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Harsh, cold seas require stronger, tougher materials for more durable offshore structures... *DW-62L* and *DWA-62L* meet the challenge.

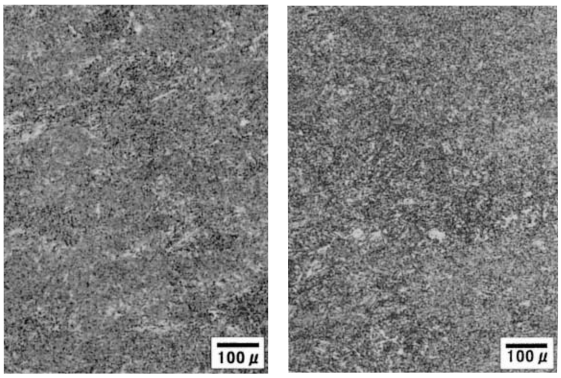
(Photo courtesy of Rigzone. com)

DW-62L (AWS A5.29 E91T1-Ni2J) and **DWA-62L** (AWS A5.29 E91T1-G), brand new rutile-based flux-cored wires for CO_2 and 80%Ar/bal.CO_2 shielding respectively, offer excellent notch toughness suitable for low temperature steel of the 500-MPa yield strength class. Both wires provide high notch toughness at −60℃ or higher by Charpy impact testing and stable fracture at −40℃ or higher by CTOD testing.

As shown in **Table 1**, both wires contain Ni at around 2% and micro-alloying with Ti and B. This sophisticated chemistry of the weld metal enables fine microstructures even in the as-cast zone or dendritic zone—**Photo 1**.

Table 1. Typical chemical compositions and tensile properties of DW-62L and DWA-62L weld metals tested per AWS A5.29

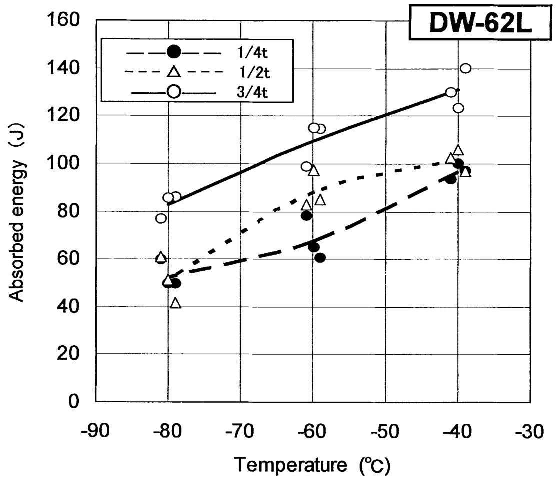
Brand	DW-62L	DWA-62L
C	0.07	0.07
Si	0.29	0.32
Mn	1.21	1.33
Ni	2.4	2.1
Ti	0.06	0.07
B	0.004	0.005
0.2%PS (MPa)	545	561
TS (MPa)	626	641
El (%)	29	27
Shielding gas	CO_2	80%Ar/bal.CO_2



DW-62L　　DWA-62L

Photo 1. Ti-B micro-alloyed fine microstructures of the as-cast zone of weld metals of thick plate joints

With Ti-B micro-alloyed fine microstructure, **DW-62L** and **DWA-62L** exhibit unsurpassed notch toughness as shown in **Fig. 1** and excellent CTOD values as shown in **Table 2**.



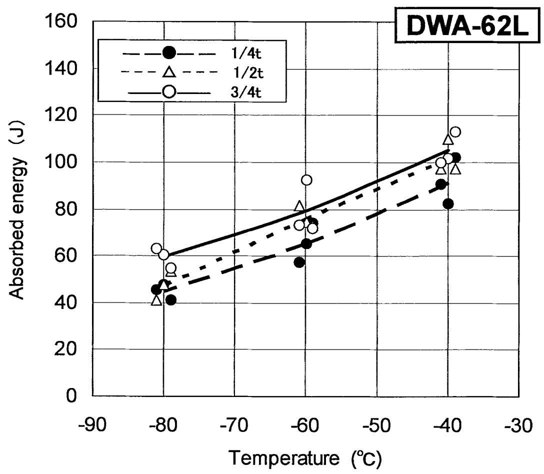


Figure 1. Charpy impact absorbed energies of weld metals tested by using a 60-mm thick double-V groove joint for DW-62L (1.2mmφ) and an 80-mm thick double-V groove joint for DWA-62L (1.2mmφ) in vertical welding

Table 2. CTOD values of DW-62L and DWA-62L weld metals welded in the vertical position

Brand	Plate thickness (mm)	Test temp. (℃)	Fracture type	CTOD (mm)
DW-62L	60	−40	Stable fracture	0.72 0.63
DWA-62L	80	−40	Stable fracture	0.66 0.51 0.49

Note: Base metal: Rolled steel of JIS G 3106 SM490A grade
Testing method: BSI BS7448-1991 (W = B)

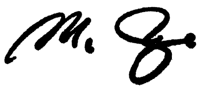
Diffusible hydrogen testing per JIS Z 3118 resulted in 2.1 ml/100g on average for **DW-62L** weld metal and 3.9 ml/100g on average for **DWA-62L** weld metal. Such low diffusible hydrogen enables the use of 100℃ preheating to prevent cold cracking in thick plate welds.

