KOBELCO WELDING TODAY

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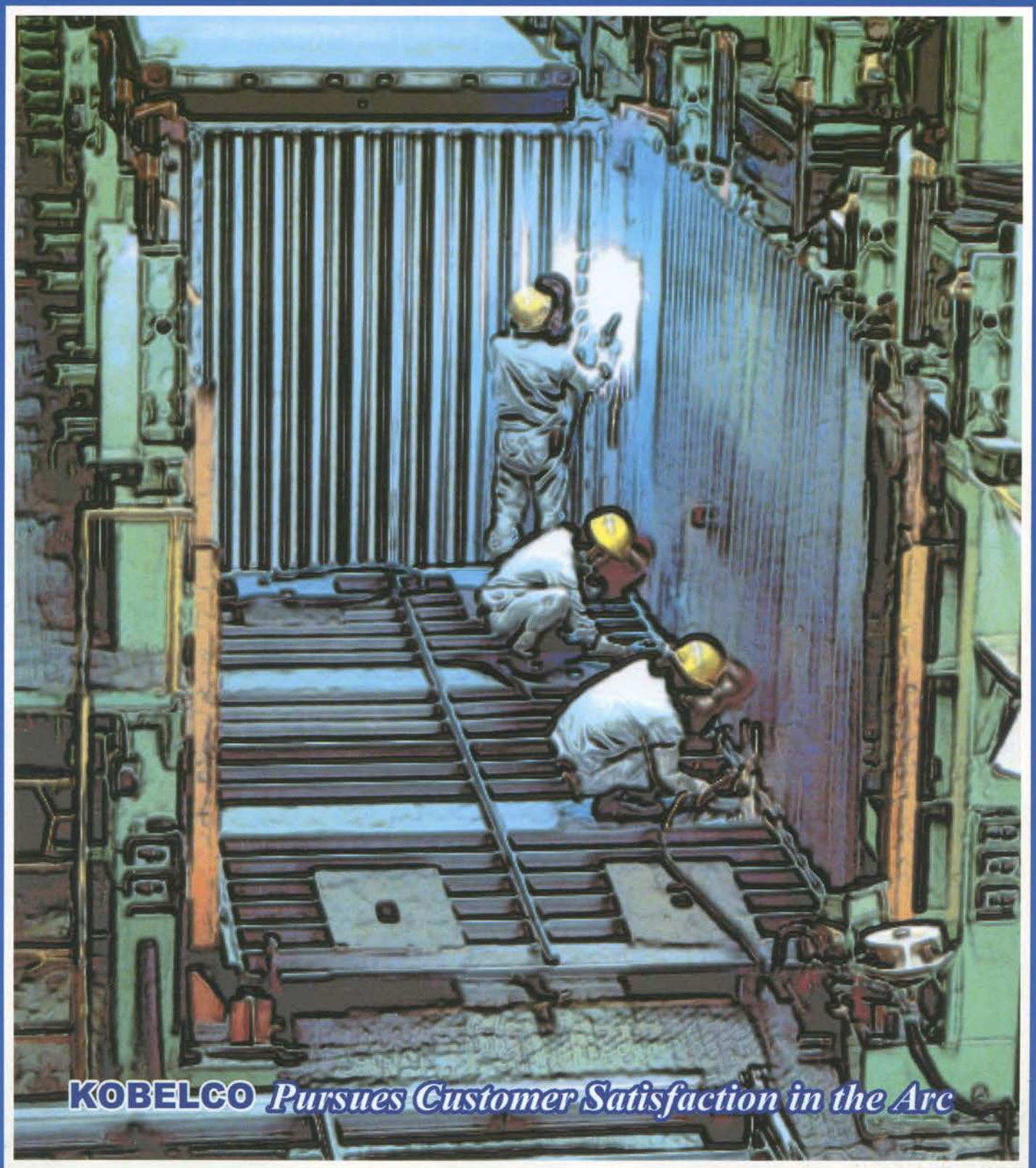

KOBELCO *Pursues Customer Satisfaction in the Arc*

Braden Manufacturing: A Proven Leader in Auxiliary Systems for GT Power Plants

Braden Manufacturing was incorporated in 1923 and for the last 30 years has occupied a unique spot halfway between the gas turbine OEMs and the power producers. No other company has spent more time listening, learning and working with both groups.

Braden's international headquarters in Tulsa, Oklahoma

As a result Braden has established itself as the most experienced and trusted name in the design of auxiliary systems for GT power plants. Turbine manufacturers acknowledge that no other company is better equipped to handle the challenges of GT plants.

Braden's Monterrey, Mexico manufacturing facility

Braden's technical capabilities are extensive. Their experienced engineering staff uses the most modern software to provide specific compliant designs to meet specific inlet and exhaust application criteria. Their manufacturing facilities are equipped with the most modern state of the art equipment offered today. With ISO 9001 certification as the baseline for their quality programs, every manufacturing process is strictly monitored to insure their customers' expectations are met. They have a strong employee commitment to a Continuous Improvement Program and everyone's ideas are seriously taken into consideration.

