

KOBELCO

WELDING OF EUROPE

The original since 1968



INTRODUCTION TO FLUX CORED WIRE

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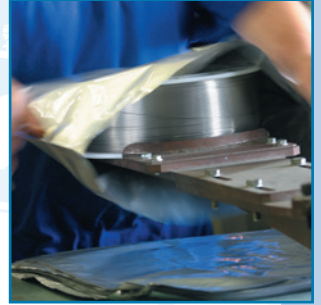
Corporate profile

The Kobe Steel Group operates in a wide range of fields that provide the very foundation of society, including both the materials sector (iron and steel, welding, aluminium and copper) and the machinery sector (industrial machinery, construction machinery, engineering, and the environmental business). The Kobe Steel Group also engage in diverse operations such as electric power supply, real estate and electronic materials.

KOBELCO is the corporate logo mark and brand name of the Kobe Steel Group. Kobe Steel Group aims to maintain the reputation of “KOBELCO, as the one and only trustworthy brand” by supplying the same top quality products, irregardless of where in the world these are manufactured and enhancing our technical support infrastructure which makes it possible for all our customers to carry out their welding jobs confidently.

We will continually research and develop new products and welding processes to contribute and meet the needs of industry and society.

Our corporate goal is to gain recognition as being not only the leading manufacturer in Japan but also the leading welding products manufacturer in the world.



Introduction

Kobelco Welding of Europe B.V. (KWE) is a modern manufacturer of Flux Cored Wire (FCW) which was established in 1994 under license from Kobe Steel, Ltd. Benefiting from Kobe Steel, Ltd.'s almost 80 years of expertise in welding consumables. Kobelco Welding of Europe B.V. has established itself as a leading producer and supplier of flux cored wire for stainless and carbon steel. The wide range of welding consumables covers almost the entire market for stainless and carbon steel.

To satisfy market demand for other welding consumables besides FCW, KWE provides a wide range of consumables manufactured by Kobe Steel, Ltd.

Kobelco welding consumables are used for welding operations all over the world. Industries such as shipbuilding, offshore, construction and many other industrial sectors rely on Kobelco welding consumables.



Foreword

Note the following preliminary information on use of this welding handbook.

1. Standards for welding consumables

AWS : American Welding Society

EN : European Norm

2. Classifications

Welding consumables are classified in accordance with basically the mechanical and / or chemical requirements of the standards, excluding such requirements as size, length, marking and identification manners.

3. The test conditions

- (1) Unless otherwise specified, the testing method and condition are as per EN or AWS standards.
- (2) All mechanical and chemical data are given separately as “Typical” (one of the manufacturer’s test data) and “Guaranty” (the guaranty value).
- (3) Unless otherwise specified, all mechanical test are carried out in the as-welded condition.

4. Packing data

Packaging data shows product length, and mass, the approximate volume.

5. Welding Parameters

Welding parameters indicate the recommended current range of for specific welding positions.

6. Approvals

They may be canceled, added, or changed and may not necessarily be applied to all the welding consumables produced at the plants of Kobe Steel. Therefore, please contact with Global Operations & Marketing Dept. of the Welding Business of Kobe Steel when you need the ship classification approval of a particular welding consumable to be used.

7. Further information

For further information about welding consumable specifications, classifications, approvals and packages, please contact the nearest Kobelco office or sales representative.



Introduction of Kobelco Flux Cored Wires

Metal fabricators face the increasingly difficult challenge of decreasing costs while improving product quality, productivity and the workers environment. In addition, high labour force turnover and lower skill levels are dictating a need for welding processes and consumables that are easy to use and require less operator training.

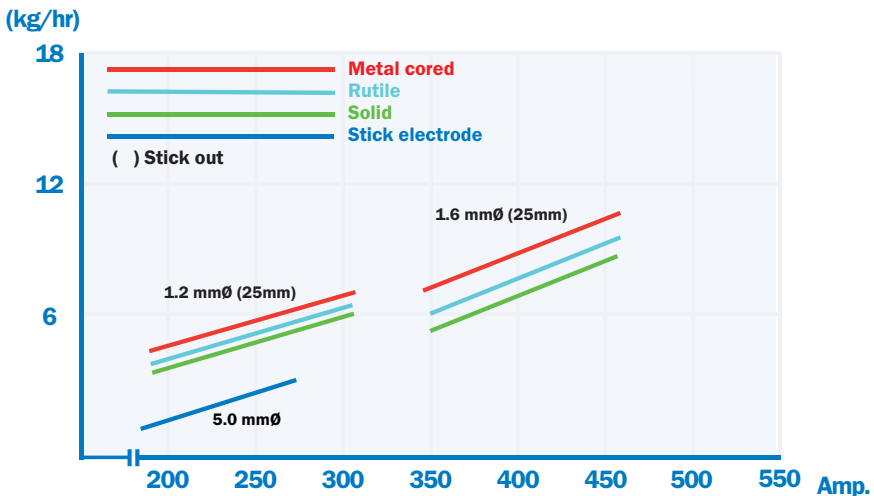
The consumption of flux cored wires (tubular wires) is increasing every year due to their excellent performance and the economical advantages of these wires. Requirements for an increased welded joint quality and productivity pave way for a wide application of flux cored wires.

The gas shielded Flux Cored Arc Welding (FCAW) process using Kobelco flux cored wire has the potential to meet current needs and is flexible enough to meet even more demanding requirements in the future. This is due to more than 50 years of research and development of flux cored wires.

Kobelco flux cored wires come in many different types in response to market requirements. Their main characteristics of superior operability, high deposition rate and excellent wire feeding are well known in the welding industry. They make a great contribution to the reduction of the total costs of welding and the improvement of the welder's working environment.

The important difference between welding with solid wire and tubular flux cored wire (FCW) is performance in productivity and weld metal integrity, particularly with respect to lack of fusion (penetration). The productivity (higher deposition rate) from FCW relies on the I^2R effect (resistance heating), which is much greater than with solid wire at a given current. With solid wire the total cross section carries all the current, but with metal cored wires a part amount of the current is carried by the core and, in the case of rutile FCW's, all of the current is conducted by the outer metal sheath (tube) to give the highest current density (A/mm^2).

High efficiency



Carbon Steel Flux Cored Wire (DW Series)

Recommended Welding Parameters (Shielding gas: 80%Ar - 20%CO₂)

Wire Diameter (mm)	Wire Speed (m/min.)	Welding Current (A)	Arc Voltage (V)	Deposition Rate (kg/hr)	CTWD (mm)	Shielding Gas Flow Rate (litres/min.)
1.2	5.0	150	22-24	2.4	20	20-25
	8.0	200	25-29	3.0		
	10.0	250	28-32	4.2		
	12.0	300	31-35	5.1		

Table shown is approximate values that will vary with change in welding conditions. DC-Electrode positive. Gas flow rate is measured at the torch nozzle.

Carbon Steel Flux Cored Wire (MX Series)

Recommended Welding Parameters (Shielding gas: 80%Ar - 20%CO₂)

Wire Diameter (mm)	Wire Speed (m/min.)	Welding Current (A)	Arc Voltage (V)	Deposition Rate (kg/hr)	CTWD (mm)	Shielding Gas Flow Rate (litres/min.)
1.2	4.0	160	25-28	2.4	20	20-25
	8.0	230	27-31	3.9		
	12.0	300	31-35	6.0		
	15.0	340	34-38	7.2		
1.4	4.0	200	21-27	3.0	20	20-25
	8.0	300	28-33	4.2		
	10.0	350	32-36	6.6		
	12.0	400	35-39	7.8		

Table shown is approximate values that will vary with change in welding conditions. DC-Electrode positive. Gas flow rate is measured at the torch nozzle.

Stainless Steel Flux Cored Wire (DW Series)

Recommended Welding Parameters (Shielding gas: 80%Ar - 20%CO₂)

Wire Diameter (mm)	Wire Speed (m/min.)	Welding Current (A)	Arc Voltage (V)	Deposition Rate (kg/hr)	CTWD (mm)	Shielding Gas Flow Rate (litres/min.)
1.2	4.0	120	20-24	1.8	20	20-25
	6.0	150	22-26	2.4		
	8.5	200	26-30	4.2		
	12.0	250	28-33	6.0		

Table shown is approximate values that will vary with change in welding conditions. DC-Electrode positive. Gas flow rate is measured at the torch nozzle.

Welding with Kobelco Flux Cored Wires

Before welding, the shielding gas to be applied, parameters and welding method must be determined.

Shielding gases

The proper gas flow rate (20 - 25 litres/min) and gas composition is very important for the bead appearance, weldability and the mechanical properties of the weld metal.

Welding parameters

Welding current and voltage influence the arc stability, bead appearance, penetration, spatter, etc. A proper welding current depends on type and size of wire and welding position. Welding speed and stick-out should also be adjusted for optimum results.

Welding technique and torch angle

For welding stainless steel FCW, backhand welding achieves best results. Either backhand or forehand can be used with carbon steel FCW.

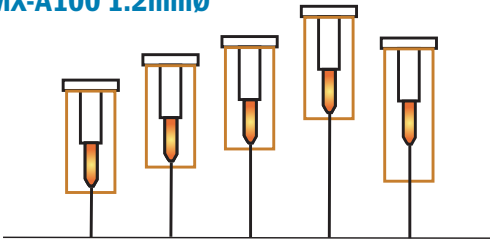
Importance of wire stick-out length

Wire stick-out describes the distance between the contact tip of the welding torch and the base material. For a given wire feed rate, lengthening of the wire stick out has the effect of reducing the amperage drawn from the power source.

Increasing the wire feed speed to compensate for the current (amperage) drop will result in a significant increase in weld metal deposition rate.

The higher deposition rate is due to the I^2R effect (resistance heating of the wire) as all of the current is conducted by the thin outer metal sheath (tube) to give a high current density (A/mm^2) in the FCW.

MX-A100 1.2mmØ



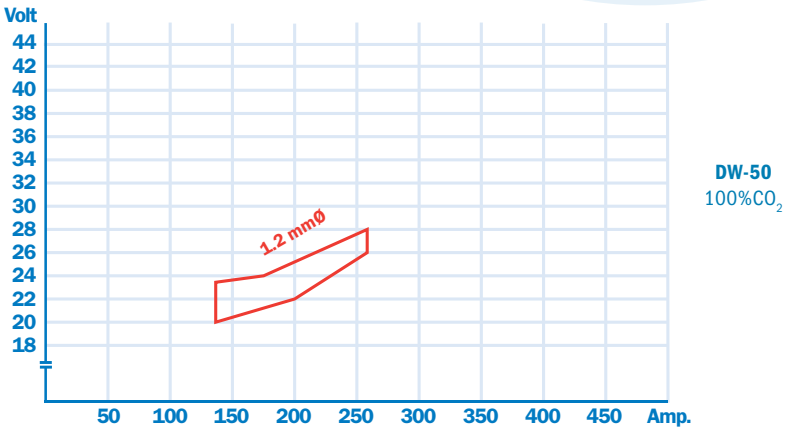
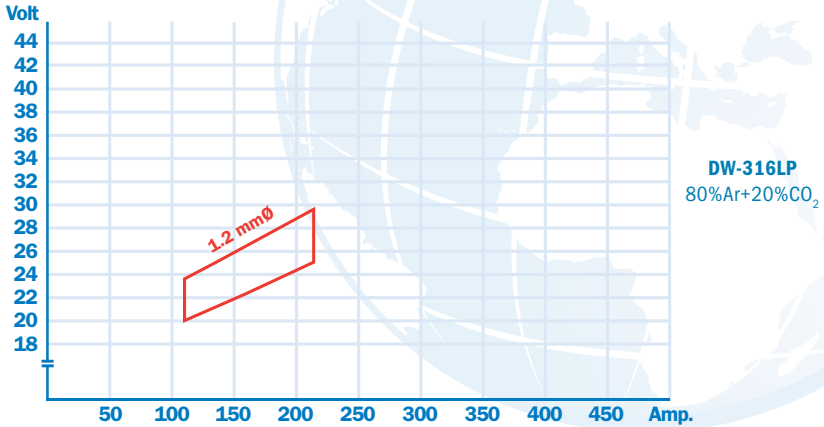
For non mechanised welding, a longer gas cup (gas shroud) can make it easier for the welder to maintain a long stick-out and it is usual to use a longer gas cup for FCW than with solid wire.

Wire Stick Out (mm)	12	18	25	30	25
Wire Feed (m/min)	8.5	8.5	8.5	8.5	12
Current (Amps)	300	260	230	220	300
Deposition (Kg/hr)	4	4	4	4	6

The table above shows that increasing stick-out length leads to a decrease in welding current. Due to constant wire feed speed, deposition rate remains the same. When the wire feed speed is increased to restore the original welding current, deposition rate increases substantially.

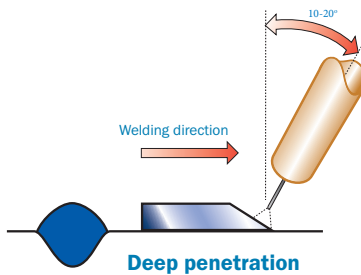
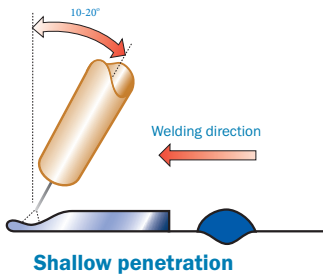
Example welding parameters for positional welding

Recommended Parameter Range, for vertical up position



• Forehand welding

• Backhand welding



Detailed Product Information

Carbon Steel

Product name	Description	Page
DW-50	Mild steel and Y.S.: 420MPa steel	12
DW-A50	Mild steel and Y.S.: 420MPa steel	13
MX-A100	Mild steel and Y.S.: 420MPa steel	14
MX-A70C6LF	Mild steel and Y.S.: 420MPa steel	15
MX-100T	Mild steel and Y.S.: 420MPa steel	16
MX-A200	Mild steel and Y.S.: 420MPa steel	17
MX-200E	Mild steel and Y.S.: 420MPa steel	18
DW-A51B	Mild steel and Y.S.: 420MPa steel (Basic type)	19
DW-55E	Y.S.: 420MPa steel for low temperature steel	20
DW-A55E	Y.S.: 420MPa steel for low temperature steel	21
DW-A55ESR	Y.S.: 420MPa steel for low temperature steel	22
DW-A55S	Y.S.: 460MPa steel	23
DW-A55EH	Y.S.: 460MPa steel for low temperature steel	24
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MX-A55T	Y.S.: 460MPa steel for low temperature steel	29
DW-A55LSR	Y.S.: 460MPa steel for low temperature steel	30
DW-62L	Y.S.: 500MPa steel for low temperature steel	32
DW-A62L	Y.S.: 500MPa steel for low temperature steel	32
DW-A65L	Y.S.: 550MPa steel for low temperature steel	33
DW-A65Ni1	Y.S.: 550MPa steel for low temperature steel	34
DW-A70L	Y.S.: 620MPa steel for low temperature steel	35
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MX-A80L	Y.S.: 690MPa steel for low temperature steel	37
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Stainless Steel and Nickel Alloy

Product name	Description	Page
DW-308L	EN 1.4316 (308L) for welding EN 1.4301 (304L)	39
DW-308LP	EN 1.4316 (308L) for welding EN 1.4301 (304L)	40
DW-309L	EN 1.4332 (309L) for dissimilar joints and cladding	41
DW-309LP	EN 1.4332 (309L) for dissimilar joints and cladding	42
DW-309MoL	EN 1.4459 (309LMo) for dissimilar joints and cladding	43
DW-309MoLP	EN 1.4459 (309LMo) for dissimilar joints and cladding	44
DW-316L	EN 1.4430 (316L) for welding EN 1.4435 (316L)	45
DW-316LP	EN 1.4430 (316L) for welding EN 1.4435 (316L)	46
DW-329A	EN 1.4462 for welding Duplex EN 1.4462 (AISI S31803)	47
DW-329AP	EN 1.4462 for welding Duplex EN 1.4462 (AISI S31803)	48
DW-2307	EN 1.4162 for welding Lean Duplex type 1.4162 - ASTM 32101	49
DW-2594	EN 1.4501 for welding Super Duplex type 1.4410 & 1.4501	50
DW-310	EN 1.4842 for welding EN 1.4845 (310S)	51
DW-312	EN 1.4337 (312) for dissimilar joints and cladding	52
DW-308LT	EN 1.4316 for welding EN 1.4307 (304L) for Cryogenic service	53
DW-308LTP	EN 1.4316 for welding EN 1.4307 (304L) for Cryogenic service	54
DW-316LT	EN 1.4430 (316L) for Cryogenic service applications (-196°C)	55
DW-308H	EN 1.4948 (308H) for high temperature service applications	56
DW-347	EN 1.4551 (347) for high temperature service applications	57
DW-347LH	EN 1.4551 (347) for high temperature service applications	58
DW-309LH	EN 1.4332 for dissimilar joints and cladding (High temp.)	59
DW-309LCb	EN 1.4556 for dissimilar joints and cladding (High temp.)	60
DW-316LH	EN 1.4430 for high temperature service and solution treatment	61
DW-307	EN 1.4370 for dissimilar joints and austenitic Mn-steels (1.3401)	62
DW-317L	EN 1.4440 for welding EN 1.4429 (316LN) & EN 1.4438 (317L)	63
DW-318	EN 1.4576 (318) for 18%Cr-12%Ni-2%Mo-Nb or Ti steels	64
DW-A904L	EN 1.4539 (904L) for welding fully austenitic 904L steel.	65
DW-G	Rutile cored wires from 308L, 309L and 316L for thin gauge plate	66
MX-A	Metal cored wires from 308L, 309L, 309MoL and 316L	67
MX-A430M	EN 1.4016 (430) type for 17%Cr and 13%Cr Ferritic stainless	68
DW-410NiMo	EN 1.4313 for welding 13Cr-Ni-Mo Martensitic stainless steel	69
MX-A410NiMo	EN 1.4313 for welding 13%Cr-Ni-Mo Martensitic stainless steel	70
DW-N82	EN 2.4806 for welding Nickel Based Alloys 600, 800	71
DW-N625	EN 2.4831 for welding Nickel Based Alloys 625, 825	72
DW-N625P	EN 2.4831 for welding Nickel Based Alloys 625, 825	73
DW-NC276	EN 2.4886 for welding Nickel Based Alloy C276	74
TG-X	Flux Cored TIG rod for root pass welding without purging gas	75

Description and Application

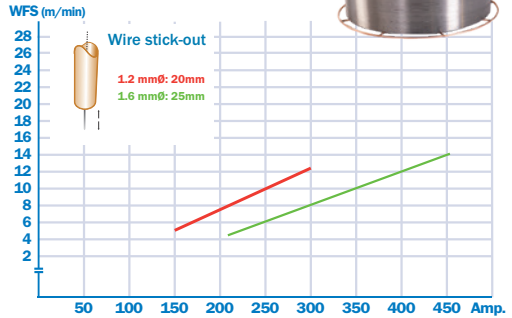
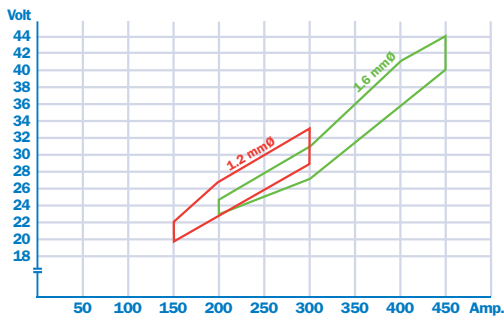
This rutile flux cored wire is very versatile due to its excellent welding characteristics. It is an all positional wire with negligible spatter loss, easy slag removal, soft stable arc, excellent bead profile and appearance, resulting in superb welder appeal.

DW-50 is used for butt or fillet welding of mild and Y.S.: 420MPa steels.

Due to its good mechanical properties combined with less than 5ml/100g hydrogen content in all weld metal (according to EN ISO), this wire is very well suited for constructional steel work, ship building, bridge construction, tank building, etc.



Recommended Parameter Range, for flat position*



* The above values and parameters are for all weld metal produced using 100%CO₂ shielding gas

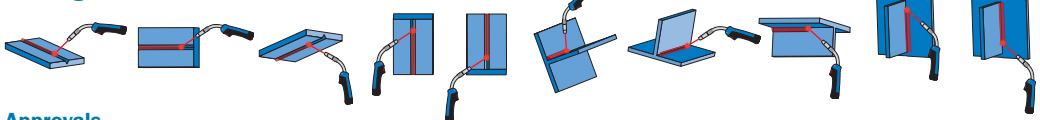
Typical Chemical Analysis (wt. %)

Shielding gas	C	Si	Mn	P	S	Ni	Cr	Mo
100%CO ₂	0.04	0.67	1.29	0.011	0.008	-	-	-
80%Ar-20%CO ₂	0.04	0.69	1.32	0.013	0.009	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C	CV(J)-30°C
100%CO ₂	540	607	30	76	68
80%Ar-20%CO ₂	567	626	29	121	89
Guaranty	min.420	500-640	min.20	min.47	min.27

Welding Positions



Example of Diffusible hydrogen content: 3.8 [ml/100g] 100% CO₂, 4.4 [ml/100g] 80%Ar-20%CO₂

Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
3YS H5	III YMS H5	SA3YM H5	3SA,3YSA H5	3YMS,3Y40MS H5	RINA,CWB

Description and Application

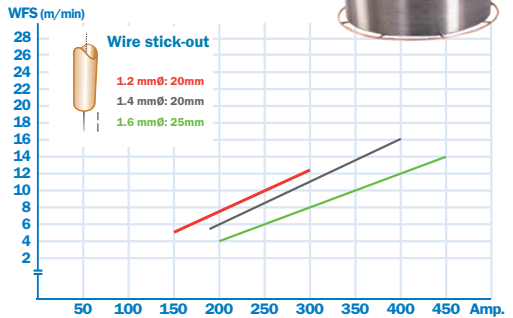
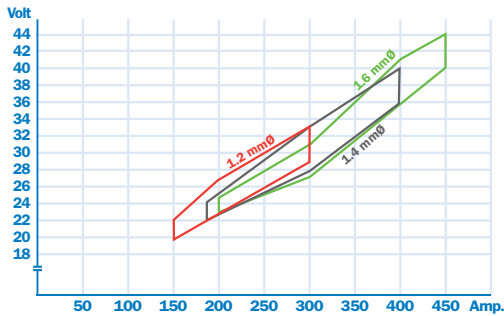
This rutile flux cored wire is very versatile due to its excellent welding characteristics. It is an all positional wire with negligible spatter loss, easy slag removal, soft stable arc, excellent bead profile and appearance, resulting in superb welder appeal.

DW-A50 is used for butt or fillet welding of mild and Y.S.: 420MPa steels.

Due to its good mechanical properties combined with less than 5ml/100g hydrogen content in all weld metal (according to EN ISO), this wire is very well suited for constructional steel work, ship building, bridge construction, tank building, etc.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

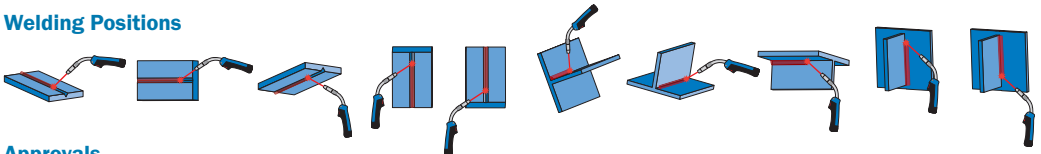
C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.48	1.22	0.013	0.009	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C
Guaranty	510	570	30	110
	min.420	500~640	min.20	min.47

Example of Diffusible hydrogen content: 4.3 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
3YS H5	III YMS H5	SA3YM H5	3SA,3YSA H5	3Y40MS H5	TÜV, DB, RINA

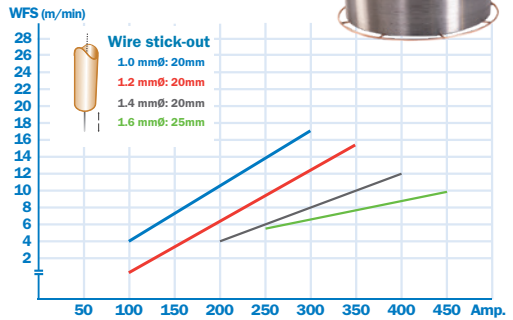
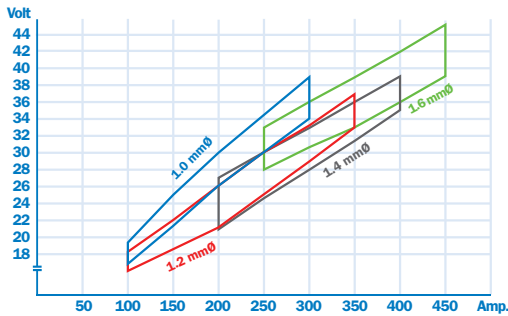
Description and Application

MX-A100 has a high percentage of metal powders in its core which provide many advantages over solid wire, such as high recovery together with high deposition rate. The deposition rate is often as much as 20% or more than that of solid wires, due to superior weldability enabling the use of higher welding currents. This wire operates with a very stable smooth arc giving very little spatter and deep penetration. Slag removal between runs is not necessary because this wire produces almost no silicate slag.