My Impressions at Beijing Essen

The Beijing ESSEN welding fair was held in Shanghai from November 26 to 29 last year. KOBELCO exhibited products made in Japan in addition to those made by KOBE WELDING OF TANGSHAN (KWT) in China. It was quite a big welding fair involving about 426 exhibitors and 30,000 visitors. During my visit I really felt China was growing steadily day by day. All visitors seemed eager to get all kinds of information on welding, cutting, positioning, manipulation, and safety goods.

In the field of welding consumables I noticed several Chinese manufactures, whom I had never heard of before, exhibiting various types of welding consumables including stick electrodes, solid wires, and flux cored wires. These exhibits suggested that the Chinese market of welding consumables has grown very large. The Chinese Welding Association announced the production of welding materials in 2002 was 1,500,000 tons. This is almost three times that of in Japan. I think they have already caught up in the general technology for the welding industry, and they will be able to grow further, even though they are still behind in more advanced technologies in particular fields.

KOBELCO introduced some of newly developed products such as flux cored wires for stainless steel thin sheets and various types of welding materials for Cr-Mo steel and low temperature steel. If you have had no chance to see such advanced products, please visit the Japan International Welding Show in Osaka in July. I am looking forward to seeing all of you.



Masakazu Tojo
General Manager
International Operations Dept.
Welding Company
Kobe Steel, Ltd.

A happy new year to all the KWT readers!

It is a great honor to be given an opportunity to introduce myself in Kobelco Welding Today. Yu Agatsuma is my name. I was placed into the International Operations Department in May, 2003, immediately after graduation from university and the company orientation period. At present, I am in charge of the European market.

Yu Agatsuma
IOD, Welding Co.
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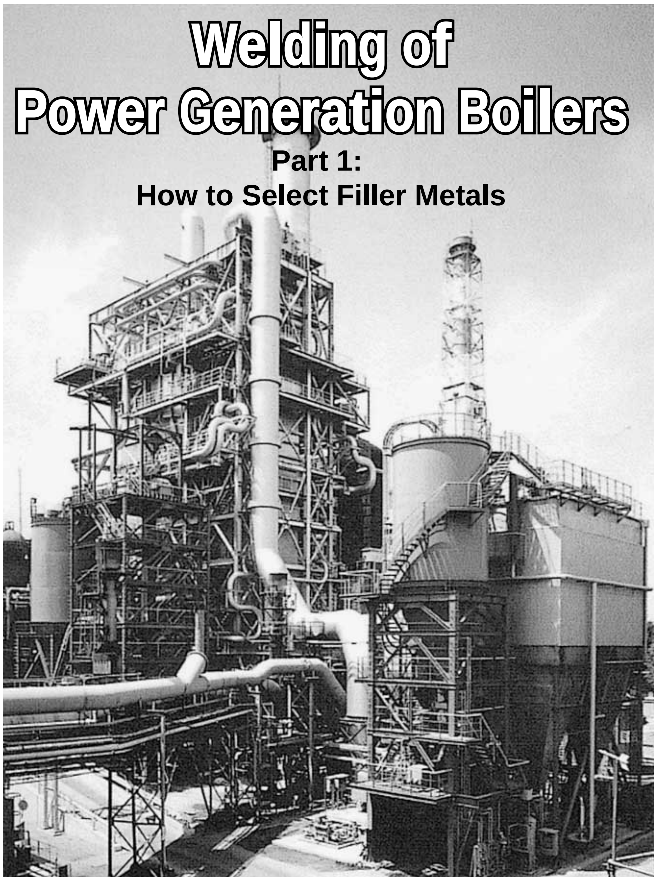
I am soccer-crazed, and I went to watch the 2002 World Cup Soccer matches in Korea while I was a student. Though I could not speak Korean at all, I made a good friend with a Korean citizen seated next to me in the stadium. I realized that you could build up a good relationship through soccer with people from another country with a different culture, despite the language barrier. For that matter, not only soccer but other sports and music can also encourage good cross-cultural interchange among peoples. I hope that I can build up a good relationship with people world over through welding.

Contents

Welding of Power Generation Boilers

Part 1: How to Select Filler Metals



Steam boilers produce high-temperature high-pressure steam by heating pressurized water in hermetically sealed vessels through the combustion of such fossil fuels as coal, LNG, and oil. Steam boilers are widely used for such applications as power plants, ships, steel mills, textile processes, chemical processes, and oil refineries. Power generation boilers are required to drive turbogenerators in central power stations or they may be used to supply steam for process requirements. A steam power station contains many thousands of welds and the failure of just one can result in a shutdown, so good weld quality is of great importance.

This two-part series of articles on welding power generation boilers will begin with Part 1: How to select filler metals. In the next issue the series will continue with Part 2: Essential factors in welding procedure controls.

Power boilers use varieties of steels

Power boilers are fabricated by using a variety of steel materials in consideration of more efficient performance with competitive materials at lower fabrication costs. **Table 1** shows the diverse steel materials used, the choice of which depends primarily on the service temperature of the individual components in a power boiler, although other factors such as steam pressure and corrosives should also be taken into account for a more precise classification. In general, high-temperature high-pressure service requires the component steel materials to contain chromium to improve creep rupture strength and thermal corrosion resistance and molybdenum, vanadium, niobium and tungsten to improve creep rupture strength at elevated temperatures.