Braden has two major manufacturing facilities in the United States located in Tulsa, Oklahoma and Fort Smith, Arkansas and distributes their product throughout the country. They also have fabrication partners in 25 countries and will meet local content requirements and provide cost-effective fabrication throughout the world.

Kobelco Welding of America has served Braden for two years through our distributor Plattner Welding Supply. DW-309L and DW-308L are used for their stainless applications making them one of the larger users of 309L flux-cored wires in the United States. FRONTIARC-711 and DWA-50 are used for their carbon steel applications.

The applications of Kobelco flux-cored wires include carbon steel, carbon steel to stainless, and stainless to stainless. The wire's superb welder appeal and cosmetics along with a low welding fume generation rate makes Kobelco highly appraised with the welders, management and the safety department.

Braden's Fort Smith, Arkansas manufacturing facility

We at Kobelco Welding of America wish to continue to be a good and useful supplier to Braden by maintaining excellent product quality, training and technical services and quick delivery so that they will be more satisfied and continue to use our product for many years to come.

*Reported By **Jerry Whiteley***
Regional Sales Manager
Kobelco Welding of America

Message from the Editor

General Manager

International Operations Department

Welding Company
Kobe Steel, Ltd.

Generally speaking, the world economy seems to be in a depression now. The governments and companies in all countries are trying to recover, although it does not look easy. Nowadays, the economy of any one nation can deeply be affected by events taking place in other economies around the world. However, we have experienced overcoming the Asian economic crisis that started in 1997. Therefore, I believe the world economy will again get well this time sooner or later. Until then, we just can do our best to survive and grow in this kind of bad economical circumstance.

The KOBELCO group has been working to supply our products and services to you, our business partners and customers all over the world, for supporting your success and satisfaction. I promise you that we will pursue the same policy to keep the same consistency in our international operations as we always have and further try to improve our activities.

Masakazu Tojo
Editorial Chairman

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Letter from Tokyo

KOBELCO | KOBE STEEL, LTD.

K. Nakamura
Manager
Welding Company
Kobe Steel, Ltd.

Let me introduce myself. My name is Kimihiko Nakamura, a manager of the IOD. I cover in my activities the areas of Europe, America, Russia, Oceania, India and the Middle East.

As you may imagine, my job requires taking a lot of overseas business trips. Personally, I like this job since I can get acquainted with many people with different culture backgrounds, although I still do not like flying.

I also like the feeling of sharing the enthusiasm with our partners when we have obtained new business, which, unfortunately, does not happen enough.

Since I am a soccer fan, I sometimes enjoy watching soccer games. I think that the way of playing soccer reflects the character of the nationality. It is often said that the Japan Soccer Team plays in a conservative, gentle way.

We, KOBELCO, are apt to take a conservative way, too, in business, but we are not gentle. We are rather aggressive to get an advantageous position in each market. Let's pull together to win the game!

CMA-96: A World-Class 1.25Cr-0.5Mo Electrode of Persistent Quality Since 1952

Since its inception, CMA-96 (AWS A5.5 E8016-B2) has persistently earned a good reputation in the high-temperature high-pressure fields such as boilers and refineries in which 1.25Cr-0.5Mo steel is used at a large consumption ratio for steam power generating equipment and reactor vessels.

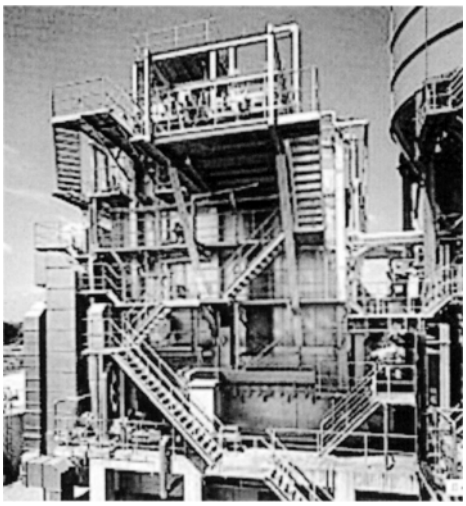
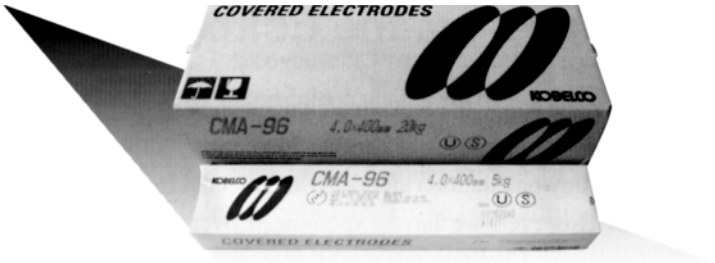


Photo 1. Heat-resistant low-alloy steel is a main material for coal firing power plants (Photo courtesy of TAKUMA Co., Ltd.)

In welding Cr-Mo steel, the weld metal should have the following essential qualities.