Thanks to its good arc re-striking characteristics combined with excellent wire feeding properties, this wire is an ideal choice for robotic or other kinds of mechanized welding applications.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

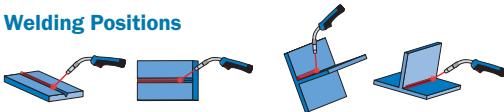
C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.63	1.58	0.017	0.011	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-30°C	CV(J)-40°C
Guaranty	450	550	33	102	89
	min.420	500~640	min.20	min.47	min.47

Example of Diffusible hydrogen content: 2.8 [ml/100g]

Welding Positions



Approvals

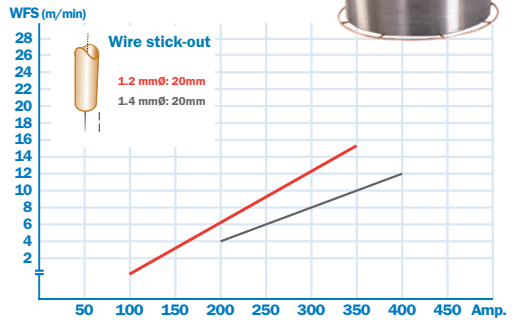
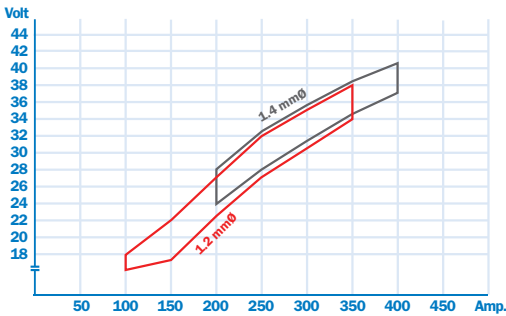
LR	DNV GL	BV	ABS	R.M.R.S	Others
4YS H5	IV YMS H5	SA4YM HHH	4YSA H5	4YMS H5	TÜV, DB, RINA

Description and Application

MX-A70C6LF is a metal-cored wire for mild steel and Y.S.: 420MPa steel. This wire can be welded with less fume level in lower optimum voltage as well comparing with our conventional metal cored wire MX-A100. That is the simple reason why this newly developed metal cored wire is named as "LF" which stands for "Low Fume".



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

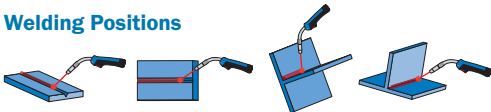
C	Si	Mn	P	S	Ni	Cr	Mo
0.03	0.85	1.70	0.008	0.010	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-30°C
Guaranty	min.420	500~640	min.20	min.47

Example of Diffusible hydrogen content: 2.9 (ml/100g)

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	SA3YM H5	-	-	-

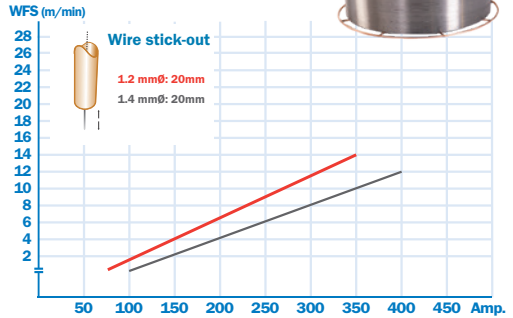
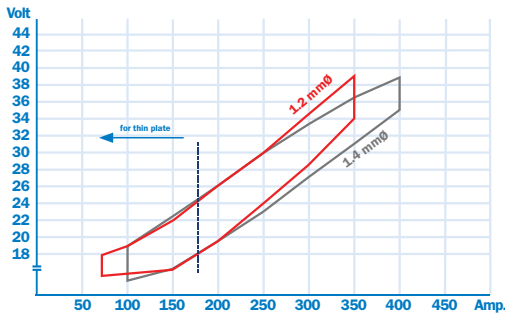
Description and Application

MX-100T is an all positional metal cored wire. Thanks to its excellent arc re-striking characteristics combined with excellent wire feeding properties, this wire is very well suited for welding thin plates.

This wire is especially well suited for root passes without ceramic backing, for example in pipeline construction, which leads to significant increases in productivity when compared to the TIG or stick electrode process.



Recommended Parameter Range, for flat position*



* The above values and parameters are for all weld metal produced using 100%CO₂ shielding gas

Typical Chemical Analysis (wt. %)

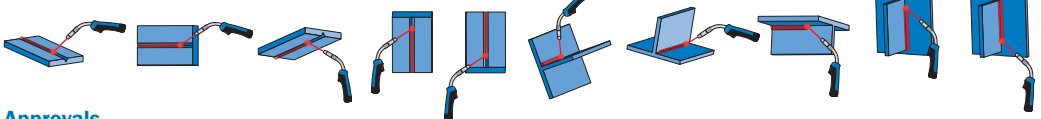
Shielding gas	C	Si	Mn	P	S	Ni	Cr	Mo
100%CO ₂	0.08	0.49	1.53	0.013	0.015	-	-	-
80%Ar-20%CO ₂	0.07	0.61	1.75	0.011	0.014	-	-	-

Typical Mechanical Properties

Shielding gas	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C	CV(J)-30°C
100%CO ₂	480	560	31	71	62
80%Ar-20%CO ₂	500	605	28	73	65
Guaranty	min.420	500~640	min.20	min.47	min.27

Example of Diffusible hydrogen content: 3.0 [ml/100g] CO₂, 3.5 [ml/100g] 80%Ar-20%CO₂

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
3YS H5	IIIYMS H5	SA3YM HHH	3SA, 3YSA H5(C1)	3Y40MS H5	TÜV, DB

Description and Application

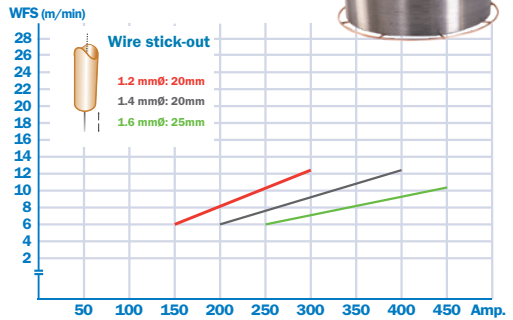
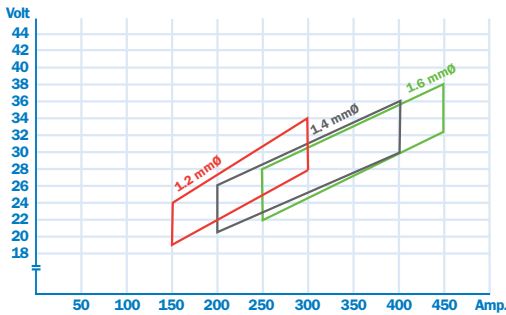
MX-A200 is a metal type flux cored wire. This wire is designed for welding on plate coated with inorganic zinc primer or rusty plate and it has a high resistance to porosity.

MX-A200 produces a clean and shiny weld bead which is totally free from any traces of silicate slag normally associated with metal cored or solid wires.

Due to the absence of silicate slag, painting or other surface treatments can be easily performed after welding.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.56	1.52	0.010	0.009	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)0°C	CV(J)-20°C
Guaranty	520	590	29	93	67
	min.420	500~640	min.20	min.47	min.47

* Example of Diffusible hydrogen content: 4.0 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
3YS H5	III YMS H5	-	3YSA H5	-	-

Description and Application

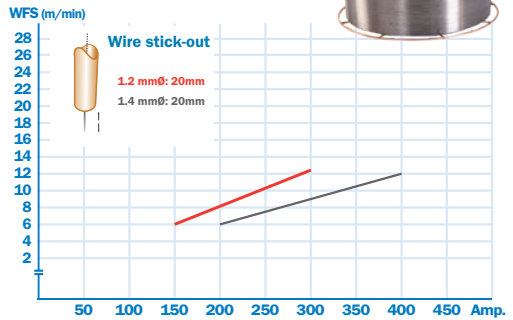
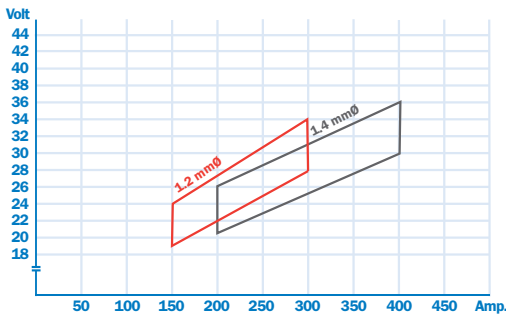
MX-200E is a metal type flux cored wire. This special metal cored wire has been formulated for high speed fillet welding of plate coated with modern inorganic zinc primers, or plate contaminated with rust or mill scale.

MX-200E produces a weld bead totally free from any traces of silicate slag normally associated with the welding of metal cored or solid wires.

This wire is an excellent choice for mechanised welding of horizontal fillets as it meets the requirements of superior wire feeding properties combined with high deposition efficiency and excellent resistance to porosity. It has found wide acceptance for the fillet welding of stiffeners in the shipbuilding industry.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.60	1.60	0.008	0.007	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-30°C
Guaranty	min.420	500~640	min.20	min.47

Example of Diffusible hydrogen content: 4.3 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
4Y40S H5	IVY40MS H5	SA4Y40M H5	4Y400SA H5	4Y40MS H5	P.R.S.

Description and Application

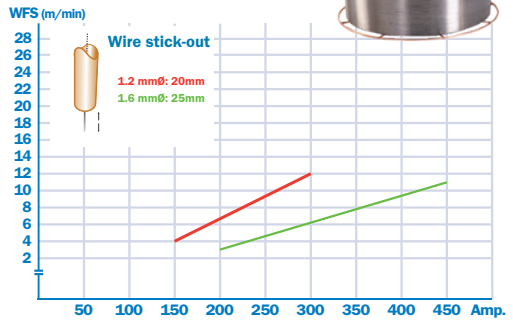
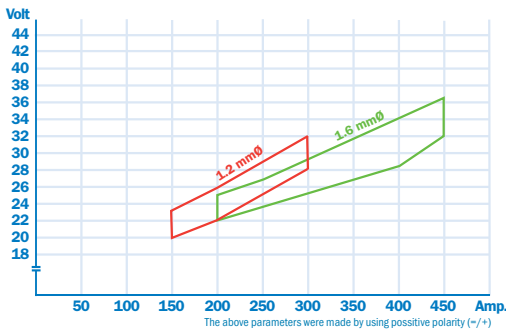
DW-A51B is a fully basic FCW which produces very low hydrogen weld metal of excellent crack resistance.

This wire is particularly suitable for multipass welding of medium to heavy sections where conditions of high restraint exist and where extra low hydrogen levels are necessary.

DW-A51B is also often applied in situations where an ideal joint fit-up can not be achieved, leading to an increased risk of cracking when applying other welding consumables, for example when welding root passes on ceramic backing.



Recommended Parameter Range, for flat position



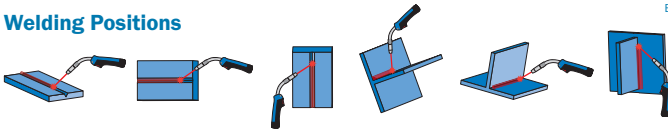
Typical Chemical Analysis (wt. %)

Polarity	C	Si	Mn	P	S	Ni	Cr	Mo
DC+	0.08	0.49	1.43	0.012	0.008	-	-	-
DC-	0.08	0.46	1.45	0.011	0.008	-	-	-

Typical Mechanical Properties

Polarity	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C	CV(J)-40°C
DC+	490	569	29	130	89
DC-	473	560	31	139	127
Guaranty	min.420	500~640	min.20	min.47	min.47

Welding Positions



Example of Diffusible hydrogen content: 4.2 (ml/100g)

Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
3YS H5	III YMS H5	SA3YM H5	-	-	TÜV, DB

Description and Application

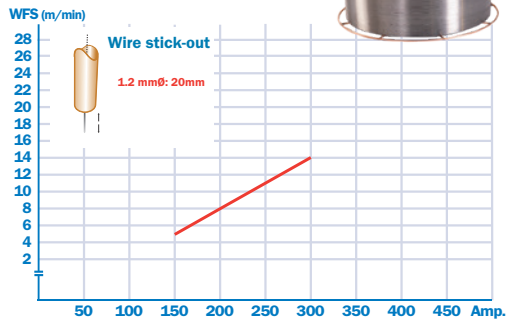
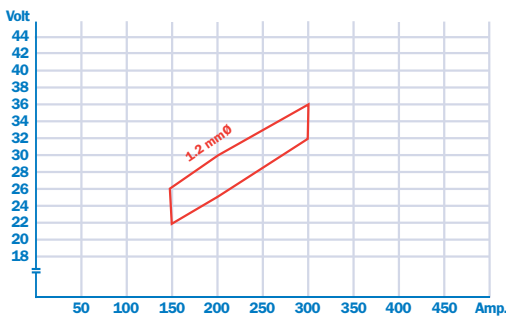
DW-55E is a rutile flux cored wire that has been specially formulated to meet rigorous demands for low temperature service steels. It is applied particularly where really good toughness is required down to -40°C.

The fast freezing slag promotes easy and very productive positional welding with slag removing easily to reveal a weld bead of smooth appearance.

This wire is used for butt or fillet welding of medium to heavy section carbon steels and is used widely in the shipbuilding and bridge construction industries.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

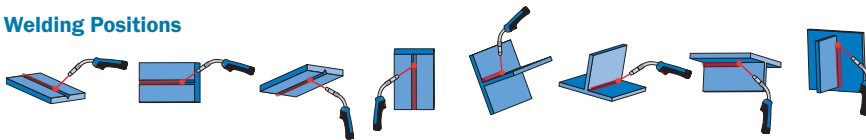
C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.40	1.42	0.012	0.010	0.41	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-40°C
Guaranty	540	590	29	80
	min.420	500~640	min.20	min.47

Example of Diffusible hydrogen content: 4.1 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
4Y40S H5	IVY40MS H5	SA4Y40M H5	4Y400SA H5	-	NK, CR

Description and Application

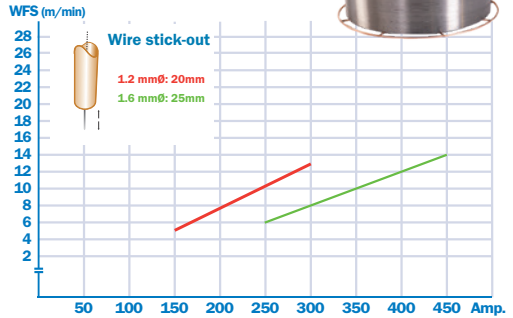
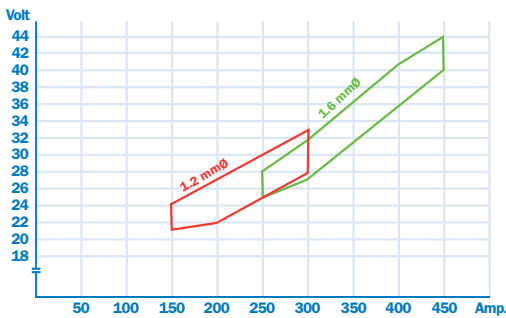
DW-A55E is a rutile flux cored wire that was specially formulated to meet rigorous demands for low temperature service steels. This wire is applied particularly where really good toughness is required down to -40°C.

The fast freezing slag promotes easy and very productive positional welding with slag removing easily to reveal a weld bead of smooth appearance.

This wire is used for the butt or fillet welding of medium to heavy section carbon steels and is used widely in the shipbuilding and bridge construction industries.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

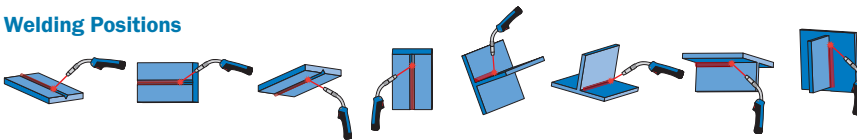
C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.54	1.31	0.013	0.009	0.34	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-40°C
Guaranty	540	600	28	100
	min.420	500~640	min.20	min.47

Example of Diffusible hydrogen content: 4.3 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
4Y40S H5	IVYMS H5	SA4Y40M HHH	4Y400SA H5	4Y40MS H5	TÜV, DB, RINA

Description and Application

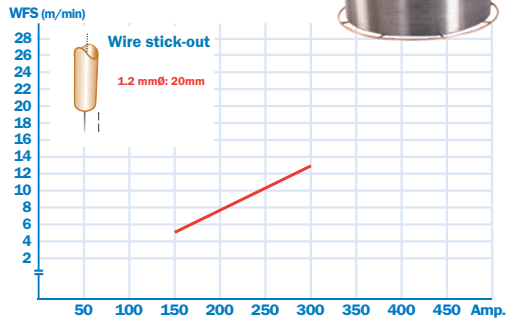
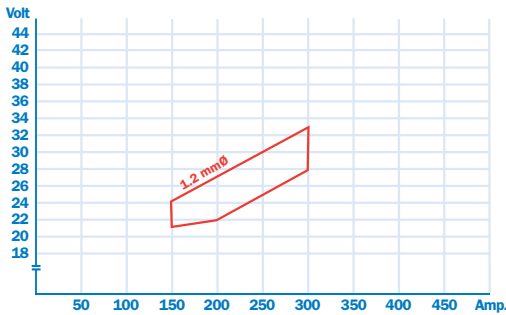
DW-A55ESR is a rutile flux cored wire that was specially formulated to meet rigorous demands for low temperature service applications requiring really good toughness down to -40°C after post weld heat treatment.

The fast freezing slag promotes easy and very productive positional welding with slag removing easily to reveal a weld bead of smooth appearance.

This wire is used for the butt and fillet welding of medium to heavy section carbon steels and is used widely in the Offshore and Pressure vessel construction industries.



Recommended Parameter Range, for flat position



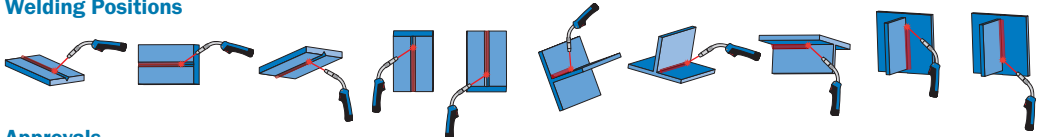
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Mo
0.06	0.57	1.50	0.009	0.006	0.45	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-40°C
As welded	521	606	32	132
620°Cx3hrs(SR)	502	585	33	96
Guaranty (As welded)*	min.420	500~640	min.20	min.47

Welding Positions



Example of Diffusible hydrogen content: 3.9 [ml/100g]

Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	4Y400SA H5	-	TÜV

*Contact us for the Guaranty value for specific SR conditions.

Description and Application

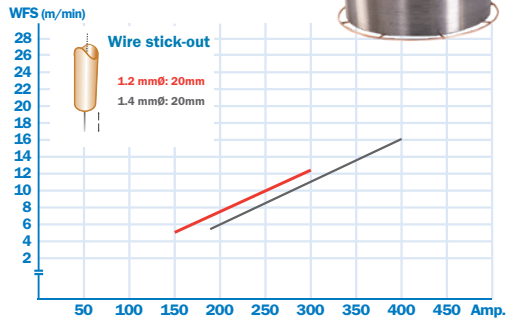
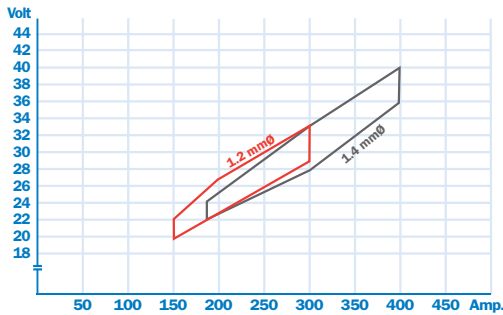
DW-A55S is a rutile type flux cored wire with negligible spatter loss, easy slag removal, soft arc, excellent bead profile and appearance.

DW-A55S is suited for butt or fillet welding of Y.S.: 460MPa steels.

Due to its good mechanical properties combined with less than 5ml/100g hydrogen content in all weld metal (according to EN ISO), this wire is very well suited for constructional steel, bridge construction, tank building, etc.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

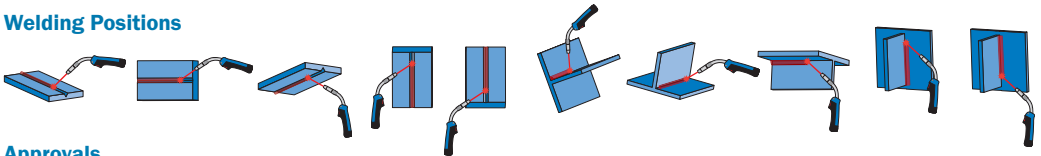
C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.51	1.28	0.010	0.009	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C
Guaranty	535	601	24	124
	min.460	530~670	min.22	min.47

Example of Diffusible hydrogen content: 4.3 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

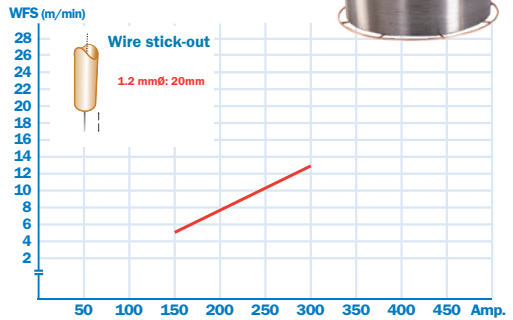
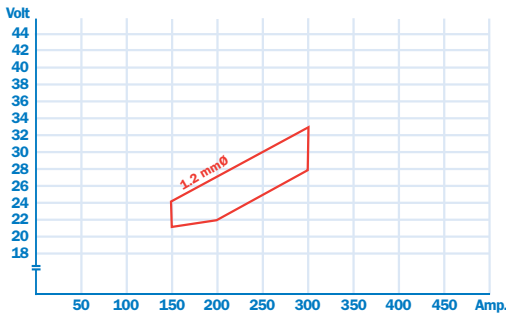
DW-A55EH is a rutile flux cored wire that was specially formulated to meet rigorous demands for low temperature service application required really good toughness down to -40°C. This wire also can be used for applications where post weld heat treatment is required depending on the conditions and toughness requirements.

This wire is very versatile due to its excellent welding characteristics. It is an all positional wire with negligible spatter loss, easy slag removal, soft arc, excellent bead profile and appearance, resulting in superb welder appeal.

This wire is used for the butt and fillet welding of medium to heavy section carbon steels and is used in the Offshore and Pressure vessel construction industries.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

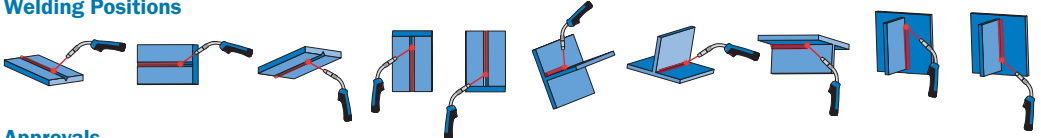
C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.63	1.17	0.010	0.007	0.38	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-40°C
As welded	561	603	29	133
620°Cx3hrs(SR)	485	579	32	119
Guaranty (As welded)	min.420	500-640	min.20	min.47

Example of Diffusible hydrogen content: 4.5 (ml/100g)

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

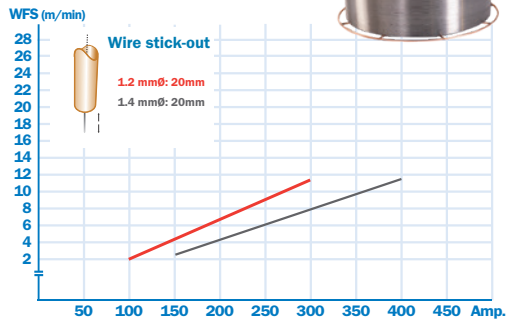
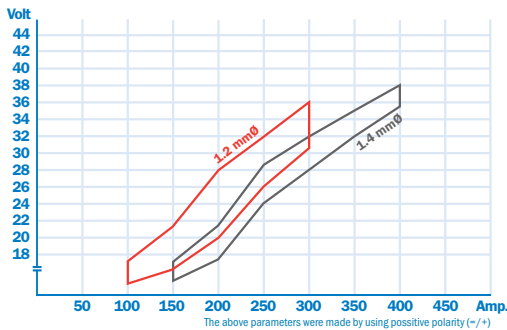
MX-A55S is a metal cored wire that produces low hydrogen weld-metal with good mechanical properties.

