ELKADESIA

Engineering Industries
Welding Consumables


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EL KADESIA ENGINEERING INDUSTRIES.

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INTRODUCTION
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EL KADESIA

El-Kadesia Engineering Industries is the Egyptian market leader in welding electrodes with more than 40 years of accumulated experience in the industry.

El-Kadesia was established in year 1985 by its founder Mr. Naguib Gwefel; who acquired the Know-how and technology of this industry from a leading European manufacturer in Austria and operated under their license until 2010.

In 2011 El-Kadesia decided to proceed independently relying on its own brand name and is now formulating its strategy to access and infiltrate foreign markets, meet those Markets' demands and meet their customers' expectations.

Currently El Kadesia™ produces 8 main types of electrodes: Rutile, Cellulose, basic coated, low alloyed, High Alloy, Hardfacing, Cast iron and Nickel Alloy electrodes. The eight types are manufactured using the latest technology and equipment's recommended in that industry. All our products are manufactured according to the requirements of American Welding Society (AWS) and American Society of Mechanical Engineering (ASME).

COMPANY

El-Kadesia™ products serve several sectors including construction, shipbuilding, Electricity, fertilizers, petrochemicals, and oil & gas along with several other sectors. El-Kadesia factory is located in the 10th of Ramadan industrial city in Egypt with more than 250 employees operating on a 21,000 square meter premises with a capacity of 20,000 tons annually.

In an effort to ensure premium quality; our products are subjected annually to international quality tests along with restricted supervision from our quality control division and continuous quality improvement from our R&D department to conform with the international standards and customers' expectations.

Guaranteeing exceptional quality to our clients; El Kadesia™ products are certified by ABS, LR, DNV and ISO 9001.

Stick Electrodes (Unalloyed, Low-alloyed)

Product Name	EN/ISO-Standard	EN/ISO-Classification	AWS-Classification	AWS-Standard	Chapter page
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TECHNICAL SPECIFICATIONS

AWS A5.1: E6013
EN ISO 2560 – A: E 42 0 RR 12

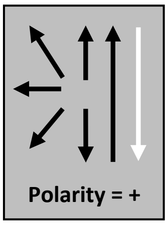
Product As Shown: EL KADESIA AG™
Application: SMAW Rutile electrode, mild steel

Typical Composition of all-weld Metal

Description

Rutile coated electrode with excellent weldability in all positions with the exception of vertical - down. It features with slightly smooth seams, easy slag removal, arc stability, with little spatter, and good weldability with AC. phenomenal re-ignition properties and easy handling, diversity in application in both industry and craft.

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	N/mm^2	N/mm^2	%	+20 °C	0 °C
Untreated	440	530	26	110	80
Typical According to ASME II part C/SFA 5.1	≥ 330	≥ 430	≥ 17	N.S	



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	60-100	90-140	140-190	170-240

Re - drying: if necessary: 70 - 80 °C, min. 1h.

Steels up to a yield strength of 420 MPa (60ksi) S235JR-S355JR, S235JO-S355JO, P195TR1- P265TR1, P195GH-P265GH, L245NB-L360NB, L245MB-L360MB, L415NB, L415MB, shipbuilding steels: A, B, D ASTM A 106, Gr. A, B; A 283 Gr. A, C; A 285 Gr. A, B, C; A 501, Gr. B; A 573, Gr. 58, 65, 70; A 633, Gr. A, C; A 711 Gr. 1013; API 5 L Gr. B, X42, X52, X60

Approvals: DNV, LR

TECHNICAL SPECIFICATIONS

AWS A5.1: E6013
EN ISO 2560 – A: E 38 2 RC 11
EN 10204 Type 3.1

Product As Shown: EL KADESIA OHVI™
Application: SMAW Rutile-cellulosic electrode, mild steel

Description

Rutile - cellulosic coated electrode with good weldability in all positions including vertical - down. Most popular is E 6013 type. For small transformers, very good operating characteristics, flexible coating and good for tack welding. Versatile applications are in structural welding, vehicle construction, boiler, and tank welding and in shipbuilding. Also, it is suitable for galvanized components.

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.07	0.18	0.25	0.015	0.02	0.03	0.02	0.09	0.01
Typical According to ASME II part C/SFA 5.1	0.20 max.	1.00 max.	1.20 max.	N.S	N.S	0.30 max.	0.20 max.	0.30 max.	0.08 max.

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	N/mm^2	N/mm^2	%	+20 °C	+0 °C	- 20 °C
Untreated	394	492	28	120	105	65
Typical According to ASME II part C/SFA 5.1	≥ 330	≥ 430	≥ 17	N.S		

Polarity = ±/~

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	60-100	90-130	110-170	170-240

Steels up to a yield strength of 380 MPa (52 ksi) S235JR-S355JR, S235JO-S355JO, P195TR1-P265TR1, P195GH-P265GH, L245NBL360NB, L245MB-L360MB, shipbuilding steels: A, B, D ASTM A 106, Gr. A, B; A 283 Gr. A, C; A 285 Gr. A, B, C; A 501, Gr. B; A 573, Gr. 58, 65; A 633, Gr. A, C; A 711 Gr. 1013; API 5 L Gr. B, X42, X52.

Approvals: DNV, ABS

EL KADESIA ENGINEERING INDUSTRIES

TECHNICAL SPECIFICATIONS

AWS A5.1: E6013
EN ISO 2560 - A : E 38 0 RC 11

Product As Shown: EL KADESIA NG™
Application: SMAW Rutile-cellulosic electrode, mild steel

Description

Rutile - cellulosic coated electrode with good weldability in all positions including vertical - down. Most popular is E 6013 type. For small transformers, very good operating characteristics, flexible coating and good for tack welding. Versatile applications are in structural welding, vehicle construction, boiler and tank welding and in shipbuilding. Also, it is suitable for galvanized components.

Typical Composition of all-weld Metal

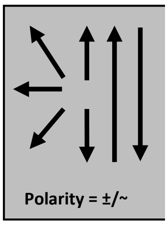
	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.08	0.40	0.50	0.01	0.01	0.01	0.02	0.004	0.02
Typical According to ASME II part C/SFA 5.1	0.20 max.	1.00 max.	1.20 max.	N.S	N.S	0.30 max.	0.20 max.	0.30 max.	0.08 max.

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	N/mm^2	N/mm^2	%	+20 °C	0 °C
Untreated	452	538	28	100	70
Typical According to ASME II part C/SFA 5.1	≥ 330	≥ 430	≥ 17	N.S	

Operating Data

Re - drying: not necessary



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350/450	350	350/450	350/450
Amps A	60-100	90-130	110-170	170-240

Base Materials

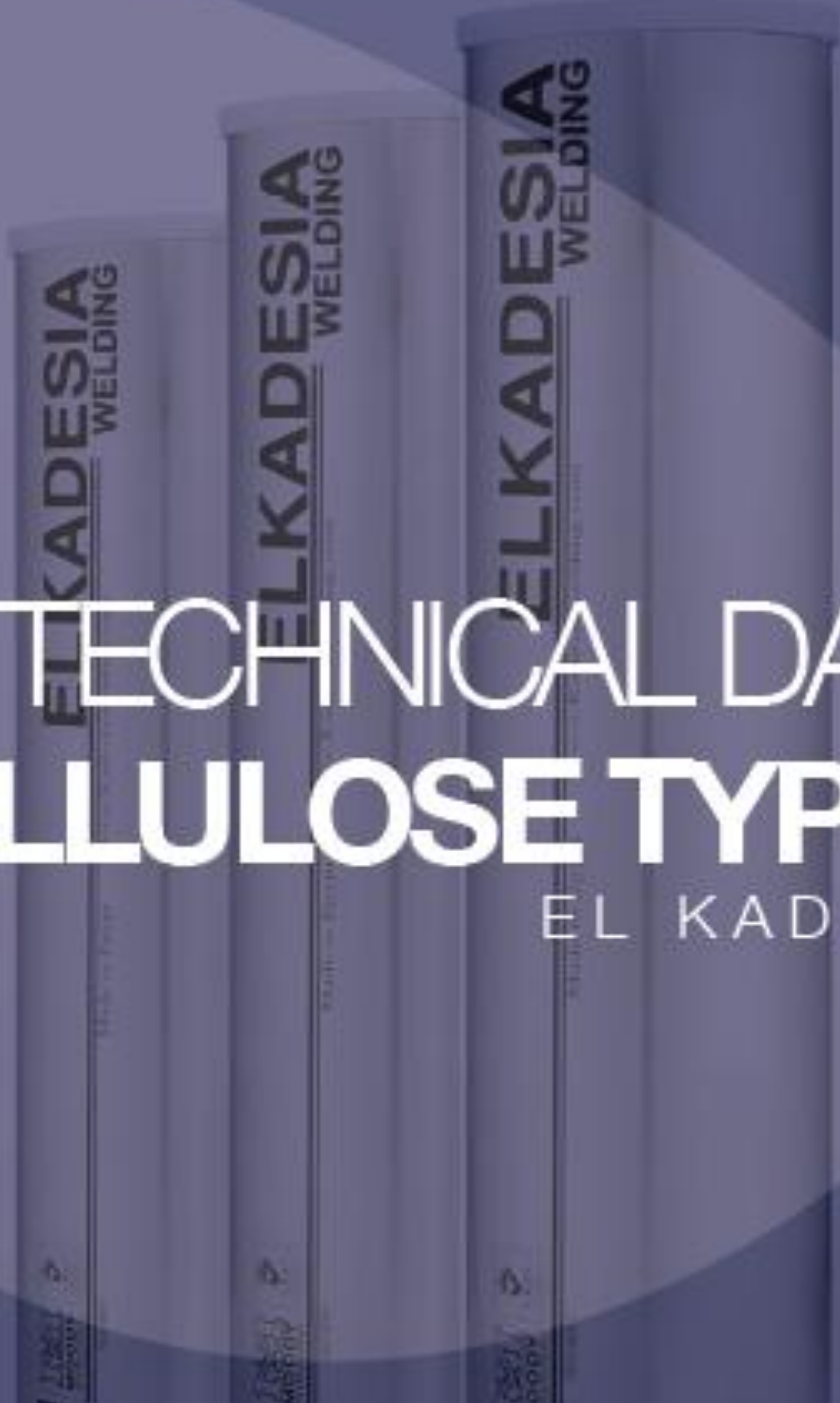
S235JRG2 - S355J2; GS-38; GS-45; St35; St45; St35.8; boiler steels P235GH, P265GH, P295GH; shipbuilding steels corresp. to app.-grade 2; fine grained structural steels up to P355N; weldable ribbed reinforcing steel bars. ASTM A36 and A53 Gr. all; A106 Gr. A, B, C; A135 Gr. A, B; A283 Gr. A, B, C, D; A366; A285 Gr. A, B, C; A500 Gr. A, B, C; A570 Gr. 30, 33, 36, 40, 45; A607 Gr. 45; A668 Gr. A, B; A907 Gr. 30, 33, 36, 40; A935 Gr. 45; A936 Gr. 50; API 5 L Gr. B, X42-X52.

Approvals: DNV , LR

TECHNICAL DATA

CELLULOSE TYPES

EL KADESIA



AWS A5.1: E6010
EN ISO 2560 - A: E 38 3 C 21

Product as Shown: EL KADESIA CEL E6010™
Application: SMAW Cellulosic electrode for Vertical-down welding, Pipe welding

Description

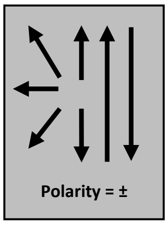
Cellulose-coated electrode for vertical-down welding of large diameter pipelines; suitable for root runs, hot passes, filler and cover layers. Especially recommended for root run Welding. Highly economical compared with vertical-up welding. Apart from its excellent welding and gap bridging characteristics ELKADESIA CEL™; offers a weld metal deposit with an outstanding impact strength value and, thus offers the benefit of still more safety in field welding of pipelines. It can be used in severe gaseous media applications.

Typical Composition of all deposited-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.12	0.14	0.50	0.01	0.01	0.01	0.07	0.07	0.02
Typical According to ASME II part C/SFA 5.1	0.20 max.	1.00 max.	1.20 max.	N.S	N.S	0.3 max.	0.20 max.	0.30 max.	0.08 max.

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	-30 °C
Untreated	450	550	26	50
Typical According to ASME II part C/SFA 5.1	≥ 330	≥ 430	≥ 22	≥ 27

Operating Data



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-90	80-130	120-180	160-210

-ve polarity for root pass only.

S235JR, S275JR, S235J2G3, S275J2G3, S355J2G3, P235GH, P265GH, P355T1, P235T2- P355T2, L210NB-L385NB, L290MB-L385MB, P235G1TH, P255G1TH root pass up to L555NB, L555MB API Spec. 5 L: A, B, X 42, X 46, X 52, X 56, root pass up to X 80.

Approvals: DNV , LR

TECHNICAL SPECIFICATIONS

AWS A5.5: E7010 - A1
EN ISO 2560 - A: E 42 3 Mo C 2 5

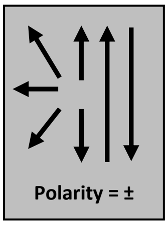
Product As Shown: EL KADESIA CEL E7010 - A1™
Application: SMAW Cellulosic electrode for Vertical- down welding, pipe welding

Description

Cellulose-coated electrode for vertical-down welding of high strength large diameter Pipelines. Highly economical compared with conventional vertical-up welding. Especially it is recommended for hot passes, filler and cover layers. The penetrating arc characteristics and the low slag formation allow good bead control and ensure best performance in all positions even with the larger diameter electrodes and high amperages. It can be used in severe gaseous media applications.

	C	Si	Mn	P	S	Mo
Wt. %	0.11	0.14	0.40	0.01	0.01	0.5
Typical According to ASME II part C/SFA 5.5	0.12 max	0.40 max	0.60 max	0.03 max	0.03 max	0.4 – 0.65

Heat Treatment	Yield Strength 0.2%	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	N/mm^2	N/mm^2	%	0 °C	-20 °C
Untreated	480	550	23	100	85
Typical According to ASME II part C/SFA 5.5	≥ 390	≥ 490	≥ 22	N.S	



mm	3.25mm	4.0mm	5.0mm
L mm	350	350	350
Amps A	80-130	120-180	160-210

-ve polarity for root pass only.

S235JR, S275JR, S235J2G3, S275J2G3, S355J2G3, P235GH, P265GH, L210-L415NB, L290MB – L415MB, P355T1, P235T2-P355T2, P235G1TH, P255G1TH root pass up to L555MB API Spec. 5 L: Grade A, B, X 42, X 46, X 52, X 56, X 60, root pass up to X 80.

TECHNICAL SPECIFICATIONS

AWS A5.5: E7010 -G,P1
EN ISO 2560 - A : E 42 3 C 2 5

Product As Shown: EL KADESIA CEL E7010 -G/P1™
Application: SMAW Cellulosic electrode for Vertical-down welding, pipe welding

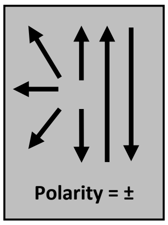
Description

Cellulose-coated electrode for vertical-down welding of high strength large diameter pipe- lines .Highly economical compared with conventional vertical-up welding. It is highly recommended for hot passes, filler and cover layers. The penetrating arc characteristics and the low slag formation allow good bead control and ensure best Performance in all positions even, with the larger diameter electrodes and high amperages. It can be used in severe gaseous media applications.

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.14	0.13	0.70	0.02	0.02	0.07	0.07	0.01	0.006

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	-30 °C
Untreated	460	550	26	76
Typical According to ASME II part C/SFA 5.5	≥ 415	≥ 490	≥ 22	≥ 27



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-90	80-130	120-180	160-210

-ve polarity for root pass only.

S235JR, S275JR, S235J2G3, S275J2G3, S355J2G3, P235GH, P265GH, L210-L415NB, L290MB-L415MB, P355T1, P235T2-P355T2, P235G1TH, P255G1TH root pass up to L480MB API Spec. 5 L: Grade A, B, X42, X 46, X 52, X 56, X 60, root pass up to X 70.

Approvals: DNV, LR, ABS

TECHNICAL SPECIFICATIONS

AWS A5.5: E8010- G,P1
EN ISO 2560 - A :E 46 4 1 Ni C 2 5

Product As Shown: EL KADESIA CEL E8010- G/P1™
Application: SMAW Cellulosic electrode for Vertical- down welding, pipe welding

Description

Cellulose-coated electrode for vertical-down welding of large diameter pipelines; suitable for root runs, hot passes, filler and cover layers. Especially recommended for root run welding. Highly economical compared with vertical-up welding. Apart from its excellent welding and gap bridging characteristics ELKADESIA CEL™ offers a weld metal deposit with outstanding impact strength values and thus offers the benefit of still more safety in field welding of pipelines. It can be used in severe gaseous media applications.

Typical Composition of all deposited-weld Metal

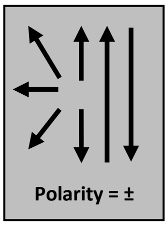
	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.13	0.13	0.75	0.02	0.02	0.65	0.02	0.01	0.03
Typical According to ASME II part C/SFA 5.5	0.2 max.	0.6 max.	1.20 max.	0.03 max.	0.03 max.	1.0 max.	0.3 max.	0.5 max.	0.10 max.

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	-30 °C
Untreated	490	580	26	85
Typical According to ASME II part C/SFA 5.5	≥ 460	≥ 550	≥ 19	≥ 27

Operating Data

Re - drying: not allowed



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-90	80-130	120-180	160-210

Base Materials

L415NB-L450NB, L415MB-L450MB API Spec. 5 L: X 56, X 60, X 65

Approvals: DNV, LR, ABS

EL KADESIA ENGINEERING INDUSTRIES

TECHNICAL SPECIFICATIONS

AWS A5.5: 9010-P1
EN ISO 2560 - A :E 50 3 1Ni C 2 5

Product As Shown: EL KADESIA CEL E 9010-P1 ™
Application: SMAW Cellulosic electrode for Vertical- down welding, pipe welding

Description

Cellulose-coated electrode is for vertical-down welding of high strength large diameter pipelines. It is highly recommended economically wise, when compared with conventional vertical-up welding. It is highly recommended for hot passes; internal filler passes and cover layers. It is the most popular cellulosic electrode; which meets all the exacting demands of the Site welding of cross country pipelines extremely well. It ensures highest weldment quality down to temperatures of -40 º C, it can be used in severe gaseous media applications. The materials mode of transfer is fine droplet stratification.

Typical Composition of all-weld Metal

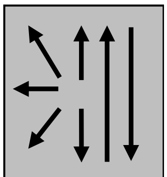
	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.16	0.22	0.90	0.02	0.02	0.80	0.02	0.01	0.01
Typical According to ASME II part C/SFA 5.5	0.20 max.	0.60 max.	1.20 max.	0.03 max.	0.03 max.	1.00 max.	0.30 max.	0.50 max.	0.10 max.

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	-30 ºC
Untreated	580	650	21	65
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	≥ 27

Operating Data

Re - drying: not allowed



Polarity =+

mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350
Amps A	80 - 120	120-180	160-210

Base Materials

API5L: X 42, X 46, X 52, X 56, X 60, X 65, X 70 and root pass up to X 80 EN 10208-2: L290MB-, L485MB- and root pass up to L555MB- and NB-qualities; EN 10113-3: S355ML, S420ML, S460ML.

TECHNICAL SPECIFICATIONS

AWS A5.5: 9010-G
EN ISO 2560 - A: E 50 3 1 Ni C 25

Product As Shown: EL KADESIA CEL 9010-G ™
Application: SMAW Cellulosic electrode for Vertical- down welding, Pipe welding

Description

Cellulose covered electrode for circumferential welds; developed for field welding of higher strength pipeline steels in the vertical down position. Excellent weldability in root, hot, fill and cap pass welding. Easy slag removal. Good bend and radiographic test results. High ductility of the welded joint.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.16	0.22	0.90	0.02	0.02	0.80	0.02	0.01	0.01
Typical According to ASME II part C/SFA 5.5	0.20 max.	0.60 max.	1.20 max.	0.03 max.	0.03 max.	1.00 max.	0.30 max.	0.50 max.	0.10 max.

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	- 30 °C
Untreated	550	640	23	67
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	

Operating Data

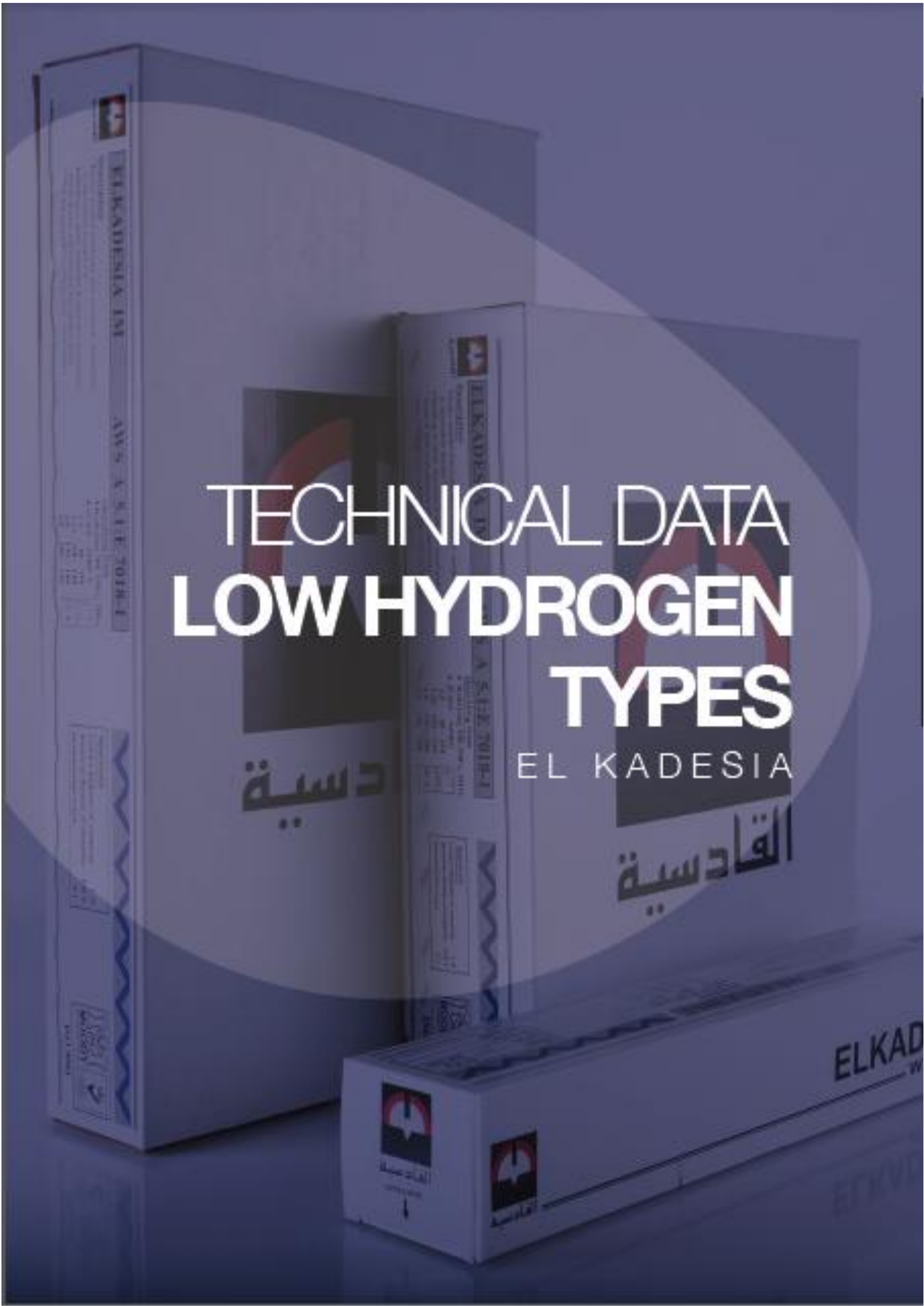
Re - drying: not allowed

Polarity =+

mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350
Amps A	80-120	120-180	160-210

Base Materials

API5L: X 60, X 65, X 70, (X 80) EN 10208-2: L415MB-, L450MB-, L485MB-, (L555MB-) .



TECHNICAL DATA
LOW HYDROGEN TYPES
EL KADESIA

TECHNICAL SPECIFICATIONS

AWS A5.1: E 6015

Product as Shown: EL KADESIA E 6015™
Application: SMAW electrode, mild steel

Description

E 6015 is characterized by easy ignition and Arc stability, good formation of metal of a seam when welding in all welding positions, easy removal of slag and low spatter. Provide a faultless seam when welding on the raised modes.