(1) Low susceptibility to cold cracking
(2) Low susceptibility to hot cracking
(3) Resistibility to extended postweld heat treatment for better mechanical properties
(4) Stable microscopic structure for better creep resistance at elevated temperatures

In order to fulfill these essential requirements, CMA-96 is ingeniously designed. First, it is of the extra-low hydrogen type; consequently, the amount of diffusible hydrogen in the weld metal can be kept lower than with conventional low hydrogen type electrodes, thereby reducing the susceptibility to cold cracking. Second, the phosphorous and sulfur content of the weld metal is kept low to decrease the susceptibility to hot cracking. Thirdly, CMA-96 with its elaborate chemical composition provides a stable weld metal microstructure, which allows the weld metal to maintain adequate mechanical properties over extended postweld heat treatment (PWHT) of high temper parameter (Figs. 1 and 2) and to increase creep resistance.



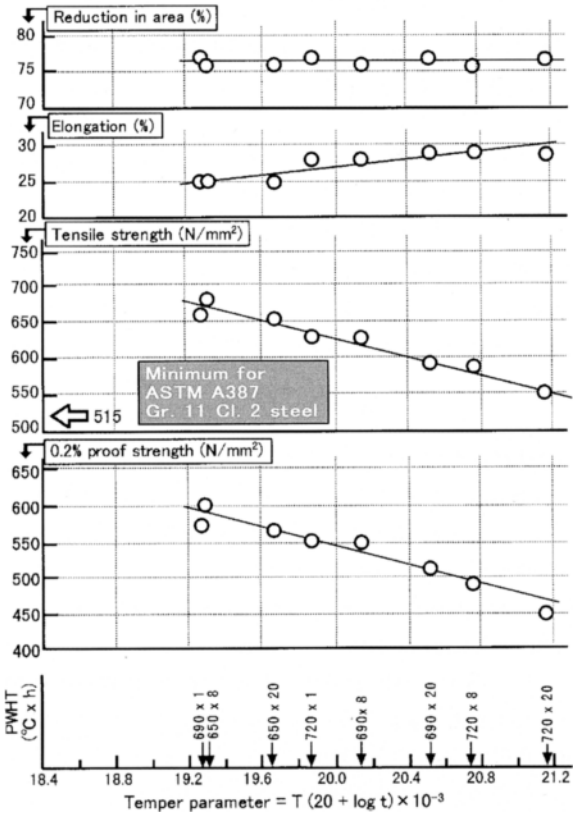


Fig. 1. Tensile properties of CMA-96 (5Ø) weld metal vs. temper parameter (T: temperature in deg. K; t: soaking time in hour) by AC welding in flat position

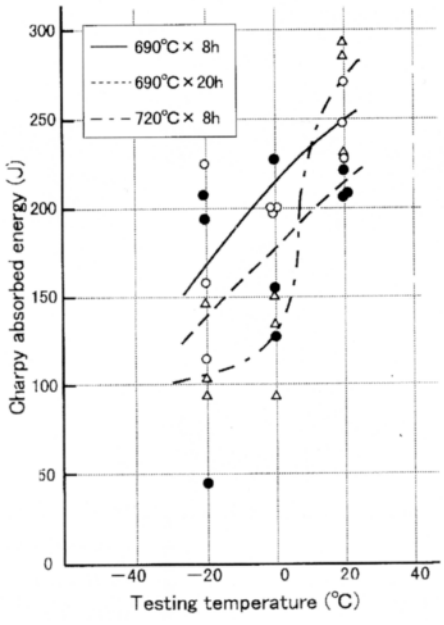


Fig. 2. Charpy impact properties of CMA-96 (5Ø) weld metal in the PWHT condition by AC welding in flat position

CMA-96MB: The Best Choice for Moderate-PWHT Fabrication of 1.25Cr-0.5Mo Components to Strict Notch Toughness and Hardness Requirements

With lower temper parameters (either with lower PWHT temperature or with shorter PWHT time), weld hardness is prone to be higher — hence lower ductility — and notch toughness tends to be lower in general. The temper parameter of PWHT will necessarily be lower depending on the thickness of the weldment, the specification or code to follow, and the base metal used.

In contrast to CMA-96, CMA-96MB (AWS A5.5 E8016-B2) is more suitable for moderate PWHT of lower temper parameter. With moderate PWHT, CMA-96MB provides better notch toughness and lower hardness — thus higher ductility — compared with CMA-96. In addition, CMA-96MB more strictly control impurity elements such as phosphorous (P), tin (Sn), antimony (Sb), and arsenic (As) to minimize temper embrittlement. Fig. 1 shows results of Charpy impact tests of CMA-96MB weld metal that sustained low temper parameter PWHT. The weld metal exhibits adequate notch toughness over the range of temper parameters.

As shown in Fig. 2, the susceptibility to temper embrittlement of the weld metal is quite low with almost no temperature shift at the standard absorbed energy of 54J.