The ability of **MX-A55S** to be welded with negative polarity (=/-) greatly widens its application range, especially for high speed vertical down welding.

This wire is very well suited for constructional steel work, ship building, bridge construction, tank building, etc.



Recommended Parameter Range, for flat position



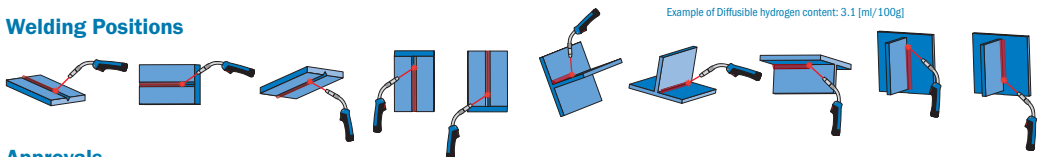
Typical Chemical Analysis (wt. %)

Polarity	C	Si	Mn	P	S	Ni	Cr	Mo
DC+	0.08	0.60	1.43	0.008	0.009	-	-	-
DC-	0.08	0.50	1.39	0.009	0.009	-	-	-

Typical Mechanical Properties

Polarity	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-30°C	CV(J)-40°C
DC+	510	600	30	122	110
DC-	523	604	29	130	116
Guaranty	min.460	530~680	min.20	min.47	min.47

Welding Positions



Example of Diffusible hydrogen content: 3.1 [ml/100g]

Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
4Y42S H5	IV Y42MS H5	-	-	-	TUV, DB

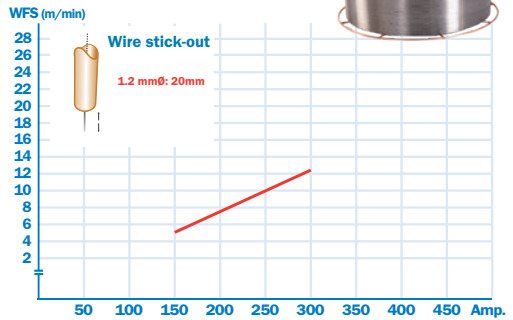
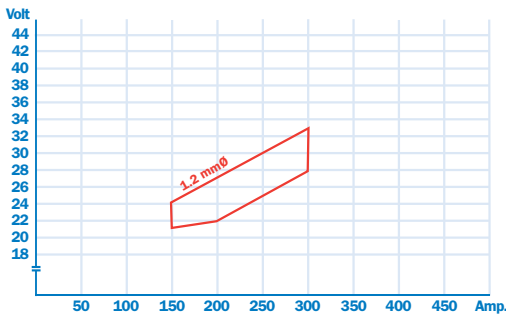
Description and Application

DW-A81Ni1 is a rutile flux cored wire which has been specially formulated to meet the rigorous demands for low temperature service steels. This wire can also be used for applications where post weld heat treatment is required depending on the conditions and toughness requirement.

DW-A81Ni1 fulfills NACE requirements for oil and gas production equipment in sour gas service and these properties make for a varied range of usages in pipeline construction, offshore applications and pressure vessels.



Recommended Parameter Range, for flat position



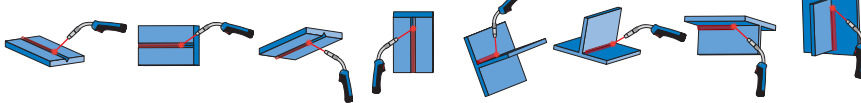
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.32	1.26	0.006	0.006	0.95	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-40°C	CV(J)-60°C
As welded	517	582	29	153	142
580°Cx2hr(SR)	490	578	30	139	128
Guaranty (As welded)	min.460	530-680	min.20	-	min.47

Welding Positions



Example of Diffusible hydrogen content: 4.4 [ml/100g]

Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
5Y42S H5	VY42MS H5	-	5YQ420SA H5, 4Y400SA H5	5Y42MS H5	TÜV

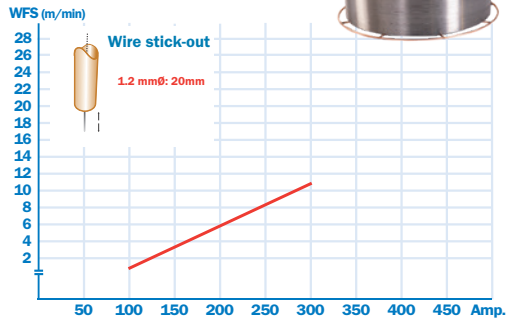
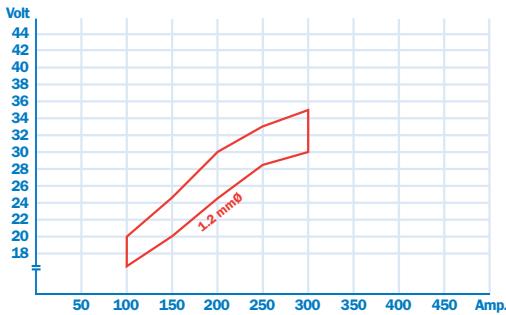
Description and Application

MX-A55Ni1 is a metal cored wire, which has been specially formulated to meet the rigorous demands for low temperature service steels.

MX-A55Ni1 fulfills the NACE requirements for oil and gas production equipment in sour gas service and these properties make for a varied range of usages in pipeline construction, offshore applications and pressure vessels.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

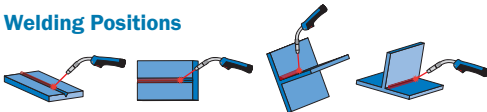
C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.34	1.67	0.007	0.008	0.86	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-60°C
Guaranty	542	607	29	123
	min.460	530~680	min.20	min.47

Example of Diffusible hydrogen content: 2.5 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

DW-A55L is a rutile flux cored wire that has been specially formulated to meet the rigorous demands for low temperature service as found in the offshore, shipbuilding and chemical industries.

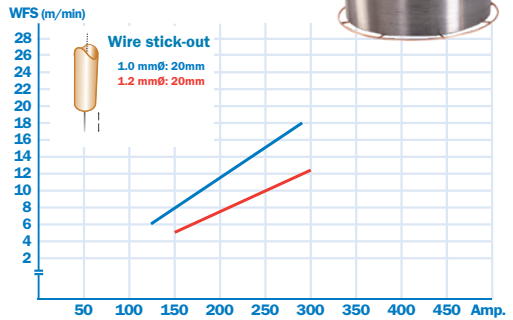
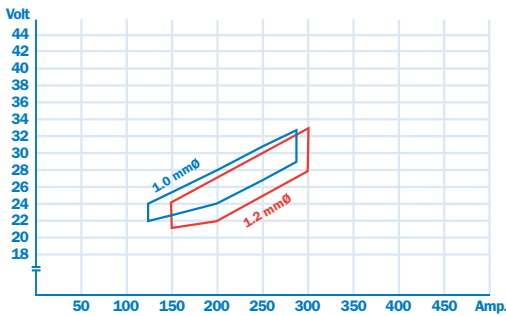
This wire has excellent weld metal toughness down to -60°C and still exhibits superb welding characteristics such as a very smooth, but forceful, stable arc producing little spatter and a fast freezing self releasing slag.

This wire is widely applied to the welding of thin to heavy section carbon steels.

Not only does this wire have excellent CTOD values at the standard -10°C test temperature, but is also has excellent CTOD values at the very severe test temperature of -40°C.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

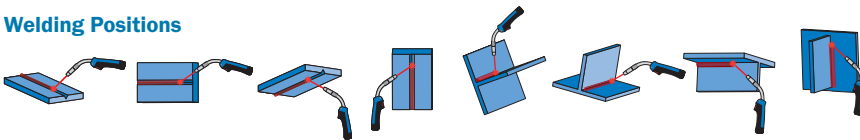
C	Si	Mn	P	S	Ni	Cr	Mo
0.06	0.30	1.15	0.009	0.007	1.41	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-60°C
	558	626	27	94
Guaranty	min.460	530~680	min.20	min.47

Example of Diffusible hydrogen content: 4.5 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
5Y46S H5	VY46MS H5	S5Y46 H5	3YSA H5	5Y46MS H5	RINA, TÜV
	NV2-4,4-4		3SA		P.R.S.

* The information contained or otherwise referenced herein is presented only as "typical" without guaranty or warranty. Typical data is obtained when welded and tested in accordance with EN or AWS standards. This data is intended to help the user choose the correct product. However, we do not assume any liability for correctness and information is subject to change without notice.

Description and Application

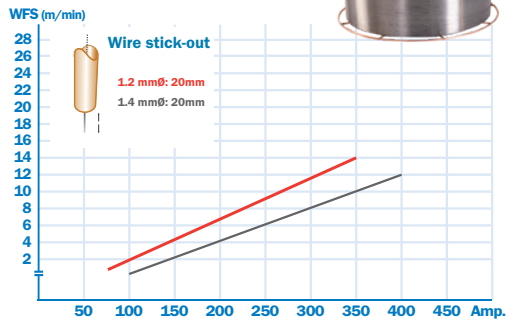
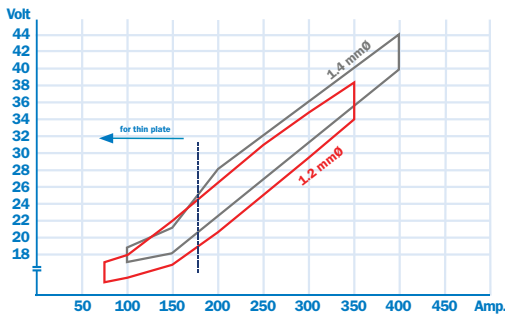
MX-A55T is a metal cored wire which has been developed for use with mixed gas and is specially designed to give good low temperature toughness, thus making it suitable for low temperature applications where conventional metal cored wires may not prove suitable.

This wire is applied for horizontal and downhand welding of thick sections and also for all positional root pass welding with short circuit arc transfer.

These properties result in a wire which is ideally suited to offshore fabrication and other applications where service temperatures down to -60°C are required.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

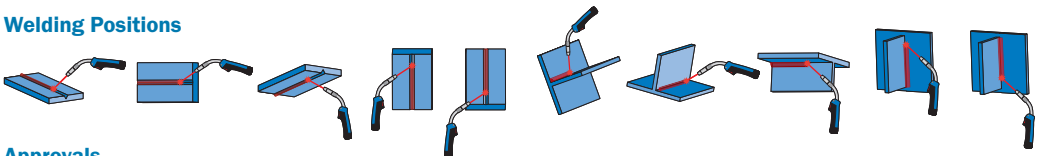
C	Si	Mn	P	S	Ni	Cr	Mo
0.06	0.35	1.41	0.011	0.017	1.48	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-40°C	CV(J)-60°C
Guaranty	517	598	31	100	97
	min.460	530~680	min.20	min.47	min.47

Example of Diffusible hydrogen content: 2.3 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
5Y40S H5	VYMS H5 NV2-4,4-4	SA3YM H5 MG	-	-	-

Description and Application

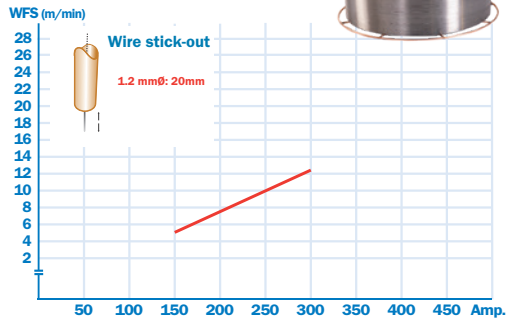
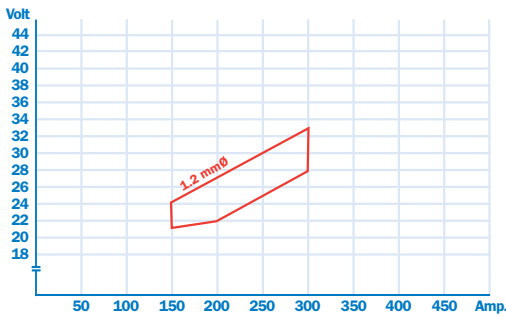
DW-A55LSR is a rutile flux cored wire whose weld metal tolerates post weld heat treatment (PWHT) without an adverse degradation of mechanical properties.

DW-A55LSR produces a nominal 0.9%Ni weld metal which means that it fulfills NACE requirements for oil and gas production equipment in sour gas service.

These properties make for a varied range of usages in pipeline construction and offshore applications.



Recommended Parameter Range, for flat position



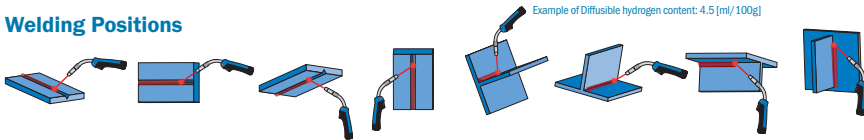
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.33	1.32	0.009	0.008	0.90	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-60°C
As welded	510	570	29	120
620°C x 2 hr (SR)	450	530	33	70
Guaranty (as welded)	min.460	530-680	min.20	min.47

Welding Positions



Example of Diffusible hydrogen content: 4.5 (ml/100g)

Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
5Y42S H5	VY42MS H5 NV2-4L,4-4L	SA5Y42 H5	5YQ420SA H5	5Y42MS H5	P.R.S.

Description and Application

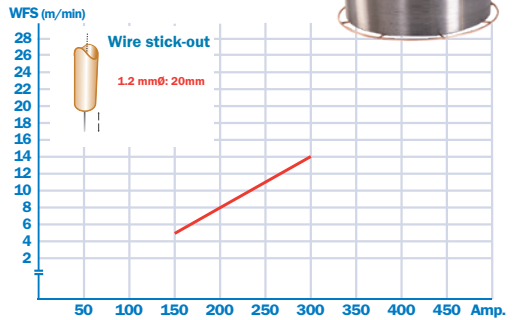
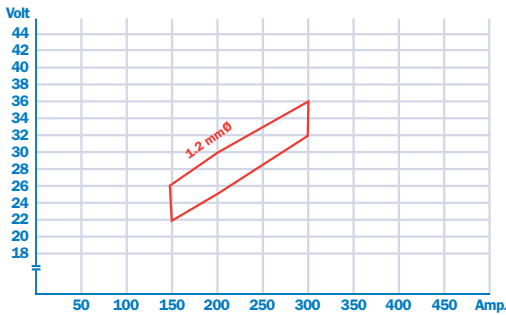
DW-62L is a rutile flux cored wire specially formulated to meet the rigorous demands for 500 MPa yield strength class low temperature service steels, as found in the offshore and shipbuilding industries.

Not only does this wire have excellent CTOD values at the standard -10°C test temperature, but it also has excellent CTOD values at the very severe test temperature of -40°C.

This wire is applied to the welding of medium to heavy section butt or fillet weld joints.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

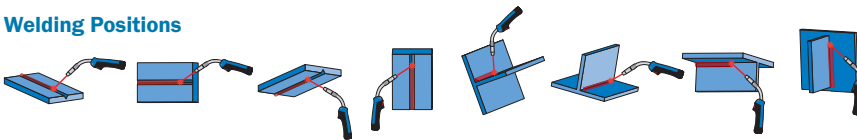
C	Si	Mn	P	S	Ni	Cr	Mo
0.08	0.27	1.32	0.009	0.007	2.6	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-60°C
Guaranty	601	660	25	100
	min.500	560~720	min.18	min.47

Example of Diffusible hydrogen content: 3.1 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	5YQ500SA H5	5Y50 MS H5	-

Description and Application

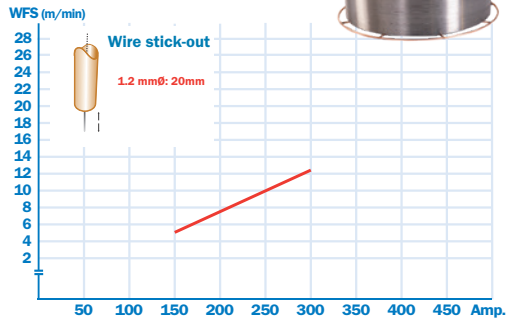
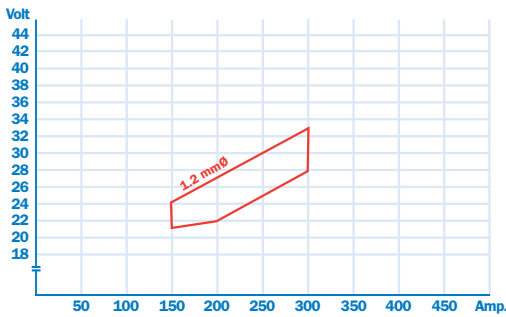
DW-A62L is a rutile flux cored wire specially formulated to meet the rigorous demands for 500 MPa yield strength class low temperature service steels, as found in the offshore and shipbuilding industries.

Not only does this wire have excellent CTOD values at the standard -10°C test temperature, but is also have excellent CTOD values at the very severe test temperature of -40°C.

This wire is applied to the welding of medium to heavy section butt or fillet weld joints.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

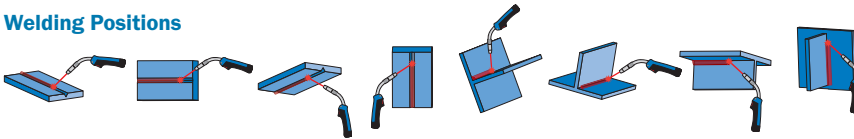
C	Si	Mn	P	S	Ni	Cr	Mo
0.07	0.32	1.33	0.007	0.011	2.1	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-60°C
Guaranty	min.500	560~720	min.18	min.47

Example of Diffusible hydrogen content: 3.9 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
5Y50S H5	VY50MS H5	-	5YQ500SA H5	-	-

Description and Application

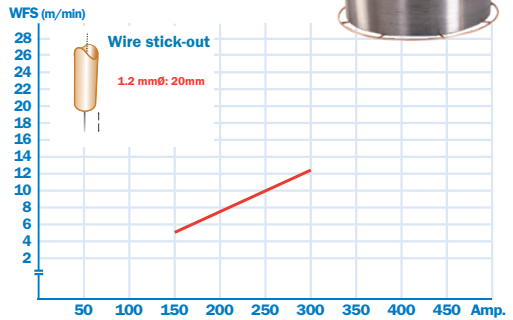
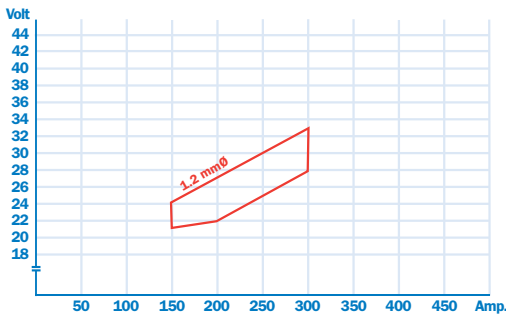
DW-A65L is a rutile flux cored wire specially formulated to meet the rigorous demands for 640 MPa tensile strength class low temperature service steels, as found in the offshore shipbuilding and chemical industries.

This wire is applied to the welding of medium to heavy section butt or fillet weld joints.

DW-A65L continues to find new applications due to the increasing use of 550 MPa yield strength low temperature service steels.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

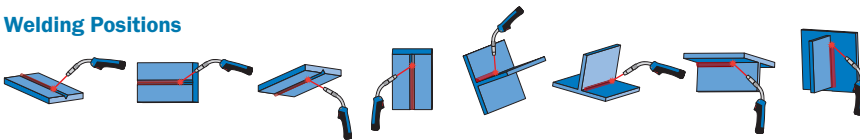
C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.35	1.17	0.010	0.009	1.69	-	0.11

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-40°C
Guaranty	min.550	640~820	min.18	min.47

Example of Diffusible hydrogen content: 4.2 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

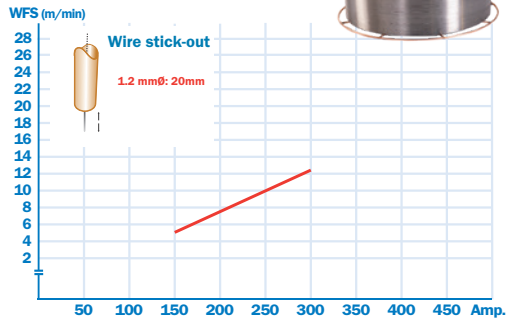
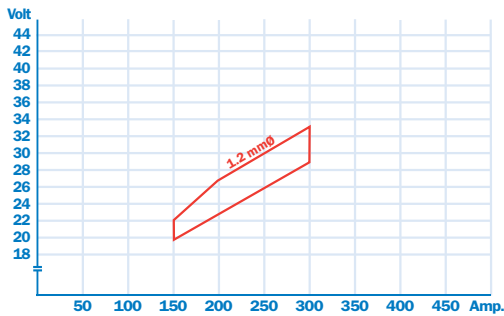
DW-A65Ni1 is especially designed to meet the demands of On-Shore and Off-Shore pipelines. This wire is used for the welding of high tensile strength steels like X65, X70, including matching and/or, overmatch requirement from the nominal yield levels of these materials.

DW-A65Ni1 produces a weld metal containing max 1.0%Ni, something that also makes this wire comply with the NACE requirements for sour gas service.

DW-A65Ni1 is a rutile flux cored wire, ensuring good operability and weldability on fixed pipes in vertical up PH (5G) position.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

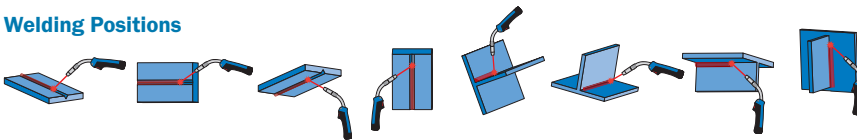
C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.33	1.51	0.009	0.008	0.95	-	0.16

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-50°C
	611	670	23	84
Guaranty	min.550	640~760	min.18	min.47

Example of Diffusible hydrogen content: 3.3 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
4Y50S H5	IVY50MS (H5)	-	-	-	-

TRUSTARC™ DW-A70L

80%Ar - 20%CO₂

EN ISO 18276-A-T 62 5 Mn1NiMo P M 2 H5

AWS A5.29 E101T1-GM

Description and Application

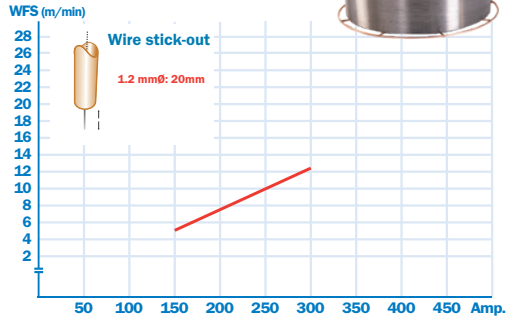
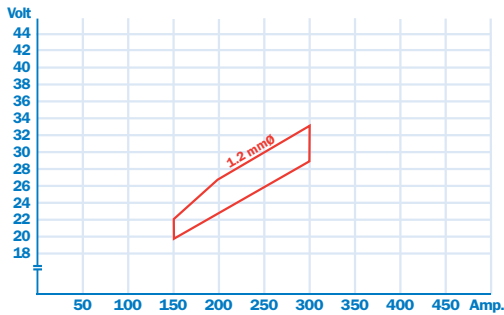
DW-A70L is especially designed to meet the increasing demands in On-Shore and Off-Shore pipelines with the introduction of high strength steels such as X70 and X80, including matching, and/or, requirements for overmatching the nominal yield levels of these materials.

