KOBELCO WELDING TODAY

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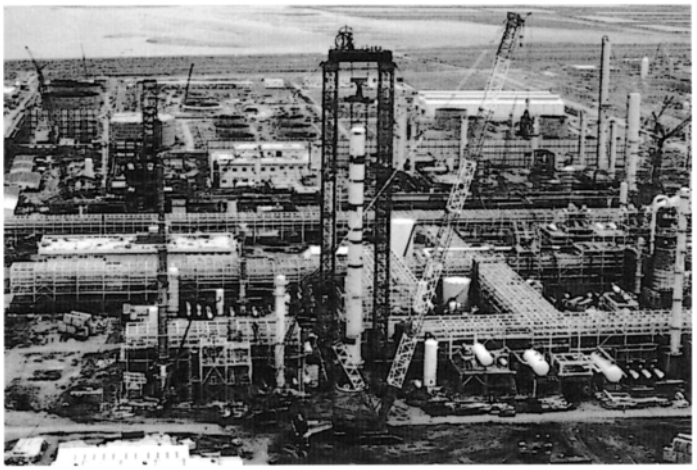
KOBELCO *Pursues Customer Satisfaction in the Arc*

High Quality Welding Consumables Reduce Fabrication Costs

In recent years, there is a strong desire for famous brands of clothing and accessories, and what are called 'brand goods' have flooded the cities and have become part of ordinary daily life. Why this popularization of 'brand goods?' A few reasons can be cited.

1) Increased incomes and improved lifestyles, making expenses for show acceptable
2) High quality and long life of products
3) Good usability

The first reason apart, reasons 2 and 3 seem to be applicable to the field of industrial technology. In the recent international economic situation, extraordinary price competition has become a matter of course in obtaining contracts for construction of industrial plants, which seems to have lessened aspiration for keeping good quality or attaining a higher level under severe pressure for lower cost.



Petrochemical plants under construction in Mai-Liao, a partial view of the Sixth Naphtha Cracker Complex

Once in the past, we welded Cr-Mo steel coils for a furnace at our factory with welding consumables made by a certain manufacturer. At that time, we were troubled with the reject ratio of the welds reaching as high as 7 to 8 per cent. At first, we attributed this high percentage of welding defects to the technical level of welders and welding operators and the working environment. However, investigations into these factors did not reveal anything.

After various trials and errors, we changed the welding consumables to those of KOBELCO. Then the reject ratio dramatically went down to less than 1 per cent, and we could fulfill the delivery term required by the customer. Certainly, KOBELCO welding consumables were higher in price as compared with those of other manufacturers, but we felt they produced merits that justified higher prices. Especially, their good usability let welders and welding operators feel relieved and the effect of this sense of relief was immeasurable. There are a few manufacturers of welding consumables in Taiwan. We once discussed differences of quality of special welding consumables made by Japanese manufacturers and Taiwanese manufacturers. The conclusion turned out to be crystal-clear. While Taiwanese welding consumables just stopped at 'satisfying the requirements of the standards,' Japanese ones 'satisfied the requirements of customers (sometimes even those of welders and welding operators) as well as the requirements of the standards.' This difference was further concluded to stem from the difference of attitude toward constant research and development for quality improvement and cost reduction.

As for assessment of cost, also, results of choice between the following two cases will be very clear.

- Preference for lower initial cost only: It is dangerous.
- Preference for operational cost (total cost): It leads to a higher level of quality of the product in the wider sense of the word and real cost reduction.

As can be seen by the instance cited above, the reject ratio of welds rose, and much time had to be spent for repair and nondestructive examination just because cheaper welding consumables were used while seeking lower cost. As a result, the quality of the product deteriorated and the danger of delayed delivery rose, thus virtually negating the difference of the initial cost. This is a point that is very simple to understand. Yet, often there are cases where management by this principle is not done due to overwhelming demand for cost reduction.

In the management of a business, reduction of the initial cost is certainly an important factor. However, I am convinced that a company that makes a selective use of 'common goods' and 'brand goods' correctly will survive the most competitive rat race of the present time.

Reported by K. Ando,
Technical Advisor
Formosa Heavy Industries Corp.

Message from the Editor

I am very happy that I could enter the gateway to the 21st century together with the dearest readers of Kobelco Welding Today.

Modern arc welding techniques, consumables and equipment have a long history; having been developed and continually improved over the past three centuries. Although the usage ratio of manual, semi-automatic and automatic welding may differ greatly among countries and areas depending on the technological level and status of labor market, they all constitute part of arc welding technology. In our estimation, more than three million tons of welding consumables are now used annually over the world. This figure changes in proportion to the volume of consumption of iron and steel materials.

Among regional welding markets in the world, consumption of iron and steel products is expected to expand greatly in China, Korea and Southeast Asian countries where outstandingly high economic growth is forecast. All of us in the KOBELCO Welding Group are determined to fully perform as local manufacturers founded and operating in many areas worldwide and to meet the versatile needs of our customers.

Now, let us all drink to the start of the voyage to the 21st century and your ever-continuing growth, *"Cheers!"*

Tetsuo (Tom) Konohira
Editorial Chairman

General Manager

International Operations Department

Welding Company Kobe Steel, Ltd.