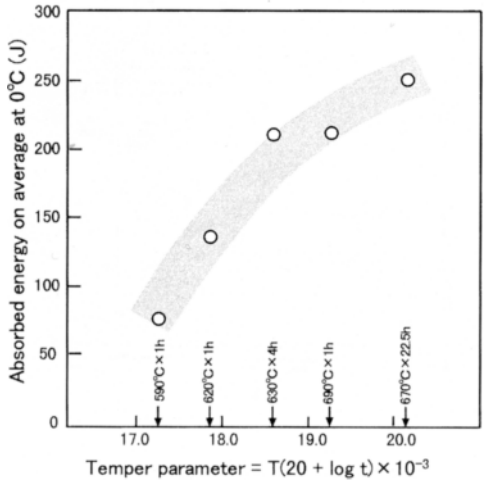


Fig. 1. Charpy impact absorbed energy of CMA-96MB (5.0Ø) weld metal as a function of temper parameter (T: PWHT temperature in deg. K; t: soaking time in hour) by AC welding in flat position

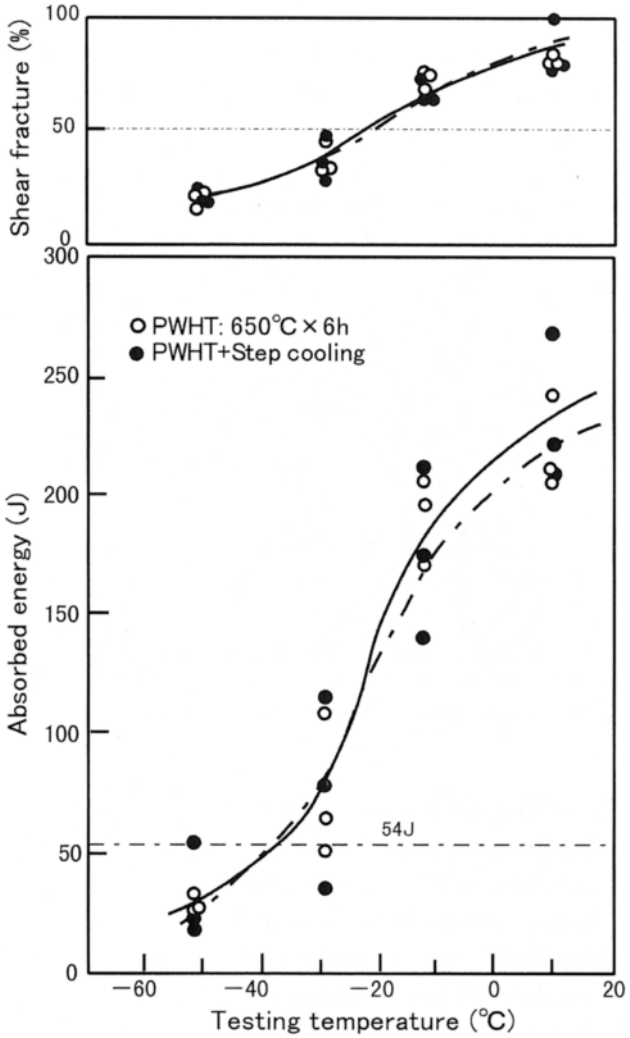


Fig. 2. Temper embrittlement test results of CMA-96MB (6Ø) weld metal by AC welding in flat position (Step cooling is a heat treatment to accelerate temper embrittlement)

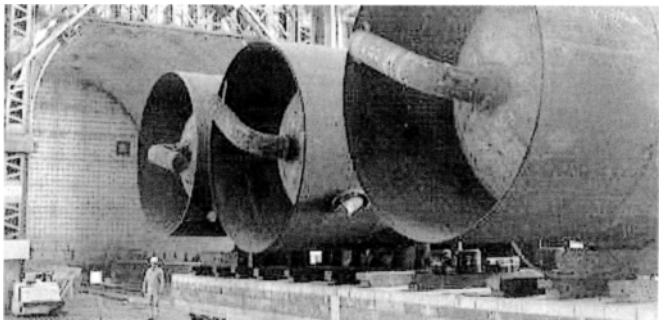


Photo 1. CMA-96MB shines in the fabrication of pressure components where PWHT uses lower temper parameters and strict control of temper embrittlement is required

TGS-1CM: A 1.25Cr-0.5Mo TIG Filler Rod, Unbeatable in Pipe Welding

Unlike conventional 1.25Cr-0.5Mo TIG filler rods classified as AWS E5.28 ER80S-B2, TGS-1CM is classified necessarily as ER80S-G because of its unique chemical composition. TGS-1CM deposited metal contains, as shown in Table 1, comparatively low carbon, phosphorous and sulfur along with a higher manganese content. This improves usability (better fluidity of the molten pool) and the resistance to hot cracking that is likely to occur in root-pass welding of pipes.

Table 1. Typical chemical composition (%) of TGS-1CM deposited metal by TIG welding with pure argon gas shielding

C	Si	Mn	P	S	Cr	Mo
0.06	0.50	0.99	7 x 10^{-3}	5 x 10^{-3}	1.22	0.54

The mechanical properties of TGS-1CM deposited metal are sufficient for tubular steel base metals such as ASTM A199 Gr. T11, A213 Gr. T11, A250 Gr. T11, and A335 Gr. P11 after extended PWHT — Table 2.