DW-A70L produces a weld metal containing max 1.0%Ni, something that also makes DW-A70L comply with the NACE requirements for sour gas service, making this product very versatile for pipeline application operating on both "sweet" and "sour" conditions.

DW-A70L is a fully rutile flux cored wire, ensuring good operability and weldability on fixed pipes in vertical up PH (5G) position. The wire is designed for manual and fully automated welding processes currently applied by pipeline contractors.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

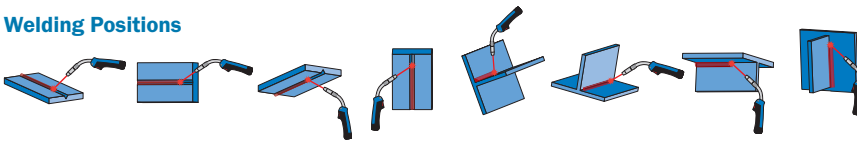
C	Si	Mn	P	S	Ni	Cr	Mo
0.05	0.36	1.90	0.008	0.011	0.97	-	0.46

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-50°C
Guaranty	min.620	700~890	min.18	min.47

Example of Diffusible hydrogen content: 3.7 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
4Y62S H5	IV Y62MS H5	-	-	-	NAKS

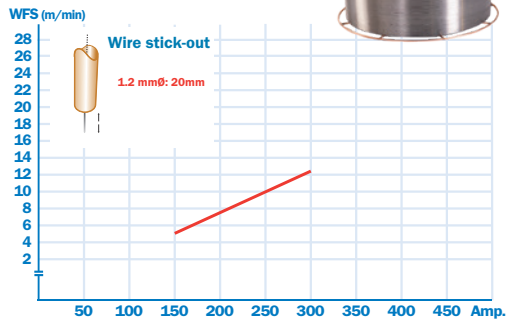
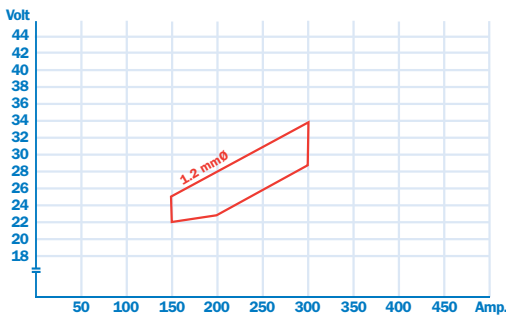
Description and Application

DW-A80L is designed for welding 690 MPa yield strength steels that are used in heavy industries such as offshore, pipeline, crane, construction machinery, etc.

DW-A80L is a rutile flux cored wire for all positional welding. This wire provides excellent mechanical properties and crack resistance.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

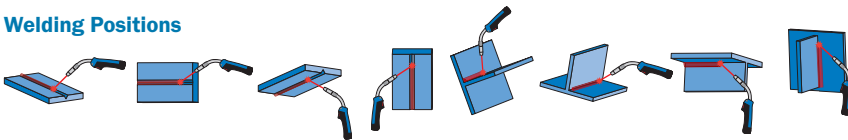
C	Si	Mn	P	S	Ni	Cr	Mo
0.07	0.32	1.82	0.008	0.006	2.42	-	0.15

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-40°C	CV(J)-60°C
Guaranty	739	808	22	94	83
	min.690	770~940	min.17	-	min. 47

Example of Diffusible hydrogen content: 2.4 [ml/100g]

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
4Y69 H5	IV Y69MS H5	-	4YQ690SA H5,MG	-	-

TRUSTARC™ MX-A80L

80%Ar - 20%CO₂

EN ISO 18276-A-T 69 6 Mn2.5Ni M M 3 H5

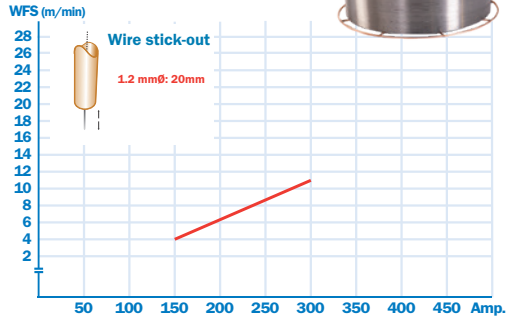
AWS A5.28 E110C-G

Description and Application

MX-A80L is designed for welding 690 MPa yield strength steels that are used in heavy industries such as offshore, pipeline, crane, construction machinery, etc.

MX-A80L is a metal cored wire for flat and horizontal welding. This wire provides excellent mechanical properties and crack resistance.

Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

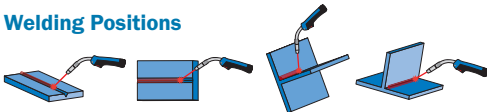
C	Si	Mn	P	S	Ni	Cr	Mo
0.06	0.48	1.87	0.008	0.010	2.37	-	0.09

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-40°C	CV(J)-60°C
Guaranty	min.690	770~940	min.17	min.47	min.47

Example of Diffusible hydrogen content: 1.3 [ml/100g]

Welding Positions



Approvals

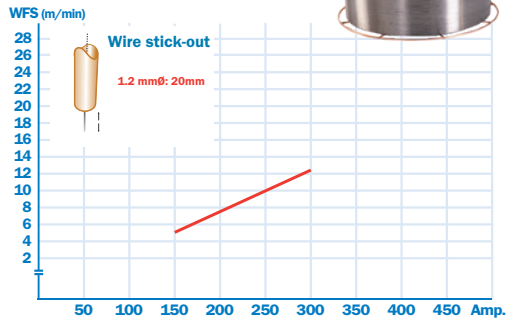
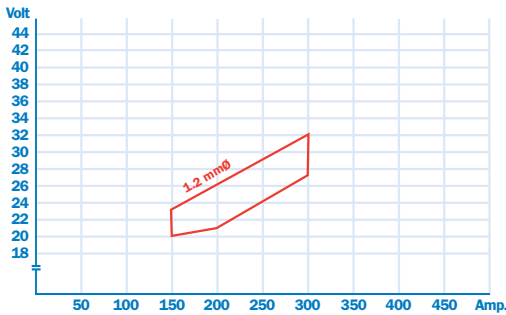
LR	DNV GL	BV	ABS	R.M.R.S	Others
5Y69S H5	VY69MS H5	-	5YQ690SA H5	-	-

Description and Application

DW-A588 is suitable for butt or fillet welding of 570 MPa weather proof steel and A588 steel (which are normally used without painting). It is a rutile type FCW applicable for all positional welding. It shows good bead appearance, bead shape and low spatter generation.



Recommended Parameter Range, for flat position



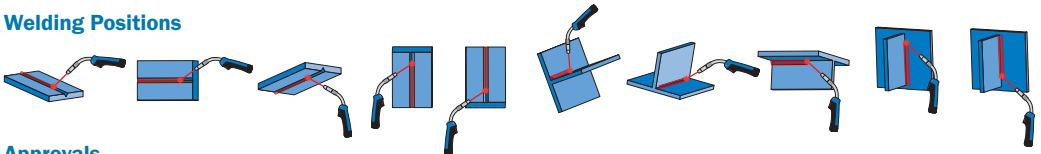
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Cu
0.03	0.55	1.16	0.008	0.006	0.53	0.50	0.32

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C	CV(J)-30°C
Guaranty	583	644	24	110	54
	min.500	560~720	min.18	min.47	min.27

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

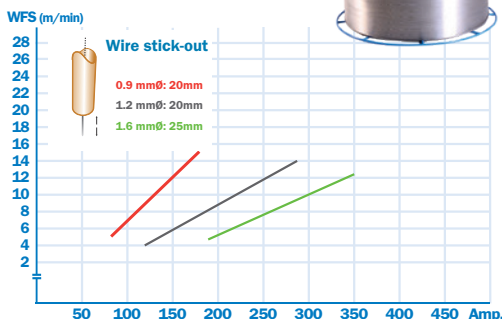
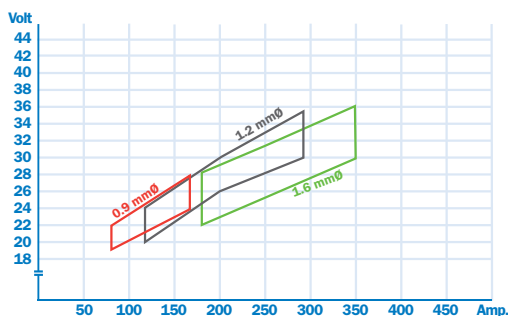
Description and Application

This is rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces and self releasing slag.

This wire is designed for welding 18%Cr-10%Ni type stainless steels like type 304L or EN 1.4307. Due to the low carbon content in the weld metal, it is possible to obtain high resistance to intergranular corrosion.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)

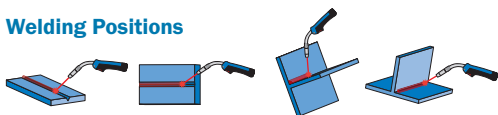
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.02	0.60	1.60	0.020	0.005	10.1	19.7	-	-	-	8.9	12.4	10.8

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C
Guaranty	min.320	min.520	min.30	45

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
304L	VL 308 L	-	MG	-	TÜV, DB, CWB

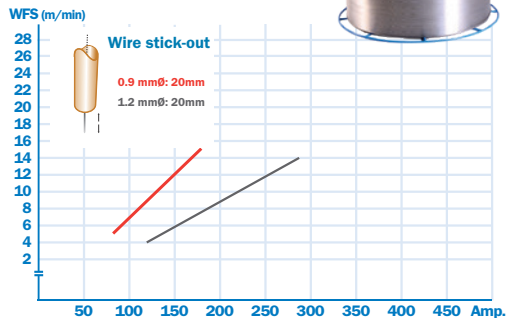
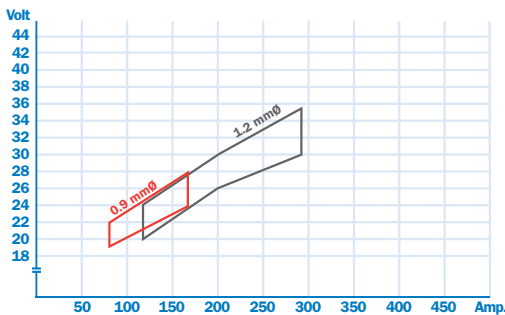
Description and Application

This is rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces and self releasing slag.

This wire is designed for welding 18%Cr-10%Ni type stainless steels like type 304L or EN 1.4307. Due to the low carbon content in the weld metal, it is possible to obtain high resistance to intergranular corrosion.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

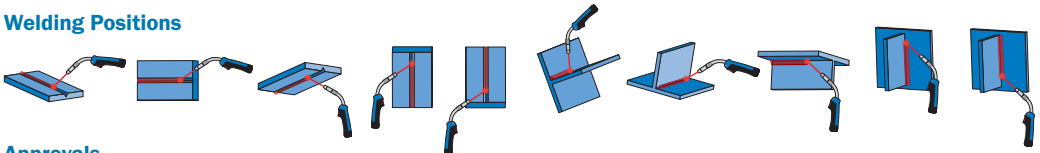
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.70	1.70	0.019	0.004	9.9	19.5	-	-	-	9.0	12.5	10.3

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)+20°C	CV(J)-20°C
Guaranty	min.320	min.520	min.30	60	51

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	VL308L	-	E 308LT1-4/ MG (C1)	-	TÜV, DB, CWB, RINA

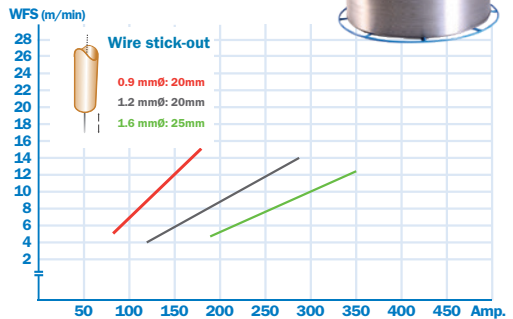
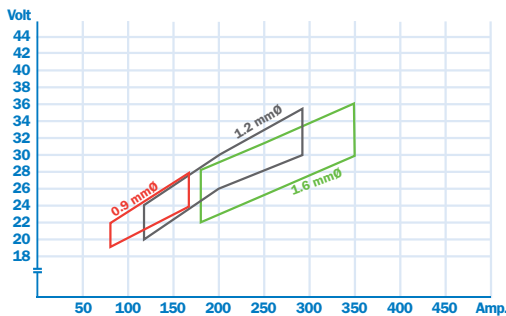
Description and Application

This is a rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces and self releasing slag.

This wire deposits a low carbon weld of about 24%Cr-13%Ni. It is designed for dissimilar welding such as welding stainless steel to mild steel or low alloy steel. The wire is also suitable for the first layer on mild or low alloy steel prior to overlaying with **DW-308L** or **DW-308LP**



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

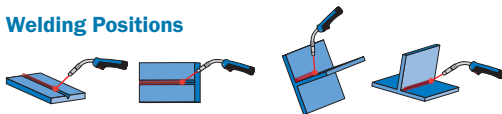
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.02	0.70	1.40	0.019	0.005	12.6	23.9	-	-	-	13.2	>18.0	19.9

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C
Guaranty	450	580	35	43
	min.320	min.520	min.30	

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
SS/CMn Dup/CMn	VL 309 L	309L	MG	-	TÜV, DB, CWB RINA

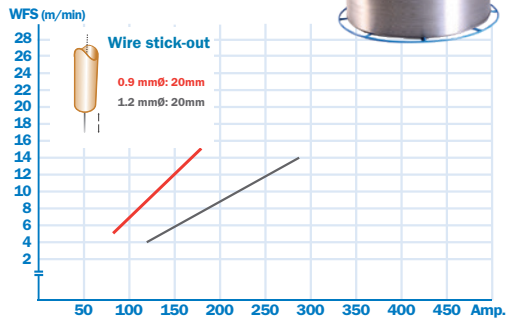
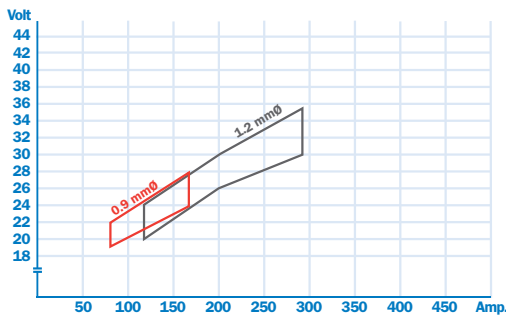
Description and Application

This is a rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces and self releasing slag.

This wire deposits a low carbon weld of about 24%Cr-13%Ni. It is designed for dissimilar welding such as welding stainless steel to mild steel or low alloy steel. The wire is also suitable for the first layer on mild or low alloy steel prior to overlaying with **DW-308L** or **DW-308LP**.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

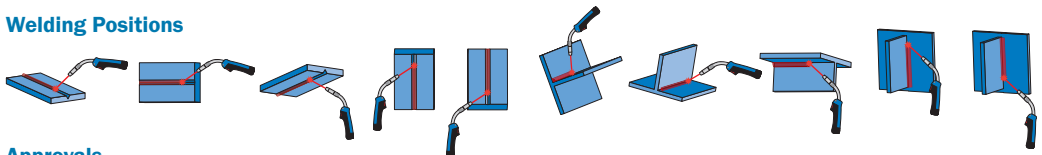
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.02	0.42	0.80	0.017	0.005	12.6	23.2	-	-	-	11.7	17.0	14.7

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)+20°C	CV(J)-20°C
Guaranty	410	580	41	60	52
	min.320	min.520	min.25		

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
SS/CMn	VL 309 L	309L	E309LT1-1/4	A-9sp	TÜV,DB,CWB, RINA

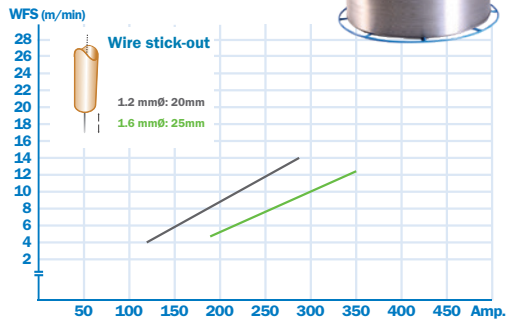
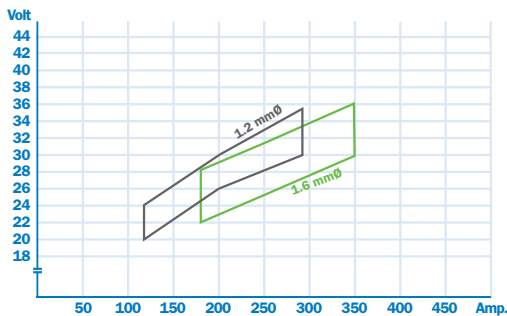
Description and Application

This is a rutile flux cored wire which operates with a very stable, spatter free arc producing a bright, smooth weld bead surface and self releasing slag.

This wire deposits low carbon weld metal of about 23%Cr-13%Ni-2.3%Mo and is designed for dissimilar welding such as welding stainless steel to mild or low alloy steel. This wire is also suitable for the first layer welding on mild steel or low alloy steel prior to overlaying with **DW-316L/LP** or **DW-317L**.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

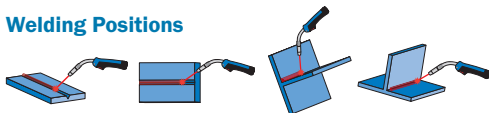
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.02	0.70	1.40	0.018	0.007	12.7	23.2	2.3	-	-	16.8	>18.0	27.0

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C
Guaranty	min.350	min.550	min.25	42

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
SS/CMn	VL 309 MoL	309MoL	-	-	TÜV, DB

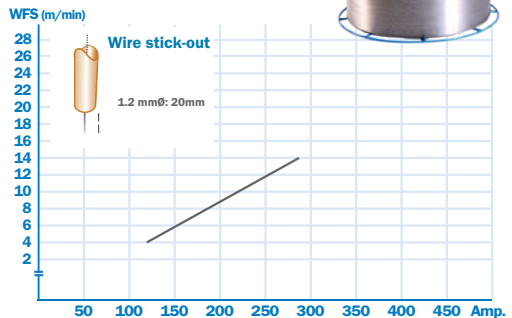
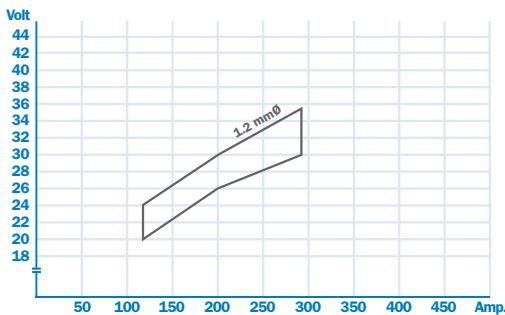
Description and Application

This is a rutile flux cored wire which operates with a very stable, spatter free arc producing a bright, smooth weld bead surface and self releasing slag.

This wire deposits low carbon weld metal of about 23%Cr-13%Ni-2.3%Mo and is designed for dissimilar welding such as welding stainless steel to mild or low alloy steel. This wire is also suitable for the first layer welding on mild steel or low alloy steel prior to overlaying with **DW-316L/LP** or **DW-317L**.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

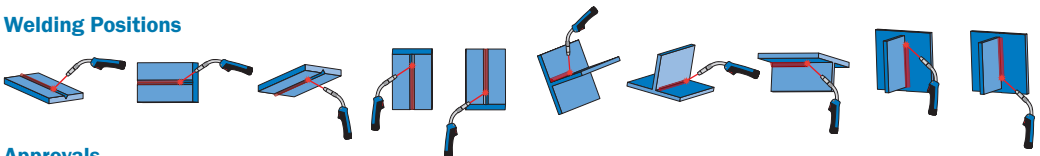
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.60	0.90	0.018	0.006	12.5	22.5	2.3	-	-	16.6	>18.0	24.4

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)+20°C	CV(J)-20°C
Guaranty	530	690	31	62	51
	min.350	min.550	min.25		

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
SS/CMn	VL 309 MoL	309MoL	-	-	-

Description and Application

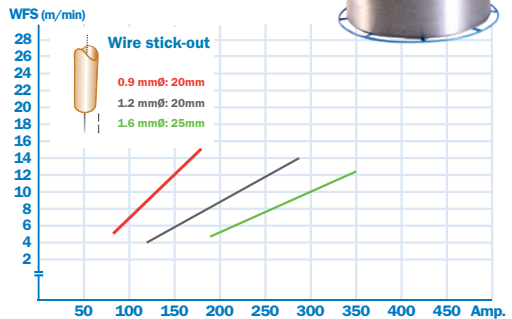
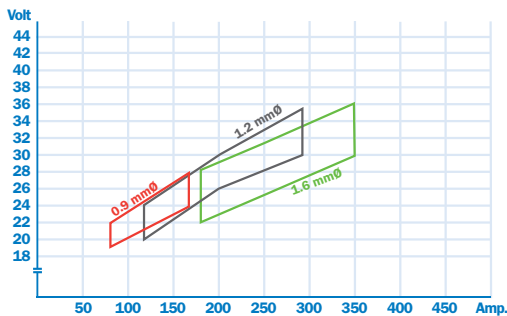
This is a rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces and self releasing slag.

This wire is designed for welding 18%Cr-12%Ni-2.5%Mo stainless steels like type 316L or EN 1.4435. Due to the low carbon content in the weld metal, it is possible to obtain high resistance to intergranular corrosion.

DW-316L is used mainly for downhand and horizontal fillet welding.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

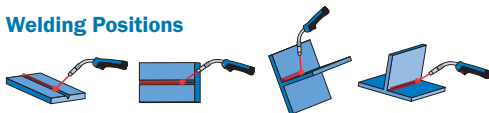
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.60	1.60	0.020	0.006	12.2	18.7	2.80	-	-	7.7	12.8	9.7

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C
Guaranty	min.320	min.510	min.25	44

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
316L	VL 316 L	316L	MG	-	TÜV, DB, CWB

Description and Application

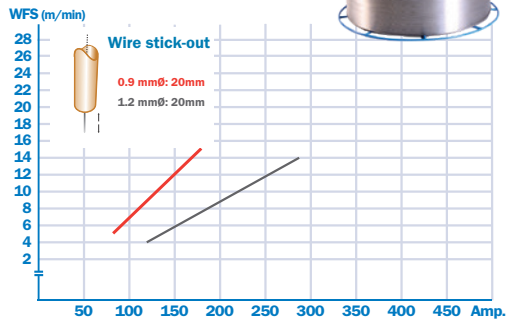
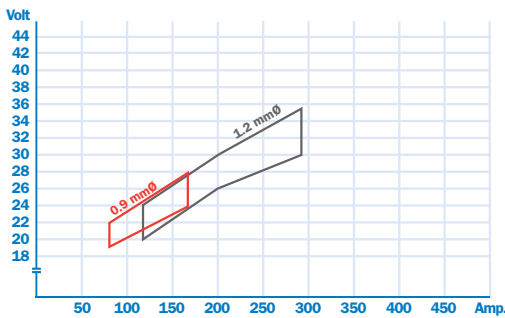
This is a rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces and self releasing slag.

This wire is designed for welding 18%Cr-12%Ni-2.5%Mo stainless steels like type 316L or EN 1.4435. Due to the low carbon content in the weld metal, it is possible to obtain high resistance to intergranular corrosion.