Typical Composition of all-weld Metal

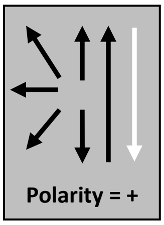
	C	Si	Mn	P	S
Wt.%	0.07	0.45	1.10	0.02	0.02

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	N/mm^2	N/mm^2	%	+20 °C	-20 °C
Untreated	520	622	28	160	75

Operating Data

Re - drying: if necessary: 300 - 350 °C, min. 2 h.



mm	2.5mm	3.25mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	60-90	90-130	130-190	160-240

TECHNICAL SPECIFICATIONS

AWS A5.1: E 6018

Product As Shown: EL KADESIA E 6018™
Application: SMAW electrode, mild steel

Description

Basic extremely low hydrogen electrode (HDM< 3 ml/100g), Repairs and tie-ins in oil and gas transport pipe lines, Low yield and ultimate tensile strength, high impact toughness, Buffer layer electrode for internally cladded stainless steel.

Typical Composition of all-weld Metal

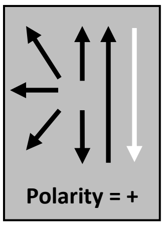
	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.025	0.25	0.50	0.01	0.01	0.02	0.03	0.02	0.02
Typical According to ASME II part C/SFA 5.1	0.03 max.	0.40 max.	0.60 max.	0.025 max.	0.015 max.	0.30 max.	0.20 max.	0.30 max.	0.08 max.

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	-30 °C
Untreated	490	585	30	85
Typical According to ASME II part C/SFA 5.1	≥ 330	≥ 430	≥ 22	≥ 27

Operating Data

Re - drying: if necessary: 300 - 350 °C, min. 2 h .



mm	2.5 mm	3.25 mm	4.0 mm	5.0 mm
L mm	350	350	350	350
Amps A	60-80	90-120	120-160	160-240

TECHNICAL SPECIFICATIONS

AWS A5.1: E7018
EN ISO 2560 - A : E 42 5 B 42 H5

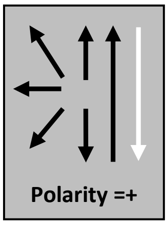
Product As Shown: EL KADESIA I™
Application: SMAW Basic electrodes, mild steel

Description

Basic coated engineered electrode for high-quality welds. Excellent strength and toughness properties down to - 50 º C, Metal recovery approx.; 110 %. Good weldability in all position except for vertical-down, Very low Hydrogen content. Suitable for welding steels with low purity and high carbon content. Welding in steel construction, boilers and tanks manufacture, vehicle construction, shipbuilding, and machine construction as well as for buffer layers on build ups on high carbon steels. Especially suitable for off-shore construction, it can be used in severe gaseous media applications.

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.07	0.40	1.20	0.01	0.01	0.01	0.05	0.02	0.02
Typical According to ASME II part C/SFA 5.1	0.15 max	0.75 max	1.60 max	0.035 max	0.035 max	0.3 max	0.20 max	0.3 max	0.08 max

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	-50 ºC
Untreated	445	550	29	95
Average Reference According to ASME II part C/SFA 5.1	≥ 400	≥ 490	≥ 22	≥ 27



mm	2.5 mm	3.25 mm	4.0 mm	5.0 mm
L mm	350	350	350/450	350/450
Amps A	80-110	100-140	130-180	180-230

Deposition efficiency = 110 %

S235JRG2 - S355J2, E295, E335, C 35; boiler steels P235GH, P265GH, P295GH, P355GH; fine grained structural steels up to S420N; shipbuilding steels A, B, D, E; pipe steels P265, P295, L290NB - L415NB, L290MB L415MB; X 42 - X 60; cast steel GS-38, GS-45, GS-52; ageing resistant steels ASt 35 - ASt 52; ASTM A27 and A36 Gr. all, A214, A242 Gr. 1-5, A266 Gr. 1, 2, 4, A283 Gr. A, B, C, D, A285 Gr. A, B, C, A299 Gr. A, B, A328, A366, A515 Gr. 60, 65, 70, A516 Gr. 55, A570 Gr. 30, 33, 36, 40, 45, A572 Gr. 42, 50, A606 Gr. all, A607 Gr. 45, A656 Gr. 50, 60, A668 Gr. A, B, A907 Gr. 30, 33, 36, 40, A841, A851 Gr. 1, 2, A935 Gr. 45, A936 Gr.50.

Approvals: DNV, LR, ABS

TECHNICAL SPECIFICATIONS

AWS A5.1: E7018-1 **Product As Shown: EL KADESIA IM™**

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	- 50 °C
Untreated	440	545	29	110
Average Reference According to ASME II part C/SFA 5.1	≥ 400	≥ 490	≥ 22	≥ 27

well as for buffer layers on build ups on high carbon steels. Especially suitable for off-shore construction, it can be used in severe gaseous media applications.

Polarity =+

mm	2.5mm	3.25mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	80-110	100-140	130-180	180-230

Deposition efficiency = 110 %

S235JRG2 - S355J2, E295, E335, C 35; boiler steels P235GH, P265GH, P295GH, P355GH; fine grained structural steels up to S420N; shipbuilding steels A, B, D, E; offshore steels; pipe steels P265, P295, L290NB - L415NB, L290MB L415MB; X 42 - X 60; cast steel GS-38, GS-45, GS-52; ageing resistant steels ASt 35 - ASt 52; ASTM A27 and A36 Gr. all, A214, A242 Gr. 1-5, A266 Gr. 1, 2, 4, A283 Gr. A, B, C, D, A285 Gr. A, B, C, A299 Gr. A, B, A328, A366, A515 Gr. 60, 65, 70, A516 Gr. 55, A570 Gr. 30, 33, 36, 40, 45, A572 Gr. 42, 50, A606 Gr. all, A607 Gr. 45, A656 Gr. 50, 60, A668 Gr. A, B, A907 Gr. 30, 33, 36, 40, A841, A851 Gr. 1, 2, A935 Gr. 45, A936 Gr.50.

Approvals: DNV, LR , ABS

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h .

Base Materials

TECHNICAL SPECIFICATIONS

AWS A5.1: E7018 -1H4R
EN ISO 2560-A: E 42 5 B 42 H5

Product As Shown: EL KADESIA 7018 -1H4R ™
Application: SMAW Basic electrodes, mild steel

Basic coated engineered electrode for high-quality welds. Exceptional strength and toughness properties down to - 50 º C, Deposition efficiency about 110 %. Good welding in all position except for vertical-down, very low Hydrogen content in the weld metal (under AWS container HD ≤ 4 ml/100g). The electrode is suitable for joint welding in steel, boiler, container, vehicle, ship and machine construction, and as well as a buffer layer for build-up welds with high-carbon steels. Suitable for welding steels of low purity and high carbon content. Particularly suitable for offshore constructions, CTOD-tested at -10 º C.

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	- 50 ºC
Untreated	460	560	27	95
Average Reference According to ASME II part C/SFA 5.1	≥ 400	≥ 490	≥ 22	≥ 27

- Deposition efficiency **110 %** - Moisture test **OK**
- Diffusible hydrogen limit for weld as per ASME II part **C** **≤ 4 ml / 100 gm weld metal**

Polarity =+

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	80-110	100-140	130-180	180-230

Re - drying: if necessary: 300 - 350 °C, min. 2 h.

Steels up to a yield strength of 420 MPa (60 ksi) S235JR-S355JR, S235JO-S355JO, S235J2- S355J2, S275N-S420N, S275M-S420M, S275NL-S420NL, S275ML-S420ML, P235GH-P355GH, P275NL1-P355NL1, P275NL2-P355NL2, P215NL, P265NL, P355N, P285NH-P420NH, P195TR1- P265TR1, P195TR2-P265TR2, P195GH-P265GH, L245NB-L415NB, L245MB-L415MB, GE200- GE240, GE300, shipbuilding steels: A, B, D, E, A 32-F 36, A 40-F 40 ASTM A 106 Gr. A, B, C; A 181 Gr. 60, 70; A 283 Gr. A, C; A 285 Gr. A, B, C; A 350 Gr. LF1, LF2; A 414 Gr. A, B, C, D, E, F, G; A 501 Gr. B; A 513 Gr. 1018; A 516 Gr. 55, 60, 65, 70; A 573 Gr 58, 65, 70; A 588 Gr. A, B; A 633 Gr. A, C, D, E; A 662 Gr. A, B, C; A 707 Gr. L1, L2, L3; A 711 Gr. 1013; A 841 Gr. A, B, C; API 5 L Gr. B, X42, X52, X56, X60.

Approvals: DNV, LR, ABS

EL KADESIA ENGINEERING INDUSTRIES

TECHNICAL SPECIFICATIONS

AWS A5.1: E 7018-1H4
EN ISO 2560 - A : E 42 5 B 32 H5

Product As Shown: EL KADESIA E 7018-1H4
Application: SMAW Basic electrodes, mild steel

Description

Basic coated engineered electrode for high-quality welds. Exceptional strength and toughness properties down to - 50 ° C, Deposition efficiency about 110 %. Good welding in all position except for vertical-down, Very low Hydrogen content in the weld metal (under AWS container HD ≤ 4 ml/100g). The electrode is suitable for joint welding in steel, boiler, container, vehicle, ship and machine construction, and as well as a buffer layer for build-up welds with high-carbon steels. Suitable for welding steels of low purity and high carbon content. Particularly suitable for offshore constructions. CTOD-tested at -10 ° C.

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.06	0.40	1.25	0.01	0.01	0.02	0.02	0.02	0.02
Typical According to ASME II part C/SFA 5.1	0.15 max.	0.75 max.	1.60 max.	0.035 max.	0.035 max.	0.30 max.	0.20 max.	0.30 max.	0.08 max.

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	- 50 °C
Untreated	460	565	28	100
Average Reference According to ASME II part C/SFA 5.1	≥ 400	≥ 490	≥ 22	≥ 27

- Soundness (x-ray) **OK** - moisture test **OK**

- Diffusible hydrogen limit for weld as per ASME || Part C **OK**

Polarity =+	mm	2.5 mm	3.25 mm	4.0 mm	5.0 mm
	L mm	350	350	350/450	350/450
	Amps A	80-110	100-140	130-180	180-230

We do hereby certify that; the weld metal deposit has been tested, mechanically and chemically and all results are comply with the requirements of specifications of Elkadesia for engineering industries and the Specification of ASME II part C SFA 5.01 Class C5 and level of tests in J or 5.

AWS A5.1: E7016 – 1
EN ISO 2560 - A: E 38 4 B 42 H5

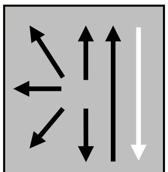
Product As Shown: EL KADESIA 7016-1™
Application: SMAW Basic electrode, Mild steel

TECHNICAL SPECIFICATIONS

Basic coated electrode for high-quality welds. Good weldability in all positions except vertical – down. The metal recovery is about 110 % and very low hydrogen content. Weld metal extremely ductile, crack and ageing resistant, thus especially suited for rigid weldments with heavy seam cross sections.

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	- 50 °C
Untreated	435	528	28	100
Typical According to ASME II part C/SFA 5.1	≥ 400	≥ 490	≥ 22	≥ 27

- Deposition efficiency **110 %**.



Polarity =+

mm	2.5mm	3.25 mm	4.0 mm	5.0 mm
L mm	350	350	350	350
Amps A	80-110	100-140	130-180	180-230

Re - drying: if necessary: 300 - 350 °C, min. 2 h.

Steels up to a yield strength of 380 MPa (52 ksi) S235JR-S355JR, S235JO-S355JO, S235J2- S355J2, S275N-S355N, S275M-S355M, P235GH-P355GH, P355N, P275NL1-P355NL1, P215NL, P265NL, P285NH-P355NH, P195TR1-P265TR1, P195TR2-P265TR2, P195GH-P265GH, L245NBL360NB, L245MB-L360MB, GE200-GE240, shipbuilding steels: A, B, D, E, A 32-E 36 ASTM A 106 Gr. A, B, C; A 181 Gr. 60, 70; A 283 Gr. A, C; A 285 Gr. A, B, C; A 350 Gr. LF1, LF2; A 414 Gr. A, B, C, D, E, F, G; A 501 Gr. B; A 513 Gr. 1018; A 516 Gr. 55, 60, 65, 70; A 573 Gr. 58, 65, 70; A 588 Gr. A, B; A 633 Gr. A, C, D; A 662 Gr. A, B, C; A 678 Gr. A, B;A 711 Gr. 1013; API 5 L Gr. B, X42, X52, X56.

Approvals: DNV, LR

TECHNICAL DATA

LOW ALLOY Steel Groups

EL KADESIA

In accordance to the research and development efforts of Elkadesia for engineering industries; to enhance the current version products of Elkadesia™-, the recent results of such R&D efforts; showed not only sounded and excellent welding performance of the developed products, but also an excellent mechanical and chemical composition of the weld metal, such development increased the added value of the company and increased the competitiveness of our products among others, where we believe that the competition is severe and needs sustainable and continuous development. The following table showed the preliminary investigation of the new developed Elkadesia™ products of welding electrodes.

AWS A5.5: E7018 - A1
EN ISO 3580-A: E Mo B 4 2 H5

Product As Shown: EL KADESIA 7018 -A1 ™
Application: SMAW Basic electrode. Low alloyed, High temperature

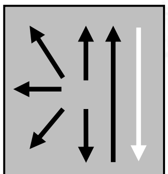
Description

Basic Coated electrode for high temperature steels up to 550 °C high pressure vessel and tube steels, extremely high ductility and cracking resistance. Metal recovery about 115 %, due to alloying elements which transferred from the flux of filler metal to the weld metal.

	C	Si	Mn	P	S	Mo
Wt. %	0.07	0.35	0.80	0.01	0.01	0.45
Typical According to	0.12	0.80	0.90	0.03	0.03	0.4-0.65

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	-50 °C
Untreated	510	590	26	65
Average Reference According to ASME II part C/SFA 5.5	≥ 390	≥ 490	≥ 22	N.S



Polarity =+

mm	2.5 mm	3.25 mm	4.0 mm	5.0 mm
L mm	350	350	350/450	350/450
Amps A	80-110	100 – 140	130-180	190-230

- Deposition efficiency **115 %**

creep-resistant steels and cast steels of the same type, steels resistant to ageing and to caustic cracking 16Mo3, 20MnMoNi4-5, 15NiCuMoNb5, S235JR-S355JR, S235JO-S355JO, S450JO, S235J2-S355J2, S275N-S460N, S275M-S460M, P235GH-P355GH, P355N, P285NH-P460NH, P195TR1-P265TR1, P195TR2-P265TR2, P195GH-P265GH, L245NB-L415NB, L450QB, L245MBL450MB, GE200-GE300 ASTM A 29 Gr. 1013, 1016; A 106 Gr. C; A, B; A 182 Gr. F1; A 234 Gr. WP1; A 283 Gr. B, C, D; A 335 Gr. P1; A 501 Gr. B; A 533 Gr. B, C; A 510 Gr. 1013; A 512 Gr. 1021, 1026; A 513 Gr. 1021, 1026; A 516 Gr. 70; A 633 Gr. C; A 678 Gr. B; A 709 Gr. 36, 50; A 711 Gr. 1013; API 5 L B, X42, X52, X60, X65.

AWS A5.5: E8018-B2
EN ISO 3580-A : E CrMo 1 B 4 2 H5

Description

It is suitable for cryogenic applications where it's crack-free, it is ideal for quenching and tempering, where it has good resistance to caustic cracking, excellent creep resistance in moderate time, has good application for severe steam boiler conditions and superheated heat exchanger.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Cr
Wt. %	0.06	0.25	0.8	0.01	0.01	1.2
Typical According to ASME II part C/SFA 5.5	0.05 - 0.12	0.80 max.	0.90 max.	0.03 max.	0.03 max.	1.0 - 1.5

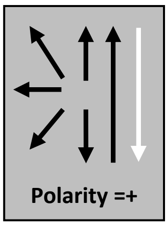
Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm²	Tensile Strength N/mm²	Elongation % $L_0=5d_0$	Impact values In J CVN		
				+20°C	- 20°C	- 50°C
Typical	480	570	24	120	80	[illegible]
Typical According to ASME II part C/SFA 5.5	≥ 460	≥ 550	≥ 19	N.S		

Tempered, 700 °C /2h/furnace up to 300 °C/air

- Deposition efficiency **115 %**

Operating Data



Polarity	2.5 mm	3.25 mm	4.0 mm	5.0 mm
L mm	350	350	350/450	350/450
Amps A	80-110	110-145	130-190	160-230

Base Materials

Joining 13 CrMo 4-5, GS - 22 CrMo 54, 42 CrMo 4

TECHNICAL SPECIFICATIONS

AWS A5.5: E8018-B2H4R
EN ISO 3580-A: E CrMo 1 B 4 2 H5

Product As Shown: EL KADESIA 8018 –B2H4R ™
Application: SMAW Basic electrode. Low alloyed, High temperature

Description

It is basic covered CrMo coated electrodes suitable for cryogenic applications where it's crack-free, it is ideal for quenching and tempering where it has good resistance to caustic cracking, excellent creep resistance in moderate time, has good application for severe steam boiler conditions and superheated heat exchanger.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Cr	Mo
Wt. %	0.06	0.30	0.80	0.01	0.01	1.25	0.52
Typical According to ASME II part C/SFA 5.5	0.05 -0.12	0.80 max.	0.90 max.	0.03 max.	0.03 max.	1.0 - 1.5	0.40 - 0.65

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation% $L_0=5d_0$	Impact values In J CVN		
				+20 °C	- 20 °C	- 50 °C
Typical	480	570	27	160	110	80
Typical According to ASME II part C/SFA 5.5	≥ 460	≥ 550	≥ 19	N.S		

- Tempered, 690 °C /2h/furnace up to 300 °C/air.
- Deposition efficiency **115 %**
- Moisture test **OK**
- Diffusible hydrogen limit for weld as per ASME II part **C** **≤ 4 ml / 100 gm. weld m**

Operating Data

Polarity =+

Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	80-110	110-145	130-190	160-230

Base Materials

same alloy creep resistant steels and cast steel, case-hardening and nitriding steels with comparable composition, heat treatable steels with comparable composition, steels resistant to caustic cracking 1.7335 13CrMo4-5, 1.7262 15CrMo5, 1.7728 16CrMoV4, 1.7218 25CrMo4, 1.7225 42CrMo4, 1.7258 24CrMo5, 1.7354 G22CrMo5-4, 1.7357 G17CrMo5-5 ASTM A 182 Gr. F12; A 193 Gr. B7; A 213 Gr. T12; A 217 Gr. WC6; A 234 Gr. WP11; A335 Gr. P11, P12; A 336 Gr. F11, F12; A 426 Gr. CP12.

TECHNICAL SPECIFICATIONS

AWS A5.5: E 9015-B6

Product As Shown: EL KADESIA E 9015-B6™
Application: SMAW Basic electrodes, High alloyed,

Description

Basic coated stick electrode, core wire alloyed, for creep resistant and high-pressure hydrogen resistant steels in boiler construction and the petrochemical industry. Preferred for X12CrMo5. in all positions except for vertical down. Weld metal can be quenched and tempered, deposition efficiency about 115 %.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo
Wt. %	0.06	0.4	0.7	0.01	0.01	0.3	5.0	0.40

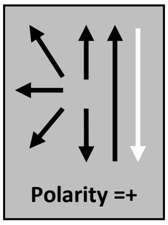
Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	N/mm²	N/mm²	%	+ 20 °C		
Untreated	550	640	18	49	48	50
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	N.S		

- Deposition efficiency **115 %**

Operating Data

Re - drying: if necessary: 300 - 350 °C, min. 2 h.



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	80 -110	110 -145	130 -190	160 -230

TECHNICAL SPECIFICATIONS

AWS A5.5: E 9015-B9

Product As Shown: EL KADESIA E 9015-B9™
Application: SMAW electrodes, High alloyed Basic,

Description

Basic coated stick electrode, core wire alloyed, for highly creep resistant, quenched and tempered 9-12% chrome steels, particularly for T91 and P91 steels. Approved for long-term use in an opera- other than vertical down, and features good ignition properties.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo
Wt. %	0.09	0.3	0.5	0.01	0.01	0.7	9.0	0.9

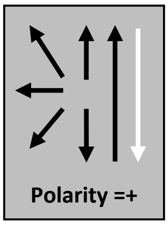
Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	MPa	MPa	%	+ 20 °C		
	550	680	18	47	48	45
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	N.S		

- Tempered, 730 °C /2h/furnace up to 300 °C/air.
- Deposition efficiency **115 %**

Operating Data

Re - drying: if necessary: 300 - 350 °C, min. 2 h.



Polarity	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	80-110	110-145	130-190	160-230

TECHNICAL SPECIFICATIONS

AWS A5.5: E9018-B3H4R
EN ISO 3580-A : E CrMo2 B 4 2 H5

Product As Shown: EL KADESIA 9018 –B3H4R ™
Application: SMAW Basic electrode. Low alloyed, High temperature

Description

E9018-B3H4R is preferred for 10 CrMo9 10, it has an advantage for items operating under temperature up to 600 °C, ideal for high creep resistance of boilers and pipe lines of the ancillaries of furnaces and heat exchangers. Crack resistance, tough weld metal, high creep strength, weld metal can be nitrided, quenching and tempering.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Cr	Mo
Wt. %	0.07	0.50	0.87	0.02	0.02	2.40	0.45
Typical According to ASME II part C/SFA 5.5	0.05-0.12	0.80 Max.	0.90 max.	0.03 Max.	0.03 Max.	1.0-1.5	0.40-0.65

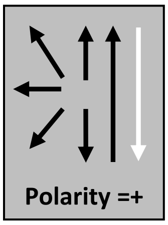
Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm²	Tensile Strength N/mm²	Elongation % $L_0=5d_0$	Impact values In J CVN	
				+20 °C	- 20 °C
Typical	550	660	25	140	
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	N	

- Tempered, 730 °C /2h/furnace up to 300 °C/air.

Operating Data

Re - drying: if necessary: 300 - 350 °C, min. 2 h.



Polarity	2.5mm	3.25 mm	4.0 mm	5.0 mm
L mm	350	350	350/450	350/450
Amps A	80-110	110-145	130-190	160-230

Base Materials

same type as creep-resistant steels and cast steels, similar alloy quenched and tempered steels up to 980 MPa strength, similar alloy case-hardening and nitriding steels 1.7380 10CrMo9-10, 1.7276 10CrMo11, 1.7281 16CrMo9-3, 1.7383 11CrMo9-10, 1.7379 G17CrMo9-10, 1.7382 G19CrMo9-10 ASTM A 182 Gr. F22; A 213 Gr. T22; A 234 Gr. WP22; 335 Gr. P22; A 336 Gr. F22; A 426 Gr. CP22.

AWS A5.5: E 9018-B6

TECHNICAL SPECIFICATIONS

Description

Basic coated stick electrode, core wire alloyed, for creep resistant and high-pressure hydrogen resistant steels in boiler construction and the petrochemical industry. Preferred for X12CrMo5. in all positions except for vertical down. Weld metal can be quenched and tempered, deposition efficiency about 115 %.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo
Wt. %	0.06	0.4	0.7	0.01	0.01	0.3	4.5	0.40

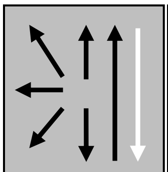
Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	MPa	MPa	%	+ 20 °C		
Untreated	550	650	18	49	48	50
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	N.S		

- Deposition efficiency **115 %**

Operating Data

Re - drying: if necessary: 300 - 350 °C, min. 2 h.



Polarity =+

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	80 -110	110 -145	130 -190	160 -230

TECHNICAL SPECIFICATIONS

AWS A5.5: E 9018-B9
EN 10204 Type 3.1

Description

Basic coated stick electrode, core wire alloyed, for highly creep resistant, quenched and tempered 9-12% chrome steels, particularly for T91 and P91 steels. Approved for long-term use in an opera- other than vertical down, and features good ignition properties.

Weld metal deposit analysis

	C	Si	Mn	P	S	Ni	Cr	Mo
Wt. %	0.09	0.3	0.5	0.01	0.01	0.7	8.5	0.9

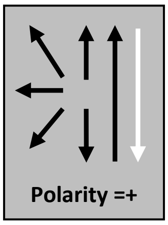
Mechanical Test of weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	MPa	MPa	%	+ 20 °C	
Untreated	550	680	19	47	48
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	N.S	

- Deposition efficiency **115 %**

Operating Data

Re - drying: if necessary: 300 - 350 °C, min. 2 h



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	80 -110	110 -145	130 -190	160 -230

TECHNICAL SPECIFICATIONS

AWS A5.5: E8018-B6
EN ISO 3580-A: E CrMo5 B 4 2 H5

Product As Shown: EL KADESIA 8018 –B6 ™
Application: SMAW Basic electrode. Low alloyed, High temperature

Description

Basic coated Stick electrode, core wire alloyed, for creep resistant and high pressure hydrogen resistant steels in boiler construction and the petrochemical industry. Preferred for X12CrMo5. Approved for long-term use in an operating temperature range of up to +650°C. High crack resistance due to low hydrogen content (under AWS conditions HD ≤ 4 ml/100g). Good welding in all positions except for vertical down. Weld metal can be quenched and tempered, deposition efficiency about 115%.

