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KOBELCO WELDING TODAY

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

KOBELCO

Research and development are key to becoming the most reliable welding solutions company in the world.

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NOTIFICATION

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Introduced over a century ago, the arc welding process seems to have existed in a world oddly cut off from science. More than 30 years ago, during my college days, I studied general arc welding from a famous textbook: the introduction to welding. I clearly remember how shocked I was to learn how immature a branch of technological engineering that arc welding really was. What I learned then was that the weld metal and heat affected zone (HAZ) were formed through such processes as melting of steel by arc heat, solidification, cooling and then transformation, and also that we needed to pay attention to various weld defects. Research in arc welding was not as advanced as that in other fields. For example, materials such as iron and steel, principal metals, semi-conductors, ceramics, glasses and resins were methodically investigated in solid-state physics and/or condensed matter physics, and even the arc, as a heat source, was studied within high temperature - or PLASMA - physics. In other words, I could say that arc welding in the 20th century remained in the world of analog evaluation by four senses (seeing, hearing, smelling and feeling).

However, in the 20 years since the start of the 21st century, the tables have turned. Because developments in material science have slowed, manufacturers now struggle to provide added value to their customers. With commoditization of iron and steel materials, for example, competition is won on prices, specifications and delivery terms only. By contrast, the welding business is now rapidly moving beyond the world of analog evaluation by four senses and into the world of digital measurement and control as well as automation and robotization. Accordingly, a range of factors that could never be quantitatively measured can now be quantified and visualized. With advances in computing speed, memory capacity, computer software and power electronics, we are able to control welding current and synchronize arc voltage with wire feeding speed. We also have more control over droplet transfer, molten pool swing, slag formation, depth of penetration and bead configuration by adding different types of shielding gas and/or by utilizing robots. We can reduce the generation of fume and spatter by applying the most appropriate solid wires to robotic or automated welding as well as by applying the best-suited droplet transfer by controlling the electric power waveform even if covered electrodes are manually utilized.

KOBE STEEL, LTD. is the only company in the world that provides consumables, power sources, robotic systems and equipment related to the arc welding. In other words, only KOBELCO can propose a comprehensive arc welding solution that, by exceeding the skills of individual welders, best suits the current environment in which skilled welders are in decline.

Supporting the goal of becoming the most reliable welding solutions company in the world, research and development (R & D) aims to create values for customers by providing a combined package of welding consumables, robotic systems and equipment, processes and torches and consumed parts. The welding consumables and/or robotic systems are designed to provide customers with maximum profit when used as a solution but it goes without saying that each part can be used separately.

Welding automation is comparatively easy when performed within a well-ordered environment, more specifically inside plants. However, welding automation has been implemented on large-scale structures by equipping the robotic system with both a slider for the robot's movement and a positioner to shift structural members. As a matter of fact, KOBELCO's ARCMAN™ robotic systems are highly reputed in the architectural engineering as well as construction machinery fields.

Many problems that can be solved by welding automation continue to exist at actual welding sites. To apply automated welding in an unorganized environment, it is essential to have a portable robot that can recognize CAD drawings and has the autonomy to move itself and start welding while the to-be-welded parts are being measured by the sensor and evaluated by the AI. Around the world, robots have moved out of the world of science fiction (SF) and into factories, offices and even homes, like the Spot™, the four-legged robot developed by Boston Dynamics. I'd like you to look closely at trends in other industries to see whether autonomous mobile robots can be put into actual practice in different welding environments.



Hiroyuki Shimizu
Head of Technical Center
Welding Business
KOBE STEEL, LTD.

FAMILIARC™ MIX-1TR: the solid wire for GMAW to improve electrodeposition coating property



1 Preface

Reducing consumption of fossil fuels and emissions of CO₂ is now required of all industries due to rising global awareness of the need for environmental sustainability. The control of CO₂ emissions has been particularly strict in the automobile industry, leading to advances in power systems through more efficient gasoline as well as hybrid engines and to improvements in car structure and shape to improve air resistance and reduce car weight.