KOBELCO WELDING TODAY

Contents

User Reportage
■ High quality welding consumables reduce fabrication costs. 1
Message from the Editor
■ Kobelco Welding Group will work to meet local needs worldwide. 2
Technical Report
■ DW-55L is a dependable flux-cored wire for LPG carriers. 3-4
■ NB-1SJ: the best choice for welding LPG storage tanks. 5-6
The ABC's of Arc Welding
■ How interpass temperature affects the quality of welds. 7
Kobelco Group News
■ A big stride expected for KWK in 2001. 8
Feature Articles
■ "The Spool of Excellence" attracts visitors at FABTECH 2000. 9
■ Kobelco attracts interest at Beijing Essen Welding 2000-Shanghai. 9
■ Kobelco metal-cored wires change their AWS classifications. 10
Postscript 10

Letter from Tokyo

KOBELCO | KOBE STEEL, LTD.

M. Takamura,
Dpty General Manager, IOD,
Welding Company,
Kobe Steel, Ltd.

A Happy New Year! With a refreshed determination at the outset of the 21st century, we will continue efforts to supply good products constantly to our customers.

One of the most important concerns for us, the Welding Company of Kobe Steel, Ltd., is to develop and supply such welding consumables as will fulfill unique needs and preferences of each regional market. In Korea, encouraged by the demands of world-class major shipbuilders in the market, Kobe Welding of Korea has been exerting utmost efforts since its establishment to develop flux-cored wires with a Korean taste, as it were. Thanks to recognition by the customers of the results of these efforts, it could expand manufacturing capacity and its line of products in 2000. In Thailand, also, in response to a fervent request from Thai Shin-yo-kai, Thai-Kobe Welding put on the market its own locally developed manual arc welding electrodes to match the needs of the Thai market. The electrodes have obtained a very favorable reputation among the customers. In Europe, USA, China, and everywhere in the world, we will go on with our efforts to fortify our activities in the light of regionalism to satisfy your needs.

We hope you will continue giving us your patronage.

Technical Report

DW-55L

(AWS A5.29 E81T1-K2)

With superior notch toughness at low temperatures down to minus 60°C and higher tensile strength, DW-55L surpasses DW-55E, featuring excellent usability. Offshore structures in cold districts and LNG and LPG carriers are typical applications for this rutile-base flux-cored wire using CO_2 shielding.

Figure 1. In construction of LPG ships, low-temperature impact energy of welds is strictly controlled in order to assure the fracture resistance in low-temperature services.

DW-55L Offers Unsurpassed Low-Temperature Notch Toughness over Conventional E81T1-K2 Wires

With the sophisticated design of the chemical composition (containing approximately 1.5%Ni), DW-55L produces deposited metals of high impact energy surpassing the usual E81T1-K2 class of flux-cored wires. This AWS class requires 27J at minus 29°C; however, DW-55L can assure the required value at lower temperatures down to minus 60°C. Figure 2 shows test results of impact energy of the weld metal welded in double-V butt grooves in several welding positions. Because the test specimens were removed from the backing side and final side of the joint, the impact energies are scattered a little due to a variety of microstructures caused by different heat input and pass sequences. However, they maintain adequate levels of impact energy. This extra-high quality facilitates wider applications for the wire, including the welding of LNG and LPG carries.

