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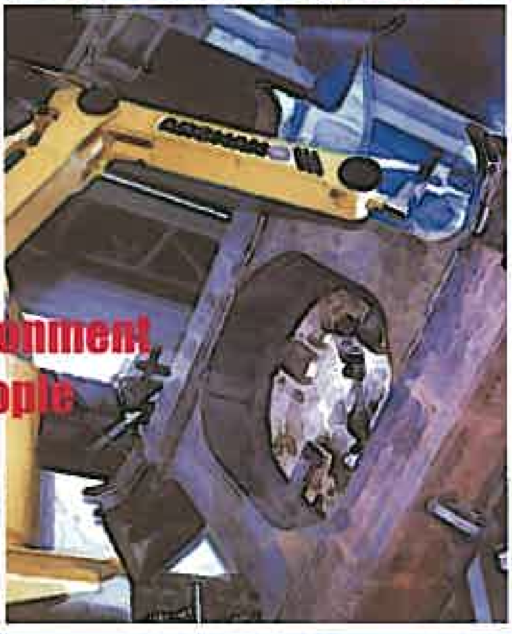


The Kobelco arc...
for a better welding environment
and harmony with people

A breakthrough in stainless steel sheet metal welding: DW-T308L (E308LT0-1/-4) DW-T309L (E309LT0-1/-4) DW-T316L (E316LT0-1/-4)

It has been common to use a small diameter—and more expensive—solid and flux-cored wire (e.g. 0.9 mm ϕ) for welding sheet metals of around 2-mm thickness at 150A or lower currents. This is because more convenient and inexpensive larger diameter wires (e.g. 1.2 mmϕ) were not suitable for welding sheet metals due to inferior arc stability at such a low welding current.

To accomplish the technically demanding challenge of using 1.2-mmϕ flux-cored wire (FCW) with good arc stability at low welding currents, Kobe Steel has developed a new series of stainless steel FCWs: DW-T308L, DW-T309L and DW-T316L classified per AWS A5.22 as E308LT0-1/-4, E309LT0-1/-4 and E316LT0-1/-4, respectively. The DW-T series FCWs offer the following outstanding performance with shielding gases of 100%CO_2 and 75-80%Ar/bal.CO_2. When the welding current is lower than 130 Amp, 100%CO_2 is strongly recommended to achieve the best performance.

(1) EXCELLENT ARC STABILITY with smooth molten droplet transfer generating very little spatter and fumes in a wide A-V range from 80-240A. This covers most of the A-V ranges for conventional 0.9 and 1.2 mm ϕ FCWs—**Figure 1**.

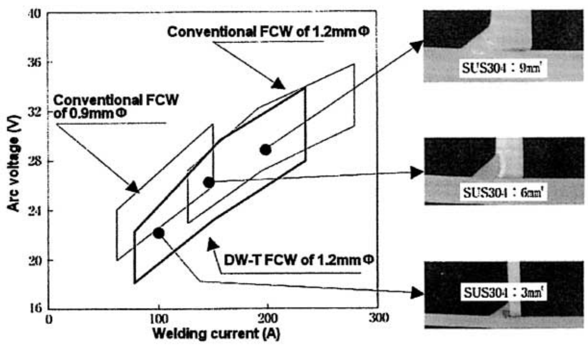


Figure 1. DW-T FCWs offer a wide range of proper welding currents and arc voltages with excellent fillet weld profiles, covering the A-V ranges for conventional 0.9 and 1.2 mmϕ FCWs

(2) SMALLER FILLET LEGS can be obtained by using higher welding speeds (**Figure 2**) due to excellent arc stability at low currents and voltages and higher deposition rates over conventional FCWs of 1.2 mmϕ. **Figure 3** shows typical applications of DW-T308L for 304L sheet metals.

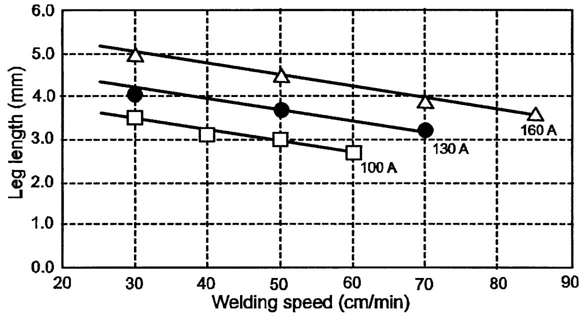


Figure 2. DW-T FCWs offer smaller leg fillet welds in a wide range of welding speeds (Horizontal fillet welding, 100%CO_2)

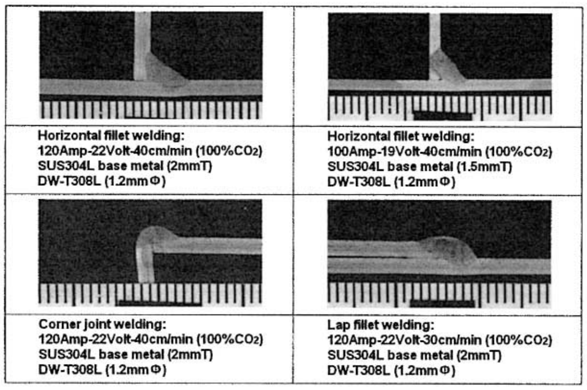


Figure 3. DW-T FCWs offer a wide range of applications in sheet metal welding of around 2-mm thick stainless steels

(3) FAILURE-FREE ARC RESTARTING enables more efficient intermittent welding without clipping off the wire end. This is because the solidified molten droplet at the tip of the wire after arc stopping can be smaller and covered by conductive slag.