One measure to lighten the weight of car bodies has been to reduce the thickness of steel parts by using high tensile strength steel sheets. While this has been extensively researched and applied to many car body components, it is impractical for undercarriage components, which require rigidity, corrosion resistance and fatigue strength in addition to static strength. Particularly in regards to corrosion resistance, sheet thickness cannot be reduced by simply applying high

tensile strength steel sheets, because sheet thickness has to be designed in consideration of the progress of corrosion.

Generally speaking, in order to increase corrosion resistance of undercarriage components, electrodeposition coating is performed. However, as coating defects easily occur at the welded zone in particular, approaches to enhance the electrodeposition coating properties have been developed that focus on both coating and welding technologies.

This article discusses FAMILIARC™ MIX-1TR, a solid wire for gas metal arc welding (GMAW) that has been developed to improve electrodeposition coating properties from the welding consumable aspect and thus help resolve the issues surrounding the lightening of undercarriage components described above.

2 The mechanism of corrosion on undercarriage components

Automobile undercarriage components are exposed to extremely severe corrosive environments in which mud, water or even the salt used as a snow melting agent in cold regions splashes up from the road and adheres to them. As corrosion progresses, steel sheets undergo thinning, resulting in a reduction of their designed strength and rigidity, or, at worst, threatening the car's safety if a component were to break.

It is extremely important, therefore, to prevent the generation and progress of corrosion, and the electrodeposition coating film applied to the surface of undercarriage components is meant to play a role in that. However, in reality, a thorough coating film might not

necessarily be formed because electrodeposition coating on the surface of actual components may be obstructed by slag or fumes, causing coating defects or reducing the adhesion of coating films. If slag, which is an oxide and is low in electric conductivity, remains on the weld, the electrodeposition coating film seldom forms as shown in Figures 1 and 2. This is where rust initiates and corrosion begins to make progress.

3 Electrodeposition coating property of FAMILIARC™ MIX-1TR

Slag consists of oxides of Si and Mn (usually contained in welding consumables as well as in steel plates) that are formed by combining with oxygen in the shielding gas during welding. Therefore, one way to lessen slag generation to a certain degree is by reducing (but not eliminating) the oxygen source in the shielding gas.

However, a better solution is to use the newly developed solid wire, FAMILIARC™ MIX-1TR, which works not by restraining slag generation but by producing slag and slag components that do not damage electrodeposition coating properties.

Figure 3 compares bead appearance in lap-welds before and after electrodeposition coating by both FAMILIARC™ MIX-1TR and a conventional wire. While bits of slag appear on the weld bead surface by FAMILIARC™ MIX-1TR, they are scattered, thin and dark brown in color. By contrast, the slag generated by the conventional wire is lustrous and thick. The "after" photos shows that electrodeposition coating film was not formed on the slag generated by welding with the conventional solid wire; however, the film was formed on the slag generated with FAMILIARC™ MIX-1TR.

In addition, the slag generated with the conventional solid wire appears fragile and easy to peel off, which could be problematic if slag, together with the coating film, detaches during the running of a vehicle; those small parts without coating film might expand and corrosion would make quick progress. By contrast, a feature of slag generated with FAMILIARC™ MIX-1TR is excellent adhesion to weld beads. In fact, adhesion to the weld bead is so strong that the slag will not detach when physically hit - even by a hammer.

In summary, FAMILIARC™ MIX-1TR can remarkably improve the rust and corrosion resistance compared with conventional solid wire for two reasons: first, the electrodeposition coating film will form even though slag exists on the weld beads; second, excellent adhesion will prevent slag from detaching from the weld beads.