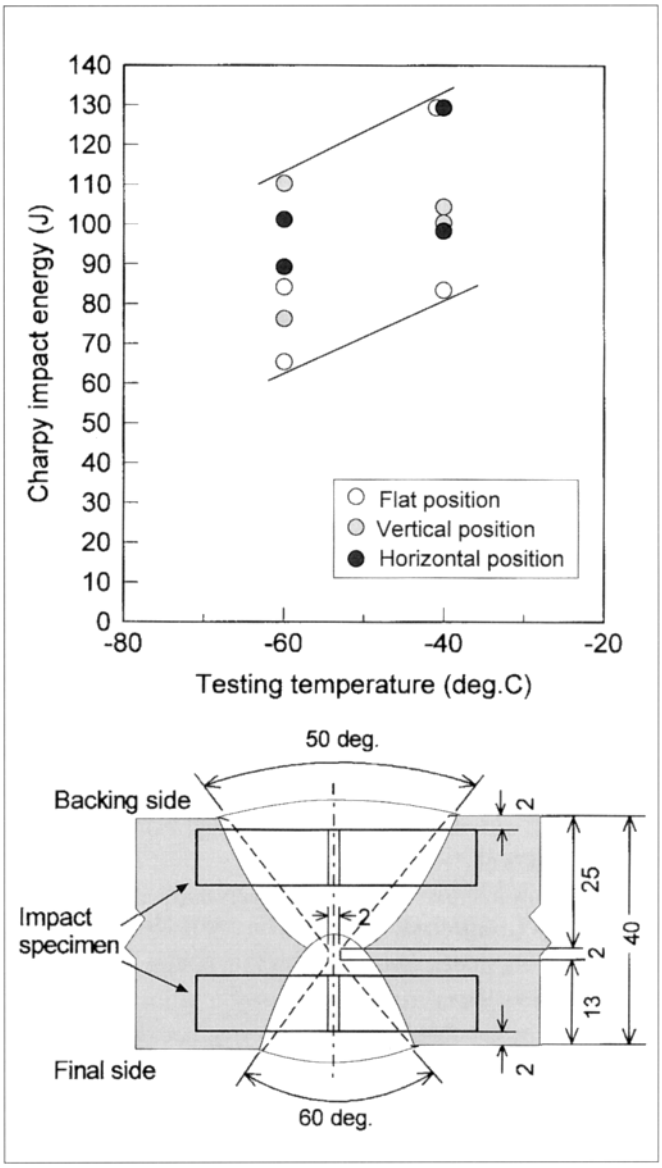


Figure 2. Impact test results of a DW-55L multiple-pass weld metal in the following conditions (Each plot shows the average of three values).
▪ Base metal: BS4360-50D; ▪ Heat input: Av. 18 kJ/cm (Flat), Av. 25 kJ/cm (Vertical), Av. 11 kJ/cm (Horizontal); ▪ Wire size: 1.2 mmØ; ▪ Preheat: 100°C; ▪ interpass-temperature: 100-150°C; ▪ shielding gas: CO_2.

High Deposition Rate Is an Essential Factor of High Welding Efficiency

Figure 3 shows deposition rates of DW-55L with diameters of 1.2 and 1.4 mm, which are higher than those of solid wires by approximately 5-10% and those

of covered electrodes by approximately 65-85%. With a higher deposition rate, the total arc time can be decreased in welding a certain mass of welding grooves and in turn, the labor cost can be decreased.

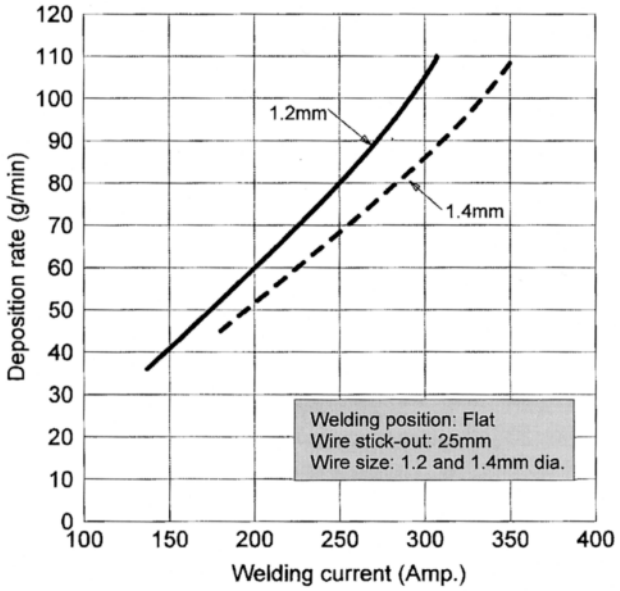


Figure 3. Deposition rates of DW-55L as a function of welding currents with a wire extension of 25 mm

Ship-Class Approvals Certify the Quality of DW-55L for High Grade Steels in Shipbuilding

DW-55L is approved as a Grade-5 flux-cored wire (5Y40S) by Lloyd's Register of Shipping (LR) in addition to as the Grade-3 by other ship-class societies (NK. AB, NV, BV, GL, and KR). The first digit, 5, designates that this wire can fulfill the minimum impact requirement of 47J in flat position and 41J in vertical position at minus 60°C. "Y40" designates the minimum yield point is 400N/mm^2. "S" stands for semi-automatic welding.

Low Diffusible Hydrogen Content Assures Better Weldability in Terms of Cold Cracking

DW-55L offers low diffusible hydrogen content. Table 1 shows the typical diffusible hydrogen content of the deposited metal determined by the gas chromatographic method specified by JIS Z 3118, which is the same level as that of low hydrogen covered electrodes.

Table 1. Typical diffusible hydrogen content of DW-55L deposited metals (Gas Chromatographic method)

Diffusible hydrogen content (ml/100g)				
4.3	4.7	4.2	4.6	Average 4.5

Note: ▪ Wire size: 1.2 mmØ; ▪ Amp-Volt-speed: 280A-30V-35 cm/min
▪ Wire extension: 25 mm; ▪ Shielding gas: CO_2 25 l/min
▪ Welding atmosphere: 26°C x 69% RH

CTOD Data Provide Critical Engineering Assessment of the Quality of DW-55L

The most common method of measuring the fracture toughness (resistance to extension of a crack) of welded joints is the Charpy V-notch test. In addition to this, other types of tests are specified, depending on the strictness required, for an engineering critical assessment. The crack tip opening displacement (CTOD) test is one of them. The CTOD requirement for welds depends on design temperature, operational strictness, plate thickness, and postweld heat treatment of the components. For general purposes, and where other guidance is lacking, a CTOD value of 0.15 mm is often regarded as a lower limit for acceptability in the case of carbon manganese and ferritic alloy steel. As shown in Table 2, the DW-55L weld metal possesses sufficient CTOD values at minus 10°C.