Table 1. Power boiler component materials and suitable service temperature ranges

Steel type	Typical ASTM (ASME) grade	Service temperature (°C) (1)
carbon steel	A106	350-400
0.5Mo	A335Gr.P1	400-475
1Cr-0.5Mo	A335Gr.P12	450-550
1.25Cr-0.5Mo	A335Gr.P11	500-550
2.25Cr-1Mo	A335Gr.P22	520-600
Low C 2.25Cr-W-V-Nb	(SA213Gr.T23) (SA335Gr.P23)	525-600
5Cr-0.5Mo	A335Gr.P5	550-600
9Cr-1Mo	A335Gr.P9	600-650
9Cr-1Mo-V-Nb	A335Gr.P91	525-600
stainless steel	A312Gr.304H	650-850

Note (1) Ka-ryoku Genshi-ryoku Hatsuden (Fire and Nuclear Power Generation), Vol.51, No.1, January 2000

In response to demands for higher power generation efficiency the steam temperature and pressure of power boilers have been increasing. As the power generation efficiency increases, the consumption of fuels for generating electrical power can be decreased; consequently, the emission of carbon dioxide can be reduced, thereby helping to combat global warming. In this respect, in addition to those shown in Table 1, advanced 9-12Cr ferritic steels enhanced by tungsten in addition to molybdenum, vanadium and niobium have been put into practice. 9Cr-W-V-Nb and 12Cr-W-V-Nb steels are typical of those used for such advanced performance, as they are tailored for the applications to be operated at around 600℃ with higher allowable stress.

Diverse filler metals for heat-resistant low-alloy steels

Choosing an appropriate filler metal suitable for various heat-resistant low-alloy steels ranging from low Mo steel to high Cr steel can be confusing because numerous filler metals are available. **Table 2** serves as a quick selection guide to appropriate filler metals for various types of heat-resistant low-alloy steels often used for fabricating power boilers.

Table 2. A selection guide to proper filler metals for heat-resistant low-alloy steels for power boilers

Steel type	ASTM (ASME) steel grade			KOBELCO filler metal				
	Plate	Pipe / Tube	Forging	SMAW	FCAW [1]	GMAW [2]	GTAW [3]	SAW [4]
0.5Mo	A204Gr.A, B, C	A209Gr.T1, T1a, T1b A205Gr.T1, T1a, T1b A335Gr.P1	A182Gr.F1 A336Gr.F1	CMA-76 (E7016-A1)	–	MGS-M (ER80S-G) MG-M (ER80S-G)	TGS-M (ER80S-G)	MF-38/ US-40 (F8P6- EA3-A3) MF-38/ US-49 (F8P6- EG-A4) MF-38/ US-A4 (F8P6- EA4-A4)
1-1.25Cr-0.5Mo	A387Gr.11 Cl.1, 2 A387Gr.12 Cl.1, 2	A199Gr.T11 A213Gr.T11, T12 A234Gr.WP11 A234Gr.WP12Cl.1, 2 A250Gr.T11, T12 A335Gr.P11, P12	A182Gr.F11Cl.1, 2, 3 A182Gr.F12Cl.1, 2 A336Gr.F11Cl.1, 2, 3 A336Gr.F12	CMA-96 (E8016-B2) CMB-95 (E7015-B2L) CMB-98 (E8018-B2)	DW-81B2 (E81T1B2/B2M) DWA-81B2 (E81T1-B2M)	MGS-1CM (ER80S-G) MG-1CM (ER80S-G)	TGS-80B2 (ER80S-B2) TGS-1CM (ER80S-G) TGS-1CML (ER80S-G)	PF-200/ US-511N (F8P2- EG-B2)
2.25Cr-1Mo	A387Gr.22 Cl.1, 2	A199Gr.T22 A213Gr.T22 A234Gr.WP22Cl.1, 3 A250Gr.T22 A335Gr.P22	A182Gr.F22Cl.1, 3 A336Gr.F22Cl.1, 3	CMA-106 (E9016-B3) CMB-105 (E8015-B3L) CMB-108 (E9018-B3)	DW-91B3 (E91T1-B3/B3M) DWA-91B3 (E91T1-B3M)	MGS-2CM (ER90S-G) MG-2CM (ER90S-G)	TGS-90B3 (ER90S-B3) TGS-2CM (ER90S-G) TGS-2CML (ER80S-G)	PF-200/ US-521S (F9P2- EG-B3)
Low C 2.25Cr-W-V-Nb	–	(SA213Gr.T23) (SA335Gr.P23)	–	CM-2CW (E9016-G)	–	MGS-2CW (ER90S-G)	TGS-2CW (ER90S-G)	PFH-80AK/ US-2CW
5Cr-0.5Mo	A387Gr.5 Cl.1, 2	A199Gr.T5 A213Gr.T5, T5b, T5c A234Gr.WP5 A335Gr.P5, P5b, P5c	A182Gr.F5, F5a A336Gr.F5, F5a	CM-5 (E8016-B6)	–	MGS-5CM (ER80S-B6)	TGS-5CM (ER80S-B6)	PF-200S/ US-502 (F7P2- EG-B6)
9Cr-1Mo	A387Gr.9 Cl.1, 2	A199Gr.T9 A213Gr.T9 A234Gr.WP9 A335Gr.P9	A182Gr.F9 A336Gr.F9	CM-9 (E8016-B8)	–	MGS-9CM (ER80S-B8)	TGS-9CM (ER80S-B8)	PF-200S/ US-505 (F7PZ- EG-B8)
9Cr-1Mo-V-Nb	A387Gr.91 Cl.2	A199Gr.T91 A213Gr.T91 A234Gr.WP91 A335Gr.P91	A182Gr.F91 A336Gr.F91	CM-96B9 (E9016-B9) CM-9Cb (E9016-G)	–	MGS-9Cb (ER90S-G)	TGS-90B9 (ER90S-B9) TGS-9Cb (ER90S-G)	PF-200S/ US-9Cb (F10PZ- EG-G)
9Cr-W-V-Nb	–	A213Gr.T92 A335Gr.P92	–	CR-12S	–	MGS12CRS	TGS-12CRS	PF-200S/ US-12CRS
12Cr-W-V-Nb	–	SA213Gr.T122 SA335Gr.P122	–					