Typical Composition of all-weld Metal

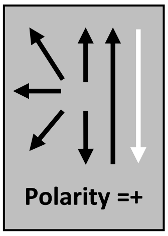
	C	Si	Mn	P	S	Ni	Cr	Mo
Wt. %	0.061	0.30	0.80	0.02	0.02	0.02	5.0	0.55
Typical According to ASME II part C/SFA 5.5	0.05-0.1	0.90 max.	1.0 max.	0.03 max.	0.03 max.	0.4 max.	4.0-6.0	0.45-0.65

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm²	Tensile Strength N/mm²	Elongation%	Impact values In J CVN	
				+20 °C	-20 °C
	520	620	24	130	70
Typical According to ASME II part C/SFA 5.5	≥ 460	≥ 550	≥ 19	N.S	

- Tempered, 730 °C /2h/furnace up to 300 °C/air.
- Deposition efficiency **115 %**

Operating Data



Polarity	2.5 mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	70-90	110-130	140-170	170 -230

Base Materials

same type as creep-resistant steels and cast steels, similar alloy quenched and tempered steels up to 1180 MPa 1.7362 X12CrMo5 ASTM A 182 Gr. F5; A 193 Gr. B5; A 213 Gr. T5; A217 Gr. C5; A 234 Gr. WP5; A 314 Gr. 501; A335 Gr. P5 and P5c; A 369 Gr. FB 5; A 387 Gr. 5; A 426 Gr. CP5

AWS A5.5: E8018-B8
EN ISO 3580 – A: E CrMo9 B 4 2 H5

Product As Shown: EL KADESIA 8018 –B8 ™
Application: SMAW Basic electrode. Low alloyed, High temperature

Description

Basic coated Stick electrode, core wire alloyed, for creep resistant and high pressure hydrogen resistant boiler and pipe steels, particularly in the petrochemical industry. Preferred for X11CrMo9-1(P9). Approved for long-term use in an operating temperature range of up to +600°C. Weld metal can be quenched and tempered, deposition efficiency about 115%.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo
Wt. %	0.06	0.30	0.8	0.01	0.01	0.12	9.31	1.05
Typical According to ASME II part C/SFA 5.5	0.05-0.10	0.9 Max.	1.0 Max.	0.03 Max.	0.03 Max.	0.4 Max	8.0-10.5	0.85-1.20

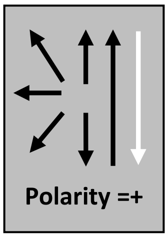
Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	**Elongation** $L_0=5d_0$	Impact values In J CVN	
				+20 °C	-20 °C
Typical	610	730	23	110	60
Typical According to ASME II part C/SFA 5.5	≥ 460	≥ 550	≥ 19	N.S	

- Tempered, 760 °C /2h/furnace up to 300 °C/air.

- Deposition efficiency **115 %**

Operating Data



Polarity	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	70-90	100-120	130-160	160 -230

Base Materials

same type as highly creep resistant steels 1.7386 X11CrMo9-1, 1.7388 X7CrMo9-1 ASTM A 182 Gr. F9; A 213 Gr. T9; A 217 Gr. C12; A 234 Gr. WP9; A 335 Gr. P9; A 336 Gr. F9; A 369 Gr. FB9; A 387 Gr. 9 and 9CR; A 426 Gr. CP9; A 989 Gr. K90941

TECHNICAL SPECIFICATIONS

AWS A5.5: E8018-C1
EN ISO 2560-A: E 46 8 2Ni B 42 H5

Product As Shown: EL KADESIA 8018 –C1 ™
Application: SMAW Basic electrode. Low alloyed

Description

Ni-alloy, basic coated stick electrode is for unalloyed and Ni-alloy fine-grained structural steels, tough, crack-resistant weld metal. It is cryogenic down to -80°C, ideal weldability in all positions except for vertical down. Very low hydrogen content (under AWS conditions HD <= 4 ml/100g).

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni
Wt. %	0.08	0.42	1.2	0.01	0.01	2.43
Typical According to ASME II part C/SFA 5.5	0.12 max.	0.80 max.	1.25 max.	0.03 max.	0.03 max.	2.0-2.75

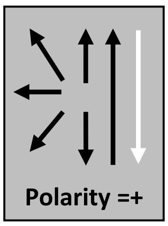
Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	- 60 °C
Untreated	490	570	30	80
Typical According to **ASME II part C/SFA 5.5**	≥ 460	≥ 550	≥ 19	≥ 27

- Deposition efficiency **115 %**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h .



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	70-100	110-140	140-180	190-230

Base Materials

cryogenic structural and Ni-alloy steels, special cryogenic shipbuilding steels. 10Ni14, 12Ni14, 13MnNi6-3, 15NiMn6, S275N-S460N, S275NL-S460NL, S275M-S460M, S275ML-S460ML, P275NL1-P460NL1, P275NL2-P460NL2 ASTM A 203 Gr. D, E; A 333 Gr. 3; A334 Gr. 3; A 350 Gr. LF1, LF2, LF3; A 420 Gr. WPL3, WPL6; A 516 Gr. 60, 65; AA 529 Gr. 50; A 572 Gr. 42, 65; A 633 Gr. A, D, E; A 662 Gr. A, B, C; A 707 Gr L1, L2, L3; A 738 Gr. A; A 841 A, B, C

AWS A5.5: E8018 – G
EN ISO 18275-A : E 55 6 1Ni Mo B 4 2 H5

Product As Shown: EL KADESIA 8018- G ™
Application: SMAW Basic electrode. Low alloyed

TECHNICAL SPECIFICATIONS

Description

Basic coated Stick electrode of high toughness and crack-resistance for high-strength fine-grained structural steels. Cryogenic down to -60°C, and resistant to ageing. Approved for armour plates. Easily handled in all positions except for vertical down. Very low hydrogen content in the weld metal (under AWS conditions HD ≤ 4 ml/100g).

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.065	0.53	1.17	0.01	0.01	0.82	0.01	0.01	0.01
Typical According to ASME II part C/SFA 5.5	-----	0.8 min.	1.00 min.	0.03 max.	0.03 max.	0.50 min.	0.30 min.	0.20 min.	0.10 min.

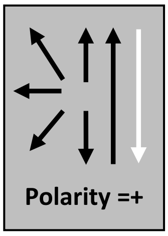
Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	N/mm^2	N/mm^2	%	+20 ºC	- 60 ºC
Untreated	480	570	31	170	100
Typical According to ASME II part C/SFA 5.5	≥ 460	≥ 550	≥ 19	N.S	

- Deposition efficiency **115 %**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	80-110	100-140	130-180	180-230

Base Materials

general structural steels, pipe and boiler steels, cryogenic fine-grained structural steels and special qualities. S460N, S460M, S460NL, S460ML, S460Q-S550Q, S460QL-S550QL, 460QL1-S550QL1, P460N, P460NH, P460NL1, P460NL2, L415NB, L415MB-L555MB, L415QB-L555QB, alform 500 M, 550 M, aldur 500 Q, 500 QL, 500 QL1, aldur 550 Q, 550 QL, 550 QL1, GE300, 20MnMoNi4-5, 15NiCuMoNb5-6-4 ASTM A 572 Gr. 65; A 633 Gr. E; A 738 Gr. A; A 852; API 5 L X60, X65, X70, X80, X60Q, X65Q, X70Q, X80Q.

Approvals: DNV, LR, ABS

AWS A5.5: E8018 – C3
EN ISO 2560 - A : E 46 6 1Ni B 4 2 H5

Product As Shown: EL KADESIA 8018-C3™
Application: SMAW Basic electrode. Low alloyed

TECHNICAL SPECIFICATIONS

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	N/mm^2	N/mm^2	%	- 40 °C
Untreated	520	620	29	90
Typical According to ASME II part C/SFA 5.5	470 - 550	≥ 550	≥ 24	≥ 27

- Deposition efficiency **115 %**

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.07	0.38	1.12	0.02	0.02	0.93	0.05	0.01	0.02

Polarity =+

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	80-110	100-140	130-180	180-230

General structural steels, pipe and boiler steels, cryogenic fine-grained structural steels and special qualities. S275N-S460N, S275NL-S460NL, S275M-S460M, S275ML-S460ML, P355N, P355NH, P460N, P460NH, P275NL1-P460NL1, P275NL2-P460NL2, L360NB, L415NB, L360MB-L450MB, L360QB-L450QB ASTM A 203 Gr. D, E; A 350 Gr. LF1, LF2, LF3; A 420 Gr. WPL3, WPL6; A 516 Gr. 60, 65, 70; A 572 Gr. 42, 50, 55, 60, 65; A 633 Gr. A, D, E; A 662 Gr. A, B, C; A 707 Gr. L1, L2, L3; A 738 Gr. A; A 841 A, B, C; API 5 L X52, X60, X65, X52Q, X60Q, X65Q.

Approvals: DNV, LR, ABS

Base Materials

TECHNICAL SPECIFICATIONS

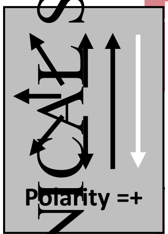
AWS A5.5: E 8018-C3 H4
EN ISO 2560 - A : E 46 6 1Ni B 4 2 H5

Product As Shown: EL KADESIA E 8018-C3 H4™
Application: SMAW Basic electrode. Low alloyed, High Strength

Description

It is basic Ni-alloyed electrode with an excellent mechanical properties, particularly high toughness and crack resistance for higher strength fine-grained constructional steels. It is suitable for service at - 60 ºC to + 350 ºC. Very good impact strength in aged condition. The metal recovery is about 115 %, easily weldable in all positions except vertical – down and very low hydrogen content.

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.07	0.38	1.12	0.02	0.02	0.93	0.05	0.01	0.02



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	80-110	100-140	130-180	180-230

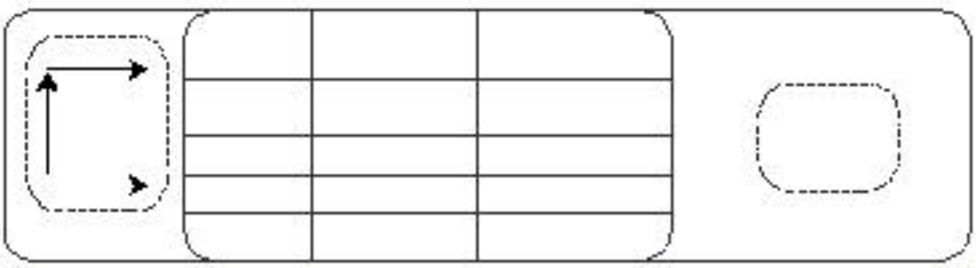
	N/mm²	N/mm²	%	- 50 °C		
Untreated	512	611	27	81	80	82
Typical According to ASME II part C/SFA 5.5	470 - 550	≥ 550	≥ 24			

- - Soundness (x-ray) OK - moisture test OK

- Diffusible hydrogen limit for weld as per ASME || Part C ≤ 4.0 ml/100 g weld metal

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



TECHNICAL SPECIFICATIONS

AWS A5.5: E7015-G
EN ISO 2560 - A: E 50 4 Mo B 42

Product As Shown: EL KADESIA 7015-G™
Application: SMAW: Basic electrode- Low alloyed

Description

Basic coated electrode for high-quality welds high strength, high temperature resistance up to 500ºC , high creep resistance up to 550ºC , high crack resistance with high strength , very low hydrogen content and excellent for welding; both boilers and tanks.

Typical Composition of all-weld Metal

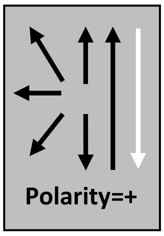
	C	Si	Mn	Ni	P	S
Wt.%	**0.08**	**0.3**	**1.2**	**0.45**	**0.02**	**0.02**

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	N/mm^2	N/mm^2	%	+20 ºC	-50 ºC
Untreated	490	570	23	120	50
Typical According to ASME II part C/SFA 5.5	≥ 390	≥ 490	≥ 22	N.S	

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	70-100	110-140	130-190	160-230

Base Materials

boiler steels P235GH, P265GH, P295GH, P355GH, 16 Mo 3, 15 NiCuMoNb 5, 17 MnMoV 64, 13 MnNiMo 54, 20 MnMoNi 45; FK-steels S355N - S460N, P355NH - P460NH, P355NL1 - P460NL1; pipe steels L360NB - L415NB, L360MB - L485MB.

TECHNICAL SPECIFICATIONS

AWS A5.5: 9018-G
EN ISO 2560 - A : E 50 4 1NiMo B 42 H5

Product As Shown: EL KADESIA 9018-G™
Application: SMAW Basic electrode- Low alloyed.

Description

Basic covered NiMo alloyed electrode with a weld metal of special metallurgical purity for nuclear reactor construction. Quality controlled according to KTA 1408.2; very low H2-content ≤5 ml/100 g; NDT-tested. Used preferably for the welding of steels in the construction of nuclear reactors, boiler and pressure vessels; for fine grained structural steels up to S500Q.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Mo
Wt. %	0.08	0.40	1.2	0.01	0.02	1.6	0.30
Typical According to ASME II part C/SFA 5.5	----	0.8 min.	1.0 min.	0.03 max.	0.03 max.	0.5 min.	0.2 min.

Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	N/mm²	N/mm²	%	+20 °C	-20 °C	- 40 °C
Untreated	550	640	23	200	110	80
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	N.S		

Operating Data

Polarity=+

mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	70-100	100-150	140-200	170-250

Base Materials

20 MnMoNi 55, 22 NiMoCr 37, ASTM A 508 CI 2, ASTM A 533 Cl 1 Gr. B, 15 NiCuMoNb 5 S 1 (WB 36), GS-18 NiMoCr 37, 11 NiMoV 53 (Welmonil 43), 12 MnNiMo 55 (Welmonil 35), S420N - S500Q, P460NH; ASTM A302 Gr. A-D; A517 Gr. A, B, C, E, F, H, J, K, M, P; A225 Gr. C; A572 Gr. 65

AWS A5.5: 11018-G
EN ISO 18275 – A : E 69 5Mn 2NiCrMo B 42 H5

Product As Shown: EL KADESIA 11018-G™
Application: SMAW: Basic electrode- Low alloyed

TECHNICAL SPECIFICATIONS

Description

Basic covered NiCrMo alloyed electrode. Low H2-content ≤5 ml/100 g (HD) in the weld metal; very low moisture pickup during long term storage. For high strength fine grained structural steels, for cast steel qualities; weld metal insensitive to cold cracking. Redry = for 2 h at 300 - 350 °C.

	C	Si	Mn	Mo	Ni	P	S
Wt.%	0.09	0.30	1.28	0.4	3.02	0.02	0.02

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	N/mm^2	N/mm^2	%	+20 °C	-50 °C
Untreated	690	770	18	120	55
Typical According to ASME II part C/SFA 5.5	≥ 670	≥ 760	≥ 15	N.S	

Operating Data

Polarity =+, ~

mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	70-100	90-140	140-190	180-250

Quenched and tempered fine grained structural steels up to 720 MPa yield point. High strength fine grained structural steels S620QL - S690QL, S620QL1, S690QU, HY 100, Suprafort 700, N-AXTRA 56, 63, 70.

TECHNICAL SPECIFICATIONS

AWS A5.5: 9015-B3
EN ISO 3580 - A: E CrMo2 B 4 2 H5

Product As Shown: EL KADESIA 9015-B3™
Application: SMAW: Basic electrode- Low alloyed

Description

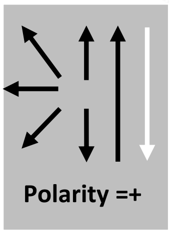
Basic covered CrMo alloyed electrode. Extra low content of trace elements; step-cooling tested; not sensitive to long term embrittlement. Manufacture of chemical apparatus, hydrocrackers; for welding work on heavy-duty boilers, superheaters, superheater lines; for welding of CrMo and CrMoV alloyed steels for the petrochemical industry, PWHT at 690°C for 1h.

	C	Si	Mn	P	S	Cr	Mo
Wt. %	0.07	0.25	0.7	0.02	0.02	2.2	0.9
Typical According to ASME II part C/SFA 5.5	0.05-0.12	1.0 max.	0.9 max.	0.03 max.	0.03 max.	2.0 - 2.5	0.9 – 1.2

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	N/mm^2	N/mm^2	%	+20 °C	-30 °C	- 40 °C
Untreated	580	640	22	130	90	80
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	N.S		

- Deposition efficiency **115 %**.

Operating Data



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	70-100	100-145	140-190	160-240

10 CrMo 9-10, 12 CrMo 9-10, 10 CrSiMoV 7, 15 CrMoV 5-10; ASTM A335 Gr. P22, A217 Gr. WC9

AWS A5.5: 9015-G
EN ISO 3580 - A: E ZCrMoV1 B 4 2 H5

Product As Shown: EL KADESIA 9015-G™
Application: SMAW Basic electrode- Low alloyed

TECHNICAL SPECIFICATIONS

Description

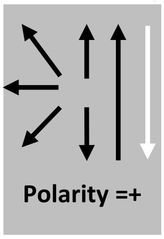
Basic Cr-Mo-Ni-V-W-Nb alloyed electrode suited for welding of high temperature steel 9%Cr-1.5% W-Mo-Nb-N (NF 616, P 92). Approved in long-term condition up to +650 °C service temperature. The electrode features a stable arc, good striking and re-striking properties, low spatter loss and an easy removable slag.

	C	Si	Mn	Cr	Mo	P	S

	C	Si	Mn	P	S	Cr	Ni	Mo
Wt. %	0.1	0.30	0.7	0.01	0.02	8.6	0.7	0.55
Typical According to ASME II part C/SFA 5.5	----	0.8 min.	1.0 min.	0.03 max.	0.03 max.	0.3 min.	0.5 min.	0.2 min.

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation $L_0=5d_0$ %	Impact values In J CVN +20 °C
Untreated	550	640	23	60
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	N.S

Operating Data



mm	3.25 mm	4.0 mm	5.0 mm
L mm	350	350/450	350/450
Amps A	90-140	140-190	180-240

GS-17 CrMoV511, GS-17 CrMo 55; Creep resistant and similar cast steel; 1.7706 – G17 CrMo V5-10

AWS A5.5: 9018-D1
EN ISO 3580 A: E ZCrMoV1 B 4 2 H5

Product As Shown: EL KADESIA 9018-D1™
Application: SMAW Basic stick electrode, Low-alloyed, High Strength
Lime Coated. CaCO3, CaF2, FeMn, FeSi, Mo, Ni

TECHNICAL SPECIFICATIONS

Description

Basic Mn-Mo-Ni alloyed electrode especially suited for high-strength fine-grained constructional steels and high-temperature steels, e.g., 15NiCuMoNb5S. Crack resistant, tough and ageing resistant. Excellent weld ability in all positions except vertical-down. Base Materials High-strength fine-grained steels, rail steels up to R 200 (for cladding)

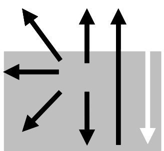
Basic coated CrMoV alloyed electrode, good welding features, inform weld pattern, easy slag removal suitable for low alloy creep resistance cast steel.

	C	Si	Mn	P	S	Ni	Mo
Wt. %	0.052	0.40	1.23	0.02	0.02	0.59	0.36
Typical According to ASME II part C/SFA 5.5	0.12 max.	0.8 max.	1.0-1.75	0.03 max.	0.03 max.	0.9 max.	0.25-0.45

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	N/mm^2	N/mm^2	%	-50 °C		
Untreated	570	670	22	55	57	54
Typical According to ASME II part C/SFA 5.5	≥ 530	≥ 620	≥ 17	≥ 27		

- Soundness (x-ray) **OK**
- moisture test **OK**
- **Diffusible hydrogen limit for weld as per ASME || Part C OK**

Operating Data



Polarity =+

mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350/450	350/450	450/450
Amps A	70-100	110-140	140-180	180-240

Base Materials

We do hereby certify that; the weld metal deposit, has been tested, mechanically and chemically and all results are comply with the requirements of specifications of Elkadesia for engineering industries and the Specification of ASME II part C SFA 5.01 Class C5 and level of tests in J or 5.

TECHNICAL SPECIFICATIONS

AWS A5.5: E 8015-B6

Product As Shown: EL KADESIA E 8015-B6™
Application: SMAW: Basic electrode- Low alloyed -High temperature
Lime Coated. $CaCO_3$, CaF_2, FeMn, FeSi ,Cr, Mo

Description

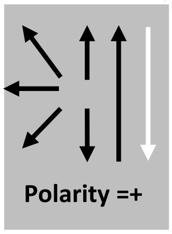
Basic coated electrode, core wire alloyed, for creep resistant and high-pressure hydrogen resistant steels in boiler construction and the petrochemical industry. Preferred for X12CrMo5. Approved for long-term use in an operating temperature range of up to +650°C. High crack resistance due to low hydrogen content (under AWS conditions HD ≤ 4 ml/100g). Good welding in all positions except for vertical down. Weld metal can be quenched and tempered, deposition efficiency 115%.

	C	Si	Mn	P	S	Ni	Cr	Mo
Wt. %	0.06	0.40	0.78	0.03	0.02	0.03	5.2	0.56
Typical According to ASME II part C/SFA 5.5	0.05-0.10	0.9 Max.	1.0 Max.	0.03 Max.	0.03 Max.	0.4 Max	4.0-6.0	0.45-0.65

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	N/mm^2	N/mm^2	%	- 50 °C		
Tempered at 740 °C/1h	515	620	23	85	84	82
Typical According to ASME II part C/SFA 5.5	≥ 460	≥ 550	≥ 19			

- Diffusible hydrogen limit for weld as per ASME || Part C **OK**
- Soundness (x-ray) **OK** - moisture test **OK**

Operating Data



Re - drying: if necessary: 300 - 350 °C, min. 2 h.

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	70-90	110-130	140-170	160-230

TECHNICAL SPECIFICATIONS

AWS A5.5: **E 8015-B8**

Product As Shown: EL KADESIA E 8015-B8™

Application: SMAW Basic electrode- Low alloyed-High temperature

Lime Coated. CaCO3, CaF2, FeMn, FeSi, Cr, Mo

Description

Basic coated electrode, core wire alloyed, for creep resistant and high-pressure hydrogen resistant boiler and pipe steels, particularly in the petrochemical industry. Preferred for X11CrMo9-1(P9). Approved for long-term use in an operating temperature range of up to +500°C. Weld metal can be quenched and tempered, deposition efficiency about 115%.

	C	Si	Mn	Cr	Mo	P	S

	C	Si	Mn	P	S	Ni	Cr	Mo
Wt. %	0.06	0.25	0.78	0.01	0.01	0.13	1.22	0.52
Typical According to ASME II part C/SFA 5.5	0.05-0.10	0.9 Max.	1.0 Max.	0.03 Max.	0.03 Max.	0.4 Max	8.0-10.5	0.85-1.20

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	MPa	MPa	%	-50 °C		
Tempered at 740 °C/1h	612	740	25	75	76	77
Typical According to ASME II part C/SFA 5.5	≥ 460	≥ 550	≥ 19			

- Diffusible hydrogen limit for weld as per ASME || Part C **OK**

- Soundness (x-ray) **OK** - moisture test **OK**

Operating Data

mm	3.25 mm	4.0 mm	5.0 mm

Polarity =+

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	70-90	100-120	130-160	160-230

TECHNICAL SPECIFICATIONS

AWS A5.5: **E 8016-B6**

Product As Shown: EL KADESIA E 8016-B6™
Application: SMAW Basic electrode- Low alloyed-High temperature
Lime Coated. $CaCO_3$, CaF_2, FeMn, FeSi, Cr, Mo

Description

Basic coated alloyed electrode, designed to weld 5% Cr - 1/2% Mo creep resisting steels such as ASTM A387 Grade 5, A213-T5 and A335-P5. These steels are normally used in pressure vessels and piping for high temperature service.

	C	Si	Mn	P	S	Ni	Cr	Mo
Wt. %	0.07	0.43	0.65	0.01	0.02	0.04	5.3	0.55
Typical According to ASME II part C/SFA 5.5	0.05-0.10	0.9 Max.	1.0 Max.	0.03 Max.	0.03 Max.	0.4 Max	4.0-6.0	0.45-0.65

Heat Treatment	Yield Strength MPa	Tensile Strength MPa	Elongation $L_0=5d_0$ %	Impact values In J CVN - 50°C		
Tempered at 740 °C/1h	550	680	23	87	85	86
Typical According to ASME II part C/SFA 5.5	≥ 460	≥ 550	≥ 19			

- Diffusible hydrogen limit for weld as per ASME || Part C **OK**
- Soundness (x-ray) **OK** - moisture test **OK**

Operating Data

Polarity =+

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	70-90	110-130	140-170	160-230

TECHNICAL SPECIFICATIONS

AWS A5.5: E 8018-B3L

Product As Shown: EL KADESIA E 8018-B3L™
Application: SMAW Basic electrode- Low alloyed High temperature
Lime Coated. $CaCO_3$, CaF_2, FeMn, FeSi ,Cr, Mo

Description

Basic coated electrode contains 2.25% Cr and 1% Mo alloy additions with low carbon content. The electrode is designed for welding 2.25% Cr - 1% Mo steels. The rod operates with a very stable arc and minimal spatter. The low carbon analysis of the weld metal contributes to its crack resistance. The addition of Cr and Mo provide for the excellent creep and stress rupture properties of weldments subjected to elevated temperature service.