DW-316LP is an all positional wire and is ideal for high productivity welding in the vertical up position.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

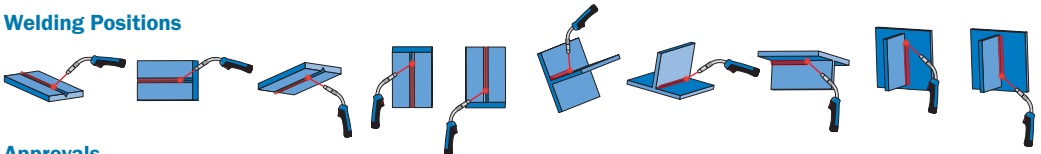
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.70	1.40	0.019	0.006	12.3	18.4	2.90	-	-	7.0	11.5	7.8

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C
Guaranty	430	570	40	46
	min.320	min.510	min.25	

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
316L	VL 316 L	316L	E316LT1-4	A-6	TÜV, CWB, RINA

Description and Application

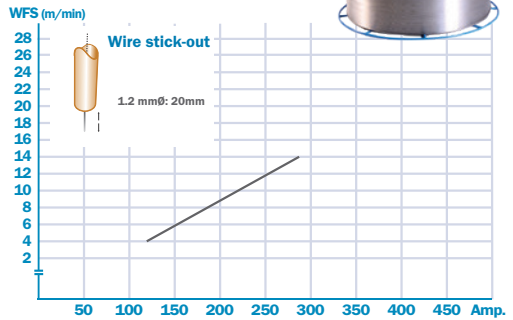
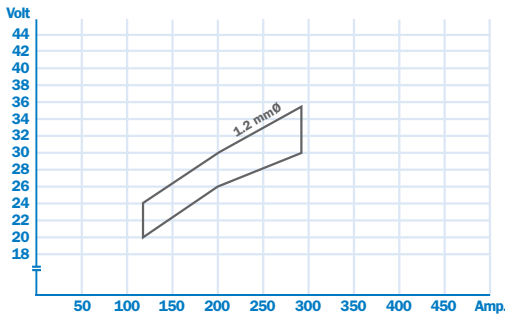
This is a rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces.

This wire is designed for welding duplex stainless steel such as AISI S31803 or EN 1.4462 stainless steels.

Due to the high nitrogen and high molybdenum content in the weld metal, it is possible to obtain excellent resistance to chloride induced pitting corrosion.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

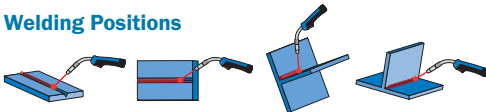
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FNW
0.03	0.75	0.97	0.019	0.006	9.3	23.3	3.4	0.14	-	49.0

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C	CV(J)-46°C
Guaranty	656	850	29	49	43
	min.450	min.690	min.20		

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
S31803	S31803	SA2205	-	-	TÜV, RINA

Description and Application

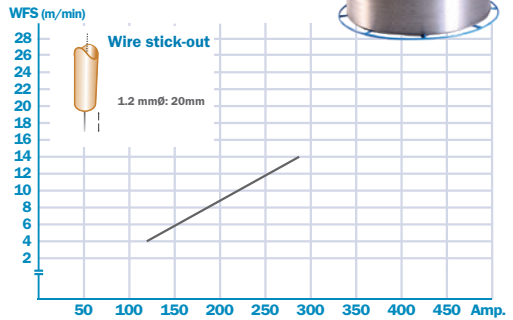
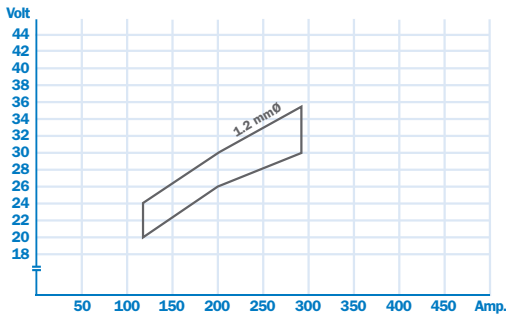
This is a rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces.

This wire is designed for welding duplex stainless steel such as AISI S31803 or EN 1.4462 stainless steels.

Due to the high nitrogen and high molybdenum levels in the weld metal, it is possible to obtain excellent resistance to chloride induced pitting corrosion.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

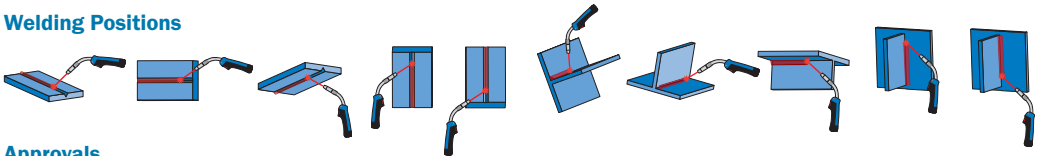
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FNW
0.03	0.58	0.78	0.019	0.008	9.4	22.9	3.5	0.15	-	42.7

Typical Mechanical Properties*

	R _s (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-20°C	CV(J)-46°C
	670	850	29	45	40
Guaranty	min.450	min.690	min.20		

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
S31803	S31803	SA2205	-	AF-8dup	TÜV, RINA

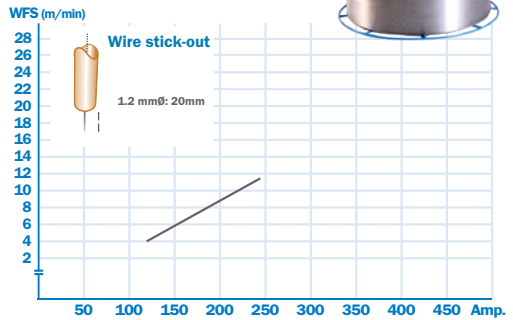
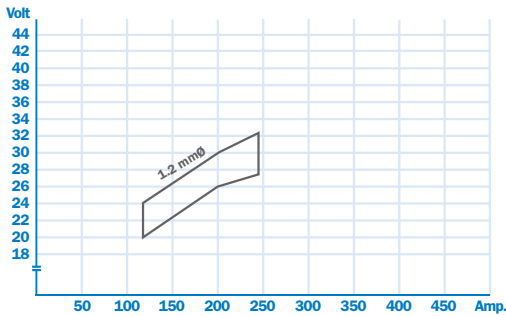
Description and Application

DW-2307 is a rutile flux cored wire designed for welding lean duplex stainless steel EN 1.4162 / ASTM 32101 grade such as LDX2101®.

This wire operates with a stable, spatter free arc producing bright, smooth weld bead surfaces and self releasing slag.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

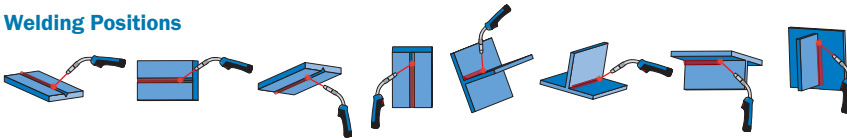
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FNW
0.03	0.45	1.26	0.020	0.003	7.9	24.6	-	0.16	-	45

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-46°C
Guaranty	min.450	min.650	min.15	

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

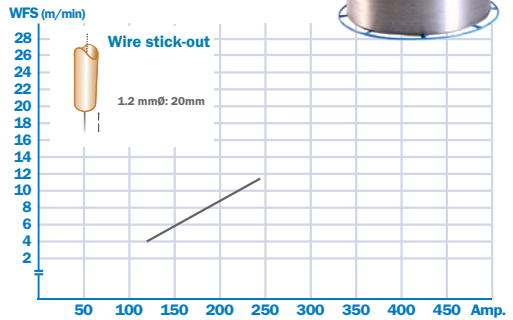
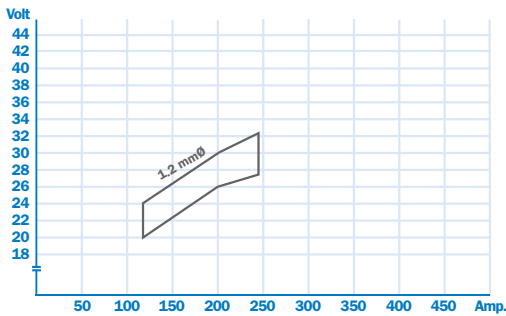
Description and Application

DW-2594 is a rutile flux cored wire designed for welding super duplex stainless steel EN 1.4410 / ASTM 32750 grade and EN 1.4501 / ASTM 32760 grade.

This wire operates with a stable, spatter free arc producing bright, smooth weld bead surfaces and self releasing slag.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

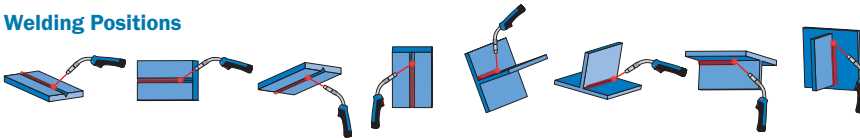
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FNW
0.03	0.50	1.20	0.019	0.004	9.7	25.9	3.90	0.25	-	48

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-40°C
Guaranty	701	906	27	39
	min.550	min.760	min.18	

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

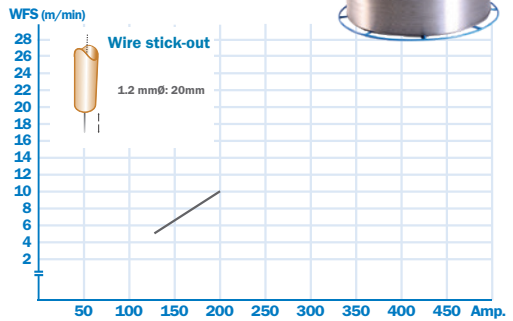
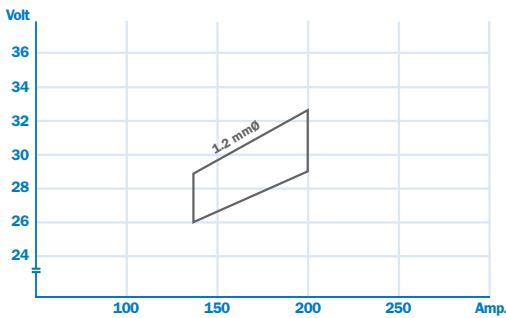
Description and Application

This rutile flux cored wire operates with a very stable, spatter free arc producing a bright, smooth weld bead surface and self releasing slag.

DW-310 has a full austenitic micro structure in its weld metal, so it is suited for the welding of heat resistant CrNi steels.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

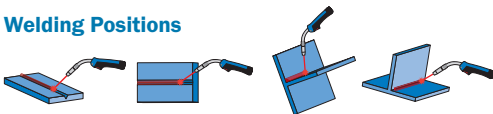
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.18	0.60	2.10	0.016	0.005	20.4	25.5	-	-	-	-	-	-

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)0°C
Guaranty	min.350	min.550	min.20	68

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

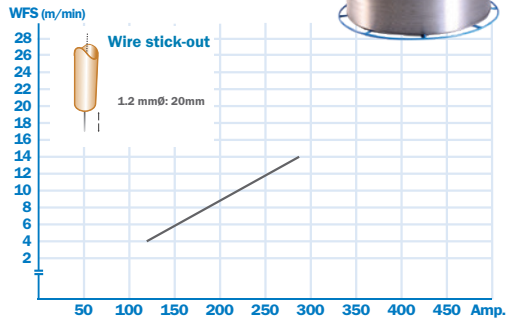
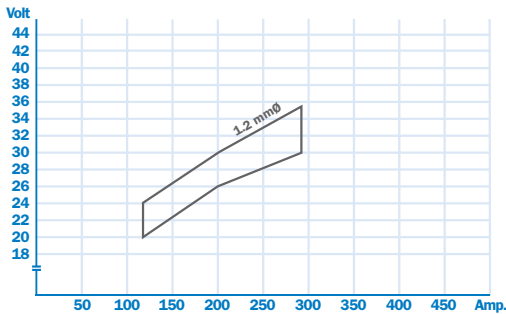
This rutile flux cored wire welds with a stable and almost spatter free arc to produce a shiny, bright, smooth weld bead surface with self-releasing slag.

Excellent crack resistance is due to a combination of high alloy and high ferrite content, which gives extreme tolerance to dilution on a wide range of hardenable and alloy steels with minimum or no preheating. The weld deposit also work-hardens and provides good wear and friction resistance.

DW-312 is applied for welding medium and high carbon hardenable steels, of known or unknown specifications, for example tool steels, shafts, free-cutting steels, dissimilar alloy combinations, overlaying, buffer layers prior to hard facing.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

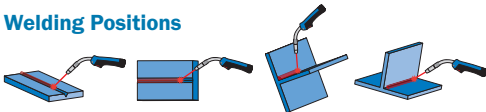
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.12	0.60	1.20	0.018	0.006	10.2	28.4	-	-	-	60.0	>18.0	50.7

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)°C
	580	740	23	-
Guaranty	min.450	min.660	min.15	

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

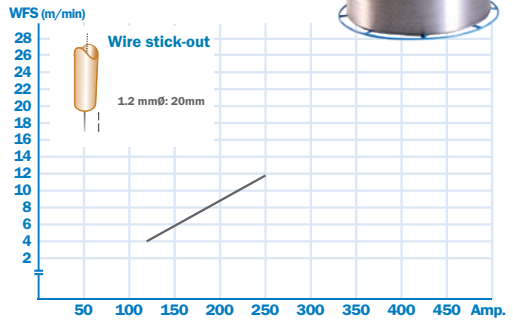
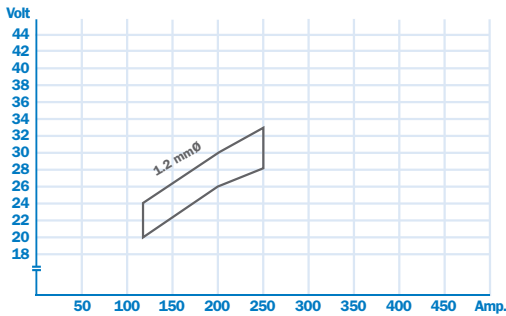
Description and Application

This is a rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces with self releasing slag.

This wire is designed for welding 18%Cr-10%Ni stainless steels for cryogenic use like liquified natural gas (LNG) tanks.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

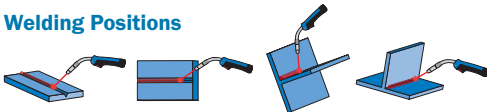
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.50	2.30	0.018	0.007	10.3	18.6	-	-	-	3.0	4.8	5.0

Typical Mechanical Properties*

	CV (J)			L.E.(mm)		CV (J)		L.E.(mm)		CV (J)		L.E.(mm)	
	R _e (MPa)	R _m (MPa)	A ₅ (%)	0°C		-100°C		-196°C					
Guaranty	380	530	51	69	1.40	51	0.92	39	0.52				
	min.320	min.520	min.30			min.27	min.0.34						

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

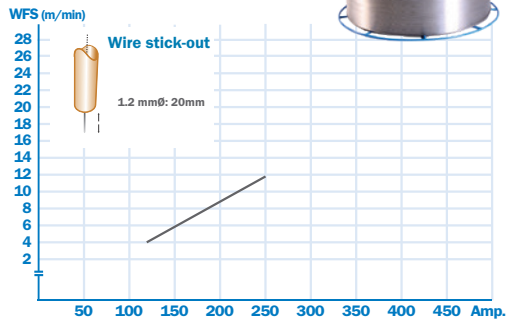
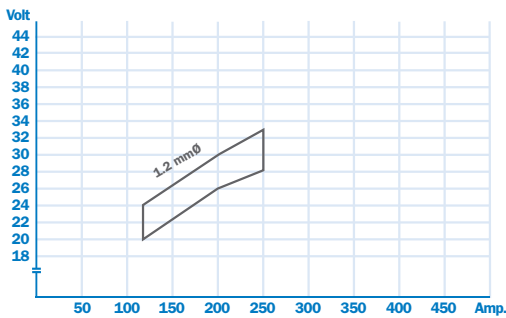
Description and Application

This is a rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces with self releasing slag.

This wire is designed for welding 18%Cr-10%Ni stainless steels for cryogenic use like liquified natural gas (LNG) tanks.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

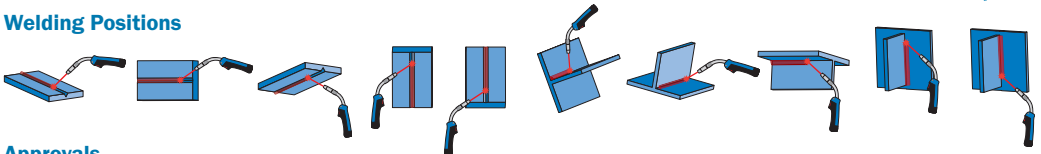
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.70	1.40	0.016	0.002	10.1	19.0	-	-	-	6.8	7.6	5.3

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV (J)	L.E.(mm)	CV (J)	L.E.(mm)	CV (J)	L.E.(mm)
				0°C		-100°C		-196°C	
				61	1.12	51	0.82	42	0.45
Guaranty	min.320	min.520	min.30	min.27		min.0.34			

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

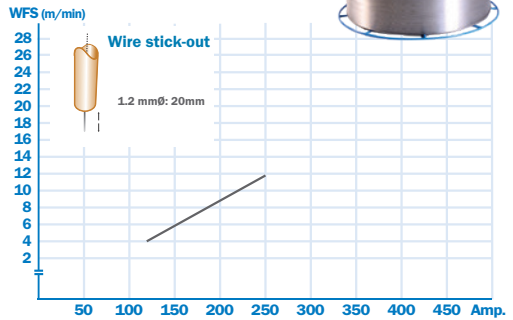
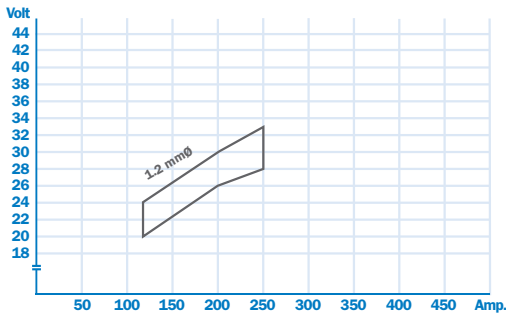
Description and Application

This is a rutile flux cored wire which operates with a very stable, spatter free arc producing a bright, smooth weld bead surface and self releasing slag.

The wire is designed for welding 18%Cr-12%Ni-2.5%Mo stainless steels for cryogenic use like liquified natural gas (LNG) tanks.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)*

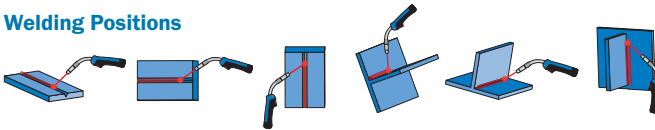
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.40	1.20	0.021	0.008	12.4	17.6	2.20	-	-	2.7	4.8	4.3

Typical Mechanical Properties*

	CV (J)			L.E.(mm)		CV (J)		L.E.(mm)		CV (J)		L.E.(mm)	
	R _e (MPa)			R _m (MPa)		A ₅ (%)		0°C		-100°C		-196°C	
	396			542		41		74		53		34	
Guaranty	min.320			min.510		min.25		min.27		min.0.34			

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

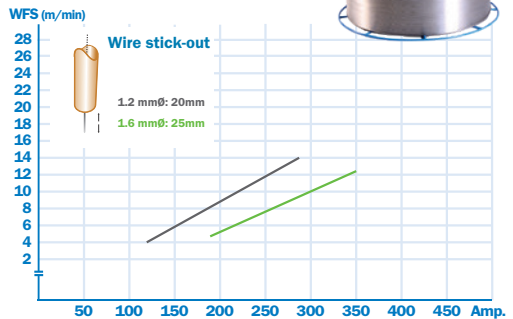
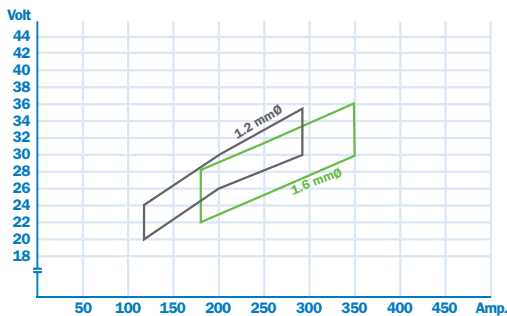
LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

DW-308H is designed for welding 18%Cr-10%Ni stainless steels which will be applied for elevated temperatures (more than 600°C). This wire is also suitable for welding of stainless steel which is to be solution treated at elevated temperatures.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

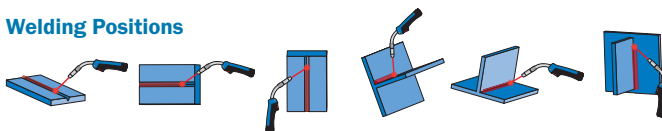
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.06	0.50	1.30	0.018	0.004	9.5	19.3	-	-	-	6.6	7.5	5.6

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)+20°C	CV(J)0°C
Guaranty	420	600	44	78	72
	min.350	min.550	min.30		

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

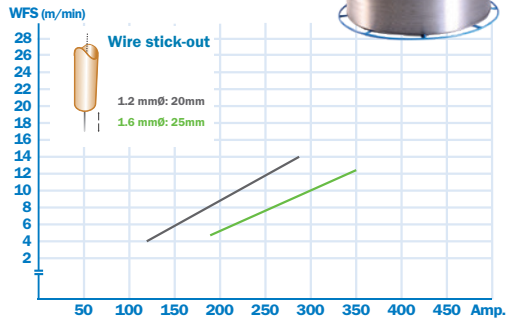
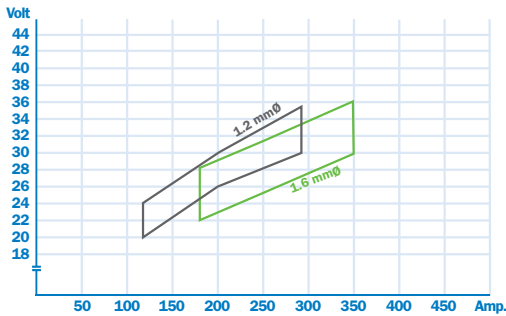
LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

DW-347 is for welding titanium or niobium stabilized stainless steel such as 18%Cr-8%Ni-Ti or 18%Cr-8%Ni-Nb stainless steels. Due to the high niobium content in the weld metal, it is possible to prevent Cr-carbide precipitation which leads to intergranular corrosion.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

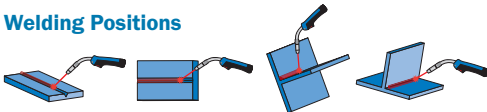
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.45	1.19	0.024	0.003	10.3	18.8	-	-	0.7	6.7	7.5	7.1

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)+20°C	CV(J)0°C
Guaranty	415	608	33	91	87
	min.350	min.550	min.30		

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

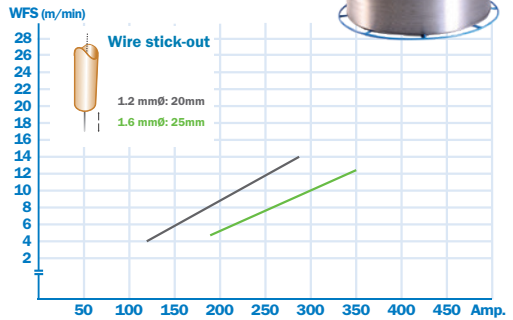
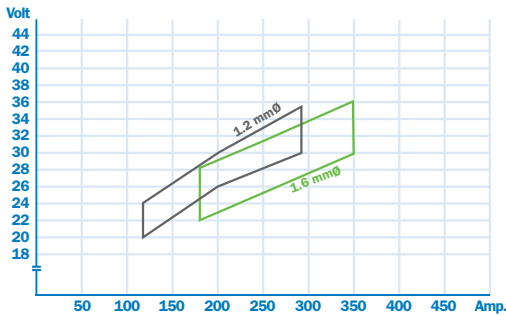
LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	TÜV

Description and Application

DW-347LH is an all positional flux cored wire for welding titanium or niobium stabilized stainless steel such as 18%Cr-8%Ni-Ti or 18%Cr-8%Ni-Nb stainless steels. Due to the high niobium content in the weld metal, it is possible to prevent Cr-carbide precipitation which leads to intergranular corrosion.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

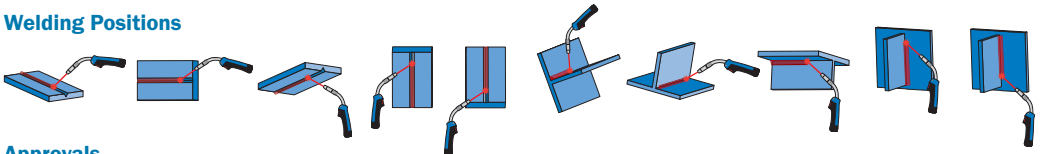
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.60	1.30	0.018	0.004	10.4	18.7	-	-	0.6	6.7	7.3	6.3

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)+20°C	CV(J)0°C
Guaranty	min.350	min.550	min.30	90	84

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	TÜV

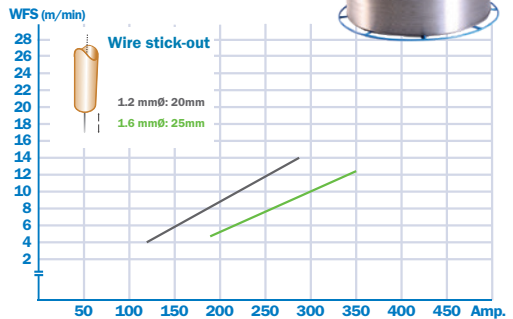
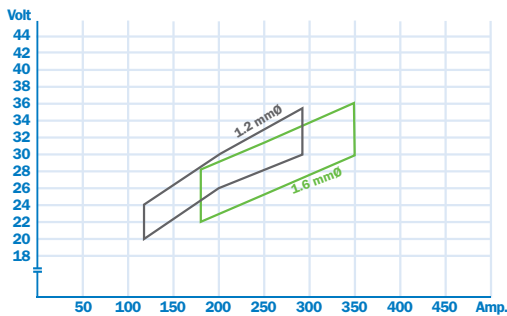
Description and Application

This wire is a rutile flux cored wire that operates with a very stable spatter free arc.

