SMAW Electrodes for Chromium-Molybdenum Low Alloy Steels

Welding Notes

Similar precautions should be taken when welding Chromium-Molybdenum Steel as with high strength steel. However, the following measures require special attentions: Inter-pass temperature, preheat and PWHT-post weld heat treatment.

1. Inter-pass temperature, preheat and PWHT (Post Weld Heat Treatment)
   For the preheat and post heat temperatures when welding low alloy Chromium-Molybdenum steel, please consult the following table. The widths of the affected area during preheat and post heat is recommended at 5 times of base metal thickness. After welding, post heat annealing treatment is needed in order to eliminate residual stress.

Preheat, Inter-pass and PWHT temperature requirement

Steel Category	Preheat and Inter-pass Temperature (°C)	PWHT Temperature x time (°C×1hr)
0.5%Mo Steel	95~110	620±15
0.5%Cr-0.5% Mo Steel 1.25%Cr-0.5% Mo Steel 2.25%Cr-1.0% Mo Steel	160~190	690±15
5.0%Cr-0.5% Mo Steel	180~230	740 ±15
9.0%Cr-1.0% Mo Steel	200~250	740 ±15

Note : max. inter-pass temperature≦350°C

2. Short Arc Technique
   Chromium-Molybdenum Steel SMAW Electrodes are mostly classified as low hydrogen type; thus, short arc technique should be observed during welding in order to prevent permeation of N_2 and O_2 into the arc creating blow hole and alloy elements burning loss. If weaving is necessary, the weaving width should not exceed 3 times of the core wire diameter. During welding, the arc starting point should be 1~2 cm behind the welding start point. Once the arc starts, pull it back to the welding start point to begin welding to avoid the occurrence of blow hole. This is known as the forehand & backhand arc starting technique.

3. For more information, please consult page A6 regarding Welding notes of SMAW Electrode for Mild and High Tensile Strength Steel use.

GL76A1 / GL78A1

AWS A5.5M E4916(8)-A1
A5.5 E7016(8)-A1
JIS Z 3223 DT1216

Product Features:
- Low hydrogen/ iron powder low hydrogen type covered electrode for low alloy heat resistant steel.
- Approximately 0.5% Mo element contained in all deposited weld metal.
- Good for RT examination, good mechanical properties.
- Low hydrogen contained in weld metal to get good crack resistance.

Applications:
- Suitable for welding of 0.5% Mo grade heat resistant steel, cast steel such as A335-P1,A336-F1.

Typical chemical composition of all-weld metal (wt%)

C	Si	Mn	Mo
0.06	0.46	0.79	0.49

Typical mechanical properties of all-weld metal

Yield Strength N/mm²	Tensile Strength N/mm²	Elongation %	Post Weld Heat Treatment (PWHT) °C×1hr
570	615	26	620

Size (mm) & recommended welding parameters(A) AC or DC+

Diameter / Length	2.6/300	3.2/350	4.0/400	5.0/450
Flat position	60~90	100~140	150~190	220~270
Vertical / over head position	50~80	80~110	120~150	—

◎ Note: 1. 300~350°C x 1hr baking prior to use.
2.Refer to page B5 welding notes.

GL86B1 / GL88B1

AWS A5.5M E5516(8)-B1
A5.5 E8016(8)-B1
JIS Z 3223 DT2316(8)

Product Features:
- Low hydrogen/ iron powder low hydrogen type covered electrode for low alloy heat resistant steel.
- Very low hydrogen contained in weld metal.
- All deposited weld metal contains approximately 0.5% Cr- 0.5%Mo alloy elements, good for serving temperature ≦ 550°C.
- Good for RT examination, good mechanical properties.

Applications:
- Suitable for welding of 0.5% Cr-0.5% Mo grade steel such as A387-Gr.2 C1.1&2.

Typical chemical composition of all-weld metal (wt%)

C	Si	Mn	Cr	Mo
0.06	0.31	0.76	0.55	0.48

Typical mechanical properties of all-weld metal

Yield Strength N/mm²	Tensile Strength N/mm²	Elongation %	Post Weld Heat Treatment (PWHT) °C×1hr
600	650	26	690

Size (mm) & recommended welding parameters(A) AC or DC+

Diameter / Length	2.6/300	3.2/350	4.0/400	5.0/450
Flat position	60~90	90~140	150~180	220~270
Vertical / over head position	50~80	80~120	120~150	—

◎ Note: 1.300~350°C x 1hr baking prior to use.
2.Refer to page B5 welding notes.

GL86B2 / GL88B2

AWS A5.5M E5516(8)-B2
A5.5 E8016(8)-B2
JIS Z 3223 DT2316(8)

Product Features:

- Low hydrogen/ iron powder low hydrogen type covered electrode for low alloy heat resistant steel.
- Very low hydrogen contained in weld metal.
- All deposited weld metal contains approximately 1.1%Cr- 0.5%Mo alloy elements, good for serving temperature ≦ 550°C.
- Good for RT examination, good mechanical properties.