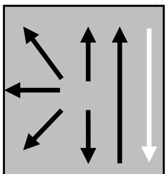
	C	Si	Mn	Cr	Mo	P	S

	C	Si	Mn	P	S	Cr	Mo
Wt. %	0.04	0.50	0.80	0.03	0.02	2.2	0.95
Typical According to ASME II part C/SFA 5.5	0.05 Max.	0.80 Max.	0.90 Max.	0.03 Max.	0.03 Max.	2.0-2.50	0.9-1.20

Heat Treatment	Yield Strength MPa	Tensile Strength MPa	Elongation $L_0=5d_0$ %	Impact values In J CVN - 50°C		
Untreated	490	580	23	83	85	87
Typical According to ASME II part C/SFA 5.5	≥ 460	≥ 550	≥ 17			

Operating Data

mm	3.25 mm	4.0 mm	5.0 mm



Polarity =+

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	70 -110	100 -160	140 -210	200 -280

TECHNICAL SPECIFICATIONS

AWS A5.4: E 10018-D2
EN ISO 18275-A: E 62 4 MnMo B 42 H5

Product As Shown: EL KADESIA E 10018-D2™
Application: SMAW: Basic electrode- Low alloyed
Lime Coated. $CaCO_3$, CaF_2, FeMn, FeSi, Ni, Mo

Description

E10018-D2 is a high-quality electrode used for joining high tensile steels and manganese molybdenum steels. The coating is specially formulated to resist moisture pick-up under conditions of high heat and humidity. This electrode offers resistance to moisture reabsorption which helps prevent hydrogen cracking and aids in elimination of starting porosity. E10018-D2 is specifically designed for applications requiring at least 100 ksi tensile strength, good ductility and crack resistance.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Mo
Wt. %	0.12	0.40	1.75	0.01	0.01	0.5	0.36
Typical According to ASME II part C/SFA 5.5	0.15 Max.	0.80 Max.	1.65-2.0	0.03 Max.	0.03 Max.	0.9 Max	0.25-0.45

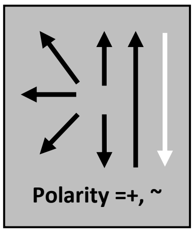
Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	MPa	MPa	%	-50 °C		
Tempered at 620 °C/1h	630	720	22	54	53	55
Typical According to ASME II part C/SFA 5.5	≥ 600	≥ 690	≥ 16	≥ 27		

- Diffusible hydrogen limit for weld as per ASME || Part C **OK**
- Soundness (x-ray) **OK** - moisture test **OK**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	75 -100	110 -140	150 -190	190 -260

TECHNICAL SPECIFICATIONS

AWS A5.4: E 12018-G
EN ISO 18275-A: E 69 3 Mn2NiMo B 4 5

Product As Shown: EL KADESIA E 12018-G ™
Application: SMAW: High alloyed, High corrosion resistant electrode
Lime Coated. $CaCO_3$, CaF_2, FeMn, FeSi, Ni, Mo

Description

Basic electrode for vertical-down welding of large diameter pipelines and for structural work. Suitable for filler and cover pass welding in pipeline construction. Deposit is extremely crack resistant, and features high toughness and a very low hydrogen content. Deposition rate is 80 – 100 % higher than for vertical up welding. This stick electrode is optimized for best striking properties and for avoiding start porosity in the cap layer. With its excellent welding properties, the electrode offers easy handling also under difficult conditions. Base Materials EN: L690, API Spec.5L: X100, X110.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Mo
Wt. %	0.07	0.42	1.83	0.01	0.01	2.22	0.34

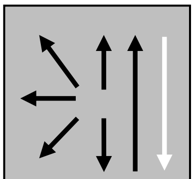
Mechanical Properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	MPa	MPa	%	+20°C	-20°C	-30°C
Untreated	810	865	18	82	61	52
Typical According to ASME II part C/SFA 5.5	≥ 740	≥ 830	≥ 14			

- Diffusible hydrogen limit for weld as per ASME || Part C **OK**
- Moisture Test **Ok** - Soundness (X-Ray) **Ok**

Operating Data

Re - drying: if necessary: 300 - 350 °C, min. 2 h.



Polarity =+, ~

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50 - 75	80 - 110	100-145	140-180

- Recommended interpass temperature > 120 °C.

TECHNICAL DATA

High Alloy Steel Groups

EL KADESIA

TECHNICAL SPECIFICATIONS

AWS A5.4: E308L-15
EN ISO 3581-A: E 19 9 L B 2 2

Product As Shown: EL KADESIA E 308L-15™
Application: SMAW high-alloyed electrode

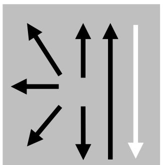
Description

The core wire is low carbon alloyed austenite with basic flux coating, applicable for similar welding in wide range industry, this including high carbon steel and ferritic 13% chrome steels are welded, has phenomenal ability to weld root, excellent bridging, and easy removal of slag, high control of the slag and weld pool, high resistance towards the intergranular corrosion.

	C	Si	Mn	Ni	Cr

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.03	0.57	1.04	0.02	0.01	9.1	18.9	0.13	0.2
Typical according to [illegible]	0.04	1.0	0.5-	0.04	0.03	9-11	18-21	0.75	0.75

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation % $L_0=5d_0$	Impact Strength "Joule" -196 º C	Ferrite Number
Typical	440	590	37	50	4
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		



Polarity =+

Polarity =+

mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

Base Materials

1.4306 X2CrNi19-11, 1.4301 X5CrNi18-10, 1.4311 X2CrNiN18-10, 1.4312 GX10CrNi18-8, 1.4541 X6CrNiTi18-10, 1.4546 X5CrNiNb18-10, 1.4550 X6CrNiNb18-10 AISI 304, 304L, [illegible]
ASTM A157 Gr. C9, A320 Gr. B8C or D

TECHNICAL SPECIFICATIONS

AWS A5.4: E308L-16
EN ISO 3581-A: E 19 9 L R 3 2

Product As Shown: EL KADESIA E 308L-16™
Application: SMAW high-alloyed electrode

Description

The bare wire is low carbon alloyed austenite with basic flux coating, applicable for similar welding in wide range industry, this including high carbon steel and ferritic 13% chrome steels are welded, has phenomenal ability to weld root, excellent bridging, and easy removal of slag, high control of the slag and weld pool, high resistance towards the intergranular corrosion.

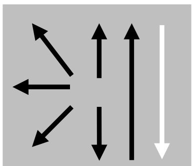
Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.03	0.40	1.2	0.01	0.01	10.0	19.0	0.02	0.02
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	9-11	18-21	0.75 max	0.75 max

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation % $L_0=5d_0$	Impact Strength "Joule" -196 °C	Ferrite Number
Typical	450	600	38	50	5
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		

Re-drying: if necessary: 300 - 350 ºC, min. 2 h.

Operating Data



Polarity =+/~

mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

Base Materials

Suitable for welding; 304 L, 304 LN, 302, 321, 347, ASTM A157 Gr

TECHNICAL SPECIFICATIONS

AWS A5.4: E308L-17
EN ISO 3581 -A: E 19 9 L R

Product As Shown: EL KADESIA E 308L-17™
Application: SMAW high-alloyed electrode

Description

This type of electrode is a chromium nickel core wire is applicable for welding all positions of 1.4301/ASTM 304 type stainless steel, it has good corrosion resistance; has good conditions under the fair severe conditions; like oxidizing acids and dilute reducing acids.

Typical Composition of all-weld Metal

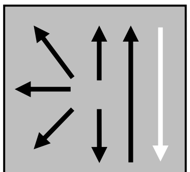
	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.03	0.70	0.8	0.01	0.01	9.6	19.2	0.01	0.01
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	9-11	18-21	0.75 max	0.75 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm2	Tensile Strength N/mm2	Elongation % L0=5d0	Impact Strength "Joule" -196 °C	Ferrite Number
Typical	420	580	38	50	4
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



Polarity=+/~

mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

Base Materials

1.4306 X2CrNi19-11, 1.4301 X5CrNi18-10, 1.4311 X2CrNiN18-10, 1.4312 G-X10CrNi18-8, 1.4541 X6CrNiTi18-10, 1.4546 X5CrNiNb18-10, 1.4550 X6CrNiNb18-10 AISI 304, 304L, 304LN, 302, 321, 347, ASTM A157 Gr. C9, A320 Gr. B8C or D

EL KADESIA ENGINEERING INDUSTRIES

AWS A5.4: E309L-15
EN ISO 3581-A : E 23 12 L B 32

Product As Shown: EL KADESIA E 309L-15™
Application: SMAW high-alloyed electrode

Description

The bare wire is low carbon alloyed austenite with rutile flux coating, high impedance of crack propagation with hard-to- weld materials, austenite- ferrite joints and weld cladding is achieved through the increased ferrite content in the weld metal, good welding properties and very good AC weldability.

Typical Composition of all-weld Metal

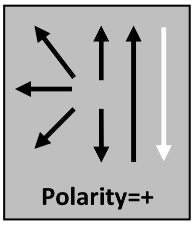
	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.025	0.41	1.22	0.02	0.01	13.5	22.7	0.1	0.01
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	12-14	22-25	0.75 max	0.75 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm²	Tensile Strength N/mm²	Elongation% $L_0=5d_0$	Impact Strength "Joule" -196 °C	Ferrite Number
Typical	420	580	35	45	9
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		

Operating Data

Re – drying: if necessary: 300 - 350 ºC, min. 2 h.



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

Base Materials

Joining stainless steel to mild or low alloy steel, joining ferritic Cr and austenitic Cr-Ni Steels, used for boiler and pressure vessels

TECHNICAL SPECIFICATIONS

AWS A5.4: E309LMo-16
EN 10204 Type 3.1

Product As Shown: EL KADESIA E 309LMo-16™
Application: SMAW high-alloyed electrode

Lime Coated. $CaCO_3$. CaF_2. FeMn. FeSi. Cr. Ni . Mo

Description

Low carbon austenitic rutile- basic electrode. High crack resistance with hard toweld materials, austenite - ferrite joints and weld cladding is achieved through the increased ferrite content in the weld metal, particularly good fine welding properties and excellent AC weldability characterize this product , for operating temperatures up to + 300 °C, for the first layer of weld cladding up to +400 °C.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.02	0.70	0.80	0.02	0.02	12.5	23.5	2.50	0.1
Typical According to ASME II part C/SFA 5.4	0.04 Max.	1.00 Max.	0.5 – 2.5	0.04 Max.	0.03 Max.	12 - 14	22 - 25	2.0-3.0	0.1-0.3

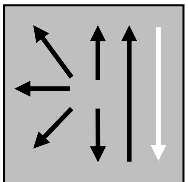
Mechanical Test of weld Metal

Heat Treatment	Yield Strength N/mm²	Tensile Strength N/mm²	Elongation% $L_0=5d_0$	Impact Strength "Joule"		
	MPa	MPa	%	-50 ° C		
Typical	580	710	31	74	72	73
Average Reference According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30	N.S		

- Soundness (x-ray) **OK** - moisture test **OK**
- **Diffusible hydrogen limit for weld as per ASME || Part C OK**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



Polarity=+/~

mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	40-70	60-100	100-140	140-180

Base Materials

We do hereby certify that; the weld metal deposit, has been tested, mechanically and chemically and all results are comply with the requirements of specifications of Elkadesia for engineering industries and the Specification of ASME II part C SFA 5.01 Class C5 and level of tests in J or 5.

Product As Shown: EL KADESIA E 309L-16™
Application: SMAW high-alloyed electrode

AWS A5.4: E309L-16
EN ISO 3581-A : E 23 12 L R 32

TECHNICAL SPECIFICATIONS

Description

This is chromium nickel molybdenum electrode is suitable for welding in all positions to join austenitic stainless steels such as1.4436/ASTM316.the adjustable chemical composition gives the weld metal ferrite number in the range of 3-8, and excellent toughness resistance up to -196ºC .

Typical Composition of all-weld Metal

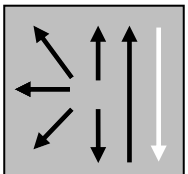
	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.03	0.80	0.8	0.01	0.01	13.3	23.5	0.01	0.01
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	12-14	22-25	0.75 max	0.75 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation% $L_0=5d_0$	Impact Strength "Joule" +20 ° C	Ferrite Number
Typical	470	590	40	60	15
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



Polarity=+/~

Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

Base Materials

Joining stainless steel to mild or low alloy steel, joining ferritic Cr and austenitic Cr-Ni Steels, used for boiler and pressure vessels

Product As Shown: EL KADESIA E 309L-17™
Application: SMAW high-alloyed electrode

AWS A5.4: E309L-17
EN ISO 3581-A: E 23 12 L R

TECHNICAL SPECIFICATIONS

Description

This is a high alloyed low carbon electrode designed for welding dissimilar base metals of stainless steel and mild or low- alloy steels. The electrode is suitable to work as buffer layer when overlay welding on mild steels. Providing an 18 Cr 8Ni deposit from the first layer, this electrode is applicable to weld high temperature steels.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.025	0.80	0.8	0.02	0.02	12.6	23.2	0.01	0.01
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	12-14	22-25	0.75 max	0.75 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation% $L_0=5d_0$	Impact Strength "Joule" +20 ° C	Ferrite Number
Typical	450	570	37	55	15
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.

Polarity=+/~

Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

Base Materials

Joints of and between high-strength, unalloyed and alloyed quenched and tempered steels, stainless, ferritic Cr and austenitic Cr-Ni steels, austenitic manganese steels and weld claddings: for the first layer of chemically resistant weld claddings on the ferritic-pearlitic steels used for boiler and pressure vessel construction up to fine grained structural steel S500N, and for the creep resistant fine-grained structural steels 22NiMoCr4-7, 20MnMoNi5-5 and GS-18NiMoCr 3 7.

TECHNICAL SPECIFICATIONS

AWS A5.4: E317L-17

Product As Shown: EL KADESIA E 317L-17™
Application: SMAW high-alloyed electrode

Description

Rutile electrode suited for corrosion resistant, CrNiMo (N)-steels. Suitable for service temperatures from -60 to +300°C. The weld metal exhibits resistance against pitting corrosion and intergranular corrosion resistance up to 300°C. Good operating characteristics on AC and DC, minimum spatter formation, self-releasing slag with smooth and clean bead surface.

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.02	0.70	0.9	0.01	0.02	13.0	19.2	3.7	0.02
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	12-14	18-21	3 - 4	0.75 max

Heat Treatment	Yield Strength N/mm²	Tensile Strength N/mm²	Elongation $L_0=5d_0$ %	Impact Strength "Joule" +20 °C	Ferrite Number
Untreated	460	610	35	65	8
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		

Operating Data

Polarity =+/~

Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

CrNiMo(N)-steels with increased Mo-content like grade AISI 316LN/317LN or corrosion resistant claddings on mild steels 1.4438 X2CrNiMo18-15-4, 1.4429 X2CrNiMoN17-13-3, 1.4434 X2CrNiMoN 18-12-4 AISI 316 LN, 317 L, 317LN.

TECHNICAL SPECIFICATIONS

AWS A5.4: E310-16
EN ISO 3581 -A: E 25 20 R 3 2

Product As Shown: EL KADESIA E 310-16™
Application: SMAW high-alloyed electrode

Description

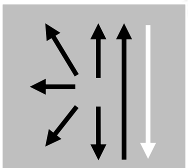
It is core wire alloyed, rutile coated stick electrode for same type, heat resistant rolled such as in annealing shops, hardening shops, steam boiler constructions, and the petrochemical industry. It has smooth seams and easy slag removal.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Cu
Wt. %	0.12	0.50	2.1	0.01	0.01	21.0	26.0	0.02
Typical according to ASME II part C /SFA 5.4	0.08-0.20	0.75 max	1.0-2.5	0.03 max	0.03 max	20-22.5	25-28	0.75 max

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation $L_0=5d_0$ %	Impact Strength "Joule" +20 °C	Ferrite Number
Untreated	430	620	35	75	0
Typical According to ASME II part C/SFA 5.4	N.S	≥ 550	≥ 30		

Operating Data



Polarity =+/~

Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

austenitic 1.4841 X15CrNiSi25-21, 1.4845 X8CrNi25-21, 1.4828 X15CrNiSi20-12, 1.4840 GX15Cr- Ni25-20, 1.4846 X40CrNi25-21, 1.4826 GX40CrNiSi22-10 ferritic-pearlitic1.4713 X10CrAlSi7, 1.4724 X10CrAlSi13, 1.4742 X10CrAlSi18, 1.4762 X10CrAlSi25, 1.4710 GX30CrSi7, 1.4740 GX40CrSi17 AISI 305, 310, 314, ASTM A297 HF, A297 HJ.

TECHNICAL SPECIFICATIONS

AWS A5.4: E310-17
EN ISO 3581 –A: E 25 20 R

Product As Shown: EL KADESIA E310-17™
Application: SMAW high-alloyed electrode

Description

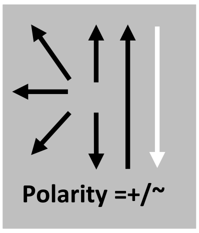
This electrode is having core wire with 25 Cr 20 Ni for conducting welding of 1.4845/ASTM310S and similar types of high temperature stainless steels it is strongly recommended to decrease the heat input and the interpass temperature to avoid the risk of hot cracking when welding full austenitic steels and nickel base alloys.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Cu
Wt. %	0.11	0.70	2.0	0.02	0.02	21.0	26.2	0.02
Typical according to ASME II part C /SFA 5.4	0.08-0.20	0.75 max	1.0-2.5	0.03 max	0.03 max	20-22.5	25-28	0.75 max

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation $L_0=5d_0$ %	Impact Strength "Joule"		Ferrite Number
				+20 º C	-196 º C	
Untreated	430	590	34	65	45	0
Typical According to ASME II part C/SFA 5.4	N.S	≥ 550	≥ 30			

Operating Data



Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

1.4845, ASTM 310S, 310S16, Z8 CN 25-20, 2361.

TECHNICAL SPECIFICATIONS

AWS A5.4: E 312-16
EN ISO 3581-A: E 29 9 R 1 2

Product As Shown: EL KADESIA E312-16 ™
Application: SMAW high-alloyed electrode

Description

E312-16 stainless steel welding was originally designed to weld cast alloys of similar composition. They have been found to be valuable in welding dissimilar metals, high in nickel. Applications should be limited to service temperature below 800°F (420°C) to avoid formation of secondary brittle phases.

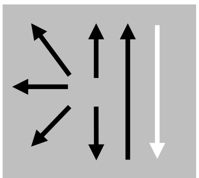
Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.12	0.55	2.1	0.01	0.01	8.7	28.2	0.40	0.01
Typical according to ASME II part C /SFA 5.4	0.15 max	1.0 max	0.5-2.5	0.04 max	0.03 max	8-10.5	28-32	0.75 max	0.75 max

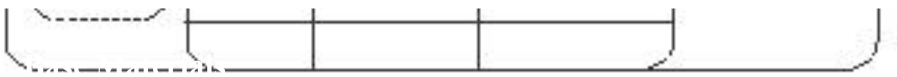
Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact Strength "Joule"		Ferrite Number
	N/mm²	N/mm²	%	+20 °C	- 40 °C	
Untreated	530	690	27	75	55	50
Typical According to ASME II part C/SFA 5.4	N.S	≥ 660	≥ 22			

- Moisture Test **Ok** - Soundness (X-Ray) **Ok**

Operating Data



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	50 - 80	80 - 110	110-140	140-200



For problem steels with high strength, joining of dissimilar materials, tool steels, heat treatable or quenched and tempered steels, spring steels, and high carbon steels etc.

TECHNICAL SPECIFICATIONS

AWS A5.4: E316L-15
EN ISO 3581-A: E 19 12 3 L B 2 2

Product As Shown: EL KADESIA E316L-15™
Application: SMAW high-alloyed electrode

Description

The core wire is low carbon alloyed austenitic with basic coating. For application in all branches of steel fabrication, where same-type steels, including higher- carbon steels and ferritic 13% chrome steels are welded, the weld metals has high toughness, it is applicable for cryogenic down to -196°C. It has good resistance towards the intergranular corrosion UP TO 400 °C.

Typical Composition of all-weld Metal

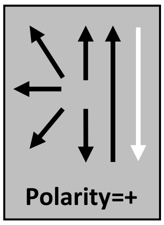
	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.02	0.30	1.14	0.01	0.01	11.4	18.2	2.65	0.04
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	11-14	17-20	2 - 3	0.75 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation $L_0=5d_0$ %	Impact Strength "Joule" -196 °C	Ferrite Number
Typical	480	600	38	52	4
Typical According to ASME II part C/SFA 5.4	N.S	≥ 490	≥ 30		

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

Base Materials

1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNi- Mo17-13-3, 1.4571 X6CrNiMoTi17-12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4583 X10CrNiMoNb18-12, 1.4409 GX2CrNiMo19-11-2 UNS S31603, S31653; AISI 316L, 316Ti, 316Cb.

EL KADESIA ENGINEERING INDUSTRIES

AWS A5.4: E316L-16
EN ISO 3581-A : E 19 12 3 L R

Product As Shown: EL KADESIA E316L-16™
Application: SMAW high-alloyed electrode

TECHNICAL SPECIFICATIONS

Description

This is chromium nickel molybdenum electrode is suitable for welding in all positions to join austenitic stainless steels such as1.4436/ASTM316.the adjustable chemical composition gives the weld metal ferrite number in the range of 3-8, and excellent toughness resistance down to -196°C.

Typical Composition of all-weld Metal

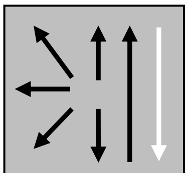
	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.02	0.40	1.2	0.01	0.01	12.3	18.5	2.6	0.02
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	11-14	17-20	2 - 3	0.75 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm2	Tensile Strength N/mm^2	Elongation% $L_0=5d_0$	Impact Strength "Joule"	Ferrite Number
	N/mm^2	N/mm^2	%	+20 ° C	
untreated	450	580	36	72	6
Typical According to ASME II part C/SFA 5.4	N.S	≥ 490	≥ 30		

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



Polarity=+,~

Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

Base Materials

For welding steels such as					
Outokumpu	EN	ASTM	BS	NF	SS
4436	1.4436	316	316S33	Z7 CND 18-12-03	2343
4432	1.4432	316L	316S13	Z3 CND 17-12-03	2353
4429	1.4429	S31653	316S63	Z3 CND 17-12 Az	2375
4571	1.4571	316Ti	320S31	Z6 CND T 17-12	2350

TECHNICAL SPECIFICATIONS

AWS A5.4: E316L-17
EN ISO 3581-A : E 19 12 3 L R 3 2

Product As Shown: EL KADESIA E316L-17™
Application: SMAW high-alloyed electrode

Description

This type of electrode is a chromium Nickel molybdenum high recover electrode for welding 1.4436/ASTM316 type stainless steels the 2D type electrodes provide a metal recovery of about 150% giving a high deposition rate and improved productivity in horizontal butt and overlay welding.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.02	0.80	0.8	0.02	0.02	11.7	18.0	2.6	0.02
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	11-14	17-20	2 - 3	0.75 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation $L_0=5d_0$ %	Impact Strength "Joule" -196 ° C	Ferrite Number
Typical	470	590	34	55	6
Typical According to ASME II part C/SFA 5.4	N.S	≥ 490	≥ 30		

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.

Polarity=+/~

Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

Base Materials

1.4401 X5CrNiMo17-12-2, 1.4404 X2CrNiMo17-12-2, 1.4435 X2CrNiMo18-14-3, 1.4436 X3CrNi- Mo17-13-3, 1.4571 X6CrNiMoTi17 12-2, 1.4580 X6CrNiMoNb17-12-2, 1.4583 X10CrNiMoNb18-12, 1.4409 GX2CrNiMo19-11-2 NS S31603, S31653; AISI 316L, 316Ti, 316Cb

TECHNICAL SPECIFICATIONS

AWS A5.4: E 317L-15

Product As Shown: EL KADESIA E 317L-15™
Application: SMAW high-alloyed electrode

Description

Core wire alloyed, suited for corrosion resistant, CrNiMo (N)-steels. It satisfies the high demands of offshore fabricators, shipyards building chemical tankers as well as the chemical / petrochemical, pulp and paper industries. Suitable for service temperatures from -60 to +300°C. The weld metal exhibits resistance against pitting corrosion and intergranular corrosion resistance up to 300°C. Good operating characteristics on DC, minimum spatter formation, self-releasing slag with smooth and clean bead surface.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.02	0.70	0.9	0.01	0.01	13.2	19.1	3.6	0.02
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	12-14	18-21	3 - 4	0.75 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation $L_0=5d_0$ %	Impact Strength "Joule" +20 °C	Ferrite Number
Untreated	480	620	32	67	8
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		

- Moisture Test **Ok** - Soundness (X-Ray) **Ok**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.

