customer service. In China, they responded to demand from energy-related projects for consumables for Cr-Mo-V steels applied in petro-chemical reactors as well as for consumables for LNG-related plants and crude oil storage tanks. The networks also support local users' Monodzukuri (production system innovation) and, as such, are highly appreciated.

KOBELCO meets the needs of regional users with local production of welding consumables that are expected to increase in demand.

Figure 7: KWT factory appearance



Figure 8: KWT's product ranges



Figure 9: SE series solid wires



Figure 10: KWQ factory appearance

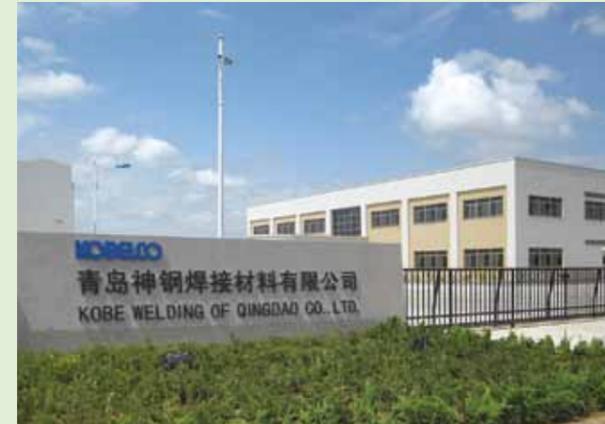


Figure 11: KWQ's product ranges



Figure 12: Entrance of KWSH



Figure 13: China-KOBELCO "Shin-Yo-Kai"



KOBELCO's recent history overseas
— Korea —

Although the Korean economy fell temporarily due to the financial crisis stemming from the subprime mortgage problems, it recovered quickly as local fabricators enjoyed increased demand from the shipbuilding and energy sectors, which resulted in more demand for welding consumables as well. Because of the rise of Chinese manufacturing, Korean manufacturers shifted production into more value added products. For example, large shipyards took on orders for offshore structures, like FPSO's as well as the world's first FLNG; accordingly, demand increased for high value added welding consumables, such as those for low temperature services and for high tensile steels.

KOBELCO's local production base, "KOBELCO WELDING OF KOREA CO., LTD. (KWK) (Figure 14), expanded its production menu (Figure 15) according to changing demand from users. For example, with increased construction of offshore structures and LNG storage tanks, inquiries increased for consumables for high performance steels like 9%Ni and Ni-based alloys; indeed, a range of KOBELCO products and technologies were supplied as well. KWK celebrated the 20th anniversary of its founding in 2015 and will continue supplying high and stable quality products.

Figure 14: KWK factory appearance



Figure 15: KWK's product ranges



Figure 16:
Entrance
of KWMK



In order to catch the market needs of front-line manufacturers and to contribute to their Monozukuri, the sales company, KOBELCO WELDING MARKETING OF KOREA CO., LTD. (KWMK) (Figure 16) was established in 2012 for better distribution of high quality consumables. Although demand for new sources of energy is presently stagnant due to sluggish crude oil prices, KOBELCO continues to watch the markets in order to meet customer needs with the supply of consumables at any time.

Figure 17: TKW/KMWT factory appearance



Figure 18: TKW/KMWT's product ranges



**KOBELCO's recent history overseas
— Southeast Asian (ASEAN) Countries —**

It is in the ASEAN regions where KOBELCO has been doing business for decades. There are two production bases in Thailand: THAI-KOBE WELDING CO., LTD. (TKW), which was established nearly 50 years ago, and KOBE MIG WIRE (THAILAND) CO., LTD. (KMWT), which celebrated its 25th anniversary in 2009. Both TKW and KMWT (Figure 17) reaffirmed their determination to continue supplying high quality products matching regional needs (Figure 18). In 2011, a major flood severely damaged local users, including Japanese-affiliated companies, and disrupted worldwide supply networks, particularly of Japanese car manufacturers. As KOBELCO's resident companies in Thailand, TKW and KMWT experienced the hardship with the people and made a donation toward reconstruction.