(4) HIGHER DEPOSITION RATE contributes to higher welding speeds or, conversely, lower heat input for getting the same amount of deposited metal when compared with conventional FCWs—**Figure 4.**

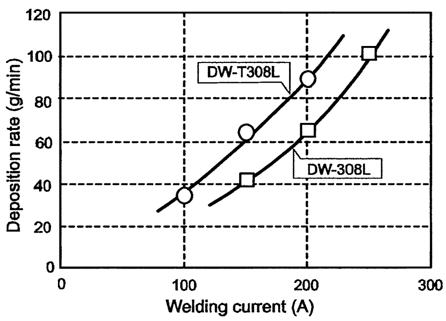


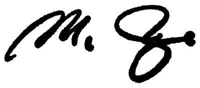
Figure 4. DW-T FCWs offer higher deposition rates over conventional DW stainless FCWs (wire size: 1.2 mmϕ)

Industrial materials shortage may last until the Beijing 2008 Olympic Games

The Beijing ESSEN Welding Fair will be held from the 10th to 13th of this November in Beijing, China. The KOBELCO group, Kobe Steel and Kobe Welding of Tangshan (KWT), will exhibit the newest products including KWT-made MG-51T (AWS ER70S-6). We will do our best so that our exhibit will be attractive to and helpful for all the visitors to our booth. I'm also looking forward to seeing our valued customers and such long-lasting business associates as the dear readers of KOBELCO WELDING TODAY in China.

I enjoyed watching the Athens 2004 Olympic Games on TV a few months ago. Most people worldwide seemed to be enjoying the Olympic Games, forgetting for a while the worrying nation-to-nation conflicts, domestic commotions and fearful terror. I wish that every country or area in the world could become as peaceful and safe as Greece. And I hope that in the next four years, the symbol of peace, the Olympic Games, will bring out real peace not only in Beijing but also around the globe.

Meanwhile, I am sure that Beijing will become in four years the biggest city in the world because China's economy and population are growing so rapidly. Even now the Chinese economy is having a great effect on the global economies because of its consumption of a large amount of fundamental industrial products such as steel, concrete, lumber, and paper especially in preparation for the next Olympic Games. The booming Chinese economy may seriously affect the balance of supply and demand for certain raw materials and manufactured products. How to manage this booming economic environment is the largest issue for the Kobelco group companies, too, and it will be for the three or four years to come.



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

Canteen in KWS


Lunch time at KWS's canteen

Kobe Welding Singapore (KWS) is in Singapore, the island of perpetual summer, located to the south of the Malay Peninsula at the southernmost tip of the Eurasian Continent. Though it is such a small island that you can travel from east to west within an hour by car, it is a melting pot of many kinds of people and cultures, populated by Chinese, Malayan, Indian and other people. KWS itself has among its only 43 employees Singaporean Chinese, Malaysian Chinese, Indonesian, Indian, and Bengalese people. And here I am, a Japanese, contributing just a little more to the melting pot. Naturally, the canteen at the lunch time turns into still another melting pot—but of various gastronomic cultures. My highest recommendation? It is curry with chicken cooked by the Bangladeshi staff. They are generous enough to allow me to share it with them from time to time.

Reported by Harada, KWS

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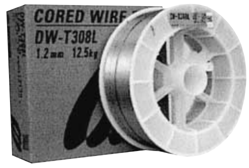
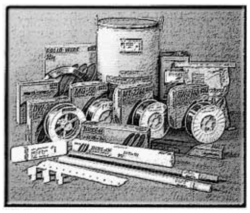
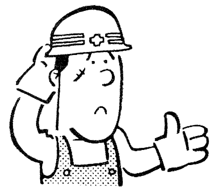
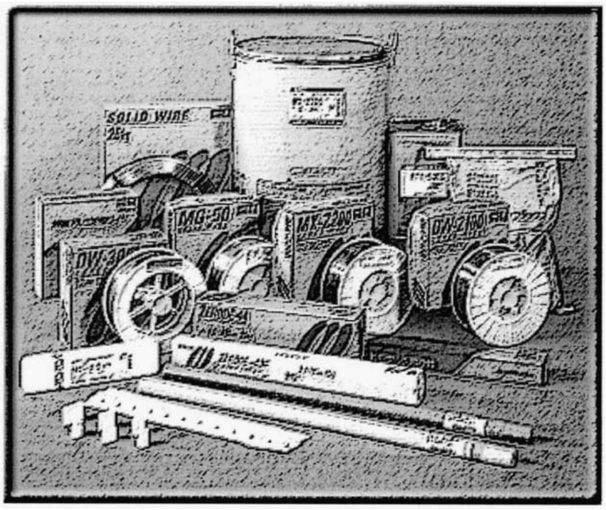






Filler Metal Standards
Part 2: AWS and EN STANDARDS



In the second installment of a two-part article begun in the last issue, we summarize the AWS filler metal standards for gas metal arc welding (GMAW), gas tungsten arc welding (GTAW) and submerged arc welding (SAW), in relation to Kobelco brands. In addition, Part-2 describes the European Standard (EN standard) that prevail more widely in the newly expanded EU and other countries that trade with Europe. Finally, Part-2 also highlights the differences between the AWS and EN standards.

AWS classification systems of GMAW and GTAW wire specifications

This section refers to the AWS classification systems for carbon steel and low-alloy steel solid wires, rods and metal-cored wires and for stainless steel and nickel alloy solid wires and rods which are used in GMAW and GTAW.