Polarity=+

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

TECHNICAL SPECIFICATIONS

AWS A5.4: E347-15
EN ISO 3581-A: E 19 9 Nb B 2 2

Product As Shown: EL KADESIA E347-15™
Application: SMAW high-alloyed electrode

Description

Due to the presence of Nb it`s stabilized, core wire alloyed austenitic stick electrode with basic coating, the weld metal has high toughness. Cryogenic down to – 196 °C. Resists intergranular corrosion UP TO + 400 °C.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Nb
Wt. %	0.02	0.8	0.8	0.02	0.02	10.2	19.3	0.25
Typical according to ASME II part C /SFA 5.4	0.08 max	1.0 max	0.5-2.5	0.04 max	0.03 max	9 - 11	18-21	1.00 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation $L_0=5d_0$ %	Impact Strength "Joule" +20 °C	Ferrite Number
Untreated	480	630	37	54	5
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h

Polarity=+

Polarity	2.5 mm	3.25 mm	4.0 mm	5.0 mm
L mm	350	350	350	350
Amps A	50-80	80-110	110-140	140-180

Base Materials

1.4550 X6CrNiNb18-10, 1.4541 X6CrNiTi18-10, 1.4552 GX5CrNiNb19-11, 1.4301 X5CrNi18-10, 1.4312 GX10CrNi18-8, 1.4546 X5CrNiNb18-10, 1.4311 X2CrNiN18-10, 1.4306 X2CrNi19-11 AISI 347, 321.302, 304, 304L, 304LN, ASTM A296 Gr. CF 8 C, A157 Gr. C9, A320 Gr. B8C or D

Product As Shown: EL KADESIA E307-15™
Application: SMAW high-alloyed electrode

AWS A5.5: E307-15
EN 10204 Type 3.1

TECHNICAL SPECIFICATIONS

Description

Core wire alloyed electrode with basic coating for joints between dissimilar steels, steels that are hard to weld and 14% Mn steels. Well suited for tough intermediate layers in case of hardfacing. Properties of the weld metal: suitable for strain-hardening, very good cavitation resistance, crack resistant, resistant to thermal shock, resistant to scaling up to +850°C, Consultation with the manufacturer is recommended for operating temperatures above +650°C. Exceptional toughness of the weld metal even at high dilution levels with hard-to-weld steels or when subject to thermal shock. Cryogenic down to -100°C. Stable arc even with AC power.

Typical Composition of all-weld Metal

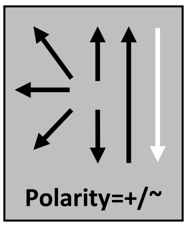
	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.07	0.77	4.88	0.03	0.01	10.5	20.2	0.80	0.26
Typical according to ASME II part C /SFA 5.4	0.04-0.14	1.0 max	3.3-4.75	0.04 max	0.03 max	9-10.7	18-21.5	0.5-1.5	0.75 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation % $L_0=5d_0$	Impact Strength "Joule" +20 °C	Hardness (HB)
Typical	475	655	38	55	200
Typical According to ASME II part C/SFA 5.4	N.S	≥ 590	≥ 30		

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h



Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	60-90	90-130	130-1760	170-210

Product As Shown: EL KADESIA E307-16™
Application: SMAW high-alloyed electrode

AWS A5.5: E307-16
EN 10204 Type 3.1

TECHNICAL SPECIFICATIONS

Description

Core wire alloyed electrode with rutile-basic coating for joints between dissimilar steels, steels that are hard to weld and 14% Mn steels. Well suited for tough intermediate layers in case of hardfacing. Properties of the weld metal: suitable for strain-hardening, very good cavitation resistance, crack resistant, resistant to thermal shock, resistant to scaling up to +850°C, little tendency to sigma-phase embrittlement above 500°C. Heat treatment is possible. Consultation with the manufacturer is recommended for operating temperatures above +650°C. Exceptional toughness of the weld metal even at high dilution levels with hard-to-weld steels or when subject to thermal shock. Cryogenic down to -100°C. Stable arc even with AC power.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.05	0.82	4.88	0.03	0.01	10.5	20.2	0.82	0.25
Typical according to ASME II part C /SFA 5.4	0.04-0.14	1.0 max	3.3-4.75	0.04 max	0.03 max	9-10.7	18-21.5	0.5-1.5	0.75 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation % $L_0=5d_0$	Impact Strength "Joule" +20 °C	Hardness (HB)
Typical	470	650	35	50	200
Typical According to ASME II part C/SFA 5.4	N.S	≥ 590	≥ 30		

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h

Polarity=+/~

Polarity	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	80-110	100-160	160-220

Base Materials

high-strength, unalloyed and alloyed structural, quenched and tempered and armour steels among themselves or among each other; unalloyed and alloyed boiler or structural steels with high-alloyed Cr and Cr-Ni steels; heat-resistant steels up to +850°C; austenitic manganese steels together and with other steels; cryogenic plate and pipe steels together with cryogenic austenitic materials.

Product As Shown: EL KADESIA E 347-16™
Application: SMAW high-alloyed electrode

EL KADESIA ENGIN

AWS A5.4: E 347-16

TECHNICAL SPECIFICATIONS

Description

The electrode is rutile type and intended for high temperature service or applications. For welding of Ti-stabilized steels such as ASTM 321 and 347 that exposed to service temperature exceeding 400oC. Also used for the second layer (first layer 309L type) when cladding mild steel.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Nb
Wt. %	0.04	0.75	0.8	0.01	0.01	10.2	19.2	0.35
Typical according to ASME II part C /SFA 5.4	0.08 max	1.0 max	0.5-2.5	0.04 max	0.03 max	9 - 11	18-21	1.00 max

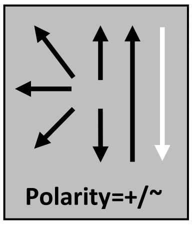
Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation $L_0=5d_0$ %	Impact Strength "Joule" +20 °C	Ferrite Number
Untreated	420	580	36	75	5
Typical According to **ASME II part C/SFA 5.4**	N.S	≥ 520	≥ 30		

- Moisture Test **Ok** - Soundness (X-Ray) **Ok**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	60-80	85-110	100-120	120-160

AWS A5.4: E347-17
EN ISO 3581-A :E 19 9 Nb R 3 2

TECHNICAL SPECIFICATIONS

Description

Stabilized, core wire alloyed, austenitic stick electrode with rutile coating. For application in all branches of industry where same type steels and ferritic 13% chrome steels are welded. Special fine welding properties, excellent welding with AC power and a high resistance to hot cracking in the weld metal are features of this product. Resists intergranular corrosion up to +400°C.

Typical Composition of all-weld Metal

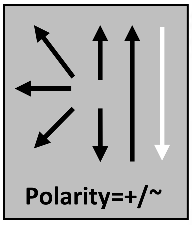
	C	Si	Mn	P	S	Ni	Cr	Nb
Wt. %	0.02	0.8	0.8	0.02	0.02	10.3	19.5	0.30
Typical according to ASME II part C /SFA 5.4	0.08 max	1.0 max	0.5-2.5	0.04 max	0.03 max	9 - 11	18-21	1.00 max

Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength N/mm²	Tensile Strength N/mm²	Elongation $L_0=5d_0$ %	Impact Strength "Joule" +20 °C	Ferrite Number
Untreated	470	620	35	54	5
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	60-80	85-110	100-120	120-160

Base Materials

1.4550 X6CrNiNb18-10, 1.4541 X6CrNiTi18-10, 1.4552 GX5CrNiNb19-11, 1.4301 X5CrNi18-10, 1.4312 GX10CrNi18-8, 1.4546 X5CrNiNb18-10, 1.4311 X2CrNiN18-10, 1.4306 X2CrNi19-11 AISI 347, 321.302, 304, 304L, 304LN, ASTM A296 Gr. CF 8 C, A157 Gr. C9, A320 Gr. B8C or D

Product As Shown: EL KADESIA E 385-16™
Application: SMAW electrode, high-alloyed

AWS A5.4: E 385-16

Description

high-alloy fully austenitic Cr-Ni-Mo-Cu electrode designed for welding 1.4539/ASTM 904L type steels. It can also be used for welding 1.4404/ASTM 316 components where a ferrite free weld is required, e.g. in cryogenic or non-magnetic applications. The weld metal has a very good impact toughness at low temperatures. To minimize the risk of hot cracking when welding fully austenitic steels, heat input and interpass temperature must be low and there must be as little dilution as possible from the parent metal.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.02	0.55	1.25	0.01	0.01	25.2	20.5	4.8	1.6
Typical according to ASME II part C /SFA 5.4	≤ 0.03	≤ 0.9	1 -2.5	≤ 0.03	≤ 0.02	24-26	19.5-21.5	4.2-5.2	1.2-2

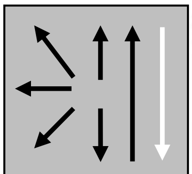
Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	MPa	MPa	%	- 196 °C
Untreated	410	630	38	55
Typical according to ASME II part C /SFA 5.4	N.S	≥ 520	≥ 30	N.S

- Moisture Test **OK** - Soundness (X-Ray) **OK**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h



Polarity=+,~

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	35-75	55-110	100-150	140-190

Product As Shown: EL KADESIA E 385-17™
Application: SMAW high-alloyed electrode

AWS A5.4: E 385-17

TECHNICAL SPECIFICATIONS

Description

high-alloy fully austenitic Cr-Ni-Mo-Cu electrode designed for welding 1.4539/ASTM 904L type steels. It can also be used for welding 1.4404/ASTM 316 components where a ferrite free weld is required, e.g. in cryogenic or non-magnetic applications. The weld metal has a very good impact toughness at low temperatures. To minimize the risk of hot cracking when welding fully austenitic steels, heat input and interpass temperature must be low and there must be as little dilution as possible from the parent metal.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.02	0.55	1.25	0.01	0.01	25.2	20.5	4.8	1.6
Typical according to ASME II part C /SFA 5.4	≤ 0.03	≤ 0.9	1 - 2.5	≤ 0.03	≤ 0.02	24-26	19.5-21.5	4.2-5.2	1.2-2

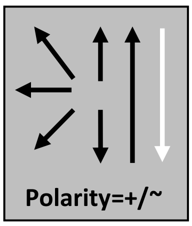
Mechanical properties of all-weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN
	MPa	MPa	%	- 196 °C
Untreated	420	620	34	53
Typical according to ASME II part C /SFA 5.4	N.S	≥ 520	≥ 30	N.S

- Moisture Test **OK** - Soundness (X-Ray) **OK**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	35-75	55-110	100-150	140-190

AWS A5.4: **E 309Nb-16**

Description

An electrode with controlled alloying elements to meet the metallurgical requirements of buffer layers. Excellent welding properties, stable arc, well detaching slag without residuals. Stringer bead technique is recommended. Normally used in combination with different corrosion resistant surfacing, depending on the base material also with an additional PWHT. For service temperatures up to +400°C.

Weld metal deposit analysis

	C	Si	Mn	P	S	Ni	Cr	Mo	Nb
Wt. %	0.02	0.80	0.72	0.02	0.01	13.8	26.6	0.07	0.90
Typical according to ASME II part C /SFA 5.4	0.12 max	1.0 max	0.5-2.5	0.04 max	0.03 max	12-14	22-25	0.75 max	0.7-1.0

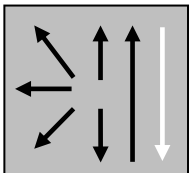
Mechanical Test of weld Metal

Heat Treatment	Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation% $L_0=5d_0$	Impact Strength "Joule" +20 °C	Ferrite Number
Typical	508	693	29	92	15
Typical According to ASME II part C/SFA 5.4	N.S	≥ 550	≥ 30		

- Moisture Test **OK**
- Soundness (X-Ray) **OK**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h



Polarity=+

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	90 -110	120-140	140-180

AWS A5.4: E 2209-17
EN ISO 3581-A: E 22 9 3 N L R 3 2

TECHNICAL SPECIFICATIONS

Description

Rutile electrode, designed for ferritic-austenitic duplex steels, Field of applications are in off-shore engineering and in the chemical industry. high mechanical strength and toughness, the weld metal is also noted for excellent resistance to stress corrosion cracking and pitting resistance. excellent positional weldability. the good wetting characteristics, slag removability, resistance to porosity with a fully alloyed core wire providing best corrosion resistance and a very homogeneous micro structure with specified ferrite contents of 30 – 60 FN.

Typical Composition of all-weld Metal

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.01	0.80	0.83	0.01	0.01	8.7	23.1	2.94	0.15
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	8.5-10.5	21.5-23.5	2.5-3.5	0.75 max

Recommend Our Basic Coated Electrode

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	MPa	MPa	%	+20 °C	- 30 °C
Untreated	650	820	25	55	41
Typical According to ASME II part C/SFA 5.4	N.S	≥ 690	≥ 20		

- Moisture Test **OK** - Soundness (X-Ray) **OK**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.

Polarity=+/~

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	40 - 75	70 - 120	110-150	150-200

Product As Shown: EL KADESIA E 2594-15™
Application: SMAW High alloyed electrode, highly corrosion resistant

TECHNICAL SPECIFICATIONS

AWS A5.4: E 2594-15
EN ISO 3581-A: E 25 9 4 N L B
EN 10204 Type 3.1

Description

2594 is a high alloyed chromium-nickel-molybdenum-nitrogen covered electrode with basic coating for welding of 25%Cr- and super duplex stainless steels. The basic type of electrode combines good welding properties in all positions with high impact strength at low temperatures. The weld metal is characterized by high strength and very good corrosion resistance. 2594 is used for welding of super duplex stainless steels in service temperatures up to 280°C (536°F), where good impact strength at temperatures down to -50°C is required. It can also be used as overmatching consumable for 21-23%Cr duplex stainless steels.

Weld Metal Deposit Analysis

	C	Si	Mn	P	S	Ni	Cr	Mo	N
Wt. %	0.03	0.48	1.33	0.02	0.02	9.66	26.4	3.64	0.27
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.0	0.04 max	0.03 max	8.0-10.5	24 - 27	3.5-4.5	0.2-0.3

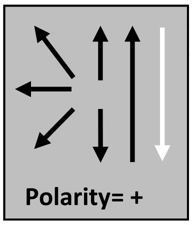
Mechanical Test of weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		FN
	MPa	MPa	%	+20 °C	- 50 °C	
Untreated	750	915	26	80	50	35-55
Typical According to ASME II part C/SFA 5.4	N.S	≥ 760	≥ 15			

- Moisture Test **OK** - Soundness (X-Ray) **OK**

Operating Data

Re - drying : if necessary: 300 - 350 ºC, min. 2 h.



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50 - 80	75 - 100	100-150	140-200

We do hereby certify that; the weld metal deposit has been tested, mechanically and chemically and all results are comply with the requirements of specifications of Elkadesia for engineering industries and the Specification of ASME II part C SFA 5.01 Class C5 and level of tests in J or 5.

Product As Shown: EL KADESIA E 2594-16™
Application: SMAW High alloyed electrode, highly corrosion resistant

AWS A5.4: E 2594-16

TECHNICAL SPECIFICATIONS

Description

Rutile coated electrode type. Designed for welding of super duplex steel and equivalent steel grades such as 1.4410 / UNS S32570, 1.4507 / UNS S32550 and 1.4501 / UNS S32760, used in desalination, pulp & paper, flue gas desulfurization and seawater systems. Properties of the weld metal match those of the parent metal, offering high tensile strength and toughness as well as an excellent resistance to stress corrosion cracking and localized corrosion in chloride containing environments. Designed for welding in all positions.

Weld Metal Deposit Analysis

	C	Si	Mn	P	S	Ni	Cr	Mo
Wt. %	0.03	0.58	0.80	0.01	0.01	9.3	25.4	4.2
Typical according to ASME II part C /SFA 5.4	0.04 max.	1.0 max.	0.5 – 2	0.04 max.	0.03 max.	8.0 –10.5	24 - 27	3.5-4.5

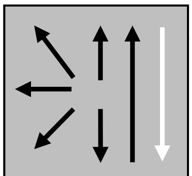
Mechanical Test of weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		FN
	MPa	MPa	%	+20 °C	- 50 °C	
Untreated	680	880	26	75	50	10
Typical According to **ASME II part C/SFA 5.4**	N.S	≥ 760	≥ 15			

- Moisture Test **OK**
- Soundness (X-Ray) **OK**

Operating Data

Re - drying : if necessary: 300 - 350 ºC, min. 2 h.



Polarity= +

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	40 - 80	75 - 110	100-150	130-200

AWS A5.4: **E 385-15**

TECHNICAL SPECIFICATIONS

Description

Basic coated alloyed-core wire special electrode for corrosion - resistant high-Molybdenum CrNi steels, apart from its markedly good chemical resistance to stress corrosion cracking and crevice corrosion, the weld metal features high resistance to pitting, particularly recommended for steels containing up to 5% molybdenum, Recommended for highly corrosive environments.

Weld Metal Deposit Analysis

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.02	0.42	1.4	0.01	0.01	25.0	20.5	4.7	1.7
Typical according to ASME II part C /SFA 5.4	0.03 max	0.9 max	1 -2.5	0.03 max	0.02 max	24-26	19.5-21.5	4.2-5.2	1.2-2

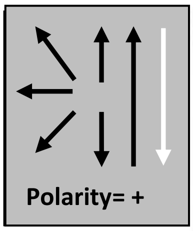
Mechanical Test of weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	MPa	MPa	%	+ 20 °C	- 196 °C
Untreated	410	640	37	85	52
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30	N.S	N.S

- Moisture Test **OK** - Soundness (X-Ray) **OK**

Operating Data

Re - drying: if necessary: 300 - 350 °C, min. 2 h



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50 - 90	80 -120	110-150	140-190

Product As Shown: EL KADESIA E 2209-15™
Application: SMAW High alloyed, High corrosion resistant electrode

AWS A5.4: **E 2209-15**
EN ISO 3581-A: E 23 12 2 L R 3 2

Description

Basic electrode, core wire alloyed, for welding of ferritic-austenitic duplex materials. Besides the high tensile strength, the special advantage of the weld metal of this electrode is its very good toughness behavior down to −60 °C. Furthermore, the high crack resistance of the weld metal and the particularly good resistance to stress corrosion cracking and pitting behavior are significant features. The electrode provides user operating characteristics in all positions except vertical down with good slag removability and weld bead appearance. Additionally, the filler metals offer high safety against the formation of porosity.

Weld Metal Deposit Analysis

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.02	0.35	0.87	0.01	0.01	8.8	22.8	2.98	0.15
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	8.5-10.5	21.5-23.5	2.5-3.5	0.75 max

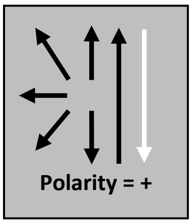
Mechanical Test of weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	MPa	MPa	%	+20 °C	- 50 °C
Untreated	640	830	27	110	55
Typical According to ASME II part C/SFA 5.4	N.S	≥ 690	≥ 20		

- Moisture Test **OK** - Soundness (X-Ray) **OK**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50 - 75	80 - 110	100-145	140-180

Product As Shown: EL KADESIA E 2209-16™
Application: SMAW High alloyed electrode,

AWS A5.4: E 2209-16

Description

A specially formulated electrode depositing a stainless steel weld metal and is ideal for welding duplex stainless steels. The weld metal possesses excellent corrosion resistance in marine environments.

Weld Metal Deposit Analysis

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.03	0.60	0.95	0.01	0.01	9.4	22.6	3.0	0.12
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	8.5-10.5	21.5-23.5	2.5-3.5	0.75 max

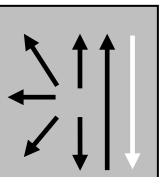
Mechanical Test of weld Metal

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	MPa	MPa	%	+20 °C	- 30 °C
Untreated	650	820	25	55	41
Typical According to ASME II part C/SFA 5.4	N.S	≥ 690	≥ 20		

- Moisture Test **OK** - Soundness (X-Ray) **OK**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



Polarity =+/~

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50 - 80	70 - 120	90-160	150-220

Product As Shown: EL KADESIA E 317L-16™
Application: SMAW High alloyed electrode,

AWS A5.4: E 317L-16

TECHNICAL SPECIFICATIONS

Description

Rutile electrode, core wire alloyed, suited for corrosion resistant, CrNiMo(N)-steels. It satisfies the high demands of offshore fabricators, shipyards building chemical tankers as well as the chemical / petrochemical, pulp and paper industries. Suitable for service temperatures from -60 to +300°C. The weld metal exhibits resistance against pitting corrosion and intergranular corrosion resistance up to 300°C. Good operating characteristics on AC and DC, minimum spatter formation, self-releasing slag with smooth and clean bead surface.

Weld Metal Deposit Analysis

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.02	0.70	0.9	0.01	0.02	13.1	19.3	3.5	0.02
Typical according to ASME II part C /SFA 5.4	0.04 max	1.0 max	0.5-2.5	0.04 max	0.03 max	12-14	18-21	3 - 4	0.75 max

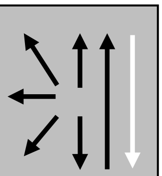
Weld metal deposit analysis

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	Ferrite Number
	MPa	MPa	%	+20 °C	
Untreated	470	615	34	70	8
Typical According to ASME II part C/SFA 5.4	N.S	≥ 520	≥ 30		

- Moisture Test **OK** - Soundness (X-Ray) **OK**

Operating Data

Re - drying: if necessary: 300 - 350 °C, min. 2 h.



Polarity =+/~

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	50-80	80-110	110-140	140-180

Product as Shown: EL KADESIA E 308H-15™
Application: SMAW High alloyed electrode,

AWS A5.4: E 308H-15

TECHNICAL SPECIFICATIONS

Description

high-alloyed, basic-coated stainless steel welding electrode for high-temperature applications (up to 700°C) on austenitic steels like AISI 304H, offering good resistance to scaling and sigma-phase embrittlement due to its controlled ferrite content (3-8 FN). It provides excellent weldability, even in all positions (except vertical-down), ensuring high-quality, durable welds for petrochemical and chemical plant fabrication.

Weld Metal Deposit Analysis

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Wt. %	0.05	0.50	1.1	0.01	0.01	10.1	19.2	0.02	0.02
Typical according to ASME II part C /SFA 5.4	0.04-0.08	1.0 max	0.5-2.5	0.04 max	0.03 max	9-11	18-21	0.75 max	0.75 max

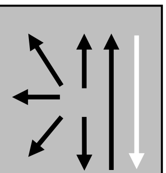
Weld metal deposit analysis

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	Ferrite Number
	MPa	MPa	%	+196 °C	
Untreated	470	620	38	54	6
Typical According to ASME II part C/SFA 5.4	N.S	≥ 550	≥ 30		

- Moisture Test **OK** - Soundness (X-Ray) **OK**

Operating Data

Re - drying: if necessary: 300 - 350 ºC, min. 2 h.



Polarity = +

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	50-80	80-110	110-140	140-180

TECHNICAL DATA

Hardfacing

EL KADESIA

Product As Shown: EL KADESIA HF 60™
Application: SMAW Basic Coated hardfacing electrode
Resisting impact and abrasion

EN 14700: E Fe1

TECHNICAL SPECIFICATIONS

Material Type Alloy Components

High Iron, Chromium and manganese (Fe – Cr - Mn)

Weld Deposit Characteristics

Thick basic-covered electrode for producing hardfacing deposits of medium hardness, which can be machined by chip-forming. Particularly suited for wear resisting parts subjected to metal-to-metal wear, heavy impact and shock. It can be easily welded in all positions, except vertical-down. Weld metal is crack resistant and free of pores.

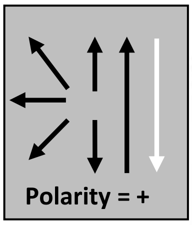
Recommended Application

Suitable for reconditioning of rails, rail crossings, switch points, sprockets and wearing parts, such as rope pulleys, tumblers, rollers, caterpillar track rollers and links, wheel flanges, stud links and others.

Weld Deposit Properties

Hardness (HB)	Pure weld deposit	1 layer on steel with C = 0,5 %
Typical	300	350

Operating Data



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	80-110	100-130	140-160	170-200

- Hold stick electrode as vertically as possible and with a short arc. Preheat heavy parts and higher-tensile steels to 250 – 350° C. Stick electrodes that have got damp should be redried for 2 h / 300° C.