Note (1) DW series wires use CO_2 or 75-85%Ar/bal. CO_2 for shielding, while DWA series wires use only 75-85%Ar/bal. CO_2 for better impact absorbed energy.
(2) MGS series wires use 95-98%Ar/bal. O_2 or 80-95%Ar/bal. CO_2 for shielding, while MG series wires use CO_2.
(3) TGS-XXXL series wires are of low carbon type.
(4) MF-38 is a fused type flux, whereas brands indicated with PF and PFH are bonded type fluxes. SAW flux/wire combinations intends to use AC current.

In using this quick selection guide, the steel type and ASTM (ASME) steel grade can be your guide to an appropriate filler metal brand name or AWS classification. Or, if an exact or equivalent AWS classification is specified by the job specification you may look directly at the appropriate brand of filler metal.

New AWS-type brands such as **CM-96B9** for SMAW, **DW-81B2**, **DWA-81B2**, **DW-91B3** and **DWA-91B3** for FCAW, and **TGS-80B2**, **TGS-90B3** and **TGS-90B9** for GTAW have recently been developed by modifying the chemical compositions of the original brands respectively to help international customers select appropriate filler metals more easily. The welding usability, mechanical properties and crack resistance of such AWS-type brands are comparable to the original brands. For the typical performance of such new AWS-type brands, please refer to the special edition of Kobelco Welding Today on filler metals for heat-resistant low-alloy steels issued last July.

However, many filler metals for GMAW, GTAW and SAW are classified with the suffix G or EG ("G" stands for "General" as per the AWS standard) because of their unique chemical compositions developed by Kobe Steel. For such filler metals you can confirm the chemical composition by mill certificate or guaranty of quality supplied from Kobe Steel.

When you will have to choose an appropriate filler metal where no exact or equivalent AWS classification is specified for welding a particular grade material that is not included in Table 2, you may follow the following steps. First, confirm the nominal chemical composition, particularly Cr, Mo, W, V and Nb, of the base metal to know the steel type. Second, confirm the minimum tensile strength of the base metal to know the matching filler metal tensile strength. This will suggest the equivalent AWS classification of the filler metal to be chosen in Table 2 for a particular welding process.

With respect to filler metals for 9Cr-W-V-Nb and 12Cr-W-V-Nb steels, no AWS classification system is available because they are presently the most advanced filler metals in the power boiler field as detailed below. They have been developed by Kobelco's state-of-the-art technology, and the application of such advanced steels has been a recent event. In using such filler metals you can confirm the chemical and mechanical properties by mill certificate or guaranty of quality issued by Kobe Steel.

High-Cr ferritic steels and filler metals are hot topics in the power boiler field

In recent years, greenhouse gases—mainly CO_2—have been held up as a global environmental problem and moves to reduce such gases have been increasing. In this respect, the reduction of CO_2 emitted especially from fossil fuel power plants is being promoted actively for environmental protection. For the reduction of CO_2 emissions at fossil fuel power plants, the improvement of electricity generation efficiency is considered to be imperative. For this purpose, high-temperature high-pressure steam must be delivered to the power turbines. The use of such ultra-supercritical pressure steam requires the boiler components to be made from special steel that is durable under such severe steam conditions for a long period of operation. In response to this demand, various types of heat-resistant low-alloy steel have been developed to improve creep rupture strength as shown in **Fig. 1**.

Creep rupture strength is an important property for steam boiler components. Creep rupture, which can have a decisive influence on the lifetime of a boiler, is a phenomenon in which a steel material ruptures as a result of progressive or creeping strain under a stress even below its yield strength when it is kept at a high temperature for long periods.

Several types of tungsten-enhanced 9-12Cr steels—typically 9Cr-W-V-Nb and 12Cr-W-V-Nb steels specified by ASME—are now drawing attention because they can supersede modified 9Cr-1Mo (9Cr-1Mo-V-Nb) steel in terms of creep rupture strength. They have been applied in the fabrication of steam boilers for many fossil fuel power plants. The applications of such innovative steels include the main steam piping, superheater tubing and reheater tubing —**Fig. 2**.

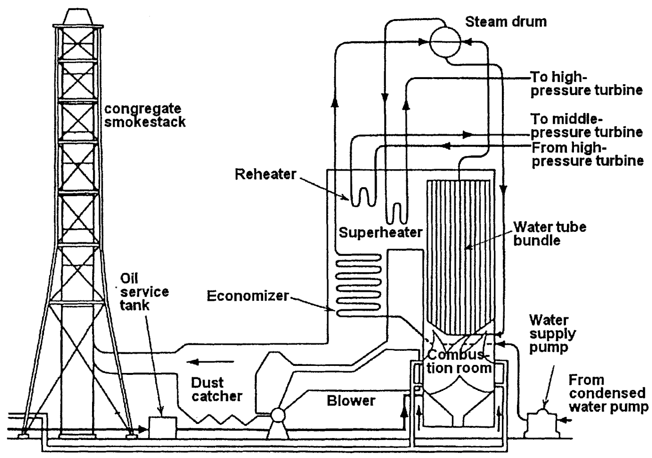


Figure 2. Tubing/piping diagram of a water tube boiler
(Source: K. Nagumo, Basic Knowledge of Boilers, Ohmsha, 2002)

