

May.2005

***Flux-Cored Wire for Gas Shield Arc Welding***  
***“FRONTIARC-711”***

 **KOBE STEEL, LTD.**

**WELDING COMPANY**

## Flux-Cored Wire for Gas Shield Arc Welding

### “FRONTIARC-711”

FRONTIARC-711 is a rutile (TiO<sub>2</sub>) based flux-cored wire for out-of-position welding work with easier arc control, which has outstanding features mainly as described below.

- 1) High welding current(220-250A) can be used in vertical upward welding with a greatly improved efficiency
- 2) Welding of all-position can be done with same welding current setting.
- 3) Welding current density is higher and deposition rate is also higher than those for the solid wire of same size.
- 4) Less spattering and good slag removability shorten the time of bead grinding operation.



### 1. Wire specification

**Table1 Specifications of wire**

Typical applications	-Mild Steels and low-alloy steels -Multi-pass and single-pass applications
Polarity of power supply	DC-EP
Applicable classification	AWS A5.20/ ASME SFA 5.20 E71T-1, E71T-1M AWS A5.20/ ASME SFA 5.20 E71T-12, E71T-12M CWB CSA W48-01 E491T-9 H8, E491T-9M H8
Applicable size	0.045in.(1.1mm), 0.052in.( 1.3mm), 1/16in.(1.6 mm)
Applicable unit quantity	11lbs(5kg Spool), 28lbs(12.5kg Spool), 44lbs(20kg Spool), 55lbs(25kg Spool), 550lbs(250kg Drum)
Approval by the shipping registers	AB, LR

## 2. Properties of undiluted deposited metal

Tensile properties, toughness property and its chemistry of undiluted deposited metal with 100%CO<sub>2</sub> and 75%Ar-25%CO<sub>2</sub> are shown in Table2 and Table3 respectively, which were obtained by testing in accordance with AWS specification A5.20.

**Table2 Typical mechanical properties of undiluted deposited metal**

Diameter inch (mm)	Shielding gas	0.2%P.S. psi (MPa)	T.S. psi (MPa)	EI %	Impact value ft-lbs (J)	
					-40°F	-20°F
0.045 (1.1)	CO <sub>2</sub>	72,520 (500)	83,690 (577)	30	60<54,62,63> (81<73,84,86>)	75<73,75,78> (102<99,102,106>)
	Ar-CO <sub>2</sub>	83,250 (574)	89,200 (615)	27	71<65,74,72> (96<88,101,98>)	92<84,93,98> (125<114,126,133>)
0.052 (1.3)	CO <sub>2</sub>	68,170 (470)	80,790 (557)	30	52<51,49,54> (70<69,67,74>)	60<60,75,46> (82<81,102,63>)
	Ar-CO <sub>2</sub>	76,290 (526)	88,330 (609)	31	60<53,65,62> (81<72,88,84>)	78<71,86,77> (106<96,117,105>)
1/16 (1.6)	CO <sub>2</sub>	64,830 (447)	77,020 (531)	32	35<36,27,41> (47<49,37,55>)	48<51,49,42> (65<69,67,57>)
	Ar-CO <sub>2</sub>	75,130 (518)	86,730 (598)	29	58<48,63,63> (79<65,86,86>)	71<64,71,78> (96<87,96,106>)

\*The values in parenthesis conform to SI unit.

**Table3 Typical Chemical composition of deposited metal (%)**

Diameter inch (mm)	Shielding gas	C	Mn	Si	P	S
0.045 (1.1)	CO <sub>2</sub>	0.04	1.28	0.44	0.016	0.008
	Ar-CO <sub>2</sub>	0.05	1.52	0.57	0.016	0.008
0.052 (1.3)	CO <sub>2</sub>	0.05	1.23	0.40	0.016	0.009
	Ar-CO <sub>2</sub>	0.06	1.40	0.50	0.016	0.009
1/16 (1.6)	CO <sub>2</sub>	0.05	1.11	0.33	0.016	0.011
	Ar-CO <sub>2</sub>	0.05	1.34	0.47	0.016	0.011

### 3. Properties of butt joint

The butt joint test was performed with both gases according to the welding conditions shown in Table4 and 5. The test results are shown in Table6 and Table7.