A5.18: Carbon steel solid wires are classified with the basic designation consisting of (1) minimum all-weld-metal (referred to as weld metal hereinafter) tensile strength and (2) wire chemical composition. Carbon steel metal-cored wires are classified with the basic designation comprised of (1) minimum weld metal tensile strength, (2) weld metal chemical composition, and (3) shielding gas. Both classifications can be suffixed with diffusible hydrogen designators similar to those specified in A5.1 and with the nuclear application designator (N). **Table 1** shows the chemical and mechanical requirements for extensively used classifications of solid wires and metal-cored wires.

Table 1. Chemical and mechanical properties and other requirements (AWS A5.18-01)

Classification	ER70S-2	ER70S-6	ER70S-G	E70C-6C E70C-6M
Type of wire	Solid (1)			Metal-cored (2)
C (%)	0.07 max	0.06-0.15	— (3)	0.12 max
Mn	0.90-1.40	1.40-1.85		1.75 max
Si	0.40-0.70	0.80-1.15		0.90 max
Cu	0.50 max	0.50 max		0.50 max
Ti	0.05-0.15	—		Total content of Ni, Cr, Mo and V: 0.50 max (4)
Zr	0.02-0.12	—		
Al	0.05-0.15	—		
TS (ksi)	70 min			
0.2%OS (ksi)	58 min			
El (%)	22 min			
IV	27J at −20 ℉		— (3)	27J at −20 ℉
Shielding gas	CO_2		— (3)	(5)

Note (1) Chemical requirements are for solid wire and mechanical properties are for weld metal
(2) Chemical and mechanical requirements are for weld metal
(3) As agreed to between purchaser and supplier. The chemical composition shall have no intentional addition of Ni, Cr, Mo and V.
(4) Ni: 0.50% max, Cr: 0.20% max, Mo: 0.30% max, V: 0.08% max
(5) E70C-6C: CO_2; E70C-6M: 75-80%Ar/bal CO_2

A5.28: Low alloy steel solid and metal-cored wires are classified, respectively, with designations similar to those of A5.18. There are also optional suffixes for diffusible hydrogen designators (H16, H8, or H4), which are similar to those specified in A5.1, plus the H2 grade. **Table 2** shows the requirements for some classifications for widely used solid wires and metal-cored wires.

Table 2. Chemical and mechanical properties and other requirements (AWS A5.28-96)

Classification	ER80S-B2	ER90S-B3	ER90S-B9	ER70S-G	E80C-G
Type of wire	Solid (1)				Metal-cored (2)
C (%)	0.07-0.12		0.07-0.13	— (3)	— (3)
Mn	0.40-0.70		1.25 max		
Si	0.40-0.70		0.15-0.30		
Cr	1.20-1.50	2.30-2.70	8.00-9.50		
Mo	0.40-0.65	0.90-1.20	0.80-1.10		
Ni	0.20 max		1.00 max		
V	—		0.15-0.25		
TS (ksi)	80 min	90 min		70 min	80 min
0.2%OS (ksi)	68 min	78 min	60 min	— (3)	— (3)
El (%)	19 min	17 min	16 min		
PWHT (℉ × h)	1150±25 × 1h	1275±25 × 1h	1375±25 × 1h	— (3)	— (3)
Shielding gas	Ar/1-5%O_2		Ar/5%CO_2	— (3)	— (3)

Note (1) Chemical requirements are for solid wire and mechanical properties are for weld metal
(2) Chemical and mechanical requirements are for weld metal
(3) As agreed to between purchaser and supplier. The chemical composition must have as a minimum of one or more of the following: 0.50%Ni, 0.30%Cr, and 0.20%Mo.

A5.9: Stainless steel solid wires and rods are classified according to their chemical composition. The chemical composition of the filler metal is identified by a series of numbers and, in some cases, chemical symbols such as Mo and Si as well as the letter L (for low carbon type) and H (for high carbon type). Chemical symbols are used to designate modifications of basic alloy types, e.g. ER309LMo for Mo-bearing ER309L filler metal. **Table 3** shows the chemical requirements for extensively used stainless steel filler metals.

Table 3. Chemical requirements for stainless steel solid wires and rods (AWS A5.9-93) [1]

Class.	ER308	ER308L	ER309L	ER309LMo	ER316	ER316L
C (%)	0.08 max	0.03 max	0.03 max		0.08 max	0.03 max
Cr	19.5-22.0		23.0-25.0		18.0-20.0	
Ni	9.0-11.0		12.0-14.0		11.0-14.0	
Mo	0.75 max			2.0-3.0		
Mn	1.0-2.5					
Si	0.30-0.65					

Note (1) The other elements, excluding iron, shall not exceed 0.50%.

A5.14: Nickel and nickel alloy solid wires and rods are classified according to their chemical composition. The chemical symbol "Ni" appears in the designations immediately after the "ER" (for Electrode or Rod) as a means of identifying the filler metal as a nickel-based alloy. The other symbols such as Cr and Mo in the designations are intended to group the filler metals according to their principal alloying elements. The individual designations are made up of these symbols plus a number at the end of the designation (ERNiMo-8 and ERNiMo-9, for example). These numbers separate one composition from another within a group. **Table 4** shows the chemical requirements for the nickel alloy filler metals that are used extensively.