Figure 19: Kwap factory appearance



Figure 20: Vacuum packed T LB-52NS



In Singapore, the well-established KOBE WELDING (SINGAPORE) PTE. LTD. (KWS) celebrated its 30th anniversary in 2009. However, in 2012, it was reorganized as KOBELCO WELDING ASIA PACIFIC PTE. LTD. (Kwap) (Figure 19), taking responsibility for the whole ASEAN region. The ASEAN OPERATIONS DIVISION was set up at Kwap to oversee sales, marketing and R & D in not only Singapore but also the other ASEAN countries. It also collects information on needs from outside the region and performs the tasks necessary for the development and supply of new products. Low hydrogen electrodes manufactured at Kwap had long been utilized by offshore structure fabricators and shipyards in Singaporean and neighboring countries. However, as these users began to apply higher grade steels, including those for low temperature services, Kwap added T LB-52NS to its manufacturing line-up and even installed more vacuum packing units (Figure 20) to meet the increased demand.

Figure 21: KWM factory appearance



Figure 22: INTIWI factory appearance



In Malaysia, KOBE WELDING (MALAYSIA) SDN. BHD. (KWM) (Figure 21) was reorganized from ST KOBE Company and restarted sales of ERB-26, an older but well-regarded product, as well as other covered electrodes in response to the needs of customers in the region.

In Vietnam, the Representative Office was set up in 2012 in order to perform community-based activities. Information about local needs, gained through the office, is fed back to our R & D engineers. KOBELCO welding consumables including ERB-26 and LB type low hydrogen covered electrodes, manufactured in Thailand and/or Singapore, have been exported to and favorably accepted in such surrounding countries as Myanmar, Cambodia, Laos, Bangladesh and Sri Lanka.

2017 marked 40 years since P.T. INTAN PERTIWI INDUSTRI (INTIWI) (Figure 22) and KOBELCO began technical collaboration in Indonesia. INTIWI manufactures KOBELCO products under license and sells them as well as other KOBELCO consumables to meet local demand. In this way, INTIWI contributes to the country's industrial development and will do so in the future as well.

Wherever it operates, KOBELCO always considers the relationship with local partners or distributors to be most important. For example, the Thailand "Shin-Yo-Kai" (sales and distribution network) meets periodically in order to reconfirm mutual relationships, assess the distribution of KOBELCO products to users, and reflect upon the unity of the organization in its contribution to the development of the industries it serves with products and technical services. The ASEAN "Shin-Yo-Kai" (Figure 23) meets every several years to accomplish similar goals throughout the region.

Southeast Asia is a growing market. Although construction of offshore structures and energy-related projects is currently slow, general construction remains healthy. KOBELCO will keep on proposing total welding solutions including automation that respond to the needs of customers in the region.

Figure 23: ASEAN "Shin-Yo-Kai"



**KOBELCO's course of history in the world
— India and the Middle East —**

One of the five rapidly-growing BRICS countries, India is a market in which KOBELCO consumables maintain a strong position in energy and construction projects. Our consumables for heat resistant steels, which are essential for boilers used in thermal power generation, have long been highly reputed by Indian fabricators. In order to maintain a close relationship with local partners and users, KOBELCO WELDING INDIA PVT. LTD. (KWI) (Figure 24) was established in a suburb of New Delhi in 2011. Responding to an inquiry for automation, KWI introduced a robotic welding system. KOBELCO's technology on robotic welding, accumulated and cultivated over many years, will play an important role in raising the production efficiency of construction machinery and penstocks, which are essential for continued growth of the Indian economy.

In the Middle East, increased demand for energy has led to a boom in construction projects - - and thus increased sales of applicable welding consumables. KOBELCO's covered electrodes for carbon steels, FCWs for carbon and stainless steels, consumables for Ni-based alloys, and products for low temperature services as well as high tensile strength steels have long been in demand. KOBELCO opened a representative office in the Middle East in 2014 and began working with local distributors to meet the needs of the region.

Figure 24: Entrance of KWI



Figure 25: KWE factory appearance



**KOBELCO's recent history overseas
— Europe —**

KOBELCO WELDING OF EUROPE B.V. (KWE) (Figure 25), the production base of FCWs for stainless steels in the Netherlands, celebrated its 20th anniversary in 2015. Since its foundation, KWE has manufactured FCWs for stainless steels and supplied them to European customers and established a reputation for stable and excellent quality. Now, in addition to conventional FCWs for stainless steels, KWE produces such high grade FCWs as **P**DW-2594, for super duplex steel; **P**DW-N625 and **P**DW-N82 for Ni-based alloys; **P**DW-A904L, for high austenitic stainless steels; and **P**DW-310, for fully austenitic stainless steels. A new plant for FCWs for mild steels was added at KWE in 2007 and has gradually expanded its production menu. In addition to conventional FCWs, such as **F**DW-A50 and **F**MX-A100, FCWs for low temperature service, such as **T**DW-A55L, **T**DW-A55LSR and **T**DW-62L have been put into production (Figure 26).