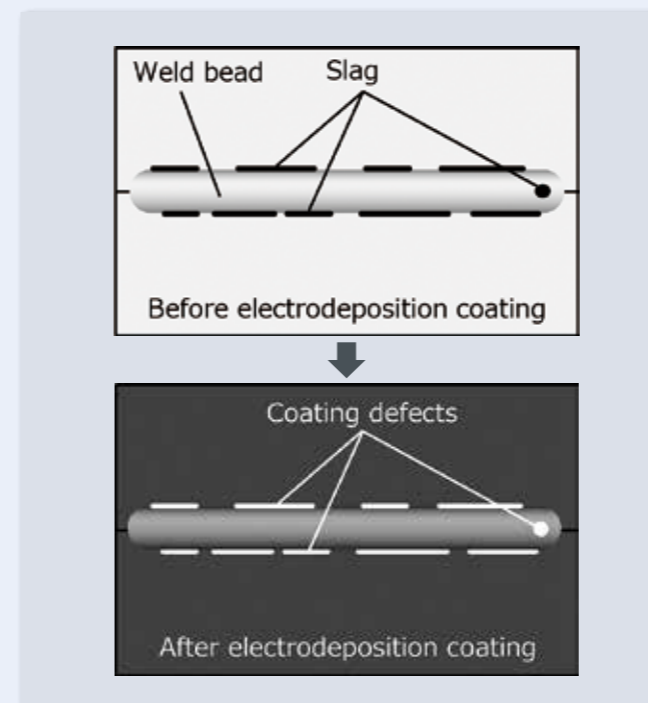


Figure 1: Progress of coating defects: before and after electrodeposition coating

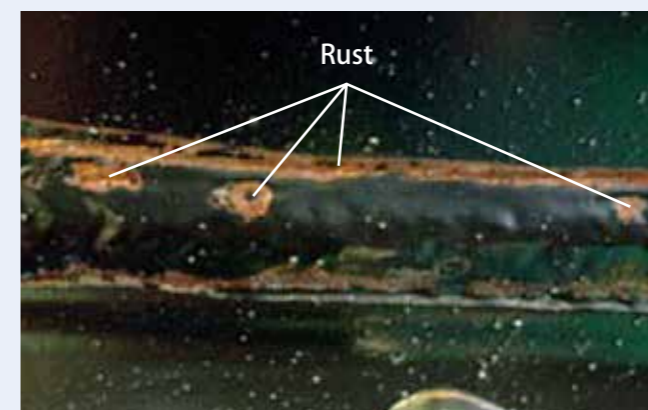

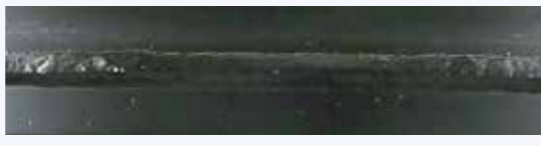

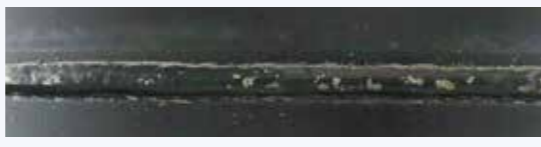


Figure 2: Progress of coating defects: rust on welds

Wire	Before electrodeposition coating	After electrodeposition coating
☒ MIX-1TR		
Conv. wire		

Steel sheet: SPGH440 Thickness: 2.3 mm Shielding gas: 80%Ar+bal.CO₂ Wire feeding speed: 6.7 m/min Arc voltage: 24 V Travel speed: 800 mm/min

Figure 3: Bead appearance comparison before and after electrodeposition coating between ☒ MIX-1TR and a conventional solid wire

4 Features of ☒ MIX-1TR

☒ MIX-1TR was developed to be applied in pulsed welding with Ar+CO₂ shielding gas which is common in the automobile industry. Details of the solid wire are shown in Table 1, and the typical mechanical properties of the all-deposited metals based on the Japanese Industrial Standard (JIS) in comparison with those of conventional solid wire appear in Table 2. The tensile strength and impact properties of ☒ MIX-1TR are better than those of conventional solid wire, and it is clear that ☒ MIX-1TR is best suited to welding 440-780 MPa class thin steel sheets for automobile production.

Penetration and bead configuration are important for welding undercarriage components, which are required to carry loads continuously. In actual welding of undercarriage components, weld gaps frequently occur because of the unevenness of component-shapes as a

Table 1: Wire details

Trade name	Classification	Wire diameter
☒ MIX-1TR	JIS Z 3312 G49 A 2 M 0	1.2 mm

Table 2: Typical mechanical properties of all-deposited metal

Wire	YS (MPa)	TS (MPa)	EI (%)	Absorbed energy at -20°C(J)
☒ MIX-1TR	530	601	30	198
Conventional solid wire	413	518	32	155
JIS Z 3312 G49 A 2 M 0	≥390	490-670	≥18	≥27

result of how they were pressed during fabrication. It is, therefore, necessary to produce sound bead shapes even though a certain degree of gap may exist. Additionally, preventing undercut during welding is essential because it contributes to a decrease in fatigue strength.