Table 4. Chemical requirements for nickel alloy solid wires and rods (A5.14-97)

Class.	ERNiCr-3	ERNiMo-8	ERNiCrMo-3	ERNiCrMo-4
C (%)	0.10 max	0.10 max	0.10 max	0.02 max
Mn	2.5-3.5	1.0 max	0.50 max	1.0 max
Fe	3.0 max	10.0 max	5.0 max	4.0-7.0
Si	0.50 max	0.50 max	0.50 max	0.08 max
Cu	0.50 max	0.50 max	0.50 max	0.50 max
Ni [1]	67.0 min	60.0 min	58.0 min	Bal.
Co	[2]	—	—	2.5 max
Al	—	—	0.40 max	—
Ti	0.75 max	—	0.40 max	—
Cr	18.0-22.0	0.5-3.5	20.0-23.0	14.5-16.5
Nb + Ta	2.0-3.0	—	3.15-4.15	—
Mo	—	18.0-21.0	8.0-10.0	15.0-17.0
V	—	—	—	0.35 max
W	—	2.0-4.0	—	3.0-4.5

Note (1) Includes incidental cobalt
(2) Co is 0.12% max when specified

AWS classification systems of SAW wire specifications

The classifications for stainless steel and nickel alloy wires discussed above are also used for SAW with properly designed fluxes. This section describes the AWS classification systems for carbon steel and low-alloy steel solid wires and fluxes for SAW.

A5.17: SAW flux-wire combinations for carbon steels are classified with designations consisting of (1) weld metal minimum tensile strength, (2) postweld heat treatment condition ("A" for as-welded, "P" for postweld heat treated), (3) the temperature at or above which the weld metal meets the impact requirement, and (4) the classification of the wire combined with the flux. **Table 5** shows the chemical requirements for solid wires and the mechanical properties of weld metals deposited with flux-wire combinations used widely for mild steels and 490-MPa class high strength steels.

Table 5. Chemical requirements for solid wires and mechanical properties of flux-wire combined weld metal for SAW (A5.17-97)

Wire class. [1][2][3]	EL8	EL12	EM12K	EH14
C (%)	0.10 max	0.04-0.14	0.05-0.15	0.10-0.20
Mn	0.25-0.60		0.80-1.25	1.70-2.20
Si	0.07 max	0.10 max	0.10-0.35	0.10 max
Cu	0.35 max			
Flux-wire combined class.	F7A0-EH14	F7A2-EH14	F7A4-EM12K	F7P6-EH14
TS (ksi)	70-95			
0.2% OS (ksi)	58 min			
El (%)	22 min			
Av. IV (ft-lb)	20 min at 0 ℉	20 min at −20 ℉	20 min at −40 ℉	20 min at −60 ℉
PWHT (℉ × h)	As-welded			1150±25×1

Note (1) L, M and H indicate Mn levels (L: low, M: medium, H: high)
(2) 8, 12 and 14 indicate the nominal C content (0.08, 0.12 and 0.14%)
(3) K indicates that the wire is made from Si-killed steel

A5.23: SAW flux-wire combinations for low-alloy steels are classified with designators that combine (1) weld metal minimum tensile strength, (2) postweld heat treatment condition ("A" for as-welded, "P" for postweld heat treated), (3) the temperature at or above which the weld metal meets the impact requirement, (4) the classification of the wire combined with the flux, and (5) weld metal chemistry. **Table 6** shows the chemical requirements for solid wires and weld metals and the mechanical properties of weld metals deposited with flux-wire combinations used widely for low-temperature and heat-resistant low-alloy steels.

Table 6. Chemical requirements for solid wires and weld metals and mechanical properties of flux-wire combined weld metals for SAW (A5.23-97)

Wire class.	EA3	EA4	ENi3	EG
C (%)	0.05-0.17	0.05-0.15	0.13 max	Not specified
Mn	1.65-2.20	1.20-1.70	0.60-1.20	
Si	0.20 max		0.05-0.30	
Mo	0.45-0.65		—	
Cr	—		0.15 max	
Ni	—		3.10-3.80	
Cu	0.35 max			

Weld metal class.	A3	A4	B2	B3	Ni3	G
C (%)	0.15 max		0.05-0.15		0.12 max	Not specified
Mn	2.10 max	1.60 max	1.20 max		1.6 max	
Si	0.80 max					
Mo	0.40-0.65			0.90-1.20	—	
Cr	—	—	1.00-1.50	2.00-2.50	0.15 max	
Ni	—	—	—	—	2.80-3.80	
Cu	0.35 max					

Flux-wire combined class.	F7P15-ENi3-Ni3	F8A4-EA4-A4	F8P4-EA4-A4	F8P2-EG-B2	F9P2-EG-B3	F9P4-EG-G
TS (ksi)	70-95	80-100			90-110	
0.2% OS (ksi)	58 min	68 min			78 min	
El (%)	22 min	20 min			17 min	
Av. IV(ft-lb)	20 min at −150 ℉	20 min at −40 ℉	20 min at −40 ℉	20 min at −20 ℉	20 min at −20 ℉	20 min at −40 ℉
PWHT(℉×h)	1150±25 ×1	As-weld	1150±25 ×1	1275±25 ×1	1275±25 ×1	Not specified

Outline of EN standards for welding consumables

The EN standards are developed and published by the European Committee for Standardization (CEN) after obtaining the agreement—by voting—of the CEN members of the national standard bodies of the European countries. Once an EN standard has been established, it will be published in three official versions (English, French, and German). In addition, a version in any other languages translated under the authority of a CEN member and notified to the Management Center has the same status as the official versions, and can be used as a national standard without any alteration. **Table 7** shows a summary of the EN standards for welding consumables published today.