DW-309LH is applied for high temperature applications where a high resistance to oxidation is required, like industrial furnaces (ovens). This wire is usually used as the buffer layer for overlay welding prior to overlaying with **DW-308H**.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

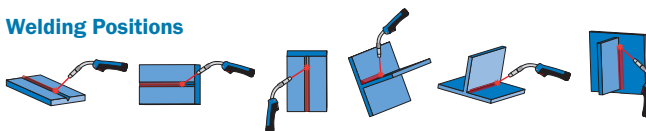
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.02	0.49	1.38	0.024	0.004	12.7	23.7	-	-	-	12.1	>18	19.1

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)+20°C	CV(J)0°C
Guaranty	406	578	31	76	73
	min.320	min.520	min.30		

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

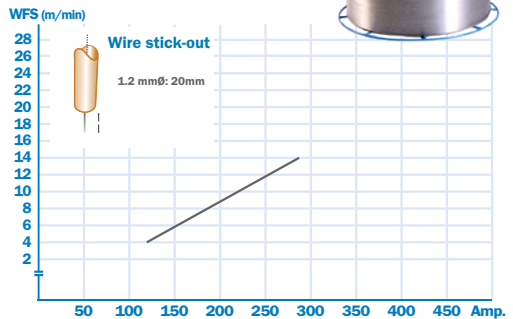
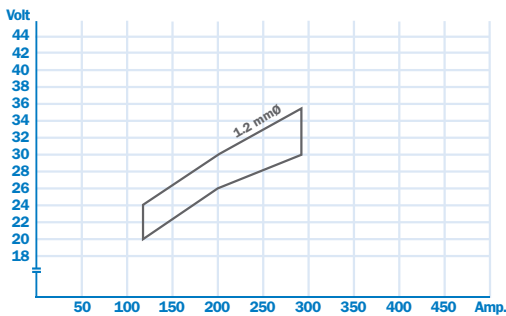
This wire is a rutile flux cored wire which operates with a very stable, spatter free arc producing a bright, smooth weld bead surface and self releasing slag.

This wire deposits low carbon weld with 24%Cr-13%Ni and Niobium to minimize the risk of sensitization. It is suitable for the first layer on mild or low alloy steel prior to overlaying with **DW-347** or **DW-347H**.

This wire is also popular for petrochemical reactors when completing cladding.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

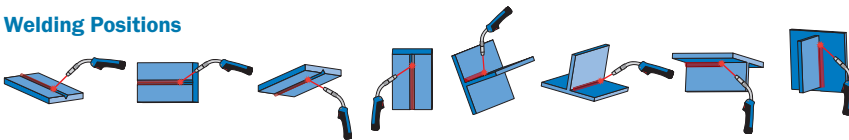
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.58	1.02	0.013	0.003	12.7	24.3	-	-	0.9	16	>18	25

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)+20°C	CV(J)0°C
Guaranty	511	689	33	84	79
	-	min.520	min.30	-	-

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

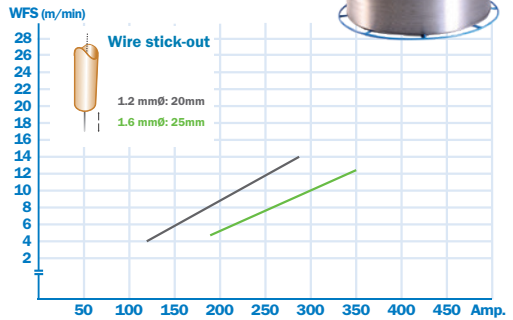
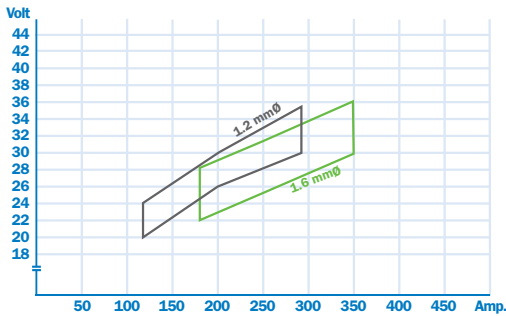
LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

This wire is a rutile flux cored wire that operates with a very stable spatter free arc. **DW-316LH** is designed for welding 18%Cr-12%Ni-2.5%Mo stainless steels which will be applied for elevated temperatures.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)*

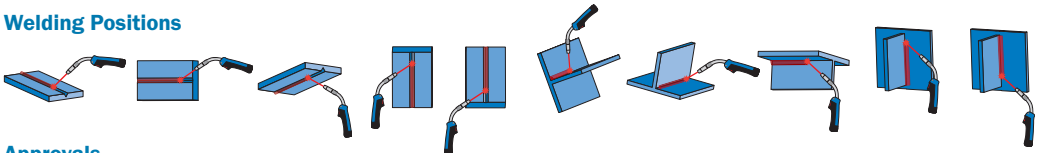
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.54	1.28	0.020	0.011	11.9	18.9	2.45	-	-	8.1	12.2	9.4

Typical Mechanical Properties*

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)+20°C	CV(J)0°C
Guaranty	411	561	41	67	64
	min.320	min.520	min.3		

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

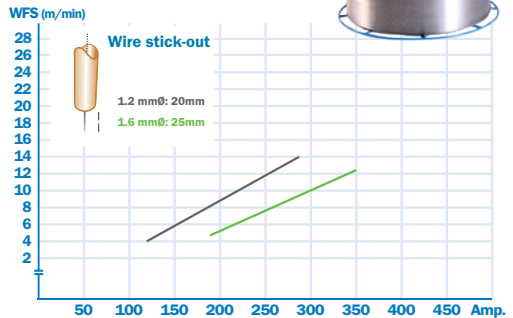
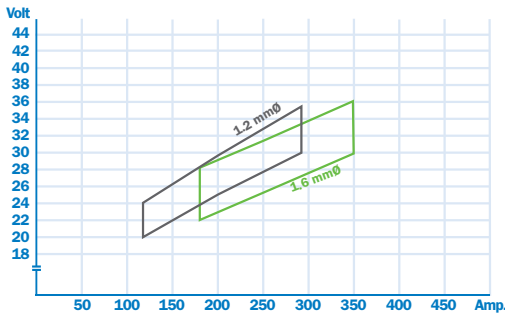
This is a versatile CrNiMn rutile flux cored wire that operates with a stable, almost spatter free arc to produce a shiny, smooth weld bead surface with a self-releasing slag.

The weld metal offers exceptionally high ductility and elongation combined with outstanding crack resistance due to the high manganese content. The weld deposit also work-hardens and provides good wear and friction resistance.

DW-307 was primarily designed for difficult to weld steels such as austenitic high manganese steels and for use in buffer layers under hard facing materials. But due to its low nickel content, it also provides a cost effective alternative to 309 welding materials for general dissimilar welding of mild steel to stainless steel.



Recommended Parameter Range, for flat position



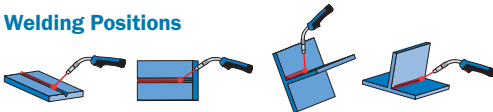
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.07	0.60	6.4	0.02	0.008	8.1	19.2	-	-	-	1.6	3.3	9.1

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)0°C
Guaranty	min.350	min.500	min.25	48

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	*	-	-	-	TÜV, DB

* EN ISO 17633-A-T 18 8 Mn R M 3

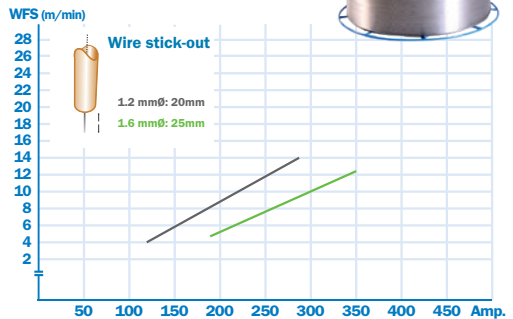
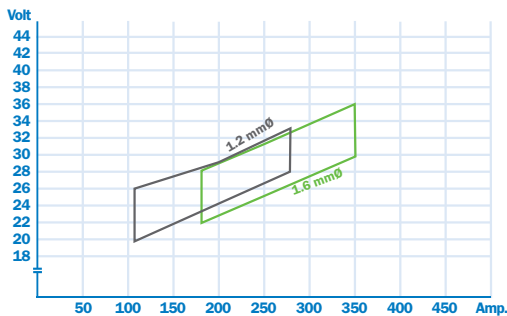
Description and Application

This is a rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces and self releasing slag.

DW-317L is designed for welding 18%Cr-12%Ni-2.5%Mo-N (type 316LN) or 19%Cr-12%Ni-3.5%Mo (type 317L) stainless steels. Due to the low carbon contents in the weld metal, it is possible to obtain high resistance to intergranular corrosion.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)

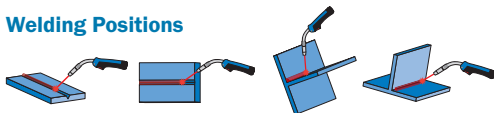
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.60	1.10	0.02	0.008	12.6	19.1	3.5	-	-	9.2	11.6	8.7

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)+20°C	CV(J)0°C
Guaranty	490	620	35	61	53
	min.350	min.520	min.20		

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	NV 317 L	-	-	-	-

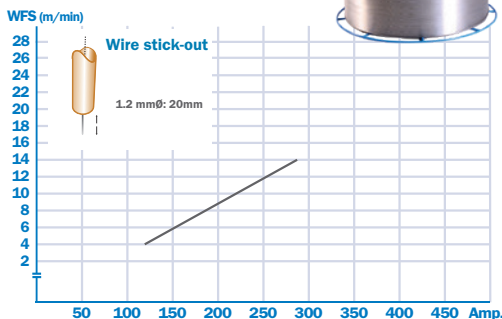
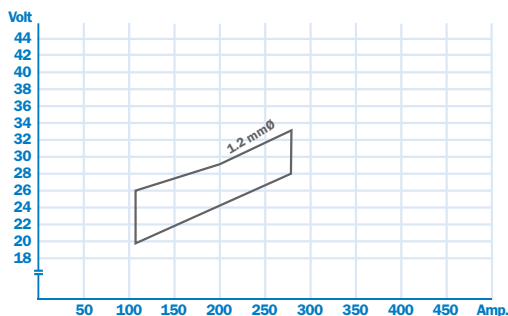
Description and Application

This is a rutile flux cored wire which operates with a very stable, spatter free arc producing bright, smooth weld bead surfaces and self releasing slag.

DW-318 is designed for welding 18%Cr-12%Ni-2%Mo-Nb or Ti stainless steel. Due to its Mo and Nb content, DW-318 provides good resistance against intergranular corrosion and non-oxidizing acid.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)

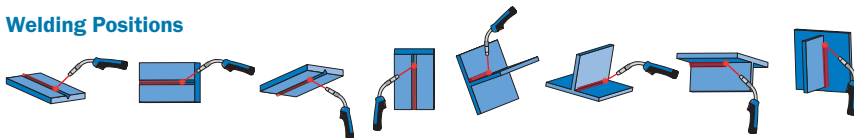
C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.02	0.50	1.30	0.02	0.012	11.6	18.5	2.8	-	0.4	8.9	16.0	12.9

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)0°C
	511	680	31	57
Guaranty	min.350	min.550	min.25	

* The above values and parameters are for all weld metal produced using Ar+CO₂ shielding gas

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

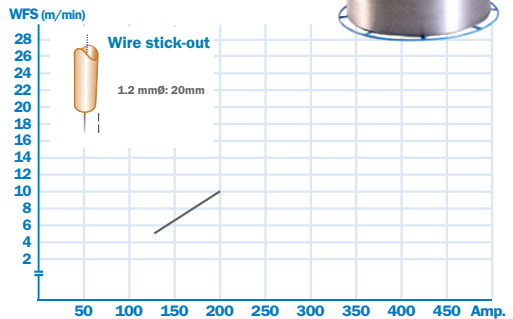
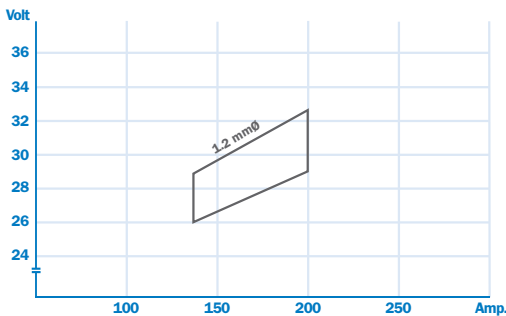
DW-904L is a rutile flux cored wire suited for the welding of 904L stainless steel (20Cr-25Ni-5Mo-Cu) which is used for manufacturing chemical vessels for use with Phosphoric acid and Sulfuric acid. This wire can be used in all positions with quite stable arc and low spatter.

DW-904L weld metal has a full austenitic micro structure which is sensitive to hot cracking.

High amperage and high welding speed should be avoided to minimize the risk of hot cracking especially for the root pass in butt joint welding.



Recommended Parameter Range, for flat position



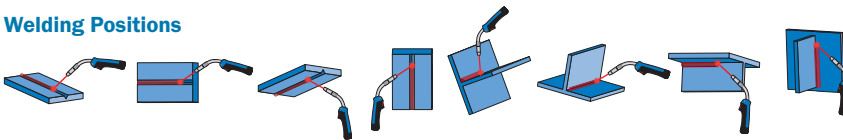
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.03	0.66	1.56	0.024	0.003	25.3	20.9	4.8	0.13	-	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)-196°C
Guaranty	423	664	36	61
	min.320	min.510	min.25	-

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

DW-G308L

80%Ar - 20%CO₂ / 100%CO₂
AWS A5.22 E308LT0-1/4

DW-G309L

80%Ar - 20%CO₂ / 100%CO₂
AWS A5.22 E309LT0-1/4

DW-G316L

80%Ar - 20%CO₂ / 100%CO₂
AWS A5.22 E316LT0-1/4

Description and Application

Standard rutile flux cored wires in 1.2mm diameter are a popular choice for use at higher welding currents (>150A) due to their arc stability advantage over other welding processes. KOBELCO's DW-G series rutile flux cored 1.2mm wires are specially designed to provide excellent arc properties at a much lower welding current (80A to 220A range). Thanks to their unique design, they can also be used for many applications where 0.9mm rutile flux cored wires are usually applied. Very high welding speed (above 1.5m/min.) are achievable when using 100% CO₂ shielding gas.

KOBELCO's DW-G wires have the following features.

1. Excellent weldability

Stable arc and self releasing slag leaves a smooth and shiny bead surface with very little spatter.

2. High deposition rate

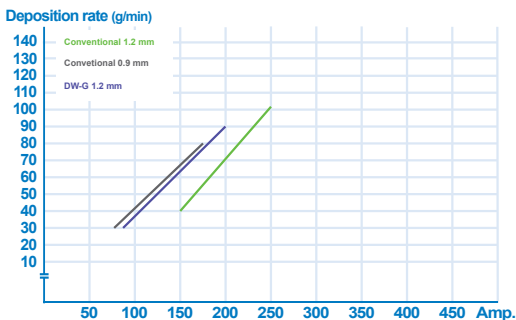
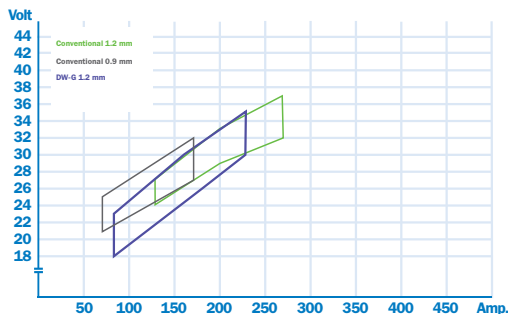
Its unique design assures a 15% higher deposition rate than regular 1.2mm rutile flux cored wire.

3. Failure-free arc ignition

Electrically conductive flux (slag) enables easy arc re-ignition for less trouble with automatic and stop start tack welding.



Recommended Parameter Range, for flat position*



Typical Chemical Analysis (wt. %)

	C	Si	Mn	P	S	Ni	Cr	Mo	FS	FNW
DW-G308L	0.03	0.62	1.25	0.03	0.02	9.7	19.3	-	8.9	9.7
DW-G309L	0.03	0.68	1.21	0.03	0.02	12.5	24.1	-	13.2	20.4
DW-G316L	0.03	0.61	1.24	0.03	0.02	12.2	18.6	2.3	6.5	6.9

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)
DW-G308L	380	553	38
DW-G309L	420	564	35
DW-G316L	402	549	37

* The above values and parameters are for all weld metal produced using 100%CO₂ shielding gas

Applied base metal thickness (minimum)

Butt joint	Horizontal joint	Lap joint	Corner Joint	Vertical Downward Fillet
1.2 mm	1.6 mm	1.2 mm	1.6 mm	1.6 mm

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

MX-A308L

80%Ar - 20%CO₂

AWS A5.22 EC308L

MX-A309L

80%Ar - 20%CO₂

AWS A5.22 EC309L

MX-A309MoL

80%Ar - 20%CO₂

AWS A5.22 EC309ML

MX-A316L

80%Ar - 20%CO₂

AWS A5.22 EC316L

Description and Application

These are metal cored stainless steel wires which can be used at higher amperage than rutile flux cored wires. These PREMIARC™ series metal cored wires provide superior weldability, deposition rate and bead appearance compare to that of solid wires.

MX-A308L : For 18%Cr-8%Ni stainless steels.

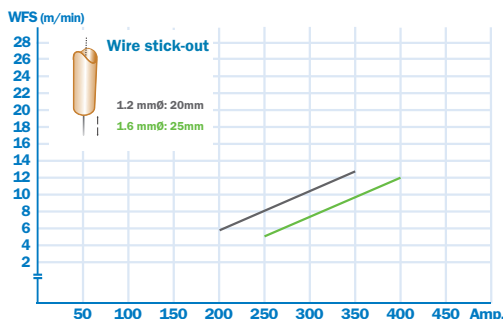
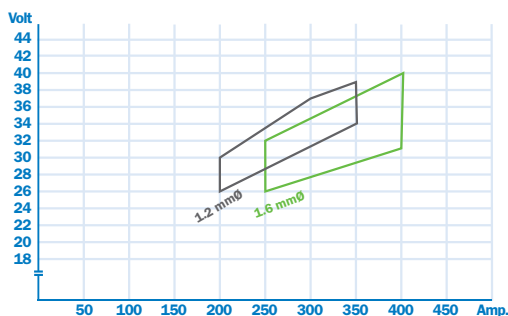
MX-A309L : For dissimilar metal and first layer in cladding.

MX-A309MoL : For dissimilar metal and first layer in cladding.

MX-A316L : For 18%Cr-12%Ni-2%Mo type stainless steels.



Recommended Parameter Range, for flat position



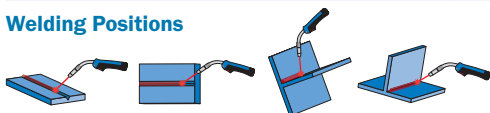
Typical Chemical Analysis (wt. %)

	C	Si	Ni	Cr	Mo	N	FS
MX-A308L	0.025	0.60	10.20	20.05	0.10	0.027	9.00
MX-A309L	0.025	0.62	12.38	24.06	0.10	0.028	14.00
MX-A309MoL	0.025	0.64	12.38	23.07	2.41	0.028	18.00
MX-A316L	0.025	0.49	12.18	18.99	2.23	0.028	6.5

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV (J)	°C
MX-A308L	400	570	45	93	0
MX-A309L	440	600	35	-	-
MX-A309MoL	505	705	33	-	-
MX-A316L	415	580	30	81	0

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

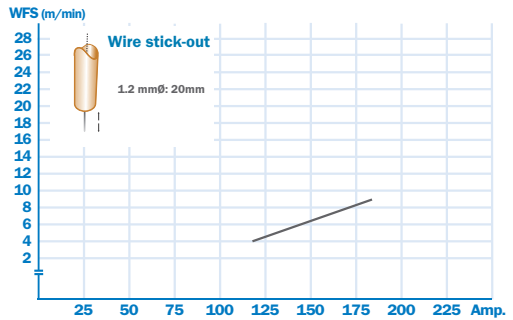
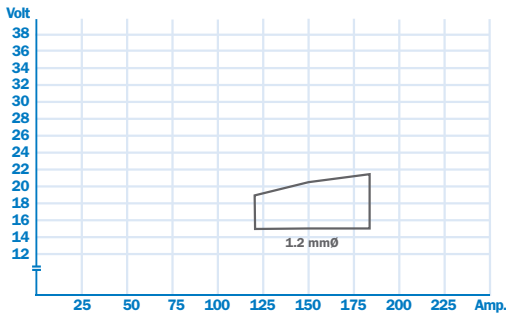
Description and Application

MX-A430M is a metal cored wire for welding 17Cr and 13Cr ferritic stainless steels used in automotive exhaust systems, catalytic converters and mufflers.

In comparison with standard 430 type solid wires, **MX-A430M** offers higher resistance to burn-through when welding thin plate such as 0.8~2.0mm, superior crack resistance when welding auto parts contaminated with oil from press-forming processes and excellent corrosion and oxidation resistance.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.05	0.40	0.14	0.008	0.017	0.08	17.0	-	-	0.75	-	-	-

Typical Mechanical Properties

R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)0°C
390	540	26	-

Welding Positions



Approvals

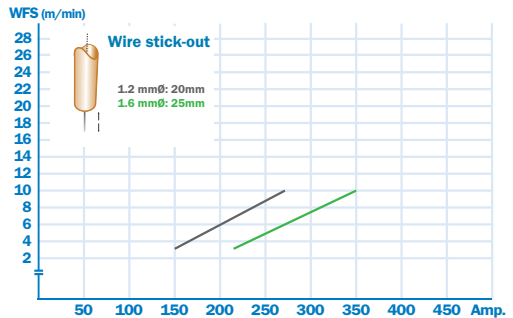
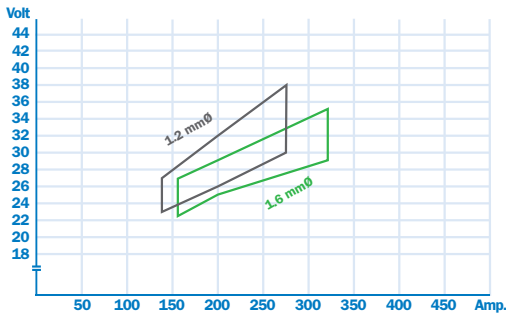
LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

DW-410NiMo is a rutile flux cored wire of which deposit has 12Cr-4Ni-0.5Mo type weld metal. It is suitable for the welding of 410NiMo type martensitic stainless steel such as CA6NM which is a common base material for hydro turbine components.