Table 2. Mechanical properties of TGS-1CM deposited metal by TIG welding with pure argon gas shielding

PWHT (°C x h)	0.2%PS (N/mm^2)	TS (N/mm^2)	El (%)	IV (J)
650X1	550	620	25	270
690X1	540	630	28	270
700X5	510	590	25	260
ASTM A335 P11	205 min	415 min	22 min	—

A335 P11: 1.25Cr-0.5Mo seamless pipe
IV: Charpy impact energy on average at 0°C

Tips for Welding with TGS-1CM

(1) Use direct current with electrode negative polarity.
(2) Pure argon gas is suitable for both torch shielding and back shielding. The shielding gas flow rate should be 10-15 liter/min. In apparent ambient wind over 1 m/sec, use a windscreen to protect the molten pool from the wind, or the wind may cause porosity, oxidation, and poor reverse bead formation.
(3) In the use of an automatic TIG welding process, the welding procedure should be determined in consideration of the quality requirements for the weld in advance. This is because, with a high feeding rate of filler wire —hence a high deposition rate —in automatic TIG welding, notch toughness of the weld metal tends to decrease because of coarser crystal grains.
(4) Preheating and interpass temperature should he 150-200°C to decrease the cooling speed and thereby minimize hardness of the weld and prevent cold cracking.
(5) Postweld heat treatment temperature should be 650-700°C to remove residual stresses, decrease hardness of the weld and improve the mechanical properties.
(6) Heat input should be properly controlled because excessive heat input may cause hot cracking, and deteriorates tensile properties and notch toughness of the weld.

Photo 1. 1.25Cr-0.5Mo steel is used for applications operated at the temperatures from 350-550°C. For such high-temperature applications, the materials must metallurgically be stable, resisting elevated temperature oxidation and creep rupture. Kobe Steel has used its accumulated technical expertise to pursue quality control of TGS-1CM, maintaining its high performance for the piping of oil refineries and power boilers.

TGS-1CML: A Low-Carbon 1.25Cr-0.5Mo Filler Rod: The Choice for Cost Savings in Preheating and PWHT

Although the AWS classification (A5.28 ER80S-G) of TGS-1CML is the same as that of TGS-1CM, its welding performance is quite different. First, as to the chemical composition, the lower carbon content (see Table 1) is effective to prevent hot cracking. Second, the lower tensile strength (or lower hardness) — hence higher ductility — is suitable for welds to be left in the as-welded condition or when more moderate PWHT of lower temper parameter is applied, as shown in Tables 2 and 3.

Table 1. Typical chemical composition (%) of TGS-1CM deposited metal by TIG welding with pure argon gas

C	Si	Mn	P	S	Cr	Mo
0.02	0.48	1.10	9 x 10^{-3}	6 x 10^{-3}	1.38	0.50

Table 2. Mechanical properties of TGS-1CML deposited metal by TIG welding with pure argon gas shielding

PWHT (°C x h)	0.2%PS (N/mm^2)	TS (N/mm^2)	EL (%)	IV (J)
As-weld	540	620	32	290
620 x 1	490	580	32	290
690 x 1	440	540	37	290
ASTM A213 T11	205 min	415 min	30	—

A213 T11: 1.25Cr-0.5Mo seamless tube
IV: Charpy impact energy on average at 0°C

Table 3. Vickers hardness of TGS-1CML deposited metal by TIG welding with pure argon gas shielding

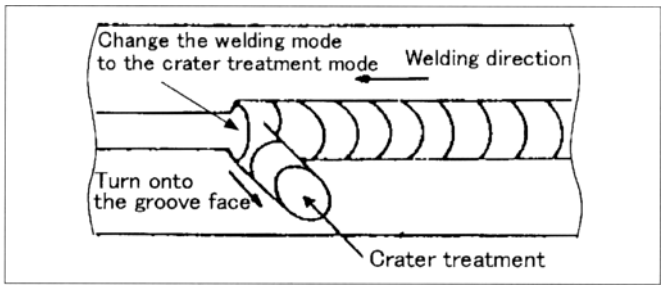
PWHT (°C x h)	Vickers hardness (Hv)	
	Cross section	Surface
As weld	196	255
620 x 1	187	237
690 x 1	177	206

Hv: Average of five individual measurements

Tips for Higher Workmanship

In addition to the aforementioned tips for TGS-1CM, the following techniques are effective to prevent weld imperfections in root-pass welding of tubular work.

(1) The weld crater should be terminated on the groove face in order to prevent hot cracks in the crater.



(2) Use proper torch placement and oscillation for making good penetration.