Table 2. Typical CTOD test results of DW-55L weld metals in the conditions mentioned in the footnotes

Welding position	Flat	Vertical	Horizontal
CTOD at –10°C δc (mm)	0.64 0.59 0.34	1.68 2.05 1.55	0.50 0.61 0.51

Note: ·Test plate: BS4360 Grade 50D, 40mmT, double-V groove
·CTOD test piece: 80T x 40W x 400L (mm), fatigue notch
·CTOD test method: BS5762-1979, three-point bending
·Heat input: Av. 18 kJ/cm in the flat position welding
Av. 25 kJ/cm in the vertical position welding
Av. 11 kJ/cm in the horizontal position welding

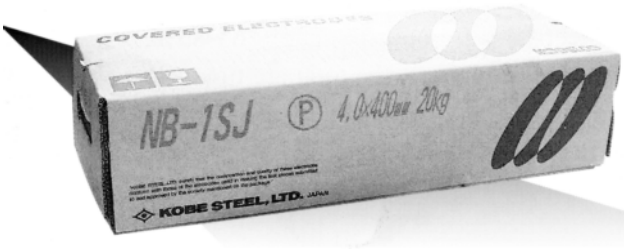
Outstanding Usability in Single and Multi-Pass Welding

DW-55L is suitable for all position welding including the vertical down position. Stable, gentle arc, low spatter loss, flat bead contour, and easy slag removal are its noticeable features.

Technical Report

NB-1SJ

(AWS A5.5 E8016-G)



In welding low-temperature high-strength steels having a minimum tensile strength of 490-550N/mm^2, NB-1SJ is one of the best selections. LPG storage tanks, offshore structures in cold districts, and other low-temperature use equipment are typical applications for NB-1SJ.

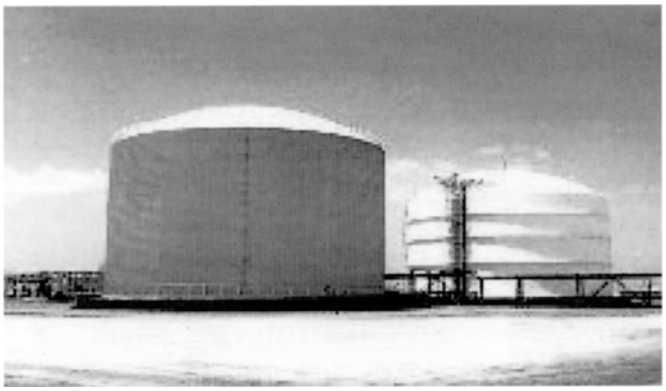


Figure 1. A Hat-bottomed cylindrical single shell tank for storing liquefied butane gas is one recent application for NB-1SJ, when constructed per BS7777 specification requiring –50°C notch toughness based on fracture mechanics (Photo courtesy of Toyo Kanetsu K.K.)

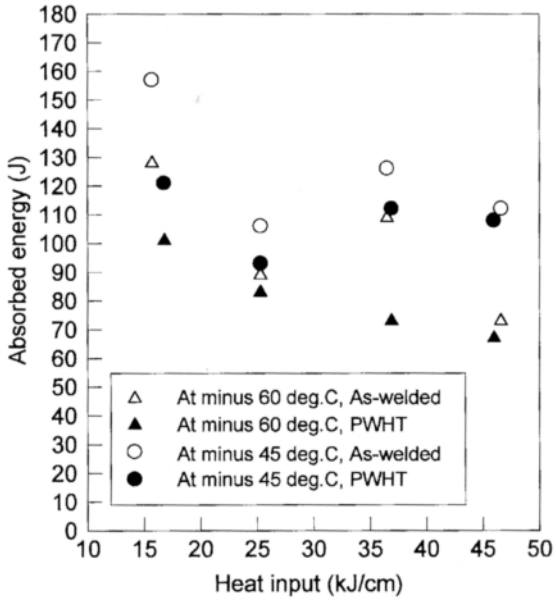


Figure 2. Charpy impact absorbed energies of NB-1SJ weld metals as a function of heat input in the as-welded and postweld heat treated (600°C x 2h) conditions (Each plot is the average of three specimens)
- *Base metal: 32-mm thick A537 Cl-2, double-V groove*
- *Heat input: Av. 25.3 kJ/cm (Flat); Av. 36.5, 36.9, 46.0 and 46.6 kJ/cm (Vertical); Av. 15.7 and 16.8 kJ/cm (Horizontal)*
- *Power source: AC*

NB-1SJ Offers Persistent Impact Absorbed Energy and Tensile Strength

Notch toughness is an indispensable quality of the materials used in low-temperature equipment to protect the constructions from brittle fractures under strict service conditions. Impact absorbed energy of weld metals, however, is prone to scatter caused by such variables as heat input, welding position, plate thickness, cooling speed, and postweld heat treatment. This is because these variables affect the microstructure of weld metals. The exquisite design of the chemical composition of NB-1SJ facilitates persistent mechanical properties of the weld metal. Approximately 1.4%Ni and strictly controlled amounts of titanium (Ti) and boron (B) are a noticeable factor to stabilize the mechanical properties as shown in Figure 2 for notch toughness and in Figure 3 for tensile strength. A typical macrostructure of the test joints and locations of the test specimens are shown in Figure 4.