As energy demand has increased, so has demand for line-pipe installation. KWE has introduced a number of welding consumables developed by KOBELCO that satisfy the needs of construction sites for high efficiency. **T**DW-A70L was developed for API 5L X70 and X80; it is applicable in all position welding and is now being used in a project in Europe. **P**DW-N625P, developed for all position welding of Ni-based alloy pipes, is now being utilized in an undersea project.

KWE established a sales subsidiary company in Sweden in order to expand sales and marketing networks. By listening to European customers who are willing to share advanced technological information, it continues to develop consumables that meet their needs. In other important countries like Germany and Italy, KWE is improving its activities by adding more staff members for sales and marketing.

Figure 26: KWE's product ranges



The high quality **F**LB-52U has long been used for repairing line-pipes in Russia. However, the application of pipes with higher tensile strength grades as well as automated production processes has recently increased. KOBELCO was able to respond to such new line-pipe requirements with **T**LB-62U and applicable FCWs. In Russia, FCWs for stainless steels, consumables for low temperature services like **T**DW-62L and consumables for Cr-Mo heat resistant steels are also in demand.

KOBELCO is determined to develop and supply customer-oriented consumables and technologies in a timely manner in technologically advanced European areas.

**KOBELCO's recent history overseas
— The Americas —**

KOBELCO WELDING OF AMERICA INC. (KWA) (Figure 27), the sales company in Houston, Texas celebrated its 25th anniversary in 2015. From there, FCWs for mild steel and stainless steels and solid wires are supplied throughout the USA, Canada and Mexico as well as South America.

For the energy industry, KWA distributes FCWs for stainless steels and for low temperature service/high tensile strength steels, whereas for the automobile industry, the company offers **F**MG-51T and SE solid wires for car fabrication and **P**MX-A430M (an FCW for 17Cr-Nb type stainless steel) for car exhaust systems. Among some users, interest has been growing for the XR series, FCW's for stainless steels that are environmentally sound.

Whereas demand for energy in the USA has dropped in comparison with past times, the American construction industry has remained active, and interest in achieving higher efficiency at construction sites has been growing. KOBELCO's product line-up now includes its robotic welding system. Based on

Figure 27: KWA office appearance



KOBELCO's confidence that robotic automation would provide the efficiency needed in American construction projects, KWA opened the ROBOTIC & EQUIPMENT DIVISION, and sales of welding robots and equipment has started. Orders have been taken from several steel frame fabricators.

Responding to American requirements for better seismic design, the company is now developing FCWs that meet seismic design specifications and are suitable for robotic welding. KOBELCO is confident that the development of these products will improve efficiency and contribute to the construction industry's further progress.

While making continual progress in partnership with local industries around the world, KOBELCO will contribute to develop the respective industries by supporting their Monodzukuri as the most reliable total welding solutions enterprise.

In order to realize this goal, the organization of the head office was changed several times in the past, and now the INTERNATIONAL OPERATIONS DEPARTMENT (IOD) has been reorganized into the GLOBAL OPERATIONS & MARKETING DEPARTMENT (GOMD). GOMD is set in the newly established MARKETING CENTER and has started its activities worldwide.

We are very thankful for your kind patronage of KOBELCO WELDING TODAY as a means of communicating about KOBELCO's welding technologies. At most of KOBELCO's overseas locations, exclusive web-sites are available, and some of them are produced in local languages. On the web-site of KOBELCO's head office, English, Spanish, Portuguese and Russian languages are available. We hope that KOBELCO can contribute to your continual growth and future prosperity.

<http://www.kobelco.co.jp/english/welding/>
<http://www.kobelco-welding.jp/>



THE KOBELCO ARC over the Last Decade: Welding systems and equipment

1 Preface

KOBELCO has supplied a range of robotic welding systems that combine the ARCMAN™ series robots and SENSARC™ power sources since 1980's, focusing on industries that apply middle to heavy plates such as construction machinery, architectural steel frames, rolling stock and bridges. In this special issue, we look back at what the Welding System Department in the Welding Business has achieved over the last decade and shine a spotlight on the development and commercialization of the welding systems and robotic welding processes that make the best use of KOBELCO's advantages.