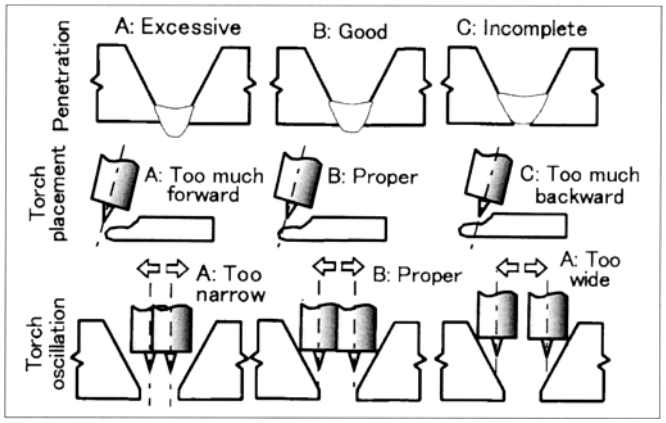


Photo 1. The tube-to-tube sheet joint of a heat exchanger made of heat resistant steel is TIG welded by using an orbital welding machine.

Cold Cracks: Causes and Cures

A cold crack is generally referred to as a spontaneous crack that occurs at temperatures blow 200°C after solidification is complete in welding. Cold cracking can develop hours or days after the weld has been made, which is referred to as "delayed cracking." Cold cracking is likely to occur in all ferritic and martensitic steels such as carbon steel, low alloy steel and high alloy steel unless adequate precautions, mainly preheating, are employed.

Cold cracks, as shown in Photos 1 and 2, are caused by the combined effects of low ductility of the weld, residual stress and diffusible hydrogen in the weld. A weld's ductility may decrease with a high carbon equivalent and a high cooling speed after solidification. Residual stress in a weld can be larger than expected if it contains weld discontinuities such as incomplete fusion, incomplete joint penetration, overlap, undercut, slag inclusions, and porosity. The source of diffusible hydrogen in a weld is mainly moisture in the welding consumable and atmosphere.

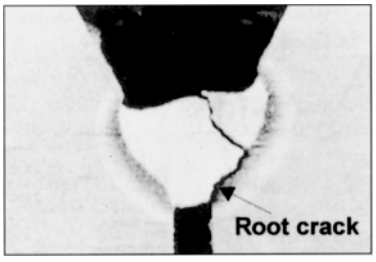


Photo 1.
A cold crack initiated at the root of the weld and developed into the weld metal

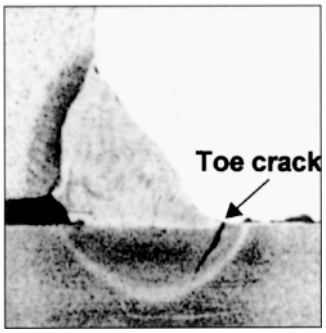
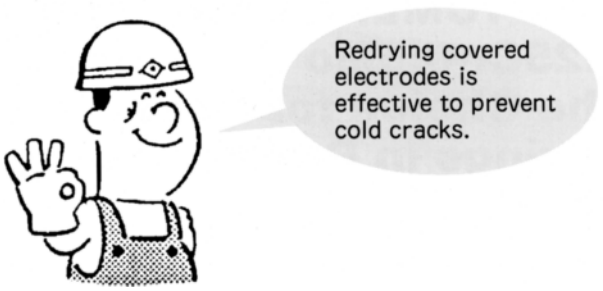


Photo 2.
A cold crack initiated at the toe of the weld and developed into the heat-affected zone

Cold cracking, therefore, can be prevented by controlling the three main factors — low ductility, residual stress, and diffusible hydrogen. That is,

(1) Preheat the base metal to reduce the cooling speed of the weld. This prevents the embrittlement of the weld and removes dissolved hydrogen from the weld.



(2) Prevent weld discontinuities to avoid stress concentration.

(3) Use low-hydrogen type welding consumables to minimize diffusible hydrogen in the weld.

On preheating, it is important to determine the temperature appropriate to the base metal and filler metal to be used. The appropriate temperature is generally determined for individual work by taking into account several factors such as chemical composition, restraint level (or plate thickness), the welding process, heat input, and the amount of diffusible hydrogen in the weld metal. Table 1 is a quick guidance to the proper preheating temperatures for different types of steels.

Table 1. A general guide to the preheating and interpass temperatures for various types of steels

Type of metal	Preheating and interpass temperature (°C)
HT50	20 - 120
HT60	50 - 120
HT80	100 - 180
0.5%Mo steel	100 - 200
1.25%Cr-0.5%Mo steel	150 - 300
2.25%Cr-1%Mo steel	200 - 350
5%Cr-0.5%Mo steel	250 - 350
9%Cr-1%Mo steel	250 - 350
17%Cr stainless steel	100 - 250
13%Cr stainless steel	100 - 400

Note: These temperatures are for general reference only.

In welding heavy-thick pressure vessels, immediate postheating (e.g. 300°C x 30 min) is often applied on the weldment right after welding finished, while the weld maintains the preheat and interpass temperature. This is to ensure no delayed cracking when the vessel is cooled to room temperature for nondestructive examinations before postweld heat treatment (PWHT). The combined use of preheating and immediate postheating is effective to prevent cold cracks in the weld.