**Table4 Welding condition and pass sequence**

Welding position	Flat (1G), Horizontal (2G), Vertical upward (3G) FRONTIARC-711	(Joint design)
Welding wire	0.045in., 0.052in., 1/16in.	<p>40°</p> <p>1</p> <p>Root gap = 5/32</p> <p>Ceramic type backing material</p>
Welding current	200~280A	
Shielding gas	100%CO <sub>2</sub> , 75%Ar-25%CO <sub>2</sub>	
Current and polarity	53CFH(25L/min)	
Preheat temp.	DC-EP	
Interpass temp.	Room temp.	
Test plate	300±20°F (150±10°C) ASTM A36 equivalent	
		Unit: [in.]

**Table5 Welding condition and pass sequence**

Welding position	Welding condition	Pass sequence
Flat	1st pass : 200A 2nd pass~ : 0.045in. 280A 0.052in. 300A 1/16in. 320A	<p>12</p> <p>1</p> <p>12passes – 7layers</p>
Horizontal	1st pass : 200A 2nd pass~ : 0.045in. 280A 0.052in. 280A	<p>20</p> <p>1</p> <p>20passes – 7layers</p>
Vertical upward	1st pass : 200A 2nd pass~ : 0.045in. 220A 0.052in. 250A	<p>1</p> <p>10</p> <p>10passes – 6layers</p>

Table6 Charpy absorbed energy

Diameter inch (mm)	Welding position	Shielding gas	-40°F ft-lbs (J)			-20°F ft-lbs (J)		
			Face <sup>*1)</sup>	Center <sup>*2)</sup>	Root <sup>*3)</sup>	Face <sup>*1)</sup>	Center <sup>*2)</sup>	Root <sup>*3)</sup>
0.045 (1.1)	Flat	CO <sub>2</sub>	35 (48)	40 (54)	28 (38)	43 (59)	44 (60)	50 (68)
		Ar-CO <sub>2</sub>	51 (69)	48 (65)	40 (54)	62 (84)	74 (101)	66 (89)
	Horizontal	CO <sub>2</sub>	46 (62)	31 (42)	34 (46)	53 (60)	53 (72)	53 (72)
		Ar-CO <sub>2</sub>	41 (55)	43 (58)	36 (49)	57 (79)	57 (77)	72 (98)
	Vertical upward	CO <sub>2</sub>	42 (57)	35 (48)	39 (53)	40 (72)	40 (54)	38 (51)
		Ar-CO <sub>2</sub>	47 (64)	43 (59)	35 (47)	60 (98)	60 (82)	68 (92)
0.052 (1.3)	Flat	CO <sub>2</sub>	38 (52)	39 (53)	36 (49)	62 (74)	62 (84)	51 (69)
	Horizontal	CO <sub>2</sub>	35 (48)	38 (51)	36 (49)	50 (78)	50 (68)	54 (73)
	V-up	CO <sub>2</sub>	28 (38)	35 (47)	33 (45)	41 (64)	41 (55)	45 (61)
1/16 (1.6)	Flat	CO <sub>2</sub>	47 (64)	41 (55)	38 (52)	52 (68)	52 (70)	49 (67)
		Ar- CO <sub>2</sub>	52 (71)	53 (72)	45 (61)	64 (91)	64 (87)	48 (65)

\*1) 5/64in.(2mm) from face side, \*2) Center of thickness, \*3) 5/64in.(2mm) from root side