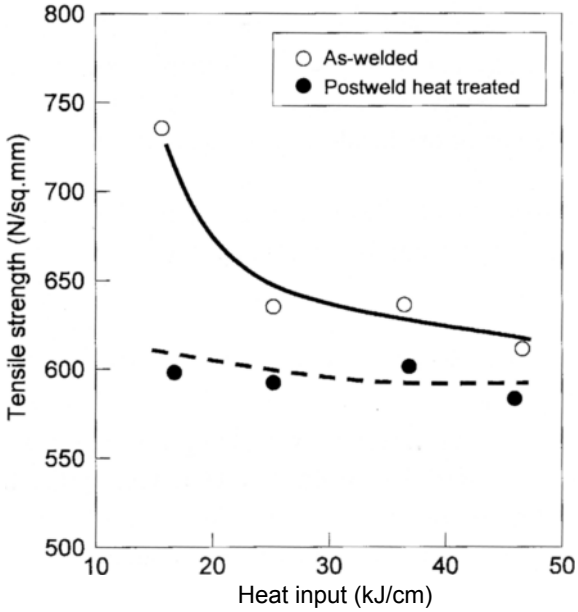


Figure 3. Tensile strength of NB-1SJ weld metal as a function of Heat input in the as-welded and postweld heat treated (600°C x 2h) conditions
- *Base metal: 32-mm thick A537 Cl-2, double-V groove*
- *Heat input: Av. 25.3 kJ/cm (Flat); Av. 36.5, 36.9, 46.0 and 46.6 kJ/cm (Vertical); Av. 15.7 and 16.8 kJ/cm (Horizontal)*
- *Power source: AC*

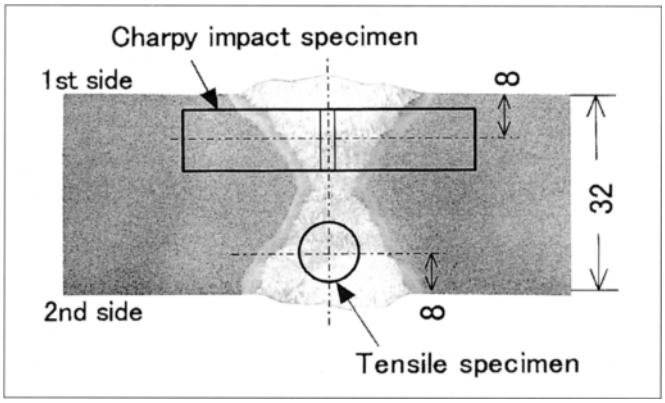


Figure 4. Macroscopic structure of the test joint and locations of the test specimens (Flat position)

As shown in Figure 2, the impact absorbed energies are in a decreasing tendency with high heat input, because high heat input causes coarse-grained microstructures. In addition, postweld heat treatment causes a decrease of notch toughness because of SR embrittlement. However, NB-1SJ weld metal maintains adequate absorbed energies at both minus 60 and 45°C in the as-welded and PWHT conditions in out-of-position welding.

As shown in Figure 3, the tensile strength is apt to decrease with high heat input, because the use of high heat input causes coarse-grained microstructures. In addition, postweld heat treatment causes a decrease of tensile strength because of stress relief of the weld metal. However, NB-1SJ weld metal maintains adequate tensile strength over the minimum tensile strength (550N/mm^2) of A537 Cl-2 steel in the as-welded and PWHT conditions in all-position welding.

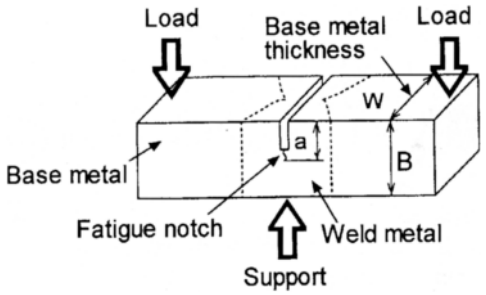
Sufficient CTOD Values Exhibit Excellent Fracture Toughness of NB-1SJ

NB-1SJ features high CTOD values at low temperatures down to minus 45°C in the as-welded condition over variables of welding position and heat input, as shown in Table 1. CTOD testing has been used mainly for carbon-manganese and low alloy steel in the ductile/brittle transition temperature range, and has found much use in weld procedure tests for work on North Sea offshore structures.