Recommended Parameter Range, for flat position



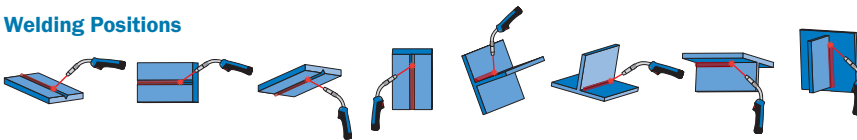
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.02	0.34	1.52	0.024	0.004	4.30	11.6	0.55	-	-	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV (J) -20°C	PWHT
Guaranty	846	926	17	44	600°C x 1hr AC
	-	min.760	min.15		

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

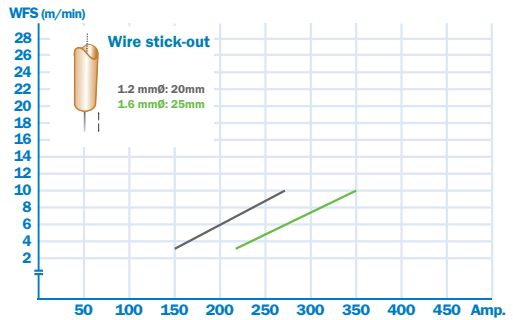
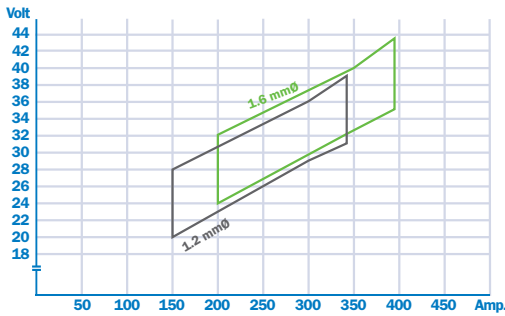
Description and Application

MX-A410NiMo is a metal cored wire for 13CrNi-Mo martensitic stainless steel.

Features of this wire is low hydrogen content and high strength in deposited weld metal. Due to its corrosion resistance combined with its high abrasion resistance, this wire finds widespread use for welding water turbines used in hydropower generation plants.



Recommended Parameter Range, for flat position



Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb	FS	FN	FNW
0.02	0.23	0.46	0.021	0.005	4.4	11.8	0.61	-	-	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)0°C	PWHT
	813	888	19	67	595°C x 8hrs AC
Guaranty	min.500	min.760	min.15		

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

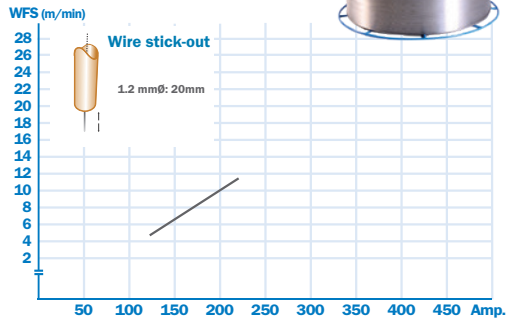
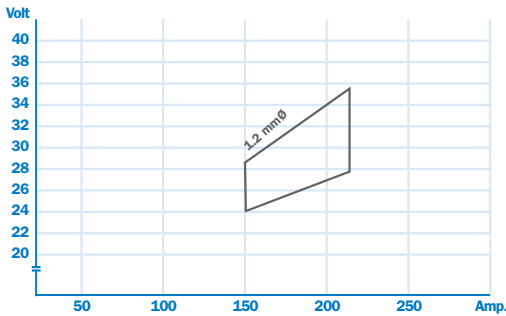
DW-N82 is a nickel based flux cored wire for welding alloy 600, 800.

DW-N82 is recommended for a variety of applications, including overlay welding of carbon steels or low alloy steels and a wide variety of dissimilar metal joints.

This wire is specially designed for applications demanding that the iron content must be below 1% Fe.



Recommended Parameter Range, for flat position



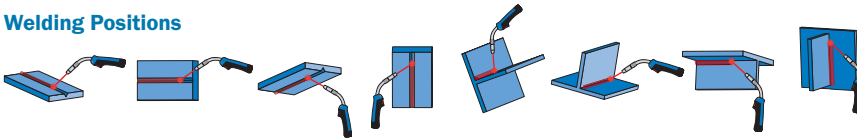
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Cu	Ni	Cr	Mo	Fe	Nb+Ta	Ti	Co	W	V
0.02	0.20	3.0	<0.01	0.003	<0.01	71.4	21.1	-	0.8	2.5	0.17	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)0°C	CV(J)-196°C
Guaranty	394	781	44	132	125
	min.360	min.550	min.25		

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

DW-N625 is a nickel based flux cored wire for welding nickel based alloys 625, 825 and also super austenitic stainless steels.

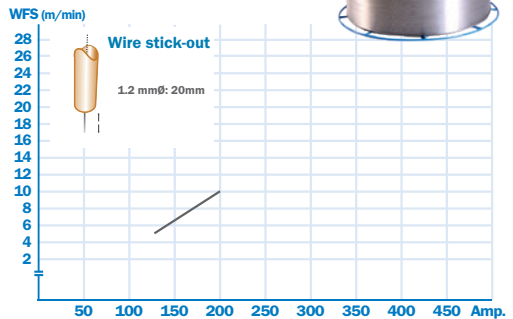
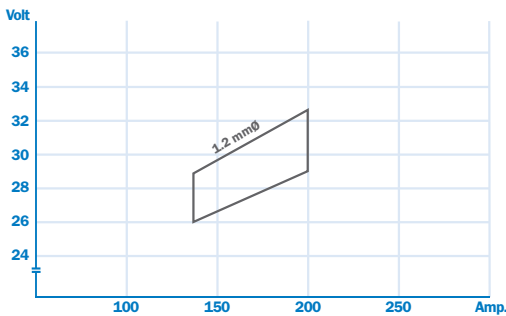
DW-N625 has a stable arc with minimal spatter, which makes it also an excellent product for welding in all positions.

This wire is recommended for a wide variety of applications, including overlay welding of carbon steel or low alloy steels and a wide variety of dissimilar metal joints.

Please note that for circumferential joining of pipes in fixed positions, DW-N625P is a better choice than DW-N625.



Recommended Parameter Range, for flat position



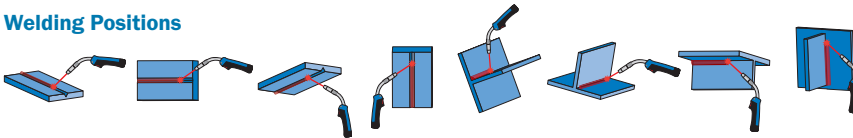
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Cu	Ni	Cr	Mo	Fe	Nb+Ta	Ti	Co	W	V
0.031	0.46	0.31	0.004	0.001	0.01	63.5	22.4	8.3	0.7	3.6	0.14	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)0°C	CV(J)-196°C
Guaranty	501	781	45	61	54
	min.420	min.690	min.25		

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

Description and Application

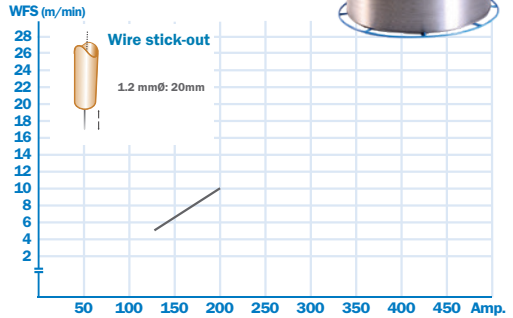
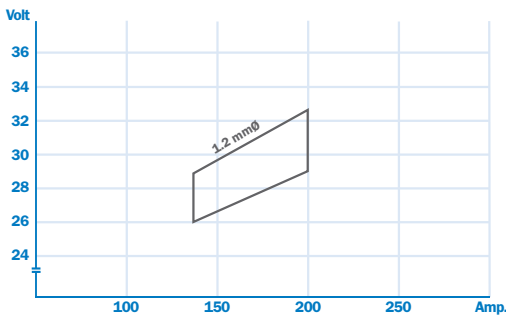
DW-N625P is a nickel based flux cored wire for welding nickel alloys 625, 825 and super austenitic stainless steels.

DW-N625P is an ideal wire for circumferential joining of pipes including clad pipes in fixed positions. Excellent bead wetting, very stable arc, little spatter and easy slag removal on circumferential joining of pipes can be obtained by both fully automated and manual welding.

For circumferential welding of pipes in fixed position, DW-N625P offers better weld metal soundness when compared with conventional 625 type FCW's. DW-N625P still retains the advantage of much higher productivity when compared with traditional SMAW, GTAW and GSAW (MIG).



Recommended Parameter Range, for flat position



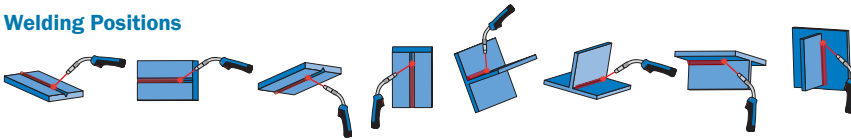
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Cu	Ni	Cr	Mo	Fe	Nb+Ta	Ti	Co	W	V
0.030	0.21	0.02	0.007	0.004	0.010	65.2	21.1	8.8	1.7	3.23	0.17	-	-	-

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)0°C	CV(J)-100°C	CV(J)-196°C
Guaranty	479	765	45	84	78	70
	min.420	min.690	min.25			

Welding Positions



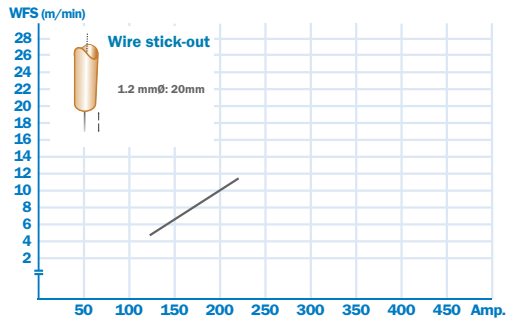
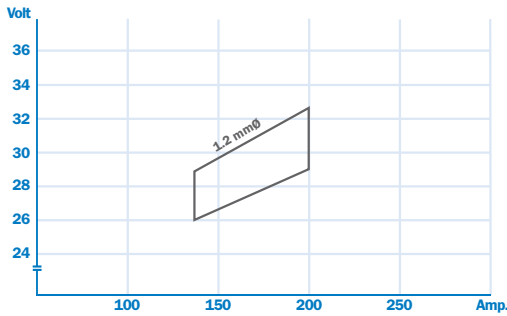
Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

DW-NC276 is a nickel based flux cored wire for alloy C276 and super austenitic stainless steel, and is suitable for welding in all positions with Ar-CO₂ mixture gas. This wire is often applied for overlay welding for applications where excellent corrosion resistance is required.



Recommended Parameter Range, for flat position



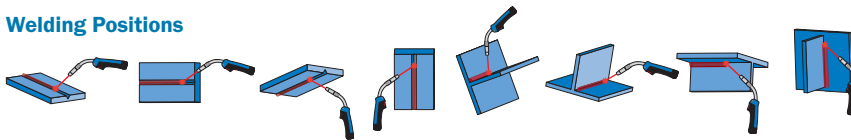
Typical Chemical Analysis (wt. %)

C	Si	Mn	P	S	Cu	Ni	Cr	Mo	Fe	Nb+Ta	Ti	Co	W	V
0.014	0.17	0.64	0.007	0.004	0.03	58.3	15.1	16.0	5.4	-	-	0.04	3.6	0.01

Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV(J)0°C	CV(J)-100°C	CV (J)-196°C
Guaranty	min.400	min.690	min.25	67	59	53

Welding Positions



Approvals

LR	DNV GL	BV	ABS	R.M.R.S	Others
-	-	-	-	-	-

TG-X308L

100%Ar
AWS A5.22 R 308LT1-5
EN 1.4316

TG-X309L

100%Ar
AWS A5.22 R 309LT1-5
EN 1.4332

TG-X316L

100%Ar
AWS A5.22 R 316LT1-5
EN 1.4430

TG-X347

100%Ar
AWS A5.22 R 347T1-5
EN 1.4551

TG-X2209

100%Ar
EN 1.4462

Description and Application

These are all rutile flux cored TIG filler rods for root pass welding of stainless steel pipe without the need for a reverse side back purge (internal shielding gas). As they produce a slag, they are not recommended for multi-pass welding.

TG-X308L is for welding 18%Cr-8%Ni type stainless steel.

TG-X309L is for dissimilar joints between stainless and mild steel or medium carbon steels.

TG-X316L is for 18%Cr-12%Ni-2%Mo stainless steel.

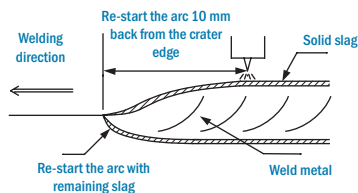
TG-X347 is for 18%Cr-8%Ni+Ti or 18%Cr-8%Ni+Nb stabilized stainless steel.

TG-X2209 for welding duplex 1.4462 stainless steel.

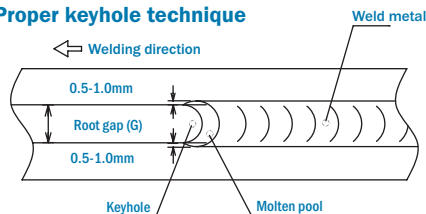
Proper root gap

Groove Preparation			
	Plate thickness (T)	4 mm	6 mm
Root gap (G)	2.0 mm	2.5 mm	3.0 mm

Proper bead connection



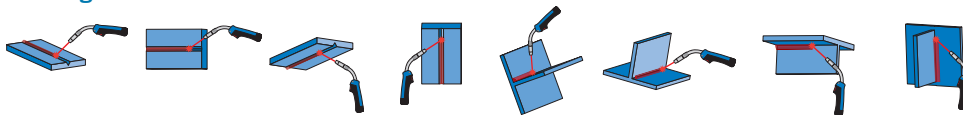
Proper keyhole technique



Typical Chemical Analysis (wt. %)

	C	Si	Mn	P	S	Ni	Cr	Mo	N	Nb+Ta	FS	FN	FNW
TG-X308L	0.02	0.80	1.70	0.023	0.005	10.3	19.6	-	-	-	9	13	-
TG-X309L	0.02	0.80	1.50	0.022	0.006	12.6	24.3	-	-	-	14	>18	-
TG-X316L	0.02	0.90	1.60	0.023	0.004	12.5	18.9	2.3	-	-	8	13	-
TG-X347	0.02	0.80	1.60	0.021	0.004	10.2	19.0	-	-	0.7	9	13	-
TG-X2209	0.02	0.64	1.84	0.015	0.003	9.5	23.1	3.34	0.15	-	-	-	47

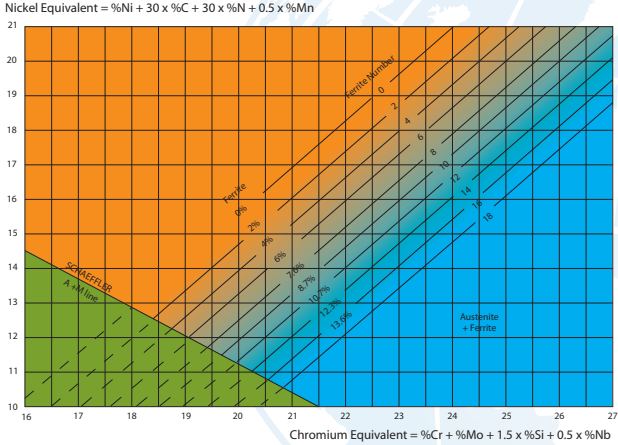
Welding Positions



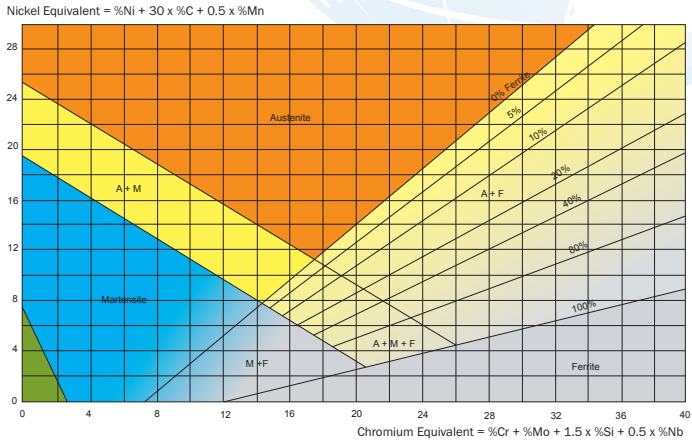
Typical Mechanical Properties

	R _e (MPa)	R _m (MPa)	A ₅ (%)	CV (J)	°C
TG-X308L	450	620	47	60	-196
TG-X309L	530	680	32	85	-20
TG-X316L	440	600	38	90	-20
TG-X347	460	630	48	110	-20
TG-X2209	603	811	32	138	-50

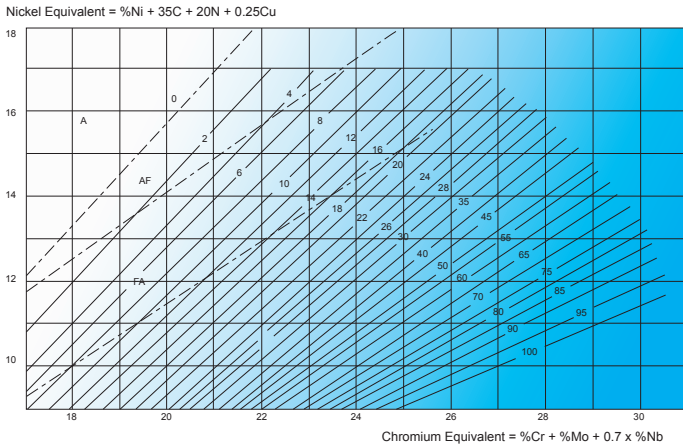
DeLong Diagram (FN)



Schaeffler Diagram (FS)

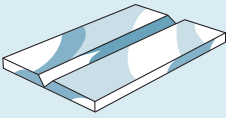


WRC Diagram-1992 (FNW)

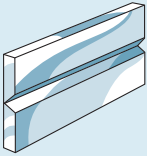


WELDING POSITIONS

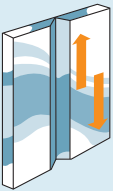
Butt welds



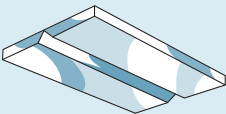
AWS: 1G
EN: PA



AWS: 2G
EN: PC

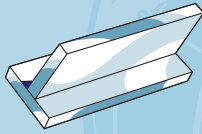


AWS: 3G
EN: PG • Down
PF • Up

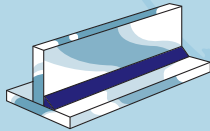


AWS: 4G
EN: PE

Fillet welds



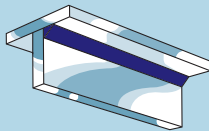
AWS: 1F
EN: PA



AWS: 2F
EN: PB

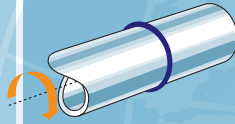


AWS: 3F
EN: PG • Down
PF • Up



AWS: 4F
EN: PD

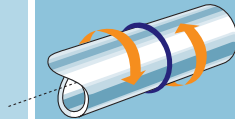
Pipe welds



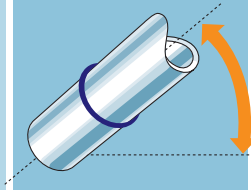
AWS: 1G
EN: PA



AWS: 2G
EN: PC

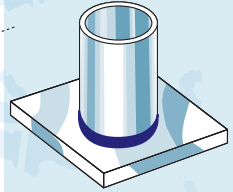


AWS: 5G
EN: PJ • Down
PH • Up

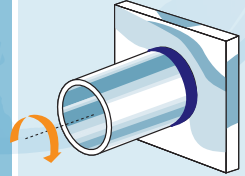


AWS: 6G
EN: H-L045 - up
J-L045 - down

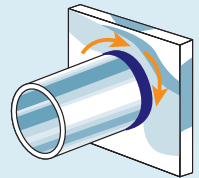
Fillet welds on pipe



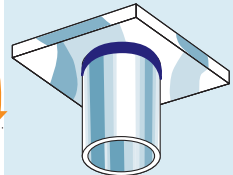
AWS: 2F
EN: PB



AWS: 2FR
EN: PB



AWS: 5F
EN: PJ • Down
PH • Up



AWS: 4F
EN: PD

AWS A5.20-2005, A5.29-2005

A5.20: Carbon steel electrodes for flux cored arc welding
 A5.29: Low alloy electrodes for flux cored arc welding

- Classification system

A 5.20 : E **1** **2** **3** **4** T - - J HZ

(Ex.) E7 1 T-1 M - J H8

A 5.29 : E **1** **2** **3** T- **5** **4** - - J HZ

(Ex.) E8 1 T-1 - B2 M - J H8

- E: Designates electrodes
- T: Designates flux-cored electrodes

1 All-weld metal tensile strength and related requirement ⁽¹⁾

Code	Tensile Strength		Impact absorbed energy, Min. ft-lb (J)
	ksi	MPa	
6	60-80	410-550	Average 20 (27) Each 15 (20) at specific temperature depending on classification
7	70-90	480-620	
8	80-100	550-690	
9	90-110	620-760	
10	100-120	690-830	
11	110-130	760-900	
12	120-140	830-970	

2 Welding position

Code	Designation
0	F, HF
1	All positions

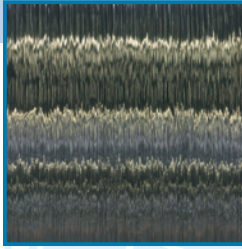
Note: (1) PWHT is required depending on classification

4 Shielding gas

Suffix	Designation
M	75%-80%Ar/Bal. CO ₂
C	CO ₂
None	Self-shield

5 Chemical composition of all-weld metal (A 5.29)

Suffix	Type	Suffix	Type
A1	C-Mo steel	Ni1	Ni steel
B1	Cr-Mo steel	Ni2	
B1L		Ni3	
B2		D1	Mn-Mo steel
B2L		D2	
B2H		D3	
B3		K1	Other low-alloy steels
B3L		K2	
B3H		K3	
B6		K3	
B6L		K4	
B8	K5		
B8L	K6		
	K7		
	K8		
	K9		
	W2		
	G		



3 Performances

Suffix (1)	Performances (Type of flux, Polarity, Application)
1	MAG, Rutile type, Fillet welding (Multi-pass)
2	MAG, Rutile type, Fillet welding (Single-pass)
3	Self-shielded, DC-EP, High welding speed
4	Self-shielded, DC-EP, High deposition rate
5	MAG, Lime type, High impact value, Good crack resistance
6	Self-shielded, DC-EP, High impact value
7	Self-shielded, DC-EN, High deposition
8	Self-shielded, DC-EN, High deposition rate
9	MAG, Rutile type, DC-EP, Small size: for all positions
10	Self-shielded, DC-EN, High welding speed
11	Self-shielded, DC-EN, Good usability
12	MAG, Rutile type, DC-EP, High impact value
13	Self-shielded, DC-EN, Root pass welding of pipes
14	Self-shielded, DC-EN, All positions, High welding speed
G	Not specified, For multiple-pass welding
GS	Not specified, For single-pass welding

Note: (1) A 5.29 designates 1, 4, 5, 6, 7, 8, 11 or G only.

Option.

⌋: Satisfies the minimum Charpy impact value 27J at -40°C (A5.20) or at a test temperature of 11°C lower (A5.29) than the specified temperature.

HZ: Diffusible hydrogen

Suffix	Diffusible hydrogen, Max. ml/100g deposited metal
H16	16.0
H8	8.0
H4	4.0
None (1)	8.0

Note: (1) A 5.29 only.