Product As Shown: EL KADESIA HF 70™
Application: SMAW Basic coated electrode for crack and wear resistant surfacing's

EN 14700: E Fe1

TECHNICAL SPECIFICATIONS

Material Type Alloy Components

High Iron, Chromium and manganese (Fe – Cr - Mn)

Weld Deposit Characteristics

Thick basic-covered electrode for producing hardfacing deposits of medium hardness, good abrasion resistance and multi-layer build up ability. Weld metal is machinable with tungsten carbide tools.

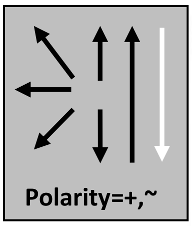
Recommended Application

suited for wear resistant surfacing on Mn-Cr-V alloyed parts, such as frogs, track rollers, chain support rolls, sprocket wheels, guide rolls etc.

Weld Deposit Properties

Hardness (HB)	Pure weld deposit	1 layer on steel with C = 0,5 %
Typical	380	420

Operating Data



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	80-110	100-140	140-180	190-230

Hold stick electrode as vertically as possible. Preheating heavy parts and higher tensile steels to 250-300°C. Re-dry electrode before use at 300°C at 2 h.

Product As Shown: EL KADESIA HF 75™
Application: SMAW Basic Coated hardfacing electrode

EN 14700: E Fe2
EN 10204 Type 3.1

TECHNICAL SPECIFICATIONS

Material Type Alloy Components

High Iron, Chromium and Molybdenum (Fe – Cr - Mo)

Weld Deposit Characteristics

Basic-covered electrode for depositing wear resisting overlays on structural members subjected to severe abrasive wear. Weld metal can be machined only by grinding, preferred to use with DC, electrode in positive (+) pole and also possible to use with AC.

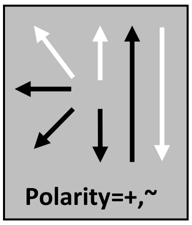
Recommended Application

Suitable for hardfacing applications of crushing and grinding of coal, mineral, soil, rocks, excavator parts, bucket edges and bucket teeth, drilling bits, coal planes, conveyor screws. In case of very crack sensitive base metals, a tough buffer layer, made 307 electrodes, is required, before hardfacing.

Weld Deposit Properties

Hardness (HB)	Pure weld deposit
Typical	55

Operating Data



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	50-80	90-120	120-150	150-185
Stick electrodes should be redrying for 2 h / 150-200° C.				

We do hereby certify that; the weld metal deposit, has been tested, mechanically and chemically and all results are comply with the requirements of specifications of Elkadesia for engineering industries and the Specification of ASME II part C SFA 5.01 Class C5 and level of tests in J or 5.

Product As Shown: EL KADESIA HF 80™

Application: SMAW Basic Coated hardfacing electrode
Resisting impact and abrasion

EN 14700: **E Fe8**

TECHNICAL SPECIFICATIONS

Material Type Alloy Components

High Iron , Chromium (Fe – Cr)

Weld Deposit Characteristics

Martensitic microstructure with good resistance to abrasion, impact and compression. Good weldability and easy slag removal, machining of the weld metal possible by grinding only.

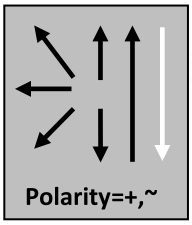
Recommended Application

Suitable for Applicable for cladding parts of steels, cast steels and high Mn-steel, subjected a simultaneously to abrasion, impact and compression. Typical application fields are the earth moving and stone treatment industry, e.g., excavator bucket teeth, crusher jaws and cones, mill hammers, rotors, etc.

Weld Deposit Properties

Hardness (HRC)	Pure weld deposit	1 layer on high Mn-steel	2 layers on high Mn-steel
Typical	55	22	40

Operating Data



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350/450	350/450
Amps A	80-100	100-145	140-180	180-210

- Preheating recommended for heavy parts and higher tensile steels to 200 – 300°C. On high Mn-Steel, cold welding (interpass temperature max. 250°C) is recommended. If necessary, intermediate cooling.

Product As Shown: EL KADESIA HF 85™
Application: SMAW Basic Coated hardfacing electrode
Resisting impact and abrasion

EN 14700 : E Fe8

TECHNICAL SPECIFICATIONS

Material Type Alloy Components

High Iron, Chromium and Other elements (Mn – Mo - Nb).

Weld Deposit Characteristics

The stick electrode is suited in impact and pressure stress situations. Machining of the weld metal only by grinding. The deposit is only machinable by grinding. It is a martensitic alloy.

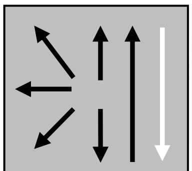
Recommended Application

The main applications are tools in the earth moving industry and crushing plants as well as cold and hot working tools. It is suitable for cladding structural parts subject to abrasion combined with impact.

Weld Deposit Properties

Hardness (HRC)	Hardness (HRC)	pure weld deposit	1 layer on high Mn-steel	2 layers on high Mn-steel
Typical	Typical	55	22	40

Operating Data



Polarity=+,~

mm	2.5mm	3.2mm	4.0mm
L mm	350	350	350
Amps A	80-110	130-170	160-200

Hold stick electrode as vertically as possible, keep a short arc. Preheating of non-alloyed steels is not necessary. Preheat heavy parts and high-tensile base materials to 250 – 350° C. If more than 3 – 4 layers are needed, apply the softer stick electrodes UTP DUR 250 or UTP DUR 300 for buildup. On high Mn-steel, UTP BMC should be used. Re-dry stick electrodes that have got damp for 2 h / 300° C.

Product As Shown: EL KADESIA HF 90™
Application: SMAW Rutile – Basic Coated hardfacing stick electrode

EN 14700: E Fe9
EN 10204 Type 3.1

Material Type Alloy Components

High Iron, Chromium, Manganese and Other elements (Ni).

Weld Deposit Characteristics

It is suitable for claddings on parts subject to highest pressure and shock in combination with abrasion. Surfacing can be made on ferritic steels as well as austenitic hard Mn-steels and joints of hard Mn-steels can be welded. Due to the addition of Cr, increased resistance against friction and corrosion. Very high work hardening and high toughness.

Recommended Application

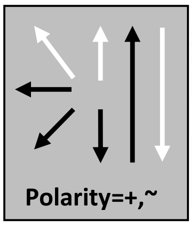
Main application fields are in mines, quarries, cement industry, railways and steel works, where working parts are regenerated, such as breaker jaws, hammer crushers, switches and crossings. Fully austenitic structure.

Weld Deposit Properties

Hardness (HRC)	After Welding	After work Hardening
Typical	260	up to 550

- Soundness (x-ray) **OK**　　- moisture test **OK**

Operating Data



mm	2.5mm	3.2mm	4.0mm
L mm	350	350	350
Amps A	110-150	140-190	190-240

Hold the stick electrode vertically. Weld at a low temperature and keep interpass temperature below 250°C. It is recommended to weld short beads and to avoid overheating. Re-drying: 2h/300°C

Product As Shown: EL KADESIA HF 100™
Application: SMAW Rutile – Basic Coated hardfacing stick electrode

EN 14700: E Fe14

Material Type Alloy Components

High Carbon, Chromium, iron.

Weld Deposit Characteristics

Rutile-basic coated hardfacing stick electrode for high abrasion and medium impact Recovery 160 %. It has excellent welding characteristics and a very easy slag removal. The homogeneous and finely rippled seam surface does, for most applications, not require any finishing by grinding.

Recommended Application

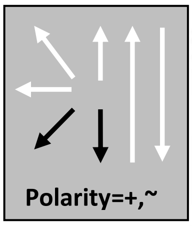
It is suited for highly wear resistant claddings on parts subject to strong grinding abrasion combined with medium impact, such as conveyor screws, scraper blades, digging teeth, mixer wings, sand pumps. Also as a final layer on crusher jaws.

Weld Deposit Properties

Hardness (HRC)	pure weld deposit	1 layer on steel with C = 0.15%	1 layer on high Mn-steel
Typical	60	55	52

- Soundness (x-ray) **OK**
- moisture test **OK**

Operating Data



mm	2.5mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	80-100	90-130	130-180	190-230

-Hold stick electrode as vertically as possible, keep a short arc. Preheating is in general not necessary. On multipass-applications a cushion layer with HF90 is recommended in order to prevent hardening cracks in the weld deposit. Re-dry stick electrodes that have got damp for 2h/300° C.

EL KADESIA ENGIN

Product As Shown: EL KADESIA HF 150™

Application: SMAW High-efficiency stick electrode without slag resisting extreme abrasion at elevated temperatures

EN 14700: E Fe16

EN 10204 Type 3.1

TECHNICAL SPECIFICATIONS

Material Type Alloy Components

High Carbon, Chromium, Molybdenum, Niobium, tungsten, Vanadium.

Weld Deposit Characteristics

Rutile-basic coated hardfacing stick electrode for high abrasion and medium impact Recovery 160 %. It has excellent welding characteristics and a very easy slag removal. The homogeneous and finely rippled seam surface does, for most applications, not require any finishing by grinding.

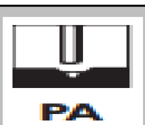
Recommended Application

Main application fields are surfacing on earth moving equipment, working parts in the cement and brick industry as well as in steel mills for radial breakers und revolving-bar screens of sintering plants.

Weld Deposit Properties

Hardness (HRC)	pure weld deposit	1 layer on steel with C = 0.15%	1 layer on high Mn-steel
Typical	65	58	55

Operating Data



Polarity=+,-

mm	3.2mm	4.0mm	5.0mm
L mm	350	350	350
Amps A	90-130	130-180	190-230

- Hold electrode as vertically as possible, keep a short arc. Reduce dilution with the base metal by weaving. For multipass applications a cushion layer with HF95 is recommended. Re-dry electrodes that have got damp for 2h/300° C.

We do hereby certify that; the weld metal deposit, has been tested, mechanically and chemically and all results are comply with the requirements of specifications of Elkadesia for engineering industries and the Specification of ASME II part C SFA 5.01 Class C5 and level of tests in J or 5.

Cast Iron group

EL KADESIA

Product As Shown: EL KADESIA E Ni-CI ™
Application: SMAW cast Iron electrode

EL KADESIA ENGIN

EN ISO 1071 : E C Ni-CI 3

TECHNICAL SPECIFICATIONS

Material Type Alloy Components

High Nickel (Ni)

Weld Deposit Characteristics

A Cast Iron electrode, depositing nickel weld metal. Hardening of heat affected zone is small and machining of the welds is comparatively easy. Therefore, it is suitable for welding alloy cast iron of poor weldability, malleable cast iron and hydraulically pressured parts as well as common cast iron.

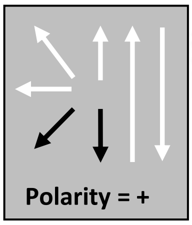
Recommended Application

Used for repairing cast iron and joining of various kinds of cast iron products such as cylinder covers, motor beds, casings and gears. Repairing of meehanite, alloy and malleable cast iron.

Weld Deposit Properties

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Hardness In BHN
	MPa	MPa	%	
Untreated	291	370	4	175
Typical according to ASME II part C /SFA 5.15	262 - 414	276 - 448	3 - 6	135 - 218

Operating Data



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	70 - 85	85 - 110	110-140	120-160

Product As Shown: EL KADESIA E NiFe-CI ™
Application: SMAW cast Iron electrode

EL KADESIA ENGIN

EN ISO 1071: E C NiFe-13

TECHNICAL SPECIFICATIONS

Material Type Alloy Components

High Nickel, Iron (Ni - Fe).

Weld Deposit Characteristics

A Cast Iron electrode for high strength joints on cast iron. Also, for the fabrication and repair of a wide range of cast iron components and for the joining of cast iron to steel. Very resistant to cracking and the weld metal is fully machinable. specially manufactured to avoid electrode overheating. very easy electrode to control due to the soft smooth arc characteristics which produce even weld beads of good contour.

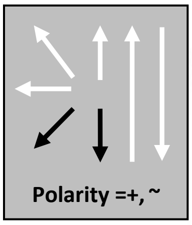
Recommended Application

Used for Welding of normal grades of cast iron, such as grey, ductile and malleable irons. Repairing of cast iron housings, blocks, machinery parts, frames.

Weld Deposit Properties

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Hardness In BHN
	MPa	MPa	%	
Untreated	380	480	18	190
Typical according to ASME II part C /SFA 5.15	296 - 434	400 - 579	6 - 18	165 - 218

Operating Data



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	60 - 90	80 - 120	110-150	140-180

Nickel Alloy Group

EL KADESIA

EN ISO 14172: E Ni 6117

TECHNICAL SPECIFICATIONS

Material Type Alloy Components

High Nickel, Chromium and Molybdenum, Cobalt and other elements (Mn – Nb).

Weld Deposit Characteristics

A nickel based low hydrogen type covered electrode containing high Ni, Cr and Co, Mo, Mn, Nb. It provides excellent heat and corrosion resistance. It can be welded in all positions except vertical-down. It has a stable arc. Easy slag removal. Proper base metals are also including 2.4663 (NiCr21Co12Mo), 2.4851 (NiCr23Fe), 1.4876 (X10 NiCrAlTi 32 20), 1.4859 (GX 10 NiCrNb 32 20).

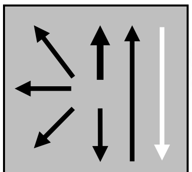
Recommended Application

The weld metal is resistant to hot-cracking and is used for service temperatures up to +100°C. Scale-resistance up to +1100 °C, high temperature resistant up to +1000 °C. High resistance to hot gases in oxidizing and carburized atmospheres, e.g., gas turbines, ethylene production plants.

Weld Deposit Properties

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	MPa	MPa	%	+20 °C	- 196 °C
Untreated	540	760	32	75	55
Typical According to ASME II part C/SFA 5.11	≥ 400	≥ 620	≥ 25		

Operating Data



Polarity =+

mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	40 - 55	70 - 90	90-110	100-160

Re - drying: if necessary: 250 – 300 ºC, min. 2 h.

EN ISO 14172: E Ni 6182

TECHNICAL SPECIFICATIONS

Material Type Alloy Components

High Nickel, Chromium and manganese, and Other element (Nb).

Weld Deposit Characteristics

A low hydrogen type covered electrode containing High Ni, Cr, and Mn, Nb. The welding is suitable for all positions with good heat resistance, oxidizations resistance and good corrosion resistance. It produces toughness under low temperature.

Recommended Application

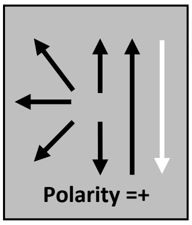
Used for welding of nickel-chromium-iron alloys to themselves, and for dissimilar welding between nickel-chromium-iron alloys and steels or stainless steels. The applications include surfacing as well as clad-side welding.

Weld Deposit Properties

Heat Treatment	Yield Strength N/mm2	Tensile Strength N/mm2	Elongation %	Impact values In J CVN	
	MPa	MPa	%	+20 °C	- 196 °C
Untreated	410	650	40	100	80
Typical According to ASME II part C/SFA 5.11	N.S	≥ 550	≥ 30	N.S	

Operating Data

Re - drying: if necessary: 250 – 300 °C, min. 2 h.



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	40 - 70	70 - 100	90-125	120-160

TECHNICAL SPECIFICATIONS

EN ISO 14172: E Ni 625

Type: EL KADESIA KAD 2841™
Application: SMAW Nickel based electrode

Material Type Alloy Components

High Nickel, Chromium and Molybdenum and other elements (Mn – Nb).

Weld Deposit Characteristics

A nickel based low hydrogen type covered electrode containing high Ni, Cr and Mo, Mn, Nb. It provides excellent heat and corrosion resistance. welding in All-position. Proper base metals are also including ASTM B443/444/446, Incon 625/825/Alloy20/AlIoy25 6Mo Mone1400.

Recommended Application

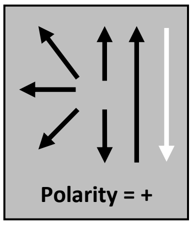
Used to weld nickel-chromium-molybdenum alloys. Its applications include dissimilar joints between nickel-chromium-molybdenum alloys to stainless steels, carbon or low alloy steels. It is also used extensively in overlay cladding where similar chemical composition is required on the clad side. This alloy is suitable for applications where the temperature ranges from cryogenic up to 1800ºF.

Weld Deposit Properties

Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN	
	MPa	MPa	%	+20 °C	- 196 °C
Untreated	500	770	35	70	50
Typical According to ASME II part C/SFA 5.11	≥ 420	≥ 760	≥ 30		

Operating Data

Re - drying: if necessary: 200 ºC, min. 2 h.



mm	2.5mm	3.25 mm	4.0mm	5.0mm
L mm	350	350	350	350
Amps A	55 - 75	65 - 100	80-140	120-170

Underwater Welding Group

EL KADESIA

AWS A5.35: UW E6013-2A

TECHNICAL SPECIFICATIONS

Description

Rutile covered welding electrode designed for general underwater wet welding applications up to 20m water depth, preferred for temporary maintenance and repair works. Simple to use in all positions in fresh and salt water. Waterproof coating prevents the solubility of the hydrogen from the water to weld metal and provides diver's safety. Good root and sidewall penetration and overhead fusion properties. Easy to strike and re-strike. Best at weld metal deposition rate, Slag removal is easy. No needed for extra surface cleaning. Typical Base Material Grades Mild Steels, Carbon Steels.

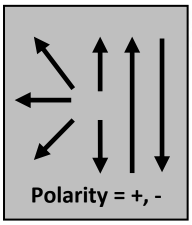
Weld metal deposit analysis

	C	Si	Mn	P	S	Ni	Cr	Mo	V
Wt. %	0.07	0.35	0.55	0.01	0.01	0.02	0.02	0.02	0.02

Mechanical Test of weld Metal

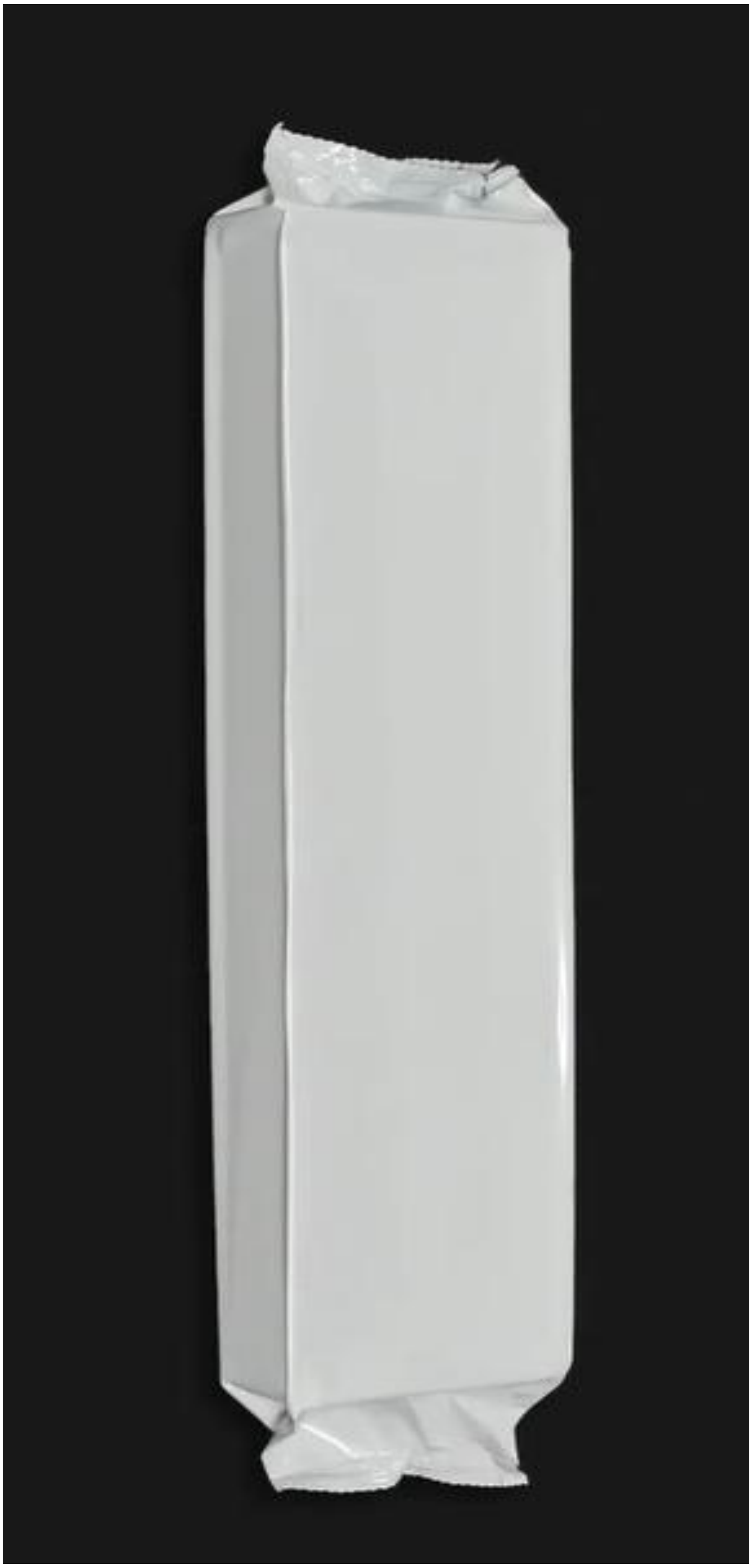
Heat Treatment	Yield Strength	Tensile Strength	Elongation $L_0=5d_0$	Impact values In J CVN		
	MPa	MPa	%	0 °C		
Untreated	430	497	7	55	53	54
Standard According to ASME II Part C SFA 5.35 Test Level II	≥ 320	≥ 430	≥ 6	≥ 40		

Operating Data



mm	3.25 mm	4.0mm
L mm	350	350/450
Amps A	110 - 150	160 - 210

VACUUM PACKAGING



Vacuum Packaging

▪ Vacuum Packaging for low-hydrogen, low-alloy-steel and Stainless-Steel groups Welding Electrodes

ELKADESIA Engineering industries is pleased to announce the launching of its 2 kg vacuum pack options in order to better serve the needs of different industries where low hydrogen content and extra protection are required.

ELKADESIA vacuum pack not only eliminates the moisture pick up but also excludes the re-baking procedures as well as reducing the risk of hydrogen embrittlement and delayed cracking. It also helps to avoid additional cost of storage, handling, re-drying or baking.

ELKADESIA vacuum pack provides an air-tight package to keep moisture from damaging the coating flux on stick electrodes.

Using a strong aluminum foil made of multi-layered, the new ELKADESIA Welding packaging offers maximum safety against loss of vacuum.

With the vacuum in place, electrodes are ready to use. The packs can be stocked in any store where the packaging cannot get damaged.

▪ Protect Your Electrode from Humidity

Low-hydrogen, low-alloy-steel and Stainless-Steel groups, the humidity captured in the flux of electrode turn in to water vapor in the welding bead. Water vapor shrink in the weld bead and porosities occur. These porosities decrease the mechanical properties of the weld metal and the beads become unstable.

Due to these negative effects of the humidity, electrodes must be protected in the best way. ELKADESIA is proud to advise the **Vacuum Packages** which do not get humid if the package is not open and which has 4 hour critical humidity level guarantee after the package is open.

▪ Cost savings through simplified storage and handling

The prevention of hydrogen induced cracking in thick structural steels or porosity in low-alloy-steel and stainless, by controlling the moisture re-absorption in the coating of low hydrogen electrodes can be very costly. In demanding applications, such as offshore fabrication,

the cost of climate controlled storage and handling and the associated

administrations are often calculated to exceed the cost of the consumables itself. With electrodes from ELKADESIA vacuum packaging, these costs are completely avoided.

▪ Not need to Re-Baking, Holding Ovens, or Quivers

Welding electrodes from Vacuum Pack can be used straight from the package without the need to re-bake them and store them temporarily in holding ovens and quivers.

The laminated, multi-layer aluminum foil is vacuum-sealed around an inner box and effectively protects the electrodes against moisture re-absorption from the air.

Protected by a cardboard outer box, they have unlimited shelf life and do not require special warehouse conditions, provided they are handled with care and the foil is not damaged. Upon opening,

Fresh and dry electrodes are guaranteed when the vacuum is confirmed.

▪ Safe Welding After Opening

ELKADESIA welding electrodes in Vacuum Pack are low moisture absorption (LMA) types with a coating that only slowly re-absorbs moisture from the air.