Table 7. A summary of current EN standards for welding consumables

Welding consumables (1) \ Steels		Non-alloy & fine-grain steels	High strength steels	Creep-resisting steels	Stainless & heat-resisting steels
Covered electrodes for MMAW		EN 499 (1994)	EN 757 (1997)	EN 1599 (1997)	EN 1600 (1997)
Tubular cored wires for MAW		EN 758 (1997)	EN 12535 (2000)	EN 12071 (1999)	EN 12073 (1999)
Solid wires for GSAW		EN 440 (1994)	EN 12534 (1999)	EN 12070 (1999)	EN 12072 (1999)
Rods and solid wires for TIGW		EN 1668 (1997)			
for SAW	Solid wires	EN 756 (2004)	EN 14295 (2003)		
	Solid wire-flux combinations and tubular cored wire-flux combinations			–	–
	Fluxes	EN 760 (1996)			

Note (1) MMAW: manual metal arc welding, MAW: metal arc welding, GSAW: gas-shielded arc welding, TIGW: tungsten inert gas welding, SAW: submerged arc welding

Differences between the EN and AWS standards

The EN standards for classifying welding consumables differ from the AWS standards in several respects: (1) grouping of applicable steels, (2) tolerability in the designation system, (3) chemistry designators, (4) tensile test specimen gauge length, (5) principle of strength design, (6) units system, and (7) official standard version.

(1) Grouping of applicable steels

The AWS and EN standards for welding consumables are prepared for particular groups of applicable metals for which a particular welding consumable can be used. As shown in **Table 8**, the grouping is different between the AWS and EN standards. This must be noted when you classify a particular welding consumable and select an appropriate welding consumable according to the AWS or EN standard.

Table 8. A comparison of the grouping of applicable steels for welding consumables between AWS and EN standards

AWS Standard	Carbon steels	Low-alloy steels		Stainless steels
EN Standard	Non-alloy & fine-grain steels	High strength steels	Creep-resisting steel	Stainless & heat-resisting steels

(2) Tolerability in the designation system

For exampled, as recognized in A5.20 (refer to Part 1 of this article) for carbon steel flux-cored wires for FCAW, the AWS standard specifies a particular filler metal classification with specific chemical composition, mechanical properties, welding positions, and type of cored flux, although users can select optional designators in terms of shielding gas composition, extra impact toughness and diffusible hydrogen content.

By contrast, as shown in **Table 9**, EN 758 for tubular cored wires for MAW allows users to compose an appropriate classification designation for a particular welding consumable by choosing several designators from among individual groups of specified chemical compositions, mechanical properties, welding positions, type of cored flux, shielding gas compositions, and diffusible hydrogen levels. In this respect the EN standard has a higher tolerability in the classification system as compared with the AWS standard.

(3) Chemistry designator

As observed in A5.22 (refer to Part 1 of this article) for stainless steel flux-cored wires for FCAW, the AWS standard specifies the chemistry of the weld metal with a series of numbers such as 308 for the nominal main chemistry of 19%Cr-9%Ni.

In contrast to this, as shown in **Table 10**, EN 12073 specifies a set of numbers representing the nominal content of main elements for the same type of austenitic stainless steel tubular cored wire for MAW.

Table 9. The classification system of EN 758—Tubular cored electrodes for metal arc welding with or without a gas shield of non-alloy and fine-grain steels

EN 758 - T ① ② ③ ④ ⑤ ⑥ ⑦

〔Ex.〕 EN 758 - T 46 3 1Ni B M 4 H5

T: Designates tubular cored electrodes for metal arc welding

①: Yield strength and related requirements

(a) Yield strength of weld metal for multiple-layer welding

Symbol	Yield strength or 0.2% proof strength Min. (N/mm^2)	Tensile strength (N/mm^2)	Elongation (L=5D) Min. (%)
35	355	440～570	22
38	380	470～600	20
42	420	500～640	20
46	460	530～680	20
50	500	560～720	18

(b) Yield strength of weld joint for single pass welding

Symbol	Yield strength of base metal Min. (N/mm^2)	Tensile strength of weld joint Min. (N/mm^2)
3T	355	470
4T	420	520
5T	500	600

②: Impact value of weld metal or weld joint

Symbol	Test temp. (°C)	Impact absorbed energy Min. (J)
Z	Not required	
A	+20	Average 47
0	0	
2	−20	
3	−30	
4	−40	
5	−50	
6	−60	

③: Chemical composition of weld metal

Symbol	Chemical composition [(1)] (%)		
	Mn	Ni	Mo
No symbol	2.0	—	—
Mo	1.4	—	0.3-0.6
MnMo	1.4-2.0	—	0.3-0.6
1Ni	1.4	0.6-1.2	—
1.5Ni	1.6	1.2-1.8	—
2Ni	1.4	1.8-2.6	—
3Ni	1.4	2.6-3.8	—
Mn1Ni	1.4-2.0	0.6-1.2	—
1NiMo	1.4	0.6-1.2	0.3-0.6
Z	Any other agreed composition		

Note: (1) Single values are maximum.
Where no specification, Mo<0.2%, Ni<0.5%, Cr<0.2%, V<0.08%, Nb<0.05%, Cu<0.3%, and for self-shielded wires, Al<2.0%

④: Type of cored flux and slag

Symbol	Features	Type of welding	Shielding gas
R	Rutile, Slow-freezing slag	Single pass or multiple pass	Required
P	Rutile, Fast-freezing slag		
B	Basic		
M	Metal powder		
V	Rutile or basic ／Fluoride	Single pass	Not required
W	Basic／Fluoride, Slow-freezing slag	Single pass or multiple pass	
Y	Basic／Fluoride Fast-freezing slag		
Z	Other types		