AWS A5.22-2010

Stainless steel electrodes for flux cored arc welding
Stainless steel flux-cored rods for gas tungsten arc welding

● Classification system

E **1** **2** T **3** - (Ex.) E 308L T 1 -1

R **1** **2** T **3** - (Ex.) R 308L T 1 -5

- E: Designates welding electrodes
- T: Designates flux-cored electrodes or rods
- R: Designates welding rods

1 Weld metal chemical composition and related requirements (See A5.22 for self-shielded wires)

Classification	Chemical composition of all-weld metal (%) ⁽¹⁾⁽²⁾										Typical Mechanical Properties of all-weld metal (as welded)		
	C	Cr	Ni	Mo	Cb+Ta	Mn	Si	P	S	Cu	TS, Min		EL., Min.
											ksi	MPa	(%)
E307	0.13	18.0-20.5	9.0-10.5	0.5-1.5	-	3.30-4.75	1.0	0.04	0.03	0.5	85	590	30
E308	0.08	18.0-21.0	9.0-11.0	0.5	-	0.5-2.5	1.0	0.04	0.03	0.5	80	550	35
E308H	0.04-0.08	18.0-21.0	9.0-11.0	0.5	-	0.5-2.5	1.0	0.04	0.03	0.5	80	550	35
E308L	0.04	18.0-21.0	9.0-11.0	0.5	-	0.5-2.5	1.0	0.04	0.03	0.5	75	520	35
E308Mo	0.08	18.0-21.0	9.0-11.0	2.0-3.0	-	0.5-2.5	1.0	0.04	0.03	0.5	80	550	35
E308LMo	0.04	18.0-21.0	9.0-12.0	2.0-3.0	-	0.5-2.5	1.0	0.04	0.03	0.5	75	520	35
E309	0.10	22.0-25.0	12.0-14.0	0.5	-	0.5-2.5	1.0	0.04	0.03	0.5	80	550	30
E309L	0.04	22.0-25.0	12.0-14.0	0.5	-	0.5-2.5	1.0	0.04	0.03	0.5	75	520	30
E309Cb	0.04	22.0-25.0	12.0-14.0	0.5	0.70-1.00	0.5-2.5	1.0	0.04	0.03	0.5	75	520	30
E309Mo	0.12	21.0-25.0	12.0-16.0	2.0-3.0	-	0.5-2.5	1.0	0.04	0.03	0.5	80	550	25
E309LMo	0.04	21.0-25.0	12.0-16.0	2.0-3.0	-	0.5-2.5	1.0	0.04	0.03	0.5	75	520	25
E309LNiMo	0.04	20.5-23.5	15.0-17.0	2.5-3.5	-	0.5-2.5	1.0	0.04	0.03	0.5	75	520	25
E310	0.20	25.0-28.0	20.0-22.5	0.5	-	1.0-2.5	1.0	0.03	0.03	0.5	80	550	30
E312	0.15	28.0-32.0	8.0-10.5	0.5	-	0.5-2.5	1.0	0.04	0.03	0.5	95	660	22
E316	0.08	17.0-20.0	11.0-14.0	2.0-3.0	-	0.5-2.5	1.0	0.04	0.03	0.5	75	520	30
E316L	0.04	17.0-20.0	11.0-14.0	2.0-3.0	-	0.5-2.5	1.0	0.04	0.03	0.5	70	485	30
E317L	0.04	18.0-21.0	12.0-14.0	3.0-4.0	-	0.5-2.5	1.0	0.04	0.03	0.5	75	520	20
E347	0.08	18.0-21.0	9.0-11.0	0.5	8xC-1.00	0.5-2.5	1.0	0.04	0.03	0.5	75	520	30
R308L	0.03	18.0-21.0	9.0-11.0	0.5	-	0.5-2.5	1.2	0.04	0.03	0.5	75	520	35
R309L	0.03	22.0-25.0	12.0-14.0	0.5	-	0.5-2.5	1.2	0.04	0.03	0.5	75	520	30
R316L	0.03	17.0-20.0	11.0-14.0	2.0-3.0	-	0.5-2.5	1.2	0.04	0.03	0.5	70	485	30
R347	0.08	18.0-21.0	9.0-11.0	0.5	8xC-1.00	0.5-2.5	1.2	0.04	0.03	0.5	75	520	30

Classification	Chemical composition of all-weld metal (%) (1)(2)									Typical Mechanical Properties of all-weld metal (3)			
	C	Cr	Ni	Mo	Mn	Si	P	S	Cu	TS, Min		El., Min.	PWHT
										ksi	MPa	(%)	
E409	0.10	10.5-13.5	0.60	0.5	0.80	1.0	0.04	0.03	0.5	65	450	15	None
E410	0.12	11.0-13.5	0.60	0.5	1.2	1.0	0.04	0.03	0.5	75	520	20	(a)
E410NiMo	0.06	11.0-12.5	4.0-5.0	0.40-0.70	1.0	1.0	0.04	0.03	0.5	110	760	15	(b)
E410NiTi	0.04	11.0-12.0	3.6-4.5	0.5	0.70	0.50	0.03	0.03	0.5	110	760	15	(b)
E430	0.10	15.0-18.0	0.60	0.5	1.2	1.0	0.04	0.03	0.5	65	450	20	(c)
E502	0.10	4.0-6.0	0.40	0.45-0.65	1.2	1.0	0.04	0.03	0.5	60	415	20	(d)
E505	0.10	8.0-10.5	0.40	0.85-1.20	1.2	1.0	0.04	0.03	0.5	60	415	20	(d)

Classification	Chemical composition of all-weld metal (%) (1)(2)										Typical Mechanical Properties of all-weld metal (3)			
	C	Cr	Ni	Mo	Mn	Si	P	S	N	Cu	TS, Min		El., Min.	PWHT
											ksi	MPa	(%)	
E2209	0.04	21.0-24.0	7.5-10.0	2.5-4.0	0.5-2.0	1.0	0.04	0.03	0.08-0.20	0.75	100	690	20	None
E2553	0.04	24.0-27.0	8.5-10.5	2.9-3.9	0.5-1.5	0.75	0.04	0.03	0.10-0.20	1.5-2.5	110	760	15	None
E2594	0.04	24.0-27.0	8.0-10.5	2.5-4.5	0.5-2.5	1.0	0.04	0.03	0.20-0.30	0.20-0.30	110	760	15	None

Note: (1) Single values are maximum

(2) The total of other elements, except iron, shall not present in excess of 0.5%.

(3) All-weld-metal mechanical properties are obtained after the following PWHT:

- a: Heated to 1350 to 1400°F (732 to 760°C), held for 1 hour, then furnace cooled to 600°F (315°C) at a rate not to exceed 100°F (55°C) per hour, then cooled in air to room temperature.
- b: Heated to 1100 to 1150°F (593 to 621°C), held for 1 hour, then cooled in air to room temperature.
- c: Heated to 1400 to 1450°F (760 to 788°C), held for 4 hours, then furnace cooled to 1100°F (593°C) at a rate not to exceed 100°F (55°C) per hour, then cooled in air to room temperature.
- d: Heated to 1550 to 1600°F (840 to 870°C), held for 2 hours, then furnace cooled to 1100°F (593°C) at a rate not to exceed 100°F (55°C) per hour, then cooled in air to room temperature.

2 Position of weldings

Code	Welding position
0	Flat and horizontal
1	All positions

3 External shielding medium and related requirements

Code	External shielding medium	Welding polarity	Welding process
1	CO ₂	DC-EP	FCAW
3	None (self-shielded)	DC-EP	FCA
4	75%-80%Ar/bal. CO ₂	DC-EP	FCA
5	100%Argon	DC-EN	GTA

AWS A5.34-2013

Nickel-Alloy Electrodes for Flux Cored Arc Welding

- Classification system

ENI **1** T **2** - **3** (Ex.) ENI Cr3 T 0 - 4

TNI **1** - **2** **3** (Ex.) TNI 6082 - 0 4

- E: Designates welding electrodes
- T: Designates flux-cored electrodes or rods

1 Weld metal chemical and mechanical requirements

Classification	Chemical composition of all-weld metal(%) ⁽¹⁾⁽²⁾										
Traditional	ISO format	C	Mn	Fe	P	S	Si	Cu	Ni ⁽³⁾	Co	Ti
Cr3	6082	0.10	2.5-3.5	3.0	0.03	0.015	0.50	0.50	67.0 min.	⁽⁵⁾	0.75
CrFe1	6062	0.08	3.5	11.0	0.03	0.015	0.75	0.50	62.0 min.	-	-
CrFe2	6133	0.10	1.0-3.5	12.0	0.03	0.02	0.75	0.50	62.0 min.	⁽⁵⁾	-
CrFe3	6182	0.10	5.0-9.5	10.0	0.03	0.015	1.0	0.50	59.0 min.	⁽⁵⁾	1.0
Mo13	1013	0.10	2.0-3.0	10.0	0.020	0.015	0.75	0.50	58.0 min.	-	-
CrMo2	6002	0.05-0.15	1.0	17.0-20.0	0.04	0.03	1.0	0.50	Balance	0.50-2.50	-
CrMo3	6625	0.10	0.5	5.0 ⁽⁴⁾	0.02	0.015	0.50	0.50	58.0 min.	⁽⁵⁾	0.40
CrMo4	6276	0.02	1.0	4.0-7.0	0.03	0.03	0.2	0.50	Balance	2.5	-
CrMo10	6022	0.02	1.0	2.0-6.0	0.03	0.015	0.2	0.50	Balance	2.5	-
CrCoMo1	6117	0.05-0.15	0.3-2.5	5.0	0.03	0.015	0.75	0.50	Balance	9.0-15.0	-

1 Weld metal chemical and mechanical requirements (Continued)

Classification	Chemical composition of all-weld metal(%) ^{(1),(2)}						Mechanical properties of all-weld metal ⁽⁷⁾	
	ISO format	Cr	Nb(Cb)+ Ta ⁽⁶⁾	Mo	V	W	TS, Min (ksi)	El., Min. (%)
Cr3	6082	18.0-22.0	2.0-3.0	-	-	-	80	25
CrFe1	6062	13.0-17.0	1.5-4.0	-	-	-	80	25
CrFe2	6133	13.0-17.0	0.5-3.0	0.5-2.5	-	-	80	25
CrFe3	6182	13.0-17.0	1.0-2.5	-	-	-	80	25
Mo13	1013	4.0-8.0	-	16.0-19.0	-	2.0-4.0	100	25
CrMo2	6002	20.5-23.0	-	8.0-10.0	-	0.2-1.0	90	25
CrMo3	6625	20.0-23.0	3.15-4.15	8.0-10.0	-	-	100	25
CrMo4	6276	14.5-16.5	-	15.0-17.0	0.35	3.0-4.5	100	25
CrMo10	6022	20.2-22.5	-	12.5-14.5	0.35	2.5-3.5	100	25
CrCoMo1	6117	21.0-26.0	1.0	8.0-10.0	-	-	90	25

(1) Single values are maximum.

(2) The total of other elements shall not present in excess of 0.50%.

(3) Includes residual cobalt.

(4) Iron is 1.0 maximum when specified by the purchaser.

(5) Cobalt is 0.10 maximum when specified by the purchaser.

(6) Tantalum is 0.30 maximum when specified by the purchaser.

(7) As-welded condition.

2 Welding Position

Code	Welding position
0	Flat and horizontal fillet
1	All positions

3 Shielding gas

Code	External shielding medium
1	CO ₂
3	None (self-shielded)
4	75%-80%Ar/bal. CO ₂

EN ISO 17632:2008

Tubular cored electrodes for gas shielded or self-shielded metal arc welding of non-alloy and fine-grain steels.

- Classification (system A)

EN ISO 17632-A-T **1** **2** **3** **4** **5** **6** **7**

[Ex.] EN ISO 17632-A-T **46** **3** **1Ni** **B** **M** **4** **H5**

- T: Designates tubular cored electrodes for metal arc welding

1 Yield strength and related requirements

(a) Multiple-layer welding
Yield strength of all-weld metal

Code	Yield strength or 0.2% offset strength Min. (MPa)	Tensile strength (MPa)	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) Single pass welding
Yield strength of weld joint

Code	Yield strength of base metal Min. (MPa)	Tensile strength of weld joint Min. (MPa)
3T	355	470
4T	420	520
5T	500	600

2 Impact value of all-weld metal or weld joint

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

3 Chemical composition of all-weld metal

Code	Chemical composition ⁽¹⁾ %		
	Mn	Ni	Mo
-	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	Other elements as agreed		

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

Code	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	Basic/Fluorides or Rutile	Single pass	Not required
W	Basic/Fluorides Slow-freezing slag	Single pass or multiple pass	
Y	Basic/Fluorides Fast-freezing slag		
Z	Other types		

5 Shielding gas

Code	Designation
M	Gas mixtures (Gases specified as M2 per ISO 14175 except He)
C	CO ₂ (Gases specified as C1 per ISO 14175)
N	Self-shielded

6 Welding position (Option)

Code	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 in the code 3

7 Diffusible hydrogen (option)

Code	Diffusible hydrogen, max. ml/100g deposited metal
H5	5
H10	10
H15	15

EN ISO 17633:2010

Tubular cored electrodes and rods for gas shielded and non-gas shielded metal arc welding of stainless and heat-resisting steels

- Classification (system A)

EN ISO 17633-A-T **1** **2** **3** **4**

[Ex.] EN ISO 17633-A-T 19 12 3L R M 4

- T: Designates tubular cored electrodes for gas shielded and non-gas shielded metal arc welding

1 Chemical composition and mechanical properties of all-weld metal

Classification	Chemical composition (%)				Proof strength	Tensile strength	EI. (L=5D)	PWHT
	Cr	Ni	Mo	Others	Min. Rp0.2 (MPa)	Min. Rm (MPa)	Min. A %	
Martensite/ferrite type								
13	11.0-14.0	-	-	-	250	450	15	(a)
13 Ti	10.5-13.0	-	-	Ti ⁽¹⁾	250	450	15	(a)
13 4	11.0-14.5	3.0-5.0	0.4-1.0	-	500	750	15	(a)
17	16.0-18.0	-	-	-	300	450	15	(a)
Austenite 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
Austenite-ferrite high corrosion resistant 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
23 7 N L	22.5-25.5	6.5-10.0	-	N:0.10-0.20	450	570	20	None
25 9 4 N L	24.0-27.0	8.0-10.5	2.5-4.5	N:0.20-0.30	550	620	18	None
25 9 4 Cu N L	24.0-27.0	8.0-10.5	2.5-4.5	N:0.20-0.30 Cu: 1.0-2.5	550	620	18	None
Full-austenite high corrosion resistant 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
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
20 25 5 Cu N L	19.0-22.0	24.0-27.0	4.0-6.0	N:0.10-0.20 Cu:1.0-2.0	320	510	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 resistant type								
19 9 H	18.0-21.0	9.0-11.0	-	-	350	550	25	None
22 12 H	20.0-23.0	10.0-13.0	-	-	350	550	20	None

Note: (1) Ti:10xC%-1.5%
 (2) Nb:8xC%-1.1%: Nb can be replaced with Ta up to 20%
 (3) 840-870°Cx2H heating, followed by FC to 600°C and later AC
 (4) 580-620°Cx2H heating, followed by AC
 (5) 760-790°Cx2H heating, followed by FC to 600°C and later AC

2 Type of cored flux

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

3 Shielding gas

Code	Designation
M	Gas mixtures (Gases specified as M2 per ISO 14175 except He)
C	CO ₂ (Gases specified as C1 per ISO 14175)
N	Self-shielded

4 Welding position (Option)

Code	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 in the code 3

EN ISO 18276:2006

Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of heat-strength steels.

- Classification (system A)

EN ISO 18276-A-T **1** **2** **3** **4** **5** **6** **7** **8**

[Ex.] EN ISO 18276-A-T **55** **5** **Mn1.5Ni** **B** **M** **4** **H5** **I**

- T: Designates tubular cored electrodes for gas shielded and non-gas shielded metal arc welding

1 All-weld metal yield strength and related requirements

Code	Yield strength or 0.2% offset strength Min. (MPa)	Tensile strength (MPa)	Elongation (L=5D) Min. (%)
55	550	640~820	18
62	620	700~890	18
69	690	770~940	17
79	790	880~1080	16
89	890	940~1180	15

2 Impact value of all-weld metal

Code	Absorbed energy of 47J, Three-specimen average, ⁽⁴⁾ Test temp. (°C)
Z	Not required
A	+20
0	0
2	-20
3	-30
4	-40
5	-50
6	-60

Note: (1) One value can be lower than 47 J but be 32 J or higher

3 Chemical composition of all-weld metal

Code	Chemical composition ⁽⁴⁾ (%)			
	Mn	Ni	Cr	Mo
Z	Elements as agreed			
MnMo	1.4-2.0	-	-	0.3-0.6
Mn1Ni	1.4-2.0	0.6-1.2	-	-
Mn1, 5Ni	1.1-1.8	1.3-1.8	-	-
Mn2, 5Ni	1.1-2.0	2.1-3.0	-	-
1NiMo	1.4	0.6-1.2	-	0.3-0.6
1, 5NiMo	1.4	1.2-1.8	-	0.3-0.7
2NiMo	1.4	1.8-2.6	-	0.3-0.7
Mn1NiMo	1.4-2.0	0.6-1.2	-	0.3-0.7
Mn2NiMo	1.4-2.0	1.8-2.6	-	0.3-0.7
Mn2NiCrMo	1.4-2.0	1.8-2.6	0.3-0.6	0.3-0.6
Mn2Ni1CrMo	1.4-2.0	1.8-2.6	0.6-1.0	0.3-0.6

Note: (1) Single values are maximum.

4 Type of cored flux

Code	Features
R	Rutile, Slow-freezing slag
P	Rutile, Fast-freezing slag
B	Basic
M	Metal powder
Z	Other type

5 Shielding gas

Code	Designation
M	Gas mixtures
C	CO ₂

6 Welding position (Option)

Code	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 in the code 3

7 Diffusible hydrogen (option)

Code	Diffusible hydrogen, max. ml/100g deposited metal
H5	5
H10	10

8 Heat treatment: T: 560-600°Cx1h, Furnace Cooling to 300°C for mechanical tests of all-weld metal

Abbreviations

General

A	Ampere
AC	Air Cooling
ASTM	American Society for Testing and Materials
AWS	American Welding Society
A ₅	Elongation
CO ₂	Carbon dioxide
CTOD	Crack Tip Opening Displacement
CTWD	Contact Tip to Work Distance
CV	Charpy Impact Value
EN	European Norm
FC	Furnace Cooling
FCW	Flux Cored Wire
FN	Ferrite according to DeLong Diagram
FNW	Ferrite according to WRC Diagram - 1992
FS	Ferrite according to Schaeffler Diagram
HAZ	Heat Affected Zone
ISO	International Standards Organisation
KSL	KOBE STEEL, LTD.
KWE	KOBELCO WELDING OF EUROPE B.V.
MIG / MAG	Metal Inert Gas / Metal Active Gas
NACE	National Association of Corrosion Engineers
PWHT	Post Weld Heat Treatment
R _e	0.2% Proof Stress
R _m	Tensile Strength
SR	Stress Relief
TIG	Tungsten Inert Gas
=/-	Direct Current Straight Polarity (DCSP)
=/+	Direct Current Reverse Polarity (DCRP)

Approval Bureaus

ABS	American Bureau of Shipping
BV	Bureau Veritas
CCS	China Classification Society
CWB	Canadian Welding Bureau
DNV	Det Norske Veritas
DB	Deutsche Bahn
GL	Germanischer Lloyd
KR	Korean Register of Shipping
LR	Lloyd's Register of Shipping
NAKS	Национальное Агентство Контроля Сварки
NK	Nippon Kaiji Kyokai
P.R.S.	Polski Rejestr Statkow
RINA	Registro Italiano Navale
R.M.R.S	Russian Maritime Resister of Shipping
RRR	Russian River Register
TÜV	Technischer Überwachungs-Verein

Positions (EN and AWS A3.0)

PA	Flat Fillet (1F), Flat Butt (1G) and rotating horizontal Pipe weld (1G)
PB	Horizontal Fillet / Standing Fillet (2F)
PC	Horizontal Vertical Butt or Pipe weld (2G)
PD	Overhead Fillet weld (4F)
PE	Overhead Butt weld (4G)
PF	Vertical Up for both Butt (3G) and Fillet welds (3F)
PG	Vertical Down for both Butt (3G) and Fillet welds (3F)
PH	Vertical up welding on fixed horizontal pipe (5G)
PJ	Vertical down welding on fixed horizontal pipe (5G)
H-L045	Fixed pipe welded under 45 degree angle welding upwards (6G uphill)
J-L045	Fixed pipe welded downwards under 45 degree angle (6G downhill)

Storage & Handling

Transport

Outside transportation in original packaging must be carried out in covered vehicles, and direct exposure to rain and snow must be avoided.

Warehouse and central storage

Flux cored wires should be stored in their original, undamaged packaging, under dry conditions with a temperature ranging from 10-30°C, and a maximum 80% relative humidity. Product must not be placed directly on the floor, but on wooden pallets or similar.

Product should be stored at least 10 cm above floor level and at least 10 cm away from walls.

Handling

- If welding is carried out in an environment exposed to damp, rain, snow, sea air or dust, encased wire feeding systems shall be applied.
- Cored wires removed from their original packaging may be kept in a normal heated workshop for up to 5 days. Following this period the wire should be placed in a heated store place.
- When used outside, or in unheated workshops, the wire should be removed from the wire feeder and put in a heated storage when not used during an 8-hour period.
- If taken back to the storage, the wire should be placed in a plastic bag or similar.
- Storage time for opened packaging is up to 24 months, as long as there is no sign of rust or discoloration on the wire surface.
- Do not lift a spool by its flange, because wire can get tangled.

DON'T LIFT A SPOOL BY ITS FLANGE!



Wrong



Correct

Shelf life

- Guaranty period of flux cored wires is within 24 months from production date.

Scrapping

- Any trace of rust visible on the wire indicates that incorrect storage conditions have been used.
- Wire that shows any signs of rust must be scrapped.
- In the case it is suspected that cored wire has been stored incorrectly, KOBELCO recommends scrapping.

A handwritten signature in black ink, appearing to read 'H. H. H.', written over a horizontal line.

QA Manager



List of addresses

Europe:

KOBELCO WELDING OF EUROPE B.V.

Eisterweg 8, 6422 PN, Heerlen, The Netherlands
Tel.: +31-45-547 1111, Fax: +31-45-547 1100
Direct: +31-45-547 1127
www.kobelcowelding.nl
e-mail: marketing@kobelcowelding.nl

North America:

KOBELCO WELDING OF AMERICA INC.

Houston Head Office
4755 Alpine, Suite 250, Stafford, Texas
77477 USA
Tel.: (1) 281 240 5600, Fax: (1) 281 240 5625
www.kobelcowelding.com

Asia:

KOBELCO WELDING OF SHANGHAI CO., LTD.

8F, B District, No. 1010, Kai Xuan Road
Shanghai, 200052 People's Republic of China
Tel.: (86) 21 6191 7850, Fax: (86) 21 6191 7851

KOBE WELDING OF TANGSHAN CO., LTD.

196, Huoju Road, Tangshan, New & High-Tech
Development Zone, Tangshan, Hebei, 063020
People's Republic of China
Tel.: (86) 315 385 2806, Fax: (86)315385 2829

KOBE WELDING OF QINGDAO CO., LTD.

South 6th Rd. and West 35th Rd., FUYUAN Industrial Estate
Qingdao Development Area, Qingdao, 266555 P.R. China
Tel.: (86) 532-8098-5005, Fax: (86) 532-8098-5008



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Asia:

KOBE STEEL LTD.

Welding Business Global Operations & Marketing Department
9-12 Kita-Shinagawa 5-chome,
Shinagawa-ku, Tokyo, 141-8688, Japan
Tel.: (81) 3 5739 6331, Fax: (81) 3 5739 6960
www.kobelco.co.jp/english

KOBE WELDING OF KOREA CO., LTD.

21-14 Palryong-Dong, Changwon, Kyongnam
Republic of Korea
Tel.: (82) 551 92-6886, Fax: (82) 552 92-7786

KOBE WELDING MARKETING OF KOREA CO., LTD.

303, Daedong-ro, Sasang-Gu, Busan, 46981,
Republic of Korea
Tel.: +82-51-329-8999, Fax: +82-51-329-89496

KOBE WELDING ASIA PACIFIC PTE. LTD.

237, Pandan Loop, #07-10 Westech Building,
Singapore 609387
Republic of Singapore
Tel.: (65) 6268 2711, Fax: (65) 6264 1751

THAI-KOBE WELDING CO., LTD.

500 Moo 4 Soi 1, Bangpoo Industrial Estate, Sukhumvit Rd,
Praeksa, Muang Samutprakarn, 10280 Thailand
Tel.: (66) 2 324 0588 to 0591 Fax: (66) 2 324 0797

KOBE MIG WIRE (THAILAND) CO., LTD.

491 Moo 4 Soi 1, Bangpoo Industrial Estate Sukhumvit Rd,
Praeksa, Muang Samutprakarn, 10280 Thailand
Tel.: (66) 2 324 0588 to 0591 Fax: (66) 2 324 0797

KOBE WELDING (MALAYSIA) SDN. BHD.

Plot 502, Jalan Perusahaan Baru, Kawasan
Perusahaan Prai, 13600 Prai, Malaysia
Tel. (60) 4 3905792, Fax. (60) 4 3905827

P.T. INTAN PERTIWI INDUSTRI

(Technically Collaborated Company)
Jalan P Jayakarta 45, Block A/27, Jakarta
11110 Indonesia
Tel.: (62) 21 639 2608, Fax: (62) 21 649 6081

KOBELCO WELDING INDIA PVT. LTD.

Unit No. 409
Corporate Suites MG Road Gurgaon
Haryana, 122003 India
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