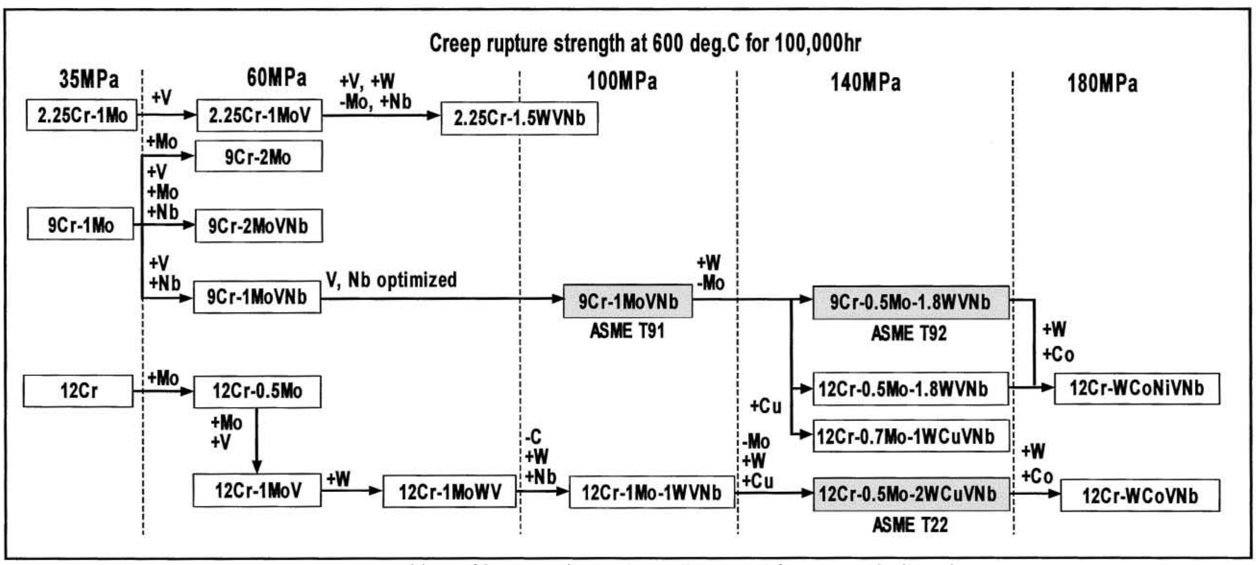


Figure 1. Transition of heat-resistant low-alloy steel for power boilers in conjunction with improvement of creep rupture strength [Ref. 1]

Kobelco W-enhanced 9-12Cr steel filler metals offer unsurpassed performances

Kobe Steel has promoted the research and development of suitable filler metals for tungsten-enhanced 9-12Cr steels. **Table 3** shows typical chemical compositions and mechanical properties of the matching filler metals for 9Cr-W-V-Nb (ASTM A213Gr.T92 and A335Gr.T92) and 12Cr-W-V-Nb (ASME SA213Gr.T122 and SA335Gr.T122) steels.

The sophisticated weld metal chemical formula, which was developed through in-depth research on the microstructure in conjunction with alloying elements such as Cr, Ni, Co and N, provides good notch toughness as well as adequate tensile properties by suppressing the residue of the δ-ferrite phase. In addition, the W-enhanced 9-12Cr steel filler metals offer higher creep rupture strength in comparison with modified 9Cr-1Mo steel filler metals. This advantage can mainly be attributed to elaborate alloying with W, V, Nb, and Mo.

Table 3. Typical weld metal chemical and mechanical properties of W-enhanced 9-12Cr steel filler metals

Welding process	SMAW	GTAW	GMAW (1)	SAW
Brand	CR-12S	TGS-12CRS	MGS-12CRS	PF-200S/US-12CRS
C (wt%)	0.06	0.06	0.07	0.09
Si	0.38	0.30	0.31	0.15
Mn	0.72	0.67	0.93	0.99
P	0.005	0.004	0.005	0.007
S	0.003	0.003	0.004	0.003
Cu	0.01	0.01	0.01	0.37
Ni	0.48	0.50	0.50	0.98
Co	1.56	1.01	1.50	0.14
Cr	9.49	10.06	9.54	10.74
Mo	0.20	0.35	0.40	0.23
V	0.29	0.21	0.29	0.19
Nb	0.03	0.03	0.04	0.03
W	1.50	1.44	1.60	1.77
N	0.05	0.03	0.04	0.02
0.2%YS (MPa)	648	686	619	624
TS (MPa)	768	790	745	781
El (%) [4D]	26	23	27	22
RA (%)	64	68	62	70
vE0°C (J)	40	44	47	37
Creep rupture time (2) (hr)	2650	3915	1670	2635
PWHT (°C×hr)	740×8	740×8	740×8	745×8

Note (1) Shielding gas: 95%Ar/bal. CO_2
(2) Testing temperature and stress: 650°C, 98MPa

What applications need low-C 2.25Cr-W-V-Nb filler metals

2.25Cr-1Mo steel, a typical heat-resistant low-alloy steel, has long been used for power boilers due to its superior high temperature strength and workability. However, in response to the demand for higher creep strength materials for high-temperature high-pressure power boilers, low-C 2.25Cr-W-V-Nb steel has also been developed by alloying with tungsten and optimizing the content of other alloying elements. This W-enhanced 2.25Cr steel offers superior creep rupture strength that is almost double that of conventional 2.25Cr-1Mo steel and almost the same as that of modified 9Cr-1Mo steel. It also offers better weldability due to its low carbon content.