Applications:

- Suitable for welding of 1.25% Cr-0.5% Mo grade steel such as A387-Gr.12 C1.1&2; A335-Gr.11&12.

Typical chemical composition of all-weld metal (wt%)

C	Si	Mn	Cr	Mo
0.08	0.62	0.80	1.09	0.43

Typical mechanical properties of all-weld metal

Yield Strength N/mm²	Tensile Strength N/mm²	Elongation %	Post Weld Heat Treatment (PWHT) °C×1hr
623	691	20	690

Size (mm) & recommended welding parameters(A) AC or DC+

Diameter / Length	2.6/300	3.2/350	4.0/400	5.0/450
Flat position	60~90	90~140	150~180	220~270
Vertical / over head position	50~80	80~120	120~150	—

◎ Note: 1. 300~350˚C x 1hr baking prior to use.
2.Refer to page B5 welding notes.

GL86B6 / GL88B6

AWS A5.5M E5516(8)-B6
A5.5 E8016(8)-B6

Product Features:

- Low hydrogen/ iron powder type covered electrode for low alloy heat resistant steel.
- Very low hydrogen contained in weld metal.
- All deposited weld metal contains approximately 5.0%Cr- 0.5%Mo alloy elements, good for serving temperature ≦ 550°C.
- Good for RT examination, good mechanical properties.

Applications:

- Suitable for welding of ASTM A387Gr5 and A335Gr.P5 steel and similar grade steels.

Typical chemical composition of all-weld metal (wt%)

C	Si	Mn	Cr	Mo
0.07	0.65	0.81	4.63	0.50

Typical mechanical properties of all-weld metal

Yield Strength N/mm²	Tensile Strength N/mm²	Elongation %	Post Weld Heat Treatment (PWHT) °C×1hr
527	635	24	740

Size (mm) & recommended welding parameters(A) AC or DC+

Diameter / Length	2.6/300	3.2/350	4.0/400	5.0/450
Flat position	60~90	90~140	150~200	220~270
Vertical / over head position	50~80	80~110	120~150	—

◎ Note: 1. 300~350˚C x 1hr baking prior to use.
2.Refer to page B5 welding notes.

GL96B3 / GL98B3

AWS A5.5M E6216(8)-B3
A5.5 E9016(8)-B3
JIS Z 3223 DT2416(8)

Product Features:

- Low hydrogen/ iron powder low hydrogen type covered electrode for low alloy heat resistant steel.
- Very low hydrogen contained in weld metal.
- All deposited weld metal contains approximately 2.25%Cr-1.0% Mo alloy elements, good for serving temperature ≦ 550°C.
- Good for RT examination, good mechanical properties.

Applications:

- Suitable for welding of 2.5% Cr-1.0% Mo grade steel such as JIS STBA24,A387 Gr.22.

Typical chemical composition of all-weld metal (wt%)

C	Si	Mn	Cr	Mo
0.07	0.49	0.66	2.28	1.05

Typical mechanical properties of all-weld metal

Yield Strength N/mm²	Tensile Strength N/mm²	Elongation %	Post Weld Heat Treatment (PWHT) °C×1hr
590	671	22	690

Size (mm) & recommended welding parameters(A) AC or DC+

Diameter / Length	2.6/300	3.2/350	4.0/400	5.0/450
Flat position	60~90	90~140	150~180	220~270
Vertical / over head position	50~80	80~120	120~150	—

◎ Note: 1. 300~350˚C x 1hr baking prior to use.
2. Refer to page B5 welding notes.

GL86B8 / GL88B8

AWS A5.5M E5516(8)-B8
A5.5 E8016(8)-B8

Product Features:

- Low hydrogen/ iron powder low hydrogen type covered electrode for low alloy heat resistant steel.
- Low hydrogen contained in weld metal to get good crack resistance.
- All deposited weld metal contains approximately 9.0%Cr-1.0 %Mo alloy elements, good for serving temperature ≦ 550°C.
- Good for RT examination, good mechanical properties.

Applications:

- Suitable for welding of ASTM A387Gr.9 and A335Gr.P9 steel and similar grade steels.

Typical chemical composition of all-weld metal (wt%)

C	Si	Mn	Cr	Mo
0.07	0.60	0.63	8.74	0.86

Typical mechanical properties of all-weld metal

Yield Strength N/mm²	Tensile Strength N/mm²	Elongation %	Post Weld Heat Treatment (PWHT) °C×1hr
669	749	20	740

Size (mm) & recommended welding parameters(A) AC or DC+

Diameter / Length	2.6/300	3.2/350	4.0/400	5.0/450
Flat position	60~90	90~140	150~200	220~270
Vertical / over head position	50~80	80~110	120~150	—

◎ Note: 1. 300~350˚C x 1hr baking prior to use.
2.Refer to page B5 welding notes.