⑤: Shielding gas

Symbol	Designation
M	Mixed gases (Gases specified as M2 per EN 439, without He)
C	CO_2 (Gases specified as C1 per EN 439)
N	Self-shielding

⑥: Welding position (Option)

Symbol	Designation
1	All positions
2	All positions except vertical downward
3	Flat butt and fillet, Horizontal fillet
4	Flat butt and fillet
5	Vertical downward and those specified for Symbol 3

⑦: Diffusible hydrogen (Option)

Symbol	Diffusible hydrogen, Max. (ml/100g deposited metal)
H5	5
H10	10
H15	15

Table 10. The classification system of EN 12073—Tubular cored electrodes for metal arc welding with or without a gas shield of stainless and heat-resisting steels

EN 12073 - T ① ② ③ ④

〔Ex.〕 EN 12073 - T 19 12 3L R M 4

T: Designates tubular cored electrodes for metal arc welding

①: Chemical composition and mechanical properties of weld metal

Classification	Chemical composition (%)				Proof strength Min. Rp0.2 (N/mm^2)	Tensile strength Min. Rm (N/mm^2)	El. (L=5D) Min. A %	PWHT
	Cr	Ni	Mo	Others				
Martensitic / ferritic type								
13	11.0-14.0	—	—	—	250	450	15	(3)
13 Ti	10.5-13.0	—	—	Ti (1)	250	450	15	(3)
13 4	11.0-14.5	3.0-5.0	0.4-1.0	—	500	750	15	(4)
17	16.0-18.0	—	—	—	300	450	15	(5)

Continued

Classification	Chemical composition (%)				Proof strength Min. Rp0.2 (N/mm²)	Tensile strength Min. Rm (N/mm²)	El. (L=5D) Min. A %	PWHT
	Cr	Ni	Mo	Others				
Austenitic type								
19 9 L	18.0-21.0	9.0-11.0	–	–	320	510	30	None
19 9 Nb	18.0-21.0	9.0-11.0	–	Nb (2)	350	550	25	None
19 12 3 L	17.0-20.0	10.0-13.0	2.5-3.0	–	320	510	25	None
19 12 3 Nb	17.0-20.0	10.0-13.0	2.5-3.0	Nb(2)	350	550	25	None
19 13 4 N L	17.0-20.0	12.0-15.0	3.0-4.5	N: 0.08-0.20	350	550	25	None
Austenitic-ferritic high corrosion resisting type								
22 9 3 N L	21.0-24.0	7.5-10.5	2.5-4.0	N: 0.08-0.20	450	550	20	None
Fully-austenitic high corrosion resisting type								
18 16 5 N L	17.0-20.0	15.5-19.0	3.5-5.0	N: 0.08-0.20	300	480	25	None
Special type								
18 8 Mn	17.0-20.0	7.0-10.0	–	–	350	500	25	None
20 10 3	19.5-22.0	9.0-11.0	2.0-4.0	–	400	620	20	None
23 12 L	22.0-25.0	11.0-14.0	–	–	320	510	25	None
23 12 2 L	22.0-25.0	11.0-14.0	2.0-3.0	–	350	550	25	None
29 9	27.0-31.0	8.0-12.0	–	–	450	650	15	None
Heat resisting type								
22 12 H	20.0-23.0	10.0-13.0	–	–	350	550	25	None
25 20	23.0-27.0	18.0-22.0	–	–	350	550	20	None

Note (1) Ti :10×C%-1.5%
(2) Nb:8×C%-1.1%; Nb can be replaced with Ta up to 20%
(3) 840-870°C×2h heating, followed by FC to 600°C and later AC
(4) 580-620°C×2h heating, followed by AC
(5) 760-790°C×2h heating, followed by FC to 600°C and later AC

②: Type of flux

Symbol	Features
R	Rutile, Slow-freezing slag
P	Rutile, Fast-freezing slag
M	Metal powder
U	Self-shielding
Z	Other types

③: Shielding gas

Symbol	Designation
M	Mixed gases (Gases specified as M2 per EN 439, without He)
C	CO_2 (Gases specified as C1 per EN 439)
N	Self-shielding

④: Welding position (Option)

Symbol	Designation
1	All positions
2	All positions except vertical downward
3	Flat butt and fillet, and horizontal fillet
4	Flat butt and fillet
5	Vertical downward and those for Symbol 3

(4) Tensile test specimen gauge length

The EN standard specifies the elongation of tensile test specimens with a 5D gauge length, while the AWS standard specifies that with a 4D gauge length. In the case of steel specimens, the use of a 5D gauge length generally results in smaller elongation than with a 4D gauge length.

(5) Principle of strength design

The EN standard specifies yield strength or 0.2% proof strength for the designator representing the strength of weld metal, while the AWS standard specifies tensile strength of weld metal for the strength designator.

(6) Unit system

The EN standard uses the International System of Units (SI unit) such as N/mm² for tensile strength, Joule for impact strength, and ℃ for testing temperature, while the AWS standard has been using the U.S. Customary Units such as psi or ksi for tensile strength, fl-lb for impact strength and ℉ for testing temperature, although the AWS standard has been expanding the SI-unit versions.

(7) Official standard version

In contrast to the publication of AWS standards in English only, the EN standards are prepared in three official versions: English, French and Germany. In addition, versions in other languages translated under the authority of the relevant CEN member, can be considered as official. After a particular EN standard has been established, it is used without alteration; e.g. BS EN 758 and DIN EN 758 have the same content.