The piping and tubing of low-C 2.25Cr-W-V-Nb steel for steam boilers including supper heater tubes can be welded by using Kobelco filler metals tailored for this steel. **Table 4** shows typical chemical and mechanical properties of the filler metals for individual welding processes. Such excellent properties are provided by the weld metal of fine bainitic microstructure as shown in **Photo 1**.

Table 4. Typical weld metal chemical and mechanical properties of low-C 2.25Cr-W-V-Nb steel filler metals

Welding process	SMAW	GTAW	GMAW (1)	SAW
Brand	CM-2CW	TGS-2CW	MGS-2CW	PFH-80AK/US-2CW
C (wt%)	0.05	0.02	0.05	0.03
Si	0.40	0.42	0.33	0.14
Mn	0.79	0.48	1.02	0.90
P	0.006	0.004	0.005	0.007
S	0.003	0.003	0.004	0.006
Cu	0.02	0.10	0.14	0.23
Ni	0.03	0.01	0.47	0.02
Cr	2.43	2.27	2.23	2.23
Mo	0.13	0.52	0.10	0.11
V	0.20	0.32	0.24	0.20
Nb	0.015	0.026	0.035	0.015
W	1.69	1.20	1.96	1.88
0.2%YS (MPa)	565	467	656	548
TS (MPa)	652	578	727	628
El (%) [4D]	20	31	21	23
RA (%)	70	84	64	74
vE0°C (J)	105	205	38	39
Creep rupture time (2) (hr)	1728	2857	2032	2579
PWHT (°C×hr)	715×2	715×2	715×2	715×2

Note (1) Shielding gas: 80%Ar/bal. CO_2
(2) Testing temperature and stress: 600°C, 129MPa

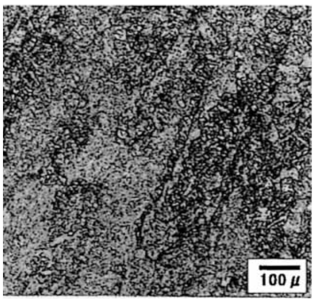


Photo 1. Fine bainitic microstructure of CM-2CW weld metal

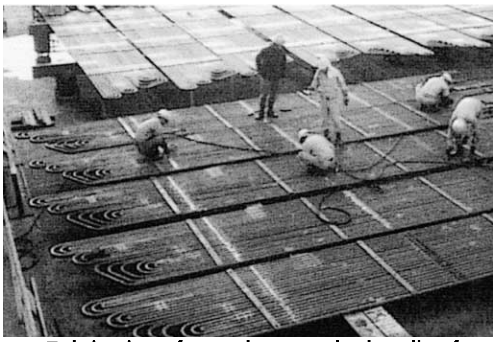


Photo 2. Fabrication of superheater tube bundles for steam boilers (Photo: Nagasaki Kogyosho Co., Ltd., Japan)

Joining dissimilar metals is unavoidable in welding power boiler components

As shown in Table 1, power boilers use various types of steel for both technical and economical reasons related to the service conditions such as service temperature and pressure. Therefore, dissimilar-metal joints are a necessity when efficient performance with competitive materials at lower fabrication costs is the goal. Dissimilar joints are needed at the interface of different service condition areas.

When joining carbon steels and Cr-Mo steels, or when joining dissimilar Cr-Mo steels, a filler metal with a composition similar to the lower-alloy steel or to an intermediate composition is commonly used for butt joints. This is because, the weld metal need not be stronger nor more resistant to creep or corrosion than the lower alloy base metal in normal applications. For a quick guide to recommended Kobelco brands for joining dissimilar metals, refer to **Table 5**.

For instance, carbon steel can readily be joined to 2.25Cr-1Mo steel by using either a carbon steel or 1.25Cr-0.5Mo steel filler metal; however, carbon steel filler metals are usually selected except where carbon migration must be minimized. Likewise, 2.25Cr-1Mo steel can be joined to 9Cr-1Mo-V-Nb steel by using a 2.25Cr-1Mo filler metal.

In contrast, Cr-Mo steel and austenitic stainless steel are joined with a high Cr-Ni stainless (e.g., E309) or, where carbon migration and thermal stress are important factors, nickel alloy (e.g., ENiCrFe-1) filler metal.

Carbon migration is a metallurgical phenomenon in which carbon diffuses from the lower-Cr metal to the higher-Cr metal to form a decarburized zone in the former metal and a carburized zone in the later metal by PWHT and exposure to high temperatures during service. Carbon migration is believed to cause adverse effects on the bending properties and creep rupture strength of the dissimilar metal joint.

Reference

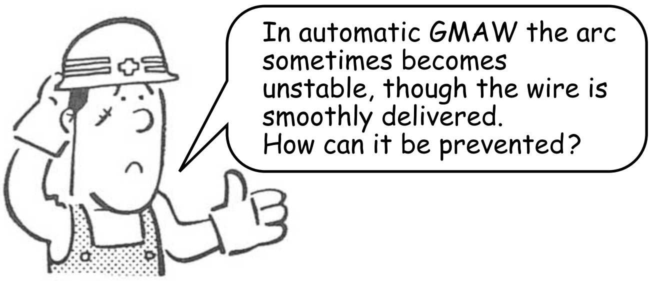
[1] F. Masuyama. Development in Environmentally Compatible Materials—Heat Resistant Materials for Ultra-Supercritical Pressure Boilers. Journal of the Japan Welding Society, Vol. 70, No. 8, p.20-25. 2001.