2 Welding procedures for middle-heavy plates

Because middle to heavy plate welding requires high volumes of deposited metals, it follows that the weldments must be of safe and sound quality. KOBELCO's ARCMAN™ series welding robots meet these requirements with such key and exclusive middle-heavy plate welding functions as sensing and multi-layer welding.

The products and welding technologies developed to solve such issues as reducing arc time and spatter, and maintaining stable and deep penetration are discussed herein.

3 Advancement of tandem-arc welding

Tandem-arc welding is a method of achieving sound welds even at faster welding speeds by holding one pool with two electrodes. KOBELCO commercialized a robotic tandem-arc welding system in 2001 and since then has worked to reduce the additional spatter generated by the two electrodes, thereby improving operability and efficiency. In 2008, dual arc sensing was developed, as shown in Figure 1. This function performs dual arc sensing with not only the leading electrode but also the trailing one, thereby ensuring high quality bead shape as well as arc stability.

Additionally, the function to automatically set up welding conditions was developed and installed in the system. The operator now had only to select the codes for groove shape and leg length, and then the optimum welding condition would be extracted from the pre-registered data base and the robot's operation orbit within the welding section would be automatically generated as well. The subsequent application of advanced robotic tandem-arc welding systems in a number of industries, such as construction machinery, which strives to improve productivity per unit area, has led to significant increases in productivity. Finally, the SENSARC™ AB500, a high quality robotic welding power source, was released in 2010. With its unique control, a stable arc resistant to disturbance could be realized, which minimized arc turbulence as well as spatter generation. Compared with conventional power sources, it can reduce spatter as much as 70% and decrease spatter particle size, too. (Figure 2)

Figure 1: Dual arc sensing function

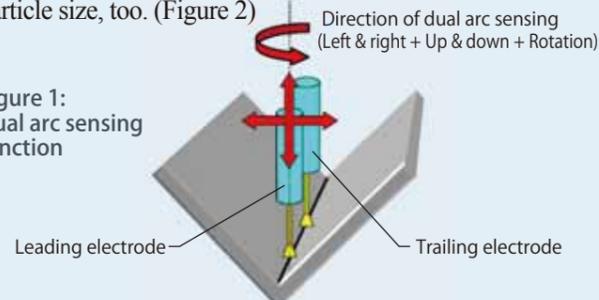
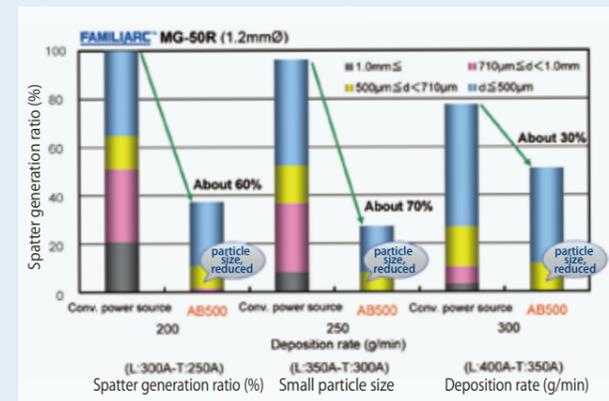


Figure 2: Comparison of spatter particle size and its amount



4 SENSARC™ AB500: a high quality welding power source for robotic welding

SENSARC™ AB500 is a power source for robotic welding that is best suited to medium-heavy plate robotic welding and that has greatly improved welding performance. It produces the best output waveform within each welding mode, such as constant voltage (CV), pulse, and wire diameter and type; it also feeds welding wires at a max. 30 m/minute, which is 20% more than a conventional power source.

1. REGARC™ Process: Low Spatter, Gas Metal Arc Welding Process with CO₂ shielding gas (CO₂ welding) (2010 ~)

In conventional CO₂ welding with a solid wire, increasing the welding current causes globular and irregular droplet transfer with large particles as well as a remarkable increase in spatter. The REGARC™ Process, however, achieved regular droplet transfer by utilizing pulsed current waveforms to control droplet transfer.

The advantages of this process include extremely low spatter, low fumes and high efficiency. By reducing spatter generation to 1/10 and fume generation to 1/2 in comparison with conventional CO₂ welding, the REGARC™ Process improves the work environment and lessens spatter-removing work. Because the process features low heat input and high deposition welding, the mechanical properties of welds are improved. Therefore, in order to make the most of the REGARC™ Process, it was determined that the process should be installed on all robotic welding systems. Beginning in 2010, installation of the process started with the systems for architectural steel frames in the Japanese markets and was gradually expanded to those for column core to column large assembly and completed in 2011 (Figures 3-1 and 3-2). The series of architectural steel frame robotic welding systems are unique to KOBELCO, one-of-a-kind products that continue to be highly reputed by customers. Yet, KOBELCO continues to develop new products and functions in order to contribute to reductions in cost, increases in productivity, and improvements in the quality of architectural steel frame fabrication.