Table7 Tensile properties of weld metal

Diameter inch (mm)	Welding position	Shielding gas	0.2%P.S psi (MPa)	T.S psi (MPa)	EI %
0.045 (1.1)	Flat	CO <sub>2</sub>	74,690 (515)	84,990 (586)	28
		Ar-CO <sub>2</sub>	77,450 (534)	87,310 (602)	27
	Horizontal	CO <sub>2</sub>	85,720 (591)	93,690 (646)	26
		Ar-CO <sub>2</sub>	89,490 (617)	95,730 (660)	26
	Vertical upward	CO <sub>2</sub>	75,850 (523)	86,590 (597)	28
		Ar-CO <sub>2</sub>	77,740 (536)	89,050 (614)	29
0.052 (1.3)	Flat	CO <sub>2</sub>	73,970 (510)	84,700 (584)	27
	Horizontal	CO <sub>2</sub>	77,740 (536)	87,170 (601)	27
	V-up	CO <sub>2</sub>	73,680 (508)	83,690 (577)	28
1/16 (1.6)	Flat	CO <sub>2</sub>	74,840 (516)	85,140 (587)	28
		Ar- CO <sub>2</sub>	76,730 (529)	87,750 (605)	26

#### 4. Diffusible hydrogen content (0.045in. 1/16in.)

The diffusible hydrogen content tested with both gases in accordance with AWS A.4.3 is shown Table8.

**Table8 Typical diffusible hydrogen content in weld metal**

Diameter inch (mm)	Shielding gas	Diffusible hydrogen content ml/100g depo				
		N=1	N=2	N=3	N=4	Ave.
0.045 (1.1)	100%CO <sub>2</sub>	3.7	3.8	3.8	3.8	3.9
	75%Ar-25%CO <sub>2</sub>	4.3	4.6	4.5	4.7	4.5
1/16 (1.6)	100%CO <sub>2</sub>	3.8	4.1	3.7	3.9	3.9
	75%Ar-25%CO <sub>2</sub>	4.6	4.6	4.9	4.7	4.7

\*Welding position: Flat. Welding condition: 240A(0.054in.), 300A(1/16in.).

#### 5. Fume generation rate (0.045in. 1/16in.)

The fume generation rate with both gases was investigated according to the condition shown Table9.

**Table9 Typical fume generation rate (mg/min)**

Diameter inch (mm)	Shielding gas	Welding current (A)				
		180	220	260	300	340
0.045 (1.1)	100%CO <sub>2</sub>	426	604	711	833	—
	75%Ar-25%CO <sub>2</sub>	299	431	495	481	—
1/16 (1.6)	100%CO <sub>2</sub>	—	500	656	819	948
	75%Ar-25%CO <sub>2</sub>	—	414	524	625	695

\*Welding position: Flat. Wire-stick out: 1in.(25mm).

## 6. Usage

**Table10 Welding position and proper range of welding current (A)**

Size of wire (mmφ) Welding position	0.045	0.052	1/16
Flat	120 - 300	150 - 400	180 - 450
Vertical upward	120 - 250	150 - 260	180 - 270
Vertical downward	200 - 300	220 - 300	250 - 300
Horizontal	120 - 300	150 - 350	200 - 400
Overhead	120 - 300	150 - 350	200 - 350
Horizontal fillet	120 - 300	150 - 350	200 - 400

## 7. Recommended welding conditions

**Table11 Welding position and proper range of welding current**

Diameter (inch)	Wire Feeding Speed (in/min)	Current (A) DC-EP	Voltage (V)	Deposition Rate (lbs/hr)	Wire Stick Out (in)
0.045	180	140	24-27	5.0	5/8-3/4
	245	180	26-29	7.0	
	330	220	27-30	9.0	
	440	260	29-31	11.5	
	560	300	29-32	15.0	
0.052	130	150	24-27	4.0	3/4-1
	215	210	25-28	7.0	
	315	270	27-29	10.0	
	460	330	30-32	13.0	
	690	400	31-34	17.5	
1/16	120	200	25-28	5.5	3/4-1
	190	260	26-29	8.0	
	250	300	29-31	10.0	
	380	380	30-33	14.0	
	520	450	32-35	18.5	

\*Voltage shown is for 100CO<sub>2</sub> shielding gas. For 75%Ar-25%CO<sub>2</sub> use approximately 2 volts less than shown here.