Table 5. A quick guide to proper filler metals for welding dissimilar metal joints for general applications (1)(2)

Base metal	Mild steel	0.5Mo	1.25Cr-0.5Mo	2.25Cr-1Mo	5Cr-0.5Mo	9Cr-1Mo 9Cr-1Mo-V-Nb
Type 304 stainless steel	•NC-39 (E309), NC-39L (E309L), TGS-309 (ER309), TGS-309L (ER309L) •NIC-703D (ENiCrFe-3), NIC-70A (ENiCrFe-1), TGS-70NCb (ERNiCr-3)					
9Cr-1Mo 9Cr-1Mo-V-Nb	LB-52 (E7016) TGS-50 (ER70S-G)	CMA-76 (E7016-A1) TGS-M (ER80S-G)	CMA-96 (E8016-B2) TGS-80B2 (ER80S-B2)	CMA-106 (E9016-B3) TGS-90B3 (ER90S-B3)	CM-5 (E8016-B6) TGS-5CM (ER80S-B6)	
5Cr-0.5Mo	LB-52 (E7016) TGS-50 (ER70S-G)	CMA-76 (E7016-A1) TGS-M (ER80S-G)	CMA-96 (E8016-B2) TGS-80B2 (ER80S-B2)	CMA-106 (E9016-B3) TGS-90B3 (ER90S-B3)		
2.25Cr-1Mo	LB-52 (E7016) TGS-50 (ER70S-G)	CMA-76 (E7016-A1) TGS-M (ER80S-G)	CMA-96 (E8016-B2) TGS-80B2 (ER80S-B2)			
1.25Cr-0.5Mo	LB-52 (E7016) TGS-50 (ER70S-G)	CMA-76 (E7016-A1) TGS-M (ER80S-G)				
0.5Mo	LB-52 (E7016) TGS-50 (ER70S-G)					

Note: (1) This table is a guide to recommended filler metals matching the lower-alloy steels in various dissimilar metal joints, excepting for Type 304 steel. Other types of filler metals may be needed where a specific requirement is imposed.

Note: (2) Preheating and postweld heat treatment for dissimilar Cr-Mo steels should be sufficient to the higher-alloy steel; however, the PWHT temperature should be lower to avoid damage to the lower-alloy steel and minimize the carbon migration. Type 304 stainless steel should not be preheated or postweld heat-treated to avoid sensitization.



A wire ring with an excessive diameter can cause an irregular electrical contact between the contact tip and the wire, thereby causing an unstable arc.

In automatic gas metal arc welding (GMAW) with robots and exclusive-use automatic systems you may adjust the wire straightener in order to deliver the welding wire as straight as possible from the contact tip and thus facilitate better wire tracking onto the welding line. This method, however, can have an adverse effect on the regular electrical contact between the contact tip and the wire, thereby causing an unstable arc. This is a typical cause of unstable arc, even though the wire feeding is smooth.

The tip-to-wire irregular electrical contact can occur where the contact pressure of the wire onto the contact tip is insufficient. The wire-to-tip contact pressure is predominantly affected by the diameter of the wire ring (**Fig. 1**).

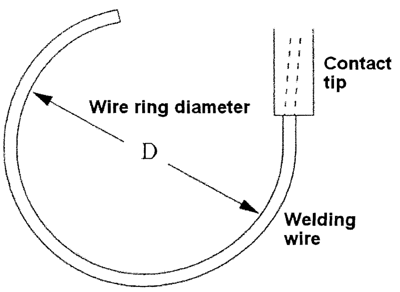


Figure 1. Wire ring diameter where the wire is fed out of the contact tip

As the wire ring diameter increases, the wire-to-tip contact pressure decreases; consequently, more unstable arcs can occur as shown in **Fig. 2**. Therefore, the diameter must be controlled small enough—normally 600 mm or smaller—by adjusting the wire straightener and pressure roller of the wire feeder to maintain stable wire-to-tip contact pressure. In addition, as shown in Fig. 2, the use of a loose contact tip having an excessively large inside diameter over the wire diameter or being worn out causes more unstable arcs.

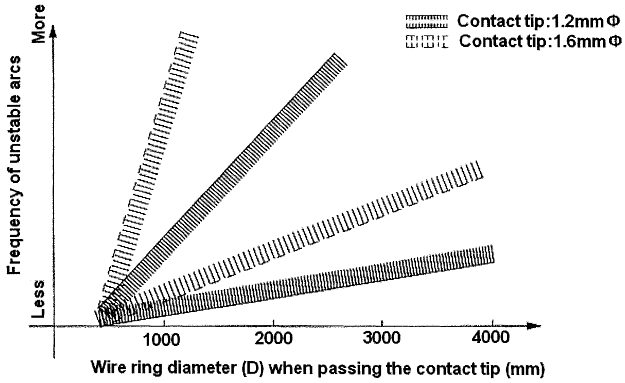


Figure 2. Frequency of unstable arcs as a function of wire ring diameter (D) when passing through the contact tip (Wire diameter: 1.2mmΦ)

An unstable arc caused by tip-to-wire irregular electrical contact can also cause fusion at the interface between the contact tip and wire, which can damage the inside surface of the contact tip and markedly increase the wire feeding resistance, thereby damaging the wire surface at the wire feeding roller. Therefore, this electrical trouble can cause subsequent wire feeding trouble.