Figures 4 and 5 show the results of an evaluation of gap tolerance in lap joint welding in flat position between ☒ MIX-1TR and a conventional solid wire and the welding conditions, respectively.

Sufficient penetration was obtained from both solid wires. However, in the welding of a test specimen with a 1 mm gap, ☒ MIX-1TR did not cause undercut, while the conventional solid wire clearly generated undercut at the toe of the lower side steel sheet.

Automobile components are frequently welded at relatively fast speeds, which can cause beads to become more convex in shape as a result of the lower heat input. However, because a convex bead shape leads directly to reducing fatigue strength, producing such shapes must be avoided.

Figure 6 compares the bead configuration produced by ☒ MIX-1TR and a conventional solid wire in lap joint welding in horizontal position. Figure 7 shows the welding conditions used in the experiment.

When the conventional solid wire was used, the bead shapes gradually became convex as the welding speed increased; however, beads produced by ☒ MIX-1TR varied little and remained stable despite increasing welding speed.

The need to decrease spatter as much as possible during welding is not limited to the automobile industry. Because ☒ MIX-1TR was designed with a special chemical composition, it is not appropriate to apply the same welding parameters that would be applied to conventional solid wire. However, sound welding can be performed by optimizing the welding parameters.

Figure 8 displays droplet transfer before and after optimizing the welding parameters. Under conventional welding parameters, spatter may be generated due to the occurrence of a droplet's short-circuit transfer; however,

under the pulsed welding process, stable droplet transfer corresponding to the pulse period is possible by optimizing the welding parameters.

Table 3 shows three examples of actual application of ☒ MIX-1TR in the assembly of automotive components and the respective welding conditions.

Figures 9, 10 and 11 show three types of components where ☒ MIX-1TR has been applied: lower arm, ladder frame and axle beam.

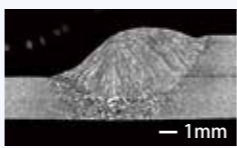

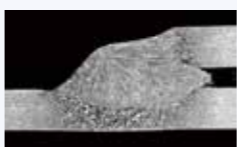
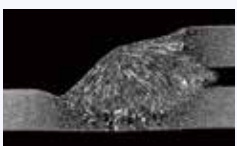
Gap	☒ MIX-1TR	Conv. wire
0 mm		
1 mm		

Figure 4: Comparison of gap tolerance between ☒ MIX-1TR and a conventional solid wire in lap joint welding in flat position

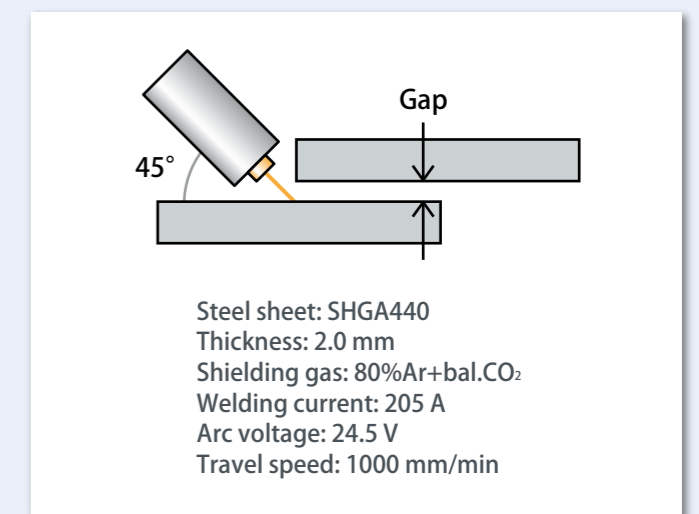


Figure 5: Welding conditions of lap joint welding in flat position






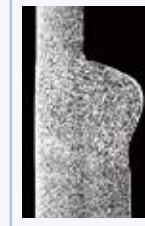
Wire	Travel speed (mm/min)		
	800	1000	1200
☒ MIX-1TR			
Conv. wire			