SEEKING A NEW STYLE OF BUSINESS

Though having almost overcome the currency crisis in Asia that started in 1997, Singapore is again very sluggish in overall production because of the sharp economic slowdown in the USA and the burst of the IT bubble economy. However, the construction of oil production facilities (oil drilling rigs for example), ships and petrochemical equipment has recently been booming.

However, for the fabrication of these installations, budgets set by owners have been slashed, while the requirements for quality have become stricter. Therefore, Singaporean industries are striving all out to reduce costs in order to compete against enterprises in other ASEAN countries, the Middle East and fast growing China, let alone Korea and Taiwan. Cost reduction only is not enough, however. It is impossible to secure orders unless the quality and delivery requirements of the customers, which are becoming stricter, are also satisfied. In other words, it is hard to survive in this global competition only by reducing the costs of manpower or by using cheaper raw materials to the possible detriment of quality. Furthermore, the acquisition of new technology is indispensable for winning new fabrication orders against the competition.

Since our establishment in 1979, we, Kobe Welding Singapore, have been manufacturing low hydrogen and ilmenite electrodes of high quality for not only the domestic and Malaysian markets but also for a wide area including Hong Kong, Vietnam, Philippines, Oceania, Middle East and Europe. In addition, we have been importing welding consumables for low-temperature steel, heat-resistant low-alloy steel and stainless steel from Kobe Steel Japan for petrochemical plants and offshore structures that require especially high reliability and performance.

The ASEAN Marketing Department (AMD) of our company has assisted customers with technical services and new products. However, in order to respond more effectively to the seemingly incompatible demand for "cost reduction with high quality" from customers, we have changed the organization of the AMD, transforming it to the Business Development Department (BDD).

Top: Hello, from all staff of BDD
Bottom: Welding demonstration by the BDD personnel for technical support for customers

BDD takes over the functions of technical services and offering new products from the old AMD. In addition, the BDD's biggest function is to find solutions that provide individual customers with "cost reductions with high quality" by visiting them to discover, more than ever, their real needs. More concretely, we will realize on-time delivery by production and inventory control that reflects the market situation. We will also make proposals to Kobe Steel for the development of new products based on the needs of the market. It is also our primary mission to show customers how to rationalize their welding procedures and to choose the most appropriate welding consumables.

It is our belief that business must be bi-directional between customer and supplier. For this, we make it a rule to visit our customers continually to collect information so that we can offer them the best proposal that will lead to better profits — our target — for both the customers and KOBELCO. Our proposals are backed up by superb quality of Kobe Steel's products and the achievements and experiences accumulated through international activities.

We, BDD staff, must have met many readers of Kobelco Welding Today sometime, somewhere. If you may think, "No I haven't met any of them. What are they doing and where?," please contact us any time. We will be with you immediately. Then let us start business. Oh, yes, we both will get busy, though, for BUSINESS is busy + ness.

*Reported by **K. Harada**, **Roy Goh** and **G. Sivakumar***
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KOBELCO Group News

CM-96B9 and TGS-90B9: Suitable for High-Temperature High-Pressure Steam Applications

Advanced 9Cr-1Mo steel grades known as Modified 9Cr-1Mo steel (for example, ASTM A199 Gr. T9l, A2l3 Gr. T91 and A335 Gr. P91 for tube and pipe) are often used worldwide in ultra-supercritical pressure boilers — or power boilers of higher power generation efficiency superior to conventional boilers. The header, super heater and reheater tubes of the power boilers are typical applications for Modified 9Cr-1Mo steel.

CM-96B9 and TGS-90B9 are, corresponding to AWS A5.5 E9016-B9 and A5.28 ER90S-B9, a suitable covered electrode and filler wire respectively for Modified 9Cr-1Mo steel (9Cr-1Mo-V-Nb-N). Table 1 shows the typical chemical composition and mechanical properties of the covered electrode, and Table 2 shows those of the filler wire. CM-96B9 and TGS-90B9 offer excellent high-temperature strength, creep resistance and notch toughness due to the sophisticated chemical composition and the resulting uniform microstructure as shown in Photo 2. In addition, CM-96B9 is an electrode of the extra-low hydrogen type offering a lower amount of diffusible hydrogen (thus lower crack susceptibility) than the conventional low hydrogen type.