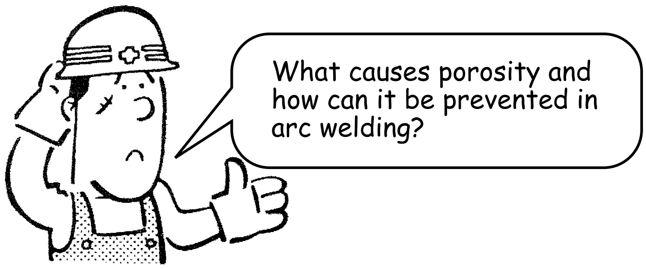
What countries approve EN standards

The following countries have approved the EN standards for welding consumables. Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxemburg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Taking this situation into consideration, Kobe Steel has been using, besides the AWS standards, the EN standards to classify mainly carbon steel, low-temperature steel and stainless steel flux-cored wires for international trade.

EN standards for other types of metals

In addition to the EN standards shown in **Table 7**, those for nickel and nickel alloys, aluminum and aluminum alloys, titanium and titanium alloys and cast irons are being established.

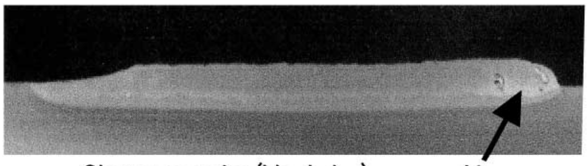


Porosity refers to cavity-type discontinuities or pores formed by gas entrapment during the solidification of molten weld metal. Porosity reduces the strength of a weld. In arc welds, it is caused by dissolved gases that are usually present in a molten weld metal. If the dissolved gases are present in amounts greater than their solubility limits, the excess is forced out of the solution in the form of bubble or gas pockets as the weld metal solidifies.

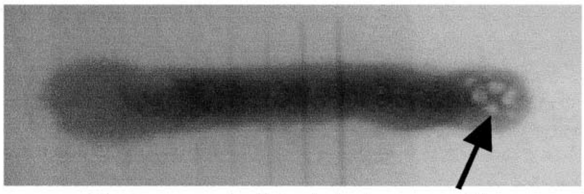
The gases, which may be present in the molten weld pool, include hydrogen, oxygen, nitrogen, carbon monoxide, carbon dioxide, water vapor, hydrogen sulfide, and rarely, argon, and helium. Hydrogen is the major cause of porosity in weld metals. In addition, when the base metal is coated with zinc-bearing primer or is galvanized, zinc vapor can be one of the gases.

Porosity is generally spherical but may be cylindrical. Cylindrical or elongated porosity is also referred to as “piping porosity” or “wormhole.” Other types are cluster porosity, which is a localized group of pores, and linear porosity, in which a number of pores are aligned. When porosity is seen in the weld face, it is also referred to as “pit.” When porosity is detected, by fracture or radiograph tests, as a sub-surfaced pore that does not extend to the weld face, it is also referred to as “blowhole.”

Typical cluster porosity (blowholes) is shown in **Figure 1**, which was caused by improper arc starting with a low hydrogen type covered electrode. This can happen even if redried before use. In order to prevent this type of porosity, the backstep technique should be used to start the arc. **Figure 2** shows typical linear porosity (pits and blowholes), which was caused by the primer coated on the base metal. In order to prevent the detrimental effect of the primer, either the primer should be removed from the fusion surfaces before welding or primer-resistant welding wire should be used. MX-200 is recommended.

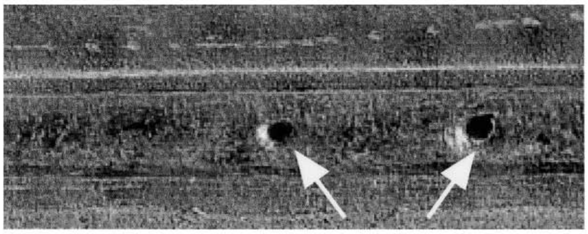


Cluster porosity (blowholes) appeared in the cross section in a weld bead

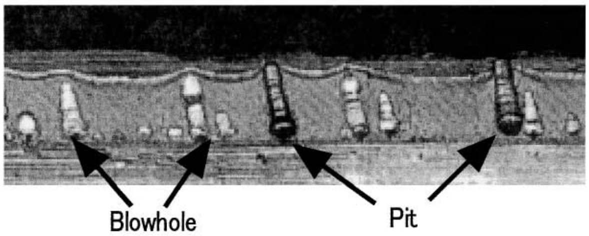


Cluster porosity (blowholes) appeared in a radiography of a weld bead

Figure 1. Typical cluster porosity occurring at the start of a weld bead (detected by cross sectional inspection for the top and by X-ray test for the bottom), caused by improper arc starting in shielded metal arc welding with a low hydrogen type covered electrode



Porosity (pits) appeared in the surface of a weld bead



Porosity appeared in the fracture surface of a weld bead

Figure 2. Typical linear porosity occurring in a fillet weld of primer-coated steel plates in gas metal arc welding

Misuse of welding processes, mishandling of welding consumables, and base metal surface contaminants cause the occurrence of porosity. Proper welding procedures for a given combination of welding process, base metal and welding consumable should produce welds that are essentially free of porosity. In this sense, the following procedures are essential.

1. Use properly dried welding consumables.
2. Use base metals that are free of contaminants
3. Maintain welding machines in good condition.
4. Use proper welding technique.