Figure 6: Comparison of bead configuration between ☒ MIX-1TR and a conventional solid wire in lap joint welding in horizontal position

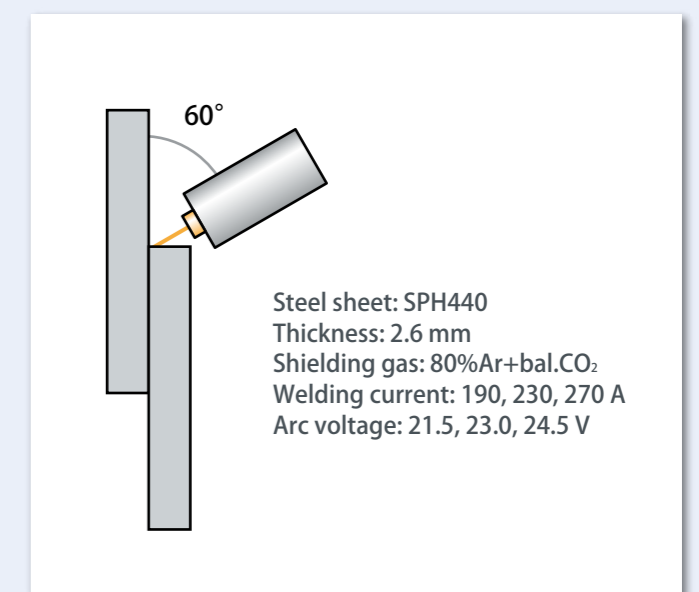


Figure 7: Welding conditions of lap joint welding in horizontal position



Figure 8: Droplet transfer with optimized and standard pulse parameter

Table 3: Examples of application to car assembly and welding conditions

Applied component	Plate thickness (mm)	Welding position	Weld mode	Shielding gas	Wire size (mm)	Welding current (A)	Travel speed (mm/min)
Lower arm	2.6-3.2	Flat Horizontal	Pulsed arc	80%Ar+bal.CO ₂	1.2	250-330	800-1200
Ladder frame	2.3-4.0	Horizontal				250-360	800-1200
Axle beam	1.6-2.3	Flat Horizontal				150-250	600-1200



Figure 9: Lower arm

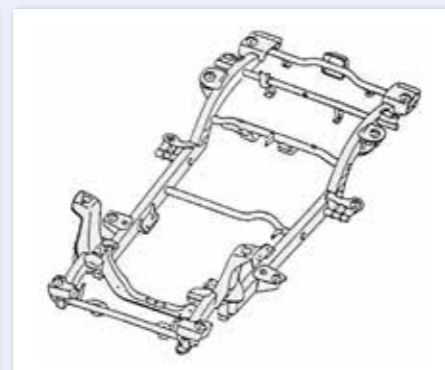


Figure 10: Ladder frame



Figure 11: Axle beam

5 Postscript

Developed in order to help reduce the weight of automobiles, **MIX-1TR**, is a solid wire for MAG welding that is superior to conventional wires in producing auto components with excellent corrosion resistance. It offers the following advantages:

1. Welds are provided with substantially improved electrodeposition coating properties.
2. Undercut is not likely to occur at the toe of the welded bead even in the welding of steel sheets with gaps.

3. Bead configuration is not likely to become convex even in high-speed welding.
4. Stable welding with little spatter is possible by selecting optimum welding parameters.

It is expected that as the issue of automobile weight reduction continues to increase in importance in the future, the welding consumable discussed in this article will be recognized as a means of making further progress. The development of welding consumables as well as procedures will further advance in KOBELCO STEEL in order to solve any problems related to the vehicle weight reduction.