Table 1. CTOD test results of NB-1SJ weld metal in the as-welded condition using a 32-mm thick A537 Cl-2 base metal having a double- V groove

Welding position	Heat input (kJ/cm)	Testing temp. (°C)	CTOD (mm)
Flat	25.3	–46	0.687
			0.702
			0.741
Vertical	36.5	–46	0.693
			1.20
			1.24
Vertical	46.6	–46	0.222
			0.552
Horizontal	15.7	–46	1.36
			0.847
			0.214

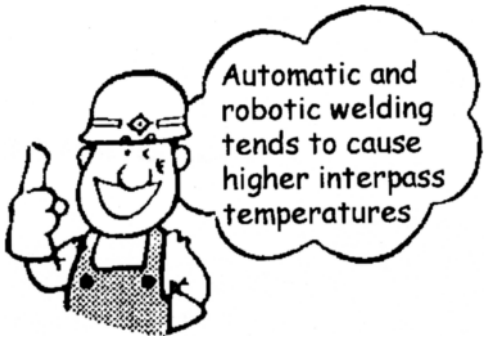
Note: The CTOD test was conducted in accordance with BS5762-1979 (three-point bending), using the test specimen as shown below. In this test, the crack tip opening displacement is measured by using the clip gauge to determine fracture toughness of the weld.



How to select NB-1SJ and LB-62L for welding A537 Cl-2 Steel

Both NB-1SJ and LB-62L (For details, see Kobelco Welding Today, July 2000, Vol. 3, No. 3) are suitable for welding ASTM A537 Cl-2 (Tensile strength ≥ 550N/mm^2) or other equivalent steels. The lowest temperature at which NB-1SJ can ensure notch toughness is minus 80°C , while minus 60°C for LB-62L. Both electrodes can inherently be used with both AC and DCEP current. However, when it comes to the guarantee of such a high tensile strength over a wide range of welding variables encountered in fabrication sites, the type of welding current is a critical factor. Therefore, select NB-1SJ for AC current and LB-62L for AC and DCEP current. This is because the type of current affects the yield of chemical elements in weld metals and, in turn, affects mechanical properties of weld metals. The use of DCEP generally decreases tensile strength of weld metals.

How Interpass Temperature Affects the Quality of Welds



Interpass temperature in a multiple-pass weld is the temperature of the weld between weld passes. The objectives of controlling the interpass temperature are

(1) to minimize the risk of hydrogen cracking for carbon, carbon-manganese, and ferritic alloy steels, in which the minimum interpass temperature is specified to be the same as the minimum preheating temperature
(2) to prevent deterioration of mechanical properties for carbon, carbon-manganese, and ferritic alloy steels, in which the maximum interpass temperature is specified
(3) to minimize the risk of solidification or liquation cracking for austenitic stainless steel, nickel and nickel alloys, and aluminum and aluminum alloys, in which the maximum interpass temperature is specified
(4) to maintain good wetting of the molten pool onto the base metal for copper and copper alloys, in which the minimum interpass temperature is specified to be the same as the minimum preheating temperature

The use of high preheating temperature raises welding costs due to increased energy use for heating the work, thus people have minimized it by using advanced welding materials featuring better weldability.

In contrast to this, interpass temperature is apt to be raised in order to fill the welding grooves as fast as possible for better welding efficiency, thus for decreasing welding costs. On the other hand, mechanical properties (as for ferritic steels) and crack resistibility (as for austenitic steels) deteriorate with high interpass temperatures and, in turn, low cooling rates. This is why a maximum interpass temperature often becomes a problem.

Figure 1 shows test results of 490 MPa-class GMAW weld metals using solid wires on mechanical properties as a function of interpass temperature (Data source: Steel Construction Engineering, Vol. 7, No. 26, June 2000). It is obvious in this figure that tensile strength, 0.2% yield strength, and impact energy of the weld metals decrease with high interpass temperatures. Therefore, the interpass temperature must be restricted to ensure the required mechanical properties. The figure suggests that a maximum interpass temperature should be 250°C to ensure 490 MPa of tensile strength.

Maximum interpass temperatures of 150°C for austenitic stainless steel and nickel-base alloys, and 70°C for aluminum alloys are generally required to prevent hot cracks.