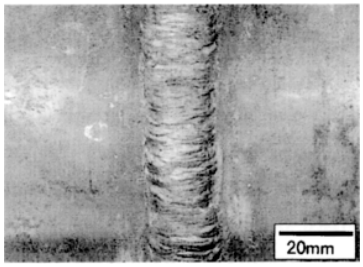

Photo 1. A Mod. 9Cr-1Mo steel weld in the 3 o'clock position of a horizontally-fixed pipe, using CM-96B9 (4.0Ø, DCEP, 120A)

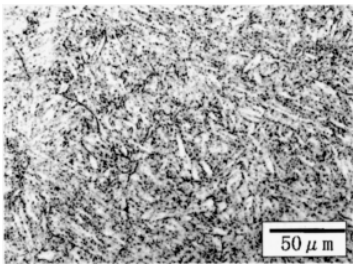

Photo 2. Microstructure of a TGS-90B9 weld metal after PWHT: 745°C x 1h

Table 1. Typical chemical composition and mechanical properties of CM-96B9

Chemical composition of weld metal (%)											
C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	N
0.11	0.23	1.12	0.009	0.002	0.01	0.83	9.13	0.99	0.23	0.037	0.027

Tensile properties of weld metal						Charpy impact energy (J, av.)		Creep rupture properties of weld metal at 600°C			
PWHT (°C x h)	Temp. (°C)	0.2%PS (N/mm^2)	TS (N/mm^2)	El (%)	RA (%)	0°C	20°C	Stress (N/mm^2)	Rupture time (h)	El (%)	RA (%)
740 x 1	RT	754	850	20	61	30	42	—	—	—	—
	550	499	544	13	64						
	600	400	436	15	77						
740 x 8	RT	637	761	22	64	48	81	157	959.4	15	60
	550	440	479	15	74			137	2282.3	17	64
	600	347	386	18	79			118	Testing	—	—

Table 2. Typical chemical composition and mechanical properties of TGS-90B9

Chemical composition of filler wire (%)											
C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	N
0.12	0.17	1.04	0.007	0.005	0.10	0.93	9.14	0.91	0.16	0.027	0.050

Tensile properties of weld metal						Charpy impact energy (J, av.)		Creep rupture properties of weld metal at 600°C			
PWHT (°C x h)	Temp. (°C)	0.2%PS (N/mm^2)	TS (N/mm^2)	El (%)	RA (%)	0°C	20°C	Stress (N/mm^2)	Rupture time (h)	El (%)	RA (%)
745 x 1	RT	756	851	23	72	172	204	—	—	—	—
	550	455	520	17	83						
	600	389	425	17	83						
745 x 8	RT	603	770	26	71	124	175	177	138.5	27	85
	550	396	458	17	81			157	397.6	26	88
	600	326	366	18	83			137	1341.1	26	85

My Invaluable Experience in China

About 900 km west of Beijing lies Intuan (literary, Silver River), the capital city of the province of Ningxia Huizu. It is about two-hour flight from Beijing. Not only is it a provincial capital today, but it was the metropolis of an ancient monarchy, Xixia Monarchy (translation: West Summer Monarchy), which prospered from 1038-1227.

Driving north from Intuan City for about one hour, you come to a big provincial city, Shizuishan, which means Stone Peak Mountain. In this city, there is a machinery producer, who is one of the biggest companies (factory area: 470,000 m^2; 2600 employees), dealing in coal mining machinery, in China. This company is so eager to control the quality of their more than 120 types of products that it has been awarded quality certificates many times by the national and provincial governments, in addition to qualifying for ISO 9001 since 1998. In order to upgrade productivity in welding fabrication, they requested the Japan Overseas Development Corporation (JODC) to dispatch a welding expert capable of analyzing welding production processes and of suggesting efficient welding procedures.

JODC is a non-profit organization established in 1970. With assistance of the Japanese Government, they dispatch experts experienced in many technical fields for the purpose of improving the management and productivity of companies in developing countries. This time, I was dispatched as a welding expert to the above-mentioned company for 20 days in June this year.

During my stay in this company, I surveyed the welding procedures and gave them suggestions for productivity-enhancing tips based on my findings in the factory. In addition, I gave a two-day seminar on the subject of welding procedure control for quality assurance in arc welding, which was attended by about 160 employees.

At the entrance to the Xixia Imperial Mausoleum, where an ancient tomb resting at the foot of a stone mountain can be seen far behind me

On holidays, I had a chance to visit a famous ancient relic, the Xixia Imperial Mausoleum. This relic is located a half-hour drive from Intuan City, at the foot of a 3500-m-high mountain range, Helan Shan. The nine successive emperors of the Xixia Monarchy rest in graves across a vast area that is 4 km from East to West and 10 km from North to South. This monarchy was destroyed by the Mongolia Monarchy in the 13th century.

My visit to a provincial city in China gave me a chance to get to know a China that was new to me and far different from what I had experienced in visiting Beijing and Shanghai.

*(Reported by **S. Yamamoto**, KWT editorial staff)*

Editorial Postscript

The 15th Schweissen & Schneiden (Welding & Cutting) 2001 international trade fair was held September 12-18 at the Messe-Essen fair site in Essen, Germany. Kobe Steel and Kobelco Welding of Europe attended the fair as a cooperate exhibitor and welcomed a large number of visitors at the Kobelco booth. Look for details the next volume of this magazine.

FABTECH International 2001, North America's largest annual metal forming and fabricating exposition, will be held November 11-14 at McCormick Place South, Chicago. The technology areas of the fair include tube/pipe, stamping, and welding, too. Kobelco Welding of America, as an exhibitor, will report on the fair in the following issue of *Kobelco Welding Today.*

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