FAMILIARC™ OW-S50P(E71T-8-H16): Self-shielded flux cored wire for overseas market

The current line-up of self-shielded flux cored wires (self-shielded FCWs) include **OW-S50H**, used in on-site welding of steel pipe piles in the flat and horizontal positions, and **OW-S50T**, which is suitable for welding thin plates with thickness of 1.0 to 4.5 mm. They are highly reputed but marketed in Japan only. However, as the pursuit of high welding efficiency becomes a rising global trend, **OW-S50P**, a self-shielded FCW matching AWS A5.20 E71T-8-H16 has been developed in order to target overseas markets. Table 1 shows KOBELCO's line-up of self-shielded FCWs.

Table 1: KOBELCO's line-up of self-shielded FCWs

	Welding position	Specification
OW-S50P	All	AWS A5.20 E71T-8-H16 EN ISO 17632-B T 49 3 T8-1 NO A
OW-S50H	1F, 1G, 2F and 2G	AWS A5.20 E70T-7 EN ISO 17632-B T 49 Y T7-0 NO A
OW-S50T	All	AWS A5.20 E71T-GS

Tables 2 and 3 show the chemical compositions and mechanical properties of all-deposited metals by **OW-S50P**, respectively.

Table 2: Chemical composition of all-deposited metal by **OW-S50P**

C	Si	Mn	P	S	Al
0.14	0.20	0.85	0.015	0.002	0.65

Table 3: Mechanical properties of all-deposited metal by **OW-S50P**

YS (MPa)	TS (MPa)	EI (%)	vE-30°C (J)
440	560	27	105

OW-S50P provides excellent bead shape and penetration in all positions. Figure 1 shows the results of butt joint welding in the horizontal, vertical upward and overhead positions.

It can be used for welding 490 MPa (70 ksi) class high tensile strength steels as it has excellent notch toughness down to -30 °C min. Furthermore, good porosity resistance against wind speeds as high as 10 m/sec makes welding in strong outdoor winds possible.

However, maintaining the arc voltage within the optimum range is necessary; because porosity defects are likely under the welding conditions exceeding the optimum range of arc voltage as well as arc length as shown in Figure 2.