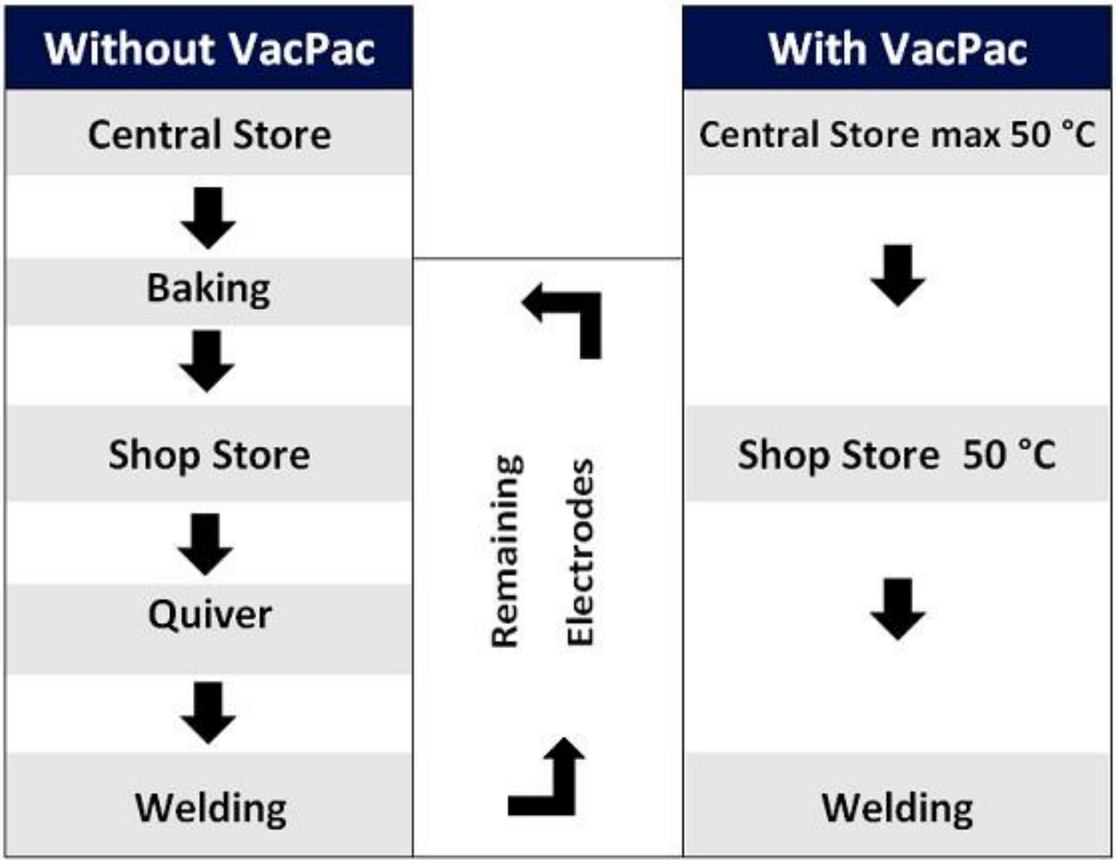
The safe exposure time is 4 hours after opening the Vacuum Pack with the foil left in place.

For optimal security, it is recommended to take out only one electrode at a time. The Vacuum Pack sizes available are 2.5 mm, 3.25mm, 4.0 and 5.0mm, Electrodes exposed beyond above limits must be re-baked.

Vacuum Pack provides security and makes the welder's life easier; in offshore and pressure vessel fabrication, the petrochemical industry, the food processing industry and other applications where the prevention of cold cracking or porosity is crucial.

▪ Vacuum Packaging benefits

1. **No re-baking, no holding ovens, no quivers.**
2. **Safe welding after opening.**
3. **Cost savings through simplified storage and handling.**
4. **Reduced risk of hydrogen cracking or porosity.**
5. **Easier for welders to carry.**



STORAGE,
RE-DRYING AND HANDLING RECOMMENDATION

Recommendations for the storage, Re-drying and handling of welding electrodes

General Recommendations for covered electrodes

Welding Electrode can meet promised and expected properties only when treated according to the storage and handling recommendations of the producer.

We recommend following the individual and validated technical rules, regulations, recommendations and standards during transport, storage and handling. Mechanical damage and moisture pick up should be avoided.

Storage Recommendations

- Store at ≤ 35°C and Humidity ≤ 60% in a dry store.
- Place packages on a pallet, not directly on the floor.
- Welding electrodes should be stored in their unopened and undamaged original packaging.
- The environment must be clean, free of dust and dry.
- The storage management should follow the first in first out principle to avoid over aging.
- Covered electrodes in opened or damaged packaging must be stored in a separate, heated room at higher temperatures.
- Direct exposure to sunlight has to be avoided.

Shelf Life

Welding covered electrodes can be stored under the above conditions and in their unopened and undamaged standard packaging, the shelf life will be as the following table:

Filler Metal	Package	Shelf Life
Low Hydrogen Electrodes	Vacuum Bags	5 yrs
	Carton Bags	3 yrs
Low Alloy Electrodes	Vacuum Bags	5 yrs
	Carton Bags	3 yrs
Stainless Steel Electrodes	Vacuum Bags	5 yrs
	Carton Bags	3 yrs
Rutile Electrodes	Carton Bags	3 yrs
Hardfacing Electrodes	Vacuum Bags	5 yrs
	Carton Bags	3 yrs
Cellulose Electrode	Sealed Cans	5 yrs

▪ Re-drying and handling

Depending on the type of electrode, the base material used and the application, covered electrodes need to be protected against moisture pick up.

The re-drying time and temperature before use depends on type, kind of packaging and application. Further information is given on the electrode package.

Covered electrodes where no re-drying recommendation is given can be dried at 100 - 120 °C / 1 h. Cellulosic Electrodes must not be re-dried.

Electrodes exposed directly to water, oil or grease must not be used.

If the H2-content in the weld deposit is limited to max. 5 ml / 100 g, re-drying is necessary: 300 to 350 °C / 2 h.

Before re-drying, the electrodes should be removed from their packages with the appropriate care and laid in the preheated (80 - 100 °C) baking oven.

Under no circumstances should the stacked height of the electrodes exceed 40 - 50 mm. The electrodes should stay for at least 2 h in the oven after reaching the re-quired re-drying temperature. Re-dryed electrodes can be stored at 100 - 200 °C in a drying cabinet up to four weeks and in a quiver up to 12 hours.

Covered electrodes should be re-dryed not more than two times.

General recommendations for re-drying of electrodes:

Not Necessary	Not allowed	300 – 350 °C / 2 h
ELKADESIA OHVI E 6013	ELKADESIA CEL E 6010	ELKADESIA I E 7018 ELKADESIA IM E 7018-1
ELKADESIA NG E 6013	ELKADESIA CEL E 7010-G,P1	ELKADESIA E 7015 ELKADESIA E 7018-1H4
70 – 80 °C / 1 h	ELKADESIA CEL E 8010-G,P1	ELKADESIA E 7018-A1 ELKADESIA E 7016-1
ELKADESIA AG E 6013	ELKADESIA CEL E 9010-G,P1	ELKADESIA E 8018-G ELKADESIA E 8018-C1
		ELKADESIA E 8018-C3
		ELKADESIA E 8018-B2
		ELKADESIA E 9018-B3
		ELKADESIA E 9018-G
		ELKADESIA E 308L-16
		ELKADESIA E 309L-16
		ELKADESIA E 316L-16
		ELKADESIA E 317L-16

Low-hydrogen basic electrodes should be re-dried before use (1st re-drying cycle) in the baking oven at 350°C, for about 2 hours (not needed for Vacuum Pac). When the electrodes are initially placed in the baking oven, the temperature should not be greater than half the re-drying temperature (±170 °C). The electrodes should be held at that temperature for ½ hour before heating the electrode to the final temperature. The re-drying time is measured from the point at which the re-drying temperature has been reached (350 °C). Do not stack more than four layers of electrodes in the baking oven. Cellulose electrodes must not be re-dried.

Re-drying electrodes will be placed in the holding oven at a steady temperature of approximately 150 °C. This intermediate storage is aimed at avoiding moisture pick-up in the coating of low-hydrogen electrodes. Storage in the holding oven should not exceed 10 days' maximum total holding time.

The remaining basic electrodes from the field should be re-dried at 300 °C for about 2 hours, in accordance with Clause 4.1.3. The total number of re- drying cycles will be limited to three (3) cycles. If, by mistake, during the re-drying process, the time exceeds 10 hours, the basic electrodes will be discarded.

Electrodes which remain unused after the 3rd re-drying cycle will be discarded.

▪ Vacuum Pack

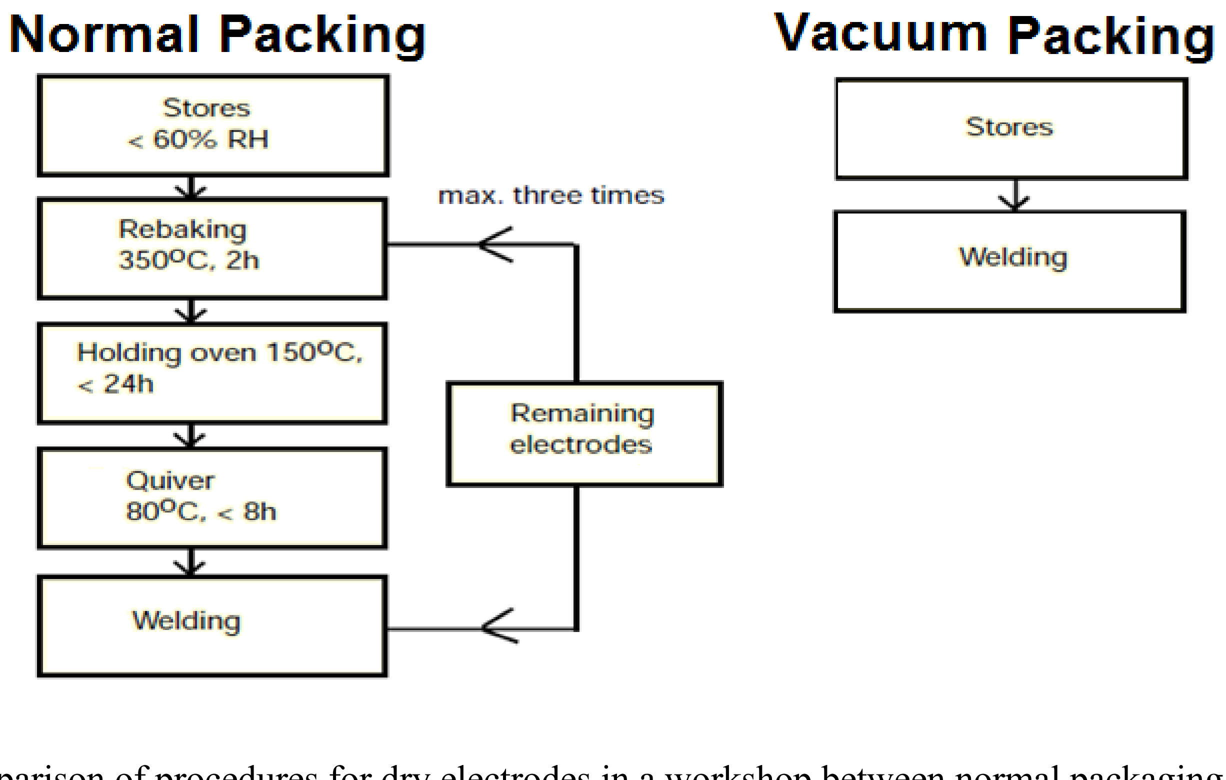
Electrodes in Vacuum Pack will not pick up any moisture during storage. They require no re-drying before use, provided that the package is undamaged. This is indicated by a vacuum in the package.

▪ Storage

- Store at ≤ 50°C.
- Place packages on a pallet within 5 rows only, not directly on the floor.
- Keep the package is undamaged.

▪ Handling and using

- Place the Packages on a pallet within 5 rows only, not directly on the floor.
- Handle the single inner metal foil with special care (not to be thrown or dropped from distances or heights of more than 30 cm).
- open the protective foil at one end.
- Leave the foil on the package.
- Do not take out more than one electrode at a time.
- Ensuring that the remaining electrodes are still protected inside the package.
- in case more than six hours have passed since opening the package, the re-drying procedure is carried out at a temperature of 300 - 350 °C for two hours.



Comparison of procedures for dry electrodes in a workshop between normal packaging and Vacuum packing

General Information

Welding consumables standard according to European standards
Summary of EN / EN ISO standards for welding consumables
Electrodes

Standard	Title of the standard
EN ISO 2560	Covered electrodes for manual metal arc welding of non-alloy and fine grain steels.
EN ISO 3580	Covered electrodes for manual metal arc welding of creep-resisting steels.
EN ISO 3581	Covered electrodes for manual metal arc welding of stainless and heat-resisting steels.
EN ISO 18275	Covered electrodes for manual metal arc welding of high-strength steels.

Examples of the classification system using various welding consumables

Classification system according to EN ISO 18275-A using EL Kadesia ™ as an example.

E 55 3 MnMo B T 4 2 H10

- **Identifier of the hydrogen content of the applied weld metal**
- **Code number for welding positions**
- **Code number for yield and type of current**
- **Abbreviation for stress-relieved condition**
- **Abbreviation for covering type**
- **Identifier for the chemical composition of the weld metal**
- **Code number for the impact energy of the weld metal**
- **Code number for the yield strength, strength and elongation of the weld metal**
- **Abbreviation for products/welding process**

Classification system according to EN ISO 3581-A using El Kadesia ™ as an example.

E 19 12 3 L B 2 2

- **Code number for welding positions**
- **Code number for yield and type of current**
- **Abbreviation for covering type**
- **Nominal composition**
- **Abbreviation for products/welding process**

Abbreviations / code numbers for welding consumables classification A in EN ISO standards

Abbreviation for welding process / product

Abbreviation	Description	EN ISO standards concerned
E	Manual metal arc welding	2560, 3580, 3581, 18275

Code number for the yield strength, strength and elongation of the weld metal

Code number	ReL [MPa]	Rm [MPa]	As [%]	EN ISO standards concerned
35	355	440-570	22	2560,14341,14171,17632
38	380	470-600	20	
42	420	500-640	20	
46	460	530-680	20	
50	500	560-720	18	
55	550	610-780	18	18275,16834,18276,26304
62	620	690-890	18	
69	690	760-960	17	
79	790	880-1080	16	
89	890	980-1180	15	

Identifier for impact energy

Code number	Temperature [°C] for impact energy > 47 J (one sample may be lower, but > 32 J)	EN ISO standards concerned
Z	No requirement	636, 2560, 14341, 14171, 16384, 18275, 18276, 26304
A	+20	
0	0	
2	-20	
3	-30	
4	-40	
5	-50	
6	-60	
7	-70	14171, 18275, 18276
8	-80	
10	-100	14171

Abbreviation for stress-relieved condition

Abbreviation	Description	EN ISO standards concerned
T	Mechanical properties after annealing 560-600°C / 1h / furnace down to 300°C / air	16834, 18275
P		26304
	Mechanical properties in the welded condition	all

Code number for yield and type of current			
Code number	**Yield [%]**	**Type of current**	**EN ISO standards concerned**
1	≤ 105	Alternating and direct current	2560, 3580, 3581, 18275
2	≤ 105	Direct current	
3	≤ 105 ≤ 125	Alternating and direct current	
4	≤ 105	Direct current	
5	≤ 125 ≤ 160	Alternating and direct current	2560, 3581, 18275
6	≤ 125 ≤ 160	Direct current	
7	≤ 160	Alternating and direct current	
8	≤ 160	Direct current	

Code number for welding positions		
Identifier	**Description**	**EN ISO standards concerned**
1	All positions	2560, 3580, 3581, 17633, 17634, 18275
2	All positions except for vertical down	
3	Butt weld in flat position, fillet weld in flat and horizontal positions.	
4	Butt weld in flat position, fillet weld in flat position	
5	Vertical down position, and positions as in code number 3	

Code number of hydrogen content in the weld-metal		
Code number	**Maximum hydrogen content [ml/100g weld metal]**	**EN ISO standards concerned**
H5	5	2560, 3580, 18275
H10	10	
H15	15	

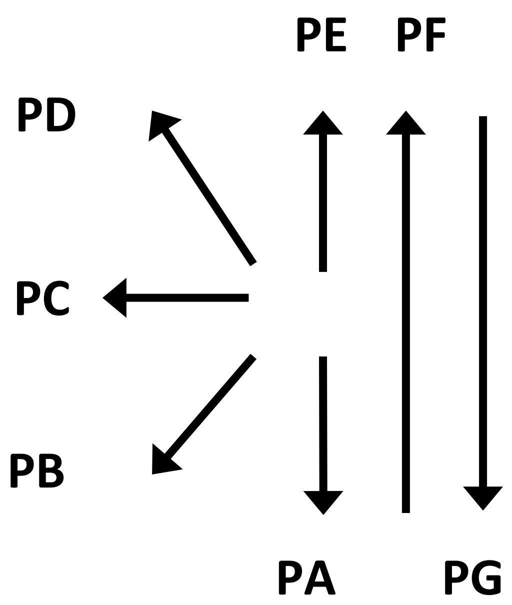
Abbreviation for covering type		
Abbreviation	**Covering type**	**EN ISO standards concerned**
A	acid covering	2560
C	cellulosic covering	
R	rutile covering	2560, 3580, 3581
RR	rutile thick covering	2560
RC	rutile-cellulosic covering	
RA	rutile-acid covering	
RB	rutile-basic covering	
B	basic covering	2560, 3580, 3581, 18275

General notes on the data section

Explanation of symbols and abbreviations

M. No. = EN/DIN material number
EN = European standard (or the national standard derived from it)
EN ISO = International standard based on the EN standard
AWS = American Welding Society
DIN = German industrial standard

Welding Positions



PA (1G, 1F) downhand/flat position
PB (2F) horizontal position
PC (2G) horizontal vertical position
PD (4F) horizontal overhead position
PE (4G) overhead position
PF (3G, 3F, 5G up) vertical position up
PG (3G, 3F, 5G down) vertical position down

Type of Current and Polarity

=+ = **direct current (positive polarity)**

=- = **direct current (negative polarity)**

~ = **alternating current**

Mechanical Property Values

▪ Yield strength R_e MPa	= independent from the base material The term yield strength covers the upper or lower elastic limit (R_{eH}, R_{eL}) or the proof stress in the case of non - proportional elongation ($R_{p0.2}$).
▪ Impact work ISO-V KV J	= the test results shown in this handbook are measured using test specimen with ISO-V-notch.

Approvals and inspecting authorities

ABS	**American Bureau of Shipping**
BV	**Bureau Veritas**
CE	**CE mark**
CRS	**Croatian Register of Shipping**
CWB	**Canadian Welding Bureau**
DB	**German Railways (Deutsche Bahn)**
DNV	**Det Norske Veritas**
KTA 1408.1	**TÜV approval – KTA safety standard 1408.1 (Germany)**
LR	**Lloyd 's Register of Shipping**

Shielded metal arc welding with covered electrodes

In shielded metal arc welding with fluxed cover electrodes, the coating fulfills the task of creating a shroud of shielding gas and of forming a slag in order to stop oxygen reaching the transferring drops of metal or the weld metal. The shield has an important effect on the welding properties and the mechanical properties of the weld metal, especially at minus temperatures. In addition, the coating has an effect on positional weldability, on deposition efficiency, and on compensation for burn-off. There are three main types of coating: rutile, basic and cellulose-coated stick electrodes. Sub mixtures of these types also exist.

Fluxed cover electrode by rutile base (R)

Rutile fluxed cover electrode type of coating is the one most widely used in practice. This is because it offers a range of advantages such as:

• Very stable arc, making it easy to handle
• DC or AC power can be used
• Good ignition and re-ignition properties
• Suitable for all welding positions except for vertical down (PG) - depending on the thickness of the coating and on the type of weld metal (high-alloy is restricted in the vertical-up (PF) and overhead (PD, PE) positions)
• Easy slag removal, finely structured, smooth seam, particularly for the thickly coated RR types (preferred for fillet welds and cover passes)
• No re-drying is necessary (except for high-alloy) Disadvantages of the rutile coated stick electrodes are:
• Cannot be used for thick-walled and stressed components (more than 20 - 25 mm)
• Inadequate impact energy at minus temperatures
• Higher hydrogen content (20 ml/100 g weld metal)
• Cannot be used for higher-carbon steels (C > 0.2%)

Fluxed cover electrode by basic base (B)

Basic fluxed cover electrodes feature with an excellent toughness, in particular in the low temperature range. Other advantages include:

• Extremely low hydrogen content (< 5 ml / 100 g).
• No restriction on wall thickness
• Can be used for all welding positions other than vertical down (PG); basic vertical down electrodes are also suitable for this position
• Also suitable for welding higher-carbon steels (C > 0.2%).

Drawbacks include:

- Arc instability, therefore somewhat more difficult for the welder to handle
- Restrictions to conduct welding; sometimes by DC.
- Slag removal easiness is moderate; the slag has coarser structure.
- Moisture absorption is relatively sensitive; basic stick electrodes must be re-dried before welding (except for high-alloy). Stick electrodes that are vacuum packed or packed in sealed tins can be used for welding without redrying, but should be used from a heated quiver after the packaging has been opened. The double-shell electrode is a special variant of the basic stick electrode. It is a stick electrode with 2 coatings: the material of the inner coating is primarily rutile, which ensures fine drop transfer and a very well aligned arc. The outer coating consists primarily of basic materials, which ensure that the weld metal has good toughness (at low temperatures) and resistance to cracks.

Fluxed cover electrodes with Cellulosic base (C)

Cellulose coating was specially modified for vertical down welding on large pipelines. High proportion of cellulose in the flux leads to an arc that is highly stable and intense. This increases the root penetration; even at high welding speeds or with larger electrode diameters. The high economy is a result of the use of electrodes with large diameters for the root, filler and cover passes, which can be carried out with high currents and at high welding speeds. Because the weld metal has high hydrogen content, application is restricted in terms of wall thickness and the required impact energy.

Hybrid types (RC, RB)

In addition to these three important main types, a large number of what are known as „mixed types “, such as the RC and RB coatings, are also available. These attempts to combine the largest possible number of positive properties in one stick electrode. RB types (rutile with basic components) are often used for root and pipe welding because of their good gap bridging and properties suited to out-of-position welding. RC types are universally applicable and, thanks to their cellulose content, can be used in all welding positions including vertical down (PG). Coated stick electrodes can be used universally on all materials that can be welded. Not a lot of equipment is required, although, due to the low deposition rate, the economy of this method must be considered low.

The weldability of steels

The following factors are the main influence on the welding suitability of steels: composition, manufacture, treatment and physical properties. The composition is of central importance, as this is the main thing that determines the strength and the deformation properties.

Weldability of unalloyed steels for welding

By step aside the phosphorus and sulphur content, the weldability of unalloyed steels is mainly judged according to the carbon content. As a result of the welding heat, part of the base material is austenitised at the edge of the welding seam. Following the rapid cooling immediately following the weld, local hardening and hydrogen embrittlement can occur in the affected zone. Unalloyed steels with carbon contents up to about 0.22% can usually still be welded without difficulty; at higher-carbon levels and Mn contents of above 1%, base materials with a wall thickness of about 20 mm or more must be preheated, in order to reduce the cooling speed involved in the austenised conversion. Steels with a C-content of more than about 0.5% are generally not considered suitable for welding. Nevertheless, the carbon content alone is not sufficient to determine the suitability of unalloyed steels for welding. Welding difficulties can occur as a result of higher hydrogen, nitrogen and oxygen contents, as well as due to the presence of strong segregation. Wall thickness and the stress level also play an important role.

Weldability of alloyed steels

Steels with alloy contents up to 5% According to their properties when in use, these steels are divided into, for example, creep resistant, high-strength and cryogenic. The steels often require appropriate heating prior to, during and after welding if usable welded joints with particular properties are to be achieved. The chemical composition in terms of the type and quantity of alloying constituents, and the microstructure, are important. Higher strength quenched and tempered steels usually have C-contents between 0.2 and 0.6%. Chromium, nickel and molybdenum are important alloying elements, and so are manganese, silicon and vanadium. Their increased tendency to form martensite leads to higher tensions in the component as the weld seam cools. The critical cooling rate is less, which means that it is possible for hardened microstructures to form even under air cooling, and this can impair the ability of the welded joint to deform. There is a high risk of hardening cracks in the transition zones. On the other hand, due to the tempering effect, zones with marked softening can also occur. Since there are no same-type welding consumables for these steels it is not generally possible to create joints with the properties of the base material.
Steels with alloy contents > 5% The stainless steels, containing either simply chromium or both chromium and nickel as the characteristic alloying elements, constitute an important group. The chromium steels are mainly divided into types with ferritic or with martensitic microstructures, which are classified as having only limited suitability for welding. The reason for this is the tendency of the ferritic chromium steels to form coarse grains, or the tendency of the martensitic chromium steels to harden in the heat affected zone of the base material. In contrast, the austenitic CrNi(Mo) steels are well-suited to welding. However, if they are not properly processed, the corrosion resistance, hot cracking resistance and toughness of these steels can be negatively affected. Certain basic rules must therefore be followed when welding stainless steels.