Figure 3-1: ARCMAN™ robotic welding system for column core, installing REGARC™ process



2. Ultra high current MAG welding process (2012 ~)

MAG welding with Ar-CO₂ mixed gas is an effective welding process that utilizes a high current range to effect spray transfer with small particle droplets and reduce spatter. However, if the current is raised too high, electric resistance may cause the wire tip to overheat, and, in the case of applying solid wires, a so-called rotating arc may be generated. This phenomenon prevented MAG welding with Ar-CO₂ mixed gas from increasing efficiency. In response, tandem-arc welding was seen as a desirable solution because two wires could remove the barrier and raise the deposition rate. On the other hand, two electrodes will generate more spatter than a single electrode, and the teaching of a robot with two electrodes is more difficult than one with a single electrode.

An ultra high current MAG welding process has been developed that solves the above problems and achieves a high deposition rate by utilizing an ultra high welding current with a single electrode.

The process applies an exclusive flux cored wire (FCW), FIMX-A100D, that prevents the FCW from overheating and the FCW's whole cross section from melting at the same time. It avoids the rotating arc, thereby maintaining spray transfer, even at an ultra high current, and generating extremely low spatter.

This process requires very large currents to achieve maximum effect. It is recommended that two SENSARC™ AB500 power sources are connected in parallel and used as a unit. This setup achieves an extremely high current exceeding 600 ampere and a high deposition rate of nearly 20 kgs/hour, almost equivalent to that of a conventional tandem-arc welding process.

Another feature of the ultra high current MAG welding process is that it offers deep penetration. Because it fulfills the needs of construction machinery fabrication, it is widely applied as a high quality and high efficient welding method.

Figure 3-2: Welding system for column large assembly



5 AP-SUPPORT™: Production support software

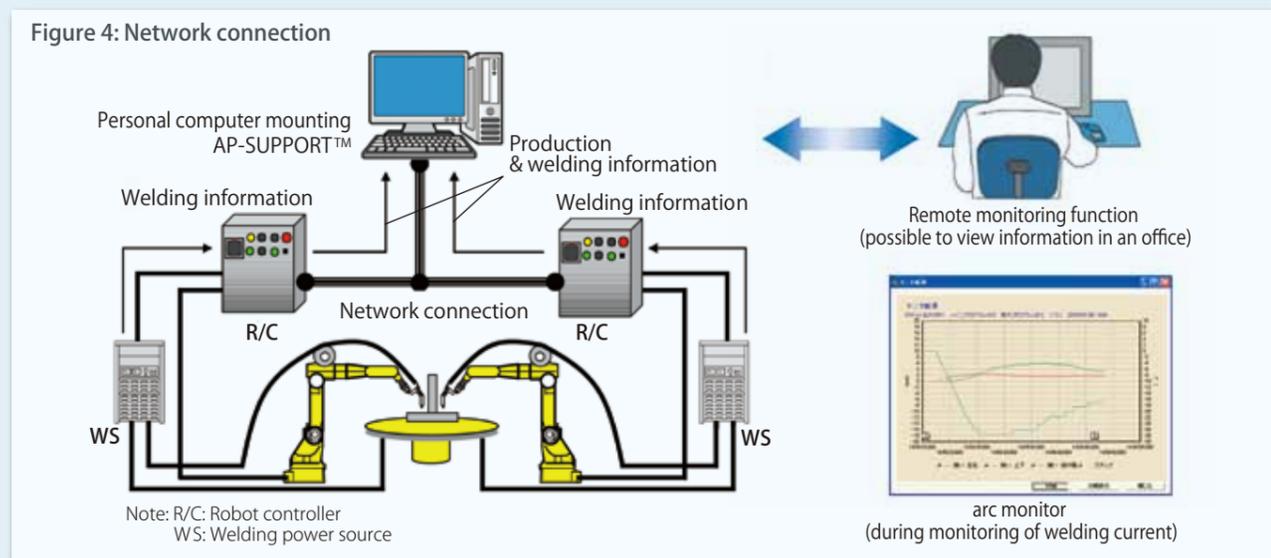
Launched in 2010, AP-SUPPORT™ is a software product that allows users to visualize a robotic welding system's operational state. With the ability to monitor the daily operations of ARCMAN™ series robots, they can more easily maintain stable production or make improvements. To be more specific, the program provides accurate and easy-to-understand production control data like the arc generation rate as well as key information in times of trouble.