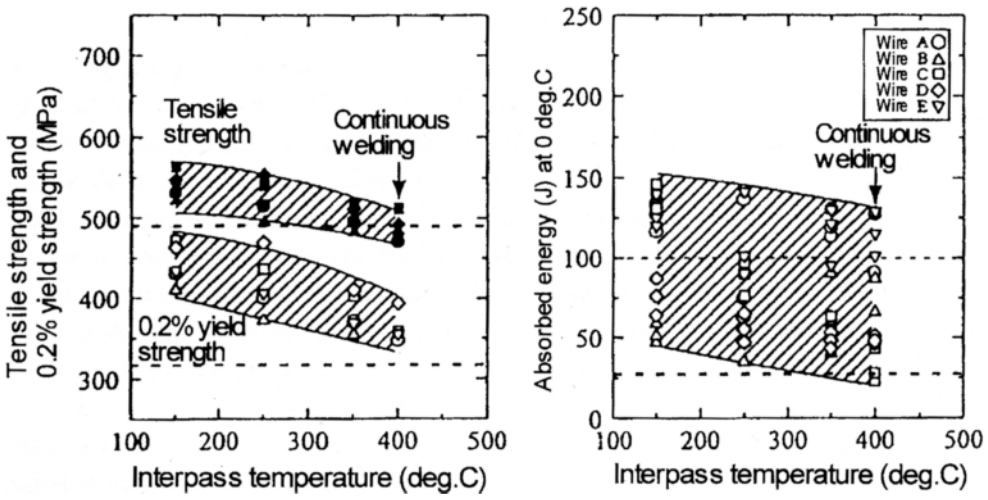
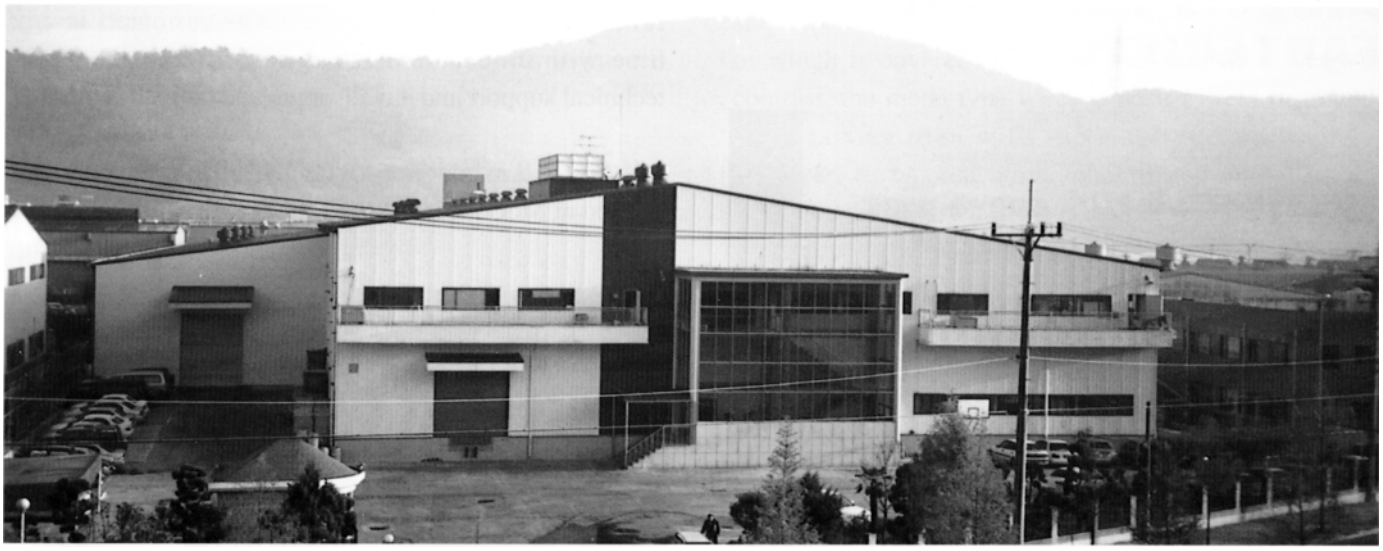


Figure 1. Effects of interpass temperature on mechanical properties of 490 MPa-class GMAW weld metals using five different brands of JIS YGW11 solid wires (Heat input: 40 kJ/cm)

A Big Stride Expected for KWK in 2001



KWK is the Kobe Steel's first affiliated producer established in Changwon city in Korea.

Kobe Welding of Korea Co., Ltd. (KWK) was established in 1995 as Kobe Steel's first joint venture in the Republic of Korea. Now it manufactures mainly flux-cored wires (FCW) for mild steel and 490N/mm^2-class high strength steel for the domestic and overseas markets.

In a very short span of 5 years, KWK has undergone economic turmoil triggered by a sharp depreciation of Korean Won and the successive bankruptcies of industrial groups. It also experienced the severe intervention by the International Monetary Fund (IMF) in Korean economy at the end of 1997. However, the Korean economy has come back booming with amazing force, centering around the electronics industry led by semi-conductors, and the shipbuilding industry, which is sure to keep its position as No. 1 in the world in getting orders in 2000 consecutively from 1999. It is on the way toward further expansion.

In harmony with the revival of the Korean economy, KWK has placed the highest importance on supplying products of better quality than all its competitors to the shipbuilding and other industries, matching their needs. KWK has also been pursuing growth of its customer base through timely technical services and quick delivery.

This business style seems to have won the confidence of customers. KWK is constantly expanding its sales and share in the domestic FCW market along with the growth of the customers. The present manufacturing capacity of 600 tons/month of KWK is becoming insufficient to cover customers' increasing demand for KWK products of the highest quality.

On December 1, all participants solemnly celebrated the completion of a new factory building expanded in KWK (Top), and an executive prayed for the safety during the construction of the factory (Bottom).

In order to cope with this situation, KWK plans to expand its facilities, raising the capacity to 900 tons/month (up 50% from the present capacity) from March 4, 2001, when KWK celebrates its sixth anniversary. Construction of a new factory building has already been finished and its completion was celebrated on December 1, 2000. KWK wishes to continue to pursue still higher quality of products to fulfill customers' needs and to grow further with them.

Reported by Ota,
Kobe Welding of Korea

The Spool of Excellence Attracts Visitors at FABTECH 2000

"The Spool of Excellence" reflects unsurpassed quality of Kobelco flux-cored wires.