To prevent such multiple troubles, when irregular electrical contact causes seriously unstable arcs or arc cutting, you should not only renew the contact tip, but also remove all the wire extended from the wire pressure roller to the welding torch through the conduit. Take preventive measures against the irregular electrical contact before restarting welding.

Unstable arc can also be caused by an excessively long or small diameter welding cable due to a voltage drop.

GMAW power sources are designed so that they perform best when the welding cable, which has a specified diameter according to the rated welding current, is extended 5-10m long in general. Therefore, the use of a cable that is either longer or thinner can cause poor arc stability due to a voltage drop. In order to overcome this trouble, increase the output terminal voltage or use a thicker—thus lower electrical resistance—welding cable to compensate the voltage drop.

When a long welding cable is spiraled during use, the arc can become more unstable because of an increase of inductance of the welding cable. This is why a long welding cable should be kept straight in use.

KWT: a New Challenge for Expanding Kobelco's Welding Business

KOBE WELDING OF TANGSHAN CO., LTD. (KWT) was established on November 1, 2002, and started production in September last year. During the first production year, MG-51T (AWS A5.18 ER70S-6), a solid wire that is used extensively in autos and construction machinery, has been manufactured and put on the market. In the second year, DW-100 (AWS A5.20 E71T-1), a flux-cored wire used mainly in shipbuilding, will be added.

All the executives of KWT celebrate the inauguration of the factory by pulling open a decorative paper ball put on the ceiling, expecting a prosperous future for the company.

Thus, KWT has taken its first step as the 9th overseas business hub of the Welding Company of Kobe Steel, Ltd. and is endeavoring to join the other great brother companies fulfilling KOBELCO's international slogan "QTQ" (Quality Products, Technical Support, and Quick Delivery). With respect to "Quality Products" especially, each and every one of the employees is ready to work creatively in order to supply materials and services reflecting local input and responding to the expectations of customers in China. In fact, many customers have already evaluated our products highly, recognizing our uncompromising attitude for quality. For "Technical Support," we will provide kind and helpful advice that is easy to understand. And we will seek to achieve "Quick Delivery," by keeping our promises for the most convenient delivery time.

Kobe Welding of Tangshan is built in Tangshan City which lies about 200 km east of Beijing. "Execute all the obligations imposed by industry, thereby contributing to the progress of social and economical prosperity in order to achieve peace and happiness for people," states the board outside the front gate of KWT's factory.

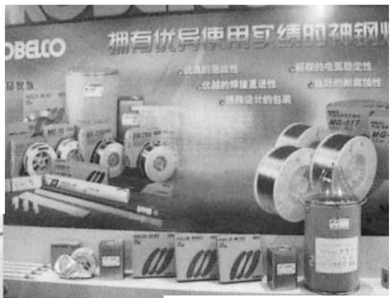
As you all may know, the 2008 Olympic Games will be held in the capital city Beijing, which is near Tangshan, the home of KWT. We expect a great expansion of demand in China, where the whole country is booming in tandem with the construction boom for the Olympic Games. With KWT at the forefront, the KOBELCO GROUP is determined to grasp this business opportunity securely and to supply welding consumables and services to as many customers as possible, and in this way contribute to the development of industries of China. We should be very happy if foreign enterprises already existing in China and those who plan to establish businesses in China will remember that KOBELCO is in China as in many other countries. KWT will continue its efforts to live up to all of your expectations.

Reported by K. Motegi, President, KWT

WELDEX-2003 and Beijing Essen: Good Chances of Publicity for KWT

Kobe Welding of Tangshan Co., LTD. (KWT) participated in the WELDEX-2003 held from September 7 to 10 at the International Exhibition Center in Wuhan and displayed welding consumables, focusing on MG-51T solid wire (AWS A5.18 ER70S-6) that they started to manufacture in September. At the Shipping Conference held at the trade show, Mr. T. Hidaka, a researcher of Kobe Steel, Ltd. (KSL) made a presentation on the electrogas arc welding process using DWS-1LG flux-cored wire and emphasized KSL's efforts to promote welding efficiency in shipbuilding to the audience.

KWT also participated in the International Welding & Cutting Fair (Beijing Essen) held from November 26 to 29 at the Everbright Convention & Exhibition Center in Shanghai and promoted a diversified line of KSL's products such as MG-51T, DW-100 (AWS A5.20 E71T-1), Cr-Mo welding consumables and high strength steel welding consumables.



Diverse exhibits from KSL at Beijing Essen (right)

MG-51T spools exhibited by KWT at Beijing Essen (left)

Prior to the Exhibition, at the Symposium, "Welding for Automobiles," held from November 24 to 26, Mr. R. Suzuki, a KSL researcher, made a presentation on the recent trends in MAG welding technologies for thin plates, which drew much attention from the audience. All through the exhibition period, there was a constant flow of visitors, letting us understand the active demand of the Chinese market.

Technical presentation by Mr. R. Suzuki, a researcher of the Technical Development Dept. of KSL, on a state-of-the-art gas metal arc welding process suitable for sheet metal welding in automobile fabrication (Beijing Essen)

KWT and KSL will strive in their advertising and publicity activities to comply with this brisk demand in the Chinese market. The next Beijing Essen is scheduled to be held in Beijing in November 2004. The KOBELCO Group is determined to respond to expectations of customers the world over, let alone customers in China. Our challenge is to realize "Whenever you see the arc, KOBELCO is here, there and everywhere."

Reported by D. Hino, KSL

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