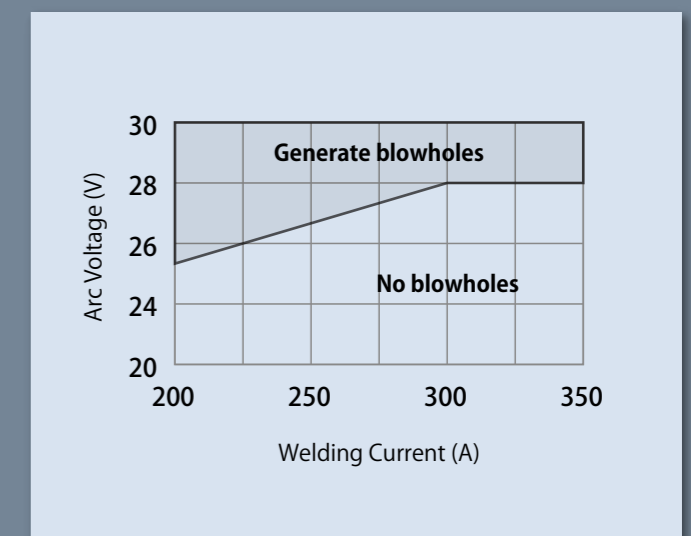


Figure 2: Optimum range of arc voltage by **OW-S50P**

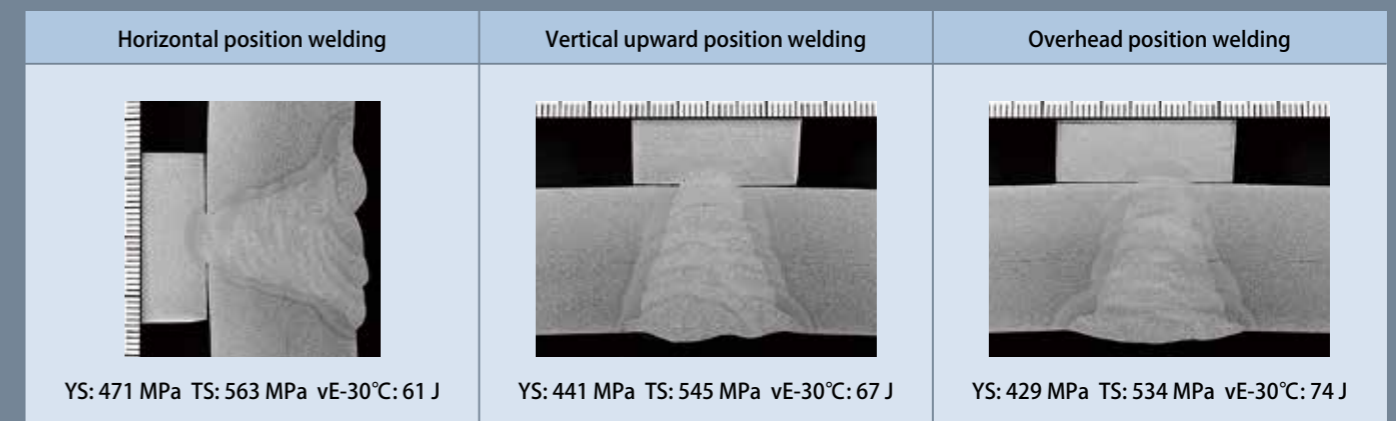


Figure 1: Results of butt joint welding in all positions by **OW-S50P**



KOBELCO technical seminar in Saudi Arabia in 2020

For the first time in two years, the KOBELCO technical seminar was held in the Kingdom of Saudi Arabia, in collaboration with KOBELCO WELDING ASIA PACIFIC PTE. LTD. (KWAP) and Abudullah Hashim Industrial Gases & Equipment Co., Ltd., the local agent, from February 23 to 26, 2020. Being the fifth seminar in Saudi Arabia, it was expanded to four locations: Jeddah, Riyadh, Dammam and Jubail. Table 1 shows a history of the seminar.

Table 1: History of seminar

Time of seminar	Location
December 2012	Jedda, Dammam, Jubail
June 2016	Riyadh
November 2017	Dammam
December 2018	Dammam
February 2020	Jedda, Riyadh, Dammam, Jubail

Let me introduce Saudi Arabia briefly. It is about 5.7 times larger than Japan in size, and its population is around 33.7 million. It has the world's second largest petroleum reserves, and 67 % of export earnings come from the oil industry. Water supply is extremely limited and dependent on numerous seawater desalination plants. On the other hand, it is completely self-sufficient in a number of foodstuffs, including meat, milk, eggs and wheat that are even exported around the world.

The first seminar was held at the Radisson Blu Hotel in Jeddah on February 23. Jedda is the second largest city with a population of four million and is located near the Red Sea in the western part of the country.

The second was at the Holiday Inn Riyadh in Riyadh on February 24. Riyadh, the capital, has a population of 6.6 million and is located in the center of the Arabian Peninsula at an elevation of 612 meters above sea level.

The third took place at the VOCO Al Khobar Hotel in Dammam on February 25. Located along the Persian

Gulf, Dammam is the capital of Eastern Province and is a very important city for commerce and foreign trade due to the large oil fields nearby.

The last seminar was held at the Intercontinental Hotel in Jubail on February 26. Jubail is a city of petro-chemical industries and is located in the Eastern Province along the Persian Gulf as well.

At each seminar, Mr Toshihiko Hama, Director of KWAP gave a presentation on recent trends of industries surrounding the welding business. He was followed by two KOBELCO engineers, who presented on the line-up of carbon steel welding consumables such as E6013, E7018 and E7018-1 as well as those for heat-resistant steels, stainless steels and high-nickel alloys that are in high demand in Saudi Arabia.

The high-light was the presentation on the newly improved LB-52-18 (E7018), provided at the request of Saudi Arabian customers. The detailed explanation covered how usability had been improved and what advantages users could expect. It was then followed by a video presentation on how the visualization of arc phenomena can contribute to research and development.

More than 250 participants in total, including welding engineers and sales agents, took part in one of the seminars, all of which ended with voices of thank-you at the get-together party held in each location.