North America's largest annual metal forming and fabricating exposition and conference was held in Cleveland. Ohio in the US on November 14-16, 2000. More than 700 exhibiting companies from around the world occupied the exposition site of over 250,000 net-square-feet to show the industry's latest technologies. There was an attendance of more than 18,000 people to see the latest in bending and folding; coil processing; controls and computer systems; cutting; finishing; lasers; material handling; plate and structural fabricating; press working and stamping; punching; robotics; roll forming; safety equipment: tube and pipe producing and fabrication; and welding.

Kobelco Welding of America (KWAI) was in the welding pavilion, together with more than 150 exhibiting companies, to introduce Kobelco's welding consumables including three new flux-cored wires of DWA-50, MXA-70Cb, and DW-329AP. KWAI announced their new slogan, "The Spool of Excellence," for their flux-cored wires. This phrase describes the excellent performance of Kobelco's spooled wires: smooth, regular bead appearance, less fume, less spatter loss, and consistent mechanical properties.

As you may imagine, with so many visitors looking for equipment there would be customers for welding consumables as well; some customers requested demonstrations at their sites after FABTECH. We are sure that they left the show with knowledge that would maximize their welding efficiency and productivity. KWAI will be right there to serve its customers at any time with its excellent welding consumables, solid technical support and a well-organized delivery system.

KWAI will exhibit at FABTECH 2001, too, which will be held at McCormick Place Chicago, Illinois this year.

KOBELCO Attracts Interest at Beijing Essen Welding 2000-Shanghai

Kobelco booth counted about 1000 visitors from a variety of industries.

Kobe Steel, Ltd. participated in Beijing Essen Welding 2000-Shanghai that was held at the Shanghai Everbright Convention & Exhibition Center from the 14th through 17th of November last year. The sixth time this event has been held, the Fair is the largest exhibition related to welding in China. This time, 264 exhibitors including 14 overseas enterprises drew 27,000 visitors from in and out of China. Overseas visitors were from 25 countries. With Shanghai being the leading business city in China, as many as 1,000 visitors from such versatile industrial fields as shipbuilding, pressure vessels, tanks, petroleum, and transportation machinery showed up at the Kobe Steel's booth, where they had lively technical discussions and renewed their friendships with their old acquaintances.

This year, Kobe Steel tried a new exhibition system to divide its main products by the industrial fields of its customers. The exhibits included DW-100 and MX-200 flux-cored wires used very much by the shipbuilding

industry and new high-strength Cr-Mo welding consumables (such as high-strength 2.25Cr and 12Cr types) that invited keen interest from the pressure-vessel-related industry. All the exhibits attracted entranced attention from the visitors.

We look forward to seeing you in your own hometown next time.

More Suitable AWS Classifications for Kobelco Metal-Cored Wires

The metal-cored wires for mild steel, 490N/mm^2-class high strength steel, and low-temperature steel have had their AWS classification changed, as shown in the table below as of November 9, 2000. The revisions are printed on Kobelco product's packages from 2000.

New classifications to AWS specifications

Brand	Old classification	New classification
MXA-100	A5.20 E70T-1M	A5.18 E70C-6M
MX-100T	A5.20 E71T-1,1M	A5.18 E70C-6, 6M
MXA-55T	A5.29 E80T1-K2	A5.28 E80C-G

Note: The years of edition are A5.20-1995, A5.29-1998, A5.18-1993, and A5.28-1996

Flux-cored wires have been roughly grouped into two families in Japan: "slag type" and "metal type." The slag type wires produce a weld bead, the entire surface of which is covered by a moderate volume of slag. In contrast, the metal type wires deposit a weld bead with far less slag than with the slag type. Nowadays, however, flux-cored wires available in markets vary. Some metal type wires for specific applications cover the entire surfaces of the weld bead with thin slag for better performance.

Taking into account the practicalities of the situation, Kobe Steel has classified all the flux-cored wires for mild steel, 49N/mm^2-class high strength steel, and low-temperature steel in accordance with AWS A5.20 (Carbon Steel Electrodes for Flux Cored Arc Welding) and A5.29 (Low Alloy Electrodes for Flux Cored Arc Welding) respectively, regardless of whether they are slag type or metal type. However, in order to follow more precisely the AWS standard, Kobe Steel revised the classification for the brands shown in the table above as "metal-cored wire" in accordance with A5.18 (Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding) and A5.28 (Low Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding) respectively. This is because these wires generate very little slag like solid wires.

Postscript

We, the editorial staff, are very pleased to have been able to issue *Kobelco Welding Today* for a fourth year. This continuing issuance is owing to the reader's support for this magazine. In order to match the expectation from our readers, we will continue to work on making it more interesting and useful for the readers. So your opinions, questions, and requests for this magazine are always welcomed.

Kobe Steel will continue to attend welding trade fairs worldwide to support our traditional customers and to cultivate new customers in existing and new markets by exhibiting both our traditional and newly developed products. The Essen Welding Fair and AWS Welding Show will represent excellent opportunities to expand our chances this year.

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