Unalloyed structural and fine-grained structural steels

Structural steels are low carbon steels with a specified carbon equivalent value (CEV) in which the carbon content lies between 0.10 and 0.60%. The steels coded with S, such as S185, S235JR+AR and S355J2+N, are used in steel construction, while those coded with E, such as E292, E335, E360, are used in mechanical engineering. The structural steels are standardized in EN 10025-2. Structural steels are either hot formed in the production condition (AR=As Rolled), normalized (N) or cold formed. In most cases the mechanical properties are adequate. Structural steels can be welded, and can be stress-relieved. The weldability of structural steels identified as S185, E295, E335 and E360 is limited as their carbon content is either not specified (S185) or is too high (E295, E335, E360), and must not be used in steel constructions that are subject to acceptance tests. Fine-grained structural steels are steels with a fine-grained structure (ferrite grain size ≤6), a carbon content of at most 0.20%, a limited carbon equivalent value, as a result of which they have very good welding properties. Their toughness, including at low temperatures, is improved over structural steels, and they are resistant to ageing. Only the unalloyed fine-grained structural steels with minimum yield strength of 275-460 MPa are considered in this chapter. They are either normalized, or are normalized rolled (code N) as standardized in EN 10025-3, or thermo-mechanically rolled (code M) as standardized in EN 10025-4. The cryogenic variant of the fine-grained structural steels, with the additional code L, can be used down to -50°C. Without additive, use is limited to -20°C. Sufficient low-temperature toughness must therefore be attended to when selecting the welding consumables. The welding of higher-strength fine-grained structural steels is treated in a separate chapter.

The weldability of unalloyed structural and fine-grained structural steels

As a rule, the same mechanical and technical properties are expected from welding consumables used for a welded joint as are found in the corresponding base material. As the carbon content rises, the suitability of the steel for welding falls due to hardening. In the case of steels whose suitability for welding is not certain, corresponding measures therefore have to be taken in order to avoid unacceptably high levels of hardening and the cracks that result. Options for predicting the tendency to hardening include the carbon equivalent value, as well as the TTT curves and the welding TTT curves. If necessary it is also possible to carry out a practical welding test followed by an examination of the microstructure or by hardness tests. As a rule of thumb, it can be said that the hardening in the transition zone of unalloyed structural steels should not exceed 350 HV (Vickers hardness units).

Welding technology for unalloyed structural and fine-grained structural steels:

The welding consumables are to be selected in accordance with the minimum requirements for the mechanical properties of the base material. Steels with „guaranteed welding suitability “and with wall thicknesses of 30 mm or even 20 mm upwards – depending on strength – should be preheated to 100 - 150°C; if stick electrodes are used, they should only be basic types. Steels with only „limited suitability for welding “should always be preheated in line with the carbon equivalent value, and only basic, redried welding consumables should be used. As the component becomes thicker, the internal stresses caused by the local heating and cooling can reach the yield strength and can exceed it when the operating stresses are added on top. The result is cold deformation, ageing and embrittlement. For this reason, steels with guaranteed suitability for welding should also be preheated above a certain wall thickness. The following limits to reliably weldable wall thickness, depending on the strength, provide a guide:

Strength [MPa]	Thickness limit [mm]
up to 355	30
> 355 - 420	20

Walls thicker than this always require preheating to 100 - 150°C. (see also the notes on Preheating Materials contained in this guide for further information)

The pipelines weldability

Currently; natural gas and oil are the most important sources of energy. Massive transport pipelines either already exist or are in the project planning stage around the world. The development of new, higher-strength tube steels is now putting tighter requirements on the welding technology. Thanks to our specially developed electrodes, which are ideally matched to individual steels, we can fully satisfy these requirements as well as the strict safety regulations. In most cases, the circumferential pipe welds are manufactured as vertical down welds using cellulose coated stick electrodes. The progress of construction largely depends on the speed with which these seams can be fabricated. This method makes it possible to weld using an electrode with a larger diameter, higher currents and higher welding speeds. This brings significant economic advantages when compared with the otherwise usual welding of a vertical up weld using rutile or basic coated stick electrodes. Welding with basic coated stick electrodes, both for the vertical up and vertical down positions, is treated below in the „Welding with cellulose coated stick electrodes “section. El kadesia™ Welding offers a complete range of types for exceptional low temperature stress. Please enquire separately about wires for gas shielded arc welding or submerged arc welding.

Welding with cellulose coated stick electrodes

AWS Designation A 5.5	A 5.1	Used for pipeline steels according to API spec. 5L
EL KADESIA CEL	E6010	A, B, X 42, X 46, X 52, X 56, (X60, X 65, X 70, X 80*)
EL KADESIA CEL	E6010	A, B, X 42, X 46, X 52, X 56, (X60, X 65, X 70, X 80*)
EL KADESIA CEL	E6010	A, B, X 42, X 46, X 52, X 56, (X60, X 65, X 70, X 80*)
EL KADESIA CEL	E7010-P1	X 52, X 56, X 60
EL KADESIA CEL	E7010-P1	X 52, X 56, X 60
EL KADESIA CEL	E7010-P1	X 52, X 56, X 60
EL KADESIA CEL	E7010-P1	X 52, X 56, X 60
EL KADESIA CEL	E8010-P1	X 56, X 60, X 65, X 70
EL KADESIA CEL	E8010-P1	X 56, X 60, X 65, X 70
EL KADESIA CEL	E8010-P1	X 56, X 60, X 65, X 70
EL KADESIA CEL	E9010-G	X 65, X 70, X 80
EL KADESIA CEL	E9010-G	X 65, X 70, X 80

* Only for root welding

The special suitability of the EL KADESIA™ electrodes for root welding even of high strength steels is particularly worth noting. Through the use of EL KADESIA 6010 for the root and, if necessary, for the hot pass, in the form of what is known as „combination welding“ It is of great importance to carefully prepare the seam if a perfect welded joint is to be achieved. Close tolerances cannot generally be achieved with flame-cut edges. In practice, the pipe ends are usually prepared by machining. In order to avoid pores and lack of fusion, the edges of the seam must be free materials such as oil, lubricant, scale or dirt. Scoring and notches also upset the handling of the electrode. The EL KADESIA™ 6010 CEL Ø 2.5 or Ø 3.2 mm electrode is recommended for the root pass on pipes with a smaller diameter (up to 250 mm).

Thermo processing of weld and base metal

Interpass temperature and preheating are the most common thermo processing technique during and before welding. Preheating the base material promotes or accelerates the effusion of hydrogen, so countering hydrogen- induced cracking. Furthermore, depending on the temperature and on the chemical composition of the steel, hardening in the heat affected zone can be reduced. The preheating and interpass temperatures can be found in the corresponding datasheets. Preheating should always be carried out for walls thicker than 20 mm, regardless of the C-content. It is helpful to increase the temperature to about 150°C for higher-carbon steels that are susceptible to hardening. The external temperature must also be taken into account! The pipe ends of thin pipe materials that do not tend to harden should be slightly warmed up to at least 50°C in order to remove water condensation. The various specifications permit different carbon contents. If the C-content is above 0.20%, we recommend that you consult the manufacturer of the welding consumable or of the steel in order to select the preheating temperature. The interpass temperature affects the metallurgical processes that take place during the solidification and cooling, and therefore has an effect on the mechanical properties of the weld metal. The rate of hydrogen effusion is also affected. It is recommended that when basic coated stick electrodes are used, the interpass temperature during the welding is kept to at least 80°C.

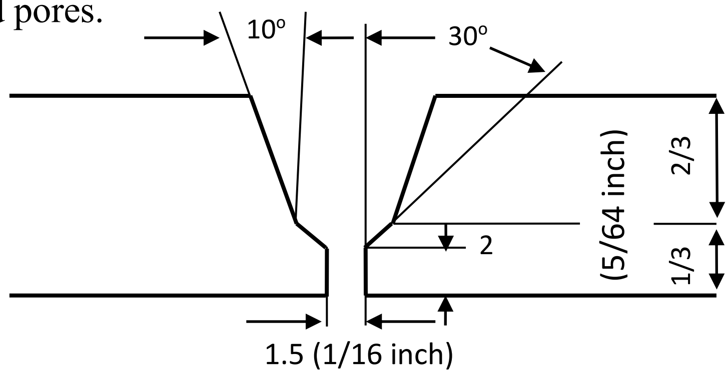
Welding with basic coated stick electrodes

In some countries, the use of basic coated stick electrodes in pipeline construction is preferred, for a number of reasons. The use of basic electrodes is generally recommended for welding very thick steels, susceptible to hardening, of more than 25 mm. The reason for this is the very low amount of hydrogen produced by these types of electrode.
The high heat dissipation resulting from the thick walls, together with the simultaneous presence of high levels of hydrogen when cellulose coated stick electrodes are used, intensifies the risk that hydrogen-induced cracks will form.

Directional vertical up welding

The use of basic coated stick electrodes of the EL KADESIA 7018-1 (E7018-1), EL KADESIA™ 8018–c3 (E8018-C3), EL KADESIA™ 8018-G (E8018-G) types, and particularly the EL KADESIA™ 7016-1 (E7016-1) and EL KADESIA™ 9018-G (E9016-G) types, which have been specifically optimized for pipe welding, is preferred. It is necessary to ensure that the electrodes are protected from moisture. Electrodes from boxes that have already been opened must be re-dried, in accordance with the specifications, for 2 hours at 300 - 350°C before they are used. The root pass is usually carried out using an electrode with a diameter of 2.5 mm, or, if the EL KADESIA™ 7018 Pipe series is used, of diameter 3.2 mm, in order to achieve proper through-welding. Welding is carried out upwards, with a root gap of about 2.5 - 3 mm. In order to save weld metal on wall thickness of >20 mm, a special form of seam may occasionally be used.

Welding the filler and cover passes is usually carried out using electrodes with diameters of 3.2 and 4 mm. The welded joint must be protected against wind, rain and so forth in order to avoid pores.



Designation	AWS classification 5.5	Use for pipeline steels according to API spec. 5L
El-Kadesia™ 8045-P2	E8045-P2	A, B, X 42 - X 65
El-Kadesia™ 9045-P2	E9045-P2	X 70, X 80
El-Kadesia™ 10045-P2	E10045-P2	X 80
El-Kadesia™ 11018-G	E11018-G	X 100

Conducting the welding

Fit-up and joint preparation: The joint is prepared by machining. The permissible dimensional tolerances of the tubes are listed in the API spec. 5L and EN 10208-2 standards. Tubes alignment; as when welding by cellulose coated electrodes, the tubes are aligned; using hydraulically operated internal centering gear. Due to the relatively strong formation of the root pass, and due to the low level of hydrogen introduced by the basic coated root electrode, the internal centering gear can be removed, provided there is no excessive edge displacement, as soon as the root pass has been finished.

Conducting welding at low external temperatures or in humidified conditions

In bad weather conditions, particularly if the air temperature is less than 0°C, welding work may only be carried out on pipelines if the welding and working conditions allow the seam to be created properly. This means that although it is not forbidden to weld when the external temperature is low, certain precautionary measures must be taken. The following rules have been found effective in practice:

1. Remove ice, frost and water by preheating.
2. Weld quickly without extended breaks, if necessary using a number of welders for one seam.
3. Use the thickest possible electrodes.
4. The welder himself must be sufficiently well protected from the cold (if necessary provide tents, wind protection or infrared heaters).

There are no generally applicable rules or restrictive specifications about carrying out welding work in the rain or on wet work pieces. Nevertheless, it goes without saying that the welding area and its surroundings must be protected from rain and other bad weather. Under all circumstances, the welding area must be free from water. Re-dried basic stick electrodes have in any case very little hydrogen in the weld metal, and therefore offer better security, under unfavorable conditions, against hydrogen-induced cracking. However, if welding is carried out in a water saturated atmosphere, even the basic weld metal can contain significant amounts of hydrogen.

Fine-grained structural steels with high strength

The micro-alloyed steels can be divided into three main groups, according to how they are Manufactured:

1. normalized fine-grained structural steels
2. thermo-mechanically treated fine-grained structural steels
3. Quenched and tempered fine-grained structural steels In fine-grained structural steels, the loss of strength resulting from the low carbon content is compensated for via micro alloying elements such as Al, Nb, Ti and V. Through the addition of Cr, Mo and Ni together with quenching and tempering, 0.2-offset yield strengths of 1300 MPa can be achieved while retaining good toughness and welding properties. Conventional, rolled, normalized fine-grained structural steels can be made with 0.2-yield limits of up to 460 MPa. The properties are achieved through the addition of micro alloying elements. In thermo-mechanically rolled steels, the strength is achieved through the addition of micro alloying elements and through rolling processes with careful temperature control. This allows 0.2-offset yield strengths of 960 MPa to be achieved. The strength properties achieved through a thermo mechanical treatment cannot be repeated. 0.2-offset yield strengths of up to 1300 MPa are achieved with quenched and tempered fine-grained structural steels. The strength is achieved through micro alloying elements, the addition of Cr, Mo and sometimes of Ni, and by a quenching and tempering process following rolling.

Welding of fine-grained structural steels

The generally applicable and recognized rules for welding low-alloy, higher-strength fine-grained structural steels meeting EN 1011-2 must be followed. It is generally necessary to ensure that as the minimum values of the 0.2-offset yield strength increase, and as the walls become thicker, greater care must be taken during processing, while a design that is appropriate for welding and for the stresses to which it will be subjected is an important prerequisite. The risk of hot cracking is low in these steels. On the other hand, the possibility of lamellar tearing must be countered by design and/or by the welding technique (reducing internal stress, preheating). At the same time, excessive hardening must be avoided, and the hydrogen content kept as low as possible in order to minimize the risk of cold cracking. The preheating temperature depends on the thickness of the workpiece and on the chemical composition of the base material and the weld metal, the energy input per unit length, and on the expected internal stresses. As the thickness increases, the upper range of temperatures should be aimed at. The values of the thickness limit for preheating, depending on the minimum value of the 0.2-offset yield strength of the base material, are contained in the following table.

Minimum value of the 0.2-offset Thickness limit [mm]	yield strength [MPa]
> 460 - 550	12
> 550	8

The temperature-time curve during welding is of crucial significance to the mechanical properties of high-strength welded joints. In particular, this is affected by the plate thickness, the shape of the seam, the energy input per unit length, the preheating temperature, and the layer structure. In order to characterize the temperature-time curve during welding, the cooling time t8/5, i.e. the time taken for a weld bead to cool from 800 to 500°C is usually selected. The cooling time t8/5 in any particular case depends on the requirements for the strength of the particular welded joints after any possible heat treatment has been carried out. A combination of welding current, arc voltage, welding speed and preheating temperature that is appropriate for the cooling time t8/5 to be applied is specified by the user in light of economic and production engineering factors. The selection of a suitable welding consumable is a further key factor that determines quality.

Welding technology

• Welding consumables are to be chosen that demonstrate controlled, diffusible hydrogen content, such as basic coated stick electrodes, basic flux for submerged arc welding, basic or metal cored wires and solid wire electrodes.
• The preheating and interpass temperature depends on the wall thickness, the chemical composition of the base material and of the weld metal, the energy input per unit length and on the existing internal stresses.
• The temperature-time curve (t8/5) is of great significance for the mechanical properties of the welded joint. It is essential that the recommendations regarding heat input from the manufacturer of the base material and of the welding consumable are observed.

Welding consumables

Weldability of El Kadesia™ welding consumables are listed in the following summary:

Material (example)	Designation
S500Q	ELKADESIA™ E8018-GH4R
S690Q	ELKADESIA™ E8010P1

Cryogenic application-steels

Massive scale industrial use of oxygen in the steel industry, nitrogen in the chemical industry, and the supply of natural gas to all industrial sectors, have become much more important in recent years. With the increased use of these gases, their economical transport and storage has become more and more important. The behavior of gases, which change to a liquid state at low temperatures and so greatly reduce their volume, is exploited here. This property of gases can only be used if suitable base materials and welding consumables, which have sufficiently good mechanical properties and are adequately tough at the low temperatures of the liquid gases, are available for the construction of the necessary transport and storage containers. Unalloyed, low-alloy or high-alloy steels that remain tough at low temperatures (e.g. below -50°C) are known as low-temperature steels. Unalloyed and low-alloy steels can in any case be used at temperatures down to -50°C. These groups of steels can be distinguished:

1. Unalloyed or low alloy, low-temperature and fine-grained steels for operating temperatures down to around -50°C in a normalized state or down to about -60°C in a quenched and tempered state.
2. Nickel alloy quenched and tempered steels with between 1.5 and 9% nickel for operating temperatures between -80°C and about 200°C.
3. Austenitic chromium-nickel steels for operating temperatures down to about -269°C.

Welding of cryogenic application- steels

The key property of welding consumables for welding cryogenic materials is their ability to change shape at low temperatures. This is usually tested using the Charpy impact test. The value of the impact energy allows conclusions to be drawn about the tendency to brittle fracture and the possibilities of use down to a particular temperature. The value of 27 joules with the Charpy V sample is often taken as the minimum value for the impact energy at the lowest operating temperature applicable. When welding low-temperature and fine-grained structural steels, controlled heat input must be ensured in order to keep the zone affected by the heat as narrow as possible and yet to avoid hardness peaks. Unalloyed and low-alloy basic coated types according to EN ISO 2560 and EN ISO 18275 are used for the stick electrodes. It is necessary to ensure that the hydrogen content of the welded joint is as low as possible in order to avoid cold cracking, which means that redrying the electrodes before welding, and taking them from a heated quiver, is recommended. This point also applies to the welding flux used in submerged arc welding. The necessary low-temperature toughness and strength must be taken into account particularly when selecting wire-flux combinations or wire-shielding gas combinations. When unalloyed flux cored wires are used, basic or metal cored wires are to be preferred because of the toughness and the low diffusible hydrogen content. When welding nickel-alloyed quenched and tempered steels, same type or similar type welding consumables containing between 2.0 and 3.5% Ni are used. Same-type welding consumables are preferred if, in addition to the necessary minimum temperature, the mechanical-technological properties (strength, toughness) and the physical properties (coefficient of thermal expansion) of the base material must be provided in the welded metal. Welding consumables with higher nickel contents have a greater tendency to hot cracking. Although it is possible to weld the 5% nickel steels using austenitic welding consumables, the use of nickel-based types is preferred for this base material. Heat treatment of the welded joint must then be omitted, in light of the austenitic weld metal (embrittlement, carbon diffusion). The 9% Ni steel is normally joined using nickel-based welding consumables. These nickel-based types have advantages over conventional austenites, due to a higher yield strength and the possibility of giving heat treatment to welded joints. They can also be used for steels with a low nickel content. With a limited dilution with the base material, resistance to cracking and adequate low-temperature toughness down to -200°C is achieved. Same type welding is used on the austenitic chrome-nickel steels for low-temperature applications

Common features of stainless steels

The stainless steels group contains a large number of very different kinds of alloy, whose common feature is a chromium content of at least 12%. This ensures that, under oxidizing conditions, an extremely thin, stable, layer of oxide forms on the surface of the steel, and the steel changes from an active (soluble) into a passive (insoluble) condition. The resistance to oxidizing media is increased in the passive condition. In the presence of a reducing environment, however, i.e. when there is little available oxygen, the otherwise passive steel changes into the active condition. The chromium content of at least 12% that is required for a degree of chemical resistance of the steel, is very often referred to as the „parting limit". The alloying element chromium, and, following on from that, nickel, are the basic elements for stainless steels. The effect that they have on the microstructure within the steel is, however, very different. Whereas the gamma region is protected as the chromium content rises and, with 12% or more, only ferrite (body-centered cubic solid solution) is the predominant form between the solidification and room temperature, rising nickel content expands the gamma region. Above a certain nickel content, the microstructure only comprises austenite (face centered cubic solid solution) between the solidification temperature and room temperature. The effect on the formation of the microstructure of all the other alloying elements that are added to steel in order to improve particular properties can be classified as either chromium-like or nickel-like. This means that it is possible to distinguish between ferrite-forming and austenite-forming elements, as follows. Ferrite-forming elements: chromium, silicon, aluminum, molybdenum, niobium, titanium, tungsten and vanadium. Austenite-forming elements: nickel, manganese, carbon, cobalt, copper and nitrogen. If sufficient quantities of nickel are added to a ferritic iron-chromium alloy, it converts to the austenitic state. The most important groups of stainless steels are listed in the following table. They are divided according to the microstructure.

Microstructure	Material types
Pearlitic-martensitic	X30Cr13
Semi-ferritic-ferritic	X8Cr17
Soft martensitic	X5CrNi13-4
Ferritic-austenitic	X2CrNiMoN22-5
Austenitic Austenite with ferrite Austenite without ferrite	X5CrNi18-9 X8CrNiNb16-13

These steel groups differ both from the metallurgical and the physical point of view, and suitable measures must be taken when welding to allow for their special features.

Common features of Austenitic Cr-Ni(-Mo) steels

The group of austenitic chromium-nickel-(molybdenum) steels is the most significant of these stainless materials. Generally speaking, these chemically resistant steels can be classified as „very well suited to welding". They cannot be quench hardened, which means that hardening does not occur in the heat affected zone, and there is no significant grain coarsening. Nevertheless, unsuitable handling can, in some circumstances, cause three problems, both in the base material and in the weld metal. These are:

• Sensitization, i.e. a reduction in the resistance to corrosion due to the formation of chromium carbide.

• Hot cracking, i.e. separation of grain boundaries during solidification, or in the highly heated HAZ when rigidly fixed.

• Embrittlement, i.e. the precipitation of intermetallic phases such as the sigma phase through exposure to high temperatures or annealing. When welding the fully austenitic steels, their inherent tendency to hot cracking must also be considered. Notes on the welding techniques for standard austenitic Cr-Ni-(Mo) steels, the subsequent heat treatment of the weld seams, and information on welding consumables can be found in the corresponding sections.

Welding technology

• Only grades corresponding to the base material concerned should be used for welding. The delta- ferrite content of the weld metal should be in the range between 3 - 15 FN (ferrite number). This ensures sufficient resistance to hot cracking. For highly corrosion-resistant special steels, same type welding consumables that yield a fully austenitic weld metal are also available.

• Ensure that austenitic steels are only processed when their surface is clean and dry.

• The arc should be kept as short as possible in order to avoid picking up nitrogen from the air. When welding with shielding gas, it is necessary to make sure that the gas shield is working perfectly. With the exception of flux cored wire welding, only shielding gases with a low CO_2 content should be used in order to keep carburizing of the weld metal to the lowest possible level.

• Preheating to 100 - 150°C is only advisable if the base material is thick, but it is not necessary in principle.

• An interpass temperature of 150°C should not be exceeded.

• Ensure that the current intensity is kept within the recommended range.

• If it is not possible to reweld the root when welding with shielding gas, then shielding gas (e.g. forming gas or pure argon) must be applied from the rear.

• If possible, dilution with the base material should be kept below 35%. If, as a result of the welding method, it is higher than this, the ferrite content of a test seam must be determined with a calibrated ferrite content meter or an estimate must be calculated from the chemical composition, e.g. using the WRC-92 diagram. The ferrite content, i.e. the FN, should not be below the minimum figure mentioned above.

• Annealing treatment after welding should be avoided at all costs. If this is not possible, then it must be expected that the corrosion resistance and/or toughness may be impaired. In such cases consultation with the manufacturer of the steel and of the welding consumable is recommended.

• In general it is possible to use unstabilized, low-carbon welding consumables for stabilized steels and vice versa, but the temperature limit for intergranular corrosion must be borne in mind.

• Greater distortion than when welding ferritic steels must be allowed for, and corresponding countermeasures, such as the seam shape, stronger tacking, pre-stressing, back-welding and so forth must be considered. Straightening with the gas flame should not be done if at all possible, as corrosion resistance can suffer from this. The harmful effect of arc strikes outside the welded joints should also be particularly stressed in this context.

• Only slag hammers and brushes of stainless Cr or Cr-Ni steels should be used for cleaning austenitic welded joints.

Subsequent treatment of welded seams

It must be noted that an entirely clean metal surface is a precondition for optimum corrosion resistance. It is not only necessary to remove all the welding scales, the slag and spatter, but all the annealing colors must also be eliminated. Subsequent treatment can comprise grinding, pickling, blasting with quartz, corundum or glass beads, brushing and/or polishing. The finer the surface, the better is the corrosion resistance (e.g. rough grinding – fine grinding – polishing). Pickling is used most often. A variety of pickling solutions or pastes are available for this purpose. They are applied to the surface, and after the recommended exposure time must be thoroughly rinsed with water. Removing the „annealing colors" from welded seams can be a challenge. These too can be removed by treating with quartz sand or by brushing. If the pickled component will soon be exposed to corrosive agents, as is frequently true for repair jobs, then passivation is recommended after the pickling. Thorough rinsing is again necessary after the passivation treatment. While we are talking about the application of pickling agents, it is important to stress that these are