IIW Annual Assembly 2004 in Osaka

The IIW Annual Assembly was held in Osaka on 11-16 July, bringing together welding researchers and engineers from all over the world. This was the 57th assembly and the third one held in Japan after the Kyoto Assembly in 1969 and the Tokyo Assembly in 1986. A total of 748 participants from 43 countries attended, including such non-IIW-member countries as South Korea, Indonesia, Malaysia and Vietnam. Since the assembly was held during the Japan International Welding Show at the same place, it was very well attended.

The assembly was combined with 24 Technical Working Units that consisted of the 1st to 16th Technical Commissions as well as eight Select Committees and Study Group Meetings, where the participants actively participated in presentations and discussions. Still more research presentations and discussions were held at the concurrent Annual IIW International Conference—entitled "Technical Trends and Future Prospectives of Welding Technology for Transportation, Land, Sea, Air and Space."

The attendees from Kobe Steel made six research presentations (including collaborative research reports) about welding consumables for high steel, two-joint synchronized robotic arc welding system, trend and perspective on welding consumables, state-of-the art welding consumables for offshore structures, hybrid laser-MAG welding of galvanized steel sheets, and MAG welding wires for thin steel sheets in the automotive industry. These presentations earned high appraisals.

The IIW flag handed over from Japan to the successor Czech Republic at the opening ceremony (left)

A traditional dance at the Japanese Summer Festival buffet party (right)

A buffet party, called "Japanese Summer Festival," as well as the annual banquet was also held, allowing the participants to enjoy night life in addition to the assembly. The next 58th Annual Assembly is scheduled to open in Prague, Czech Republic, on 10-16 July 2005.

Reported by T. Morimoto, Senior Researcher,
Technical Development Dept., Kobe Steel

Greetings from a new member of the IOD staff

Yutaka Muraoka
Manager
IOD
Kobe Steel

I feel privileged to be given an opportunity to introduce myself. Yutaka Muraoka is my name. I entered Kobe Steel in March 2004 and was posted into the International Operations Department of the Welding Company.

Back in April 1982, now 22 years ago, I entered Nissho-Iwai Co., Ltd., a trading company formerly part of the now defunct Suzuki Shoten. I worked in the Welding Material Department that was selling Kobe Steel's welding products both domestically and internationally. After 8 years in domestic sales, I was transferred to the export force and handled exports and off-shore trade of Kobe Steel's welding products for another 8 years.

Then I was assigned to Nissho-Iwai's Myanmar Office, leaving the welding business in which I had worked for 16 years. During my four years' stay in the Union of Myanmar, I was engaged in various kinds of business such as setting up schemes to implement Japan's Official Development Aid in collaboration with the Myanmar Government, plant construction contracting, export of frozen shrimps and import of chemicals.

Back in Japan after 4 years, I was given the task of developing new business in Okinawa and was assigned to the Naha Branch Office. My hard work during my two years' stay there was rewarded, I am happy to say, by the successful starting of a new business in a field that Nissho-Iwai had never been able to penetrate.

After six years, I am back again in the welding business as the manager in charge of the East Asian market (Korea, China and Taiwan) at Kobe Steel. I am tackling my tasks with a sense of familiarity. But at the same time with a fresh mind of a newcomer.

Japan International Welding Show 2004 at INTEX OSAKA

The Japan International Welding Show 2004 was held from July 14 through 17 in the scorching mid-summer heat at INTEX OSAKA in Osaka.

As the annual assembly of the IIW or the International Institute of Welding was held at the same time in Osaka, a total of 59,590 visitors attended, more than 7,000 over the number at the previous show in Osaka in 2000. The many visitors from overseas created an international atmosphere.

In total, the number of exhibitors was 186 (172 domestic; and 13 from overseas). The main theme of the Show was "*Welding and Joining Technology: Bridging the World — from Japan to Asia and to the World.*"

KOBELCO's booth drew as many as 200 foreign guests, who showed much interest in our state-of-the-art products. Our booth, featuring the slogan, "*KOBELCO Supports Your Manufacturing,*" operated 4 corners where our products were exhibited and demonstrated.

For the first time, we stationed our two demonstration cars, which are nicknamed "Yohtaro" and "Yohjiro" (literally the first and second sons of a welder), outside the exhibition halls. Beside the cars, visitors could experience arc welding trials using the exhibited products.

Visitors enjoying Kobelco's exhibitions (top), Shinyokai's 100-year memorial tree (middle) and Kobelco staff at the booth (bottom)

In commemoration of the centennial of "Shin-yo-kai," the Kobelco's domestic sales network, we fabricated using steels "The Centennial Tree of Shin-yo-kai," a collaborative display for Shin-yo-kai member visitors, who were permitted to weld leaves onto the tree.

At our booth inside the exhibition hall, visitors were drawn to the demonstration of the newest robotic welding systems, the video showing in the corners, and the photos and explanation panels. Exhibited products included the DW-T series flux-cored wires for thin stainless steels, and the advanced NC series covered electrodes for stainless steels.

Our staff members were kept busy, receiving visitors at our booth, which made us foresee the potential further expansion of the welding market.

At the show on the whole, there were no particularly novel welding consumables. However, non-Cu-coated solid wires were exhibited by various manufacturers, which indicated that non-Cu-coated solid wires are coming to be widely used.

The next Japan International Welding Show will be held in Tokyo in 2006. We, Kobe Steel, will continue our efforts to enrich our exhibits and demonstrations for the coming Show and look forward to your visit.

Reported by Yu Agatsuma
IOD, Kobe Steel

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