Reported by
Shunji Oki,
Manager, Global Operations & Marketing Department,
Marketing Center, Welding Business



Presentation by Mr Toshihiko Hama, Director, KWAP in the seminar at the Radisson Blu Hotel in Jeddah on February 23, 2020



Seminars at the Holiday Inn Riyadh in Riyadh on February 24, 2020 (Left) and at the VOCO Al Khobar Hotel in Dammam on February 25, 2020 (Right)



Get-together party after the seminar at the Intercontinental Hotel in Jubail on February 26, 2020

Video courses on fundamentals of welding uploaded to YouTube and KOBELCO's Global Website

A video course on the fundamentals of welding, "The ABC's of Arc Welding," has been uploaded to KOBELCO's Global Website and YouTube since January, 2020. It answers the questions frequently asked by welders and Certified Welding Engineers (WE) such as why welding problems occur and how they are to be solved.

The first video - on the correct way to handle a spool of solid wire or flux cored wire, - focuses on such problems as wire intrusion in between the wires wound on a spool and partial-whitening of the spool flange that frequently occur at sites utilizing spool-wound welding wires. Improper handling or setting of the spool on the wire feeder may create unstable wire feeding and cause welding to stop amid operation. The video is certain to help customers avoid or solve these common problems.

The second video will be uploaded around the same time when this issue of KOBELCO WELDING TODAY is published, and the third will follow soon after that. Both will cover the correct way of handling wire in a drum. Poor handling of wire in a drum can cause kinks or tangled wires that will stop welding by a robot or a machine, thereby reducing productivity as well. The videos explain how to handle the drum correctly in order to avoid kinks or entanglements as well as how to solve such problems once they have occurred and re-start the welding.

In addition to the fundamentals of welding courses, examples of applications of welding systems, and

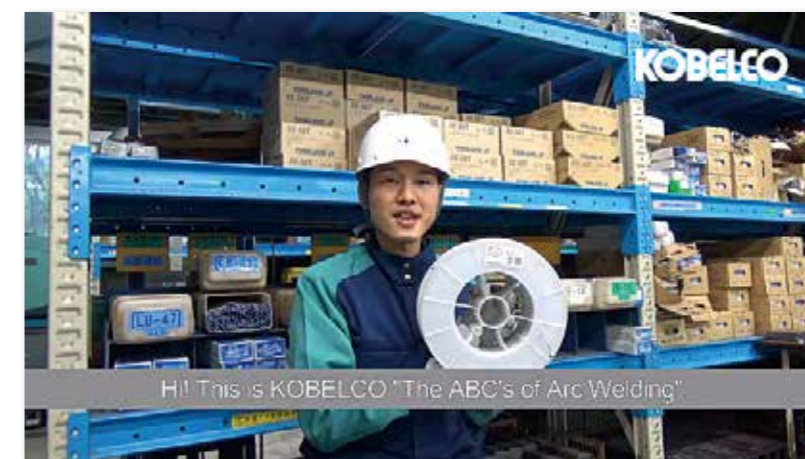
processes have also been uploaded to YouTube - but in Japanese. However, videos in English on such topics as the REGARC™ Process, Welding for Shipbuilding, and the Ultra-high current GMAW welding process are available on:

<https://www.kobelco.co.jp/english/welding/>

As discussed in KOBELCO WELDING TODAY Vol. 22, No. 3, (2019), the <Education Center> on the KOBELCO Global Website has "The ABC's of Arc Welding," that explains welding defects and technical terms and provides notes on usage in English, Spanish, Portuguese, and Russian. We are pleased that this column has attracted many readers. It would be our pleasure if even more of our readers can make good use of it, in order to educate welders and help them prevent and solve welding troubles. We look forward to hearing your requests for more videos on various problems or phenomena. Please send your requests or opinions to:

And please go to the KOBELCO Global Website at the following address to see the video described above and "The ABC's of Arc Welding:"
<https://www.kobelco-welding.jp/education-center/Fundamentals/index.html>

Reported by
Kazuyuki Harada,
Marketing Planning Section, Marketing Center, Welding Business



The ABC's of Arc Welding #1: How to handle spool wire



How to Handle the Drum:



(1) to Avoid Kink in the Wire (2) to Avoid Twisted / Entangled wire