The program gathers a large amount of the production and welding data that is sent from the robot controller and

welding power source through the network into a personal computer as shown in Figure 4. Then, by analyzing and using such production control data as the arc generation rate, moment stops and welding failure, operators can effectively control and make improvements in production.

It also enables operators to verify the increase or decrease of the arc generation rate and time of the robot's operation stops. Whereas information related to the location and details of errors once had to be obtained and analyzed manually, AP-SUPPORT™ now allows it to be output automatically, so that it can be accurately understood in a timely manner. The program not only displays real-time data but also secures past welding data, so that when a welding failure occurs, its cause can be investigated by tracing back to the moment the failure occurred.

Figure 4: Network connection



6 Distinctive robot manipulator

While workpieces continue to increase in size in the field of medium-heavy plate welding, smaller footprints and better space saving are required of robotic systems. KOBELCO has developed two distinctive robot manipulators that meet such needs.

1. ARCMAN™ GS (2010 ~)

ARCMAN™ GS is an overhead-suspended robotic welding system. It remains in constant demand because it enables an effective approach to large-scale workpieces and saves space. Two features of the ARCMAN™ GS stand out: firstly, the torch cable is installed inside the robot arm in order to prevent interference between the torch cable and the workpiece (Figure 5); and, secondly, wide motion range is achieved due to the overhead suspension.

Additionally, the ARCMAN™ GS can mount even tandem-arc welding torches on the 6th axis and take the reverse elbow position, which means the robot's upper arm can bend behind the robot.

Because the robot approaches a workpiece from above, its motion range is 40% greater than that of the

conventional ARCMAN™ MP system, which has an arm size almost the same as that of the ARCMAN™ GS. Thanks to these strong points of the manipulator, KOBELCO's robotic welding system is small in size, saves space and achieves high productivity per unit area.

Figure 5: ARCMAN™ GS with the cable-integrated upper arm



2. ARCMAN™ A30S: Ultra small manipulator (2017 ~)

The shipbuilding industry expects welding automation to reduce manpower and improve productivity and efficiency in fabrication yards. In response, KOBELCO has achieved automating the welding of blocks at hull assembly in shipbuilding, which until recently was not considered feasible. This breakthrough was made possible by developing an ultra small manipulator: the ARCMAN™ A30S and SMART TEACHING™ software. Figures 6-1 and 6-2 show the ARCMAN™ A30S on the robot carry and the welding operation inside the block, respectively.

At the block welding stage, every member to be welded, though similar, is so different in sizes and shapes and is

Figure 6-1: ARCMAN™ A30S on the robot carry

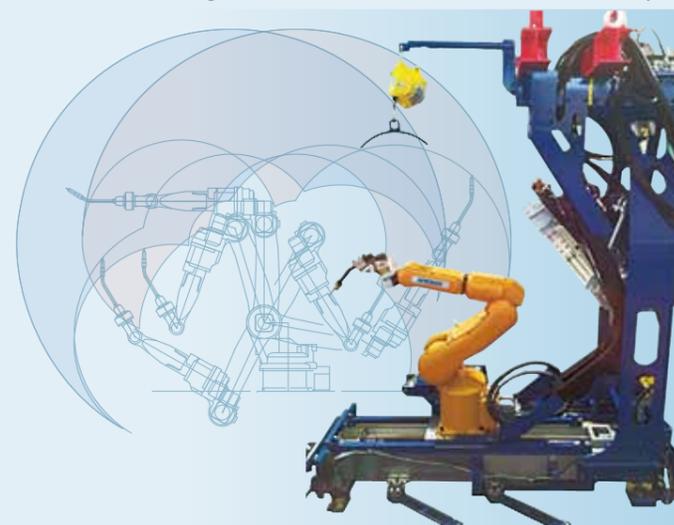


Figure 6-2: Actual welding operation with ARCMAN™ A30S at hull assembly



7 Postscript

We are determined to contribute to customers' stable production by enhancing our welding systems, functions and application software in the future as well. And we will continue supplying the robotic welding systems, taking advantage of the position as the total welding solutions enterprise who can supply not only the robotic systems, welding power sources but also the world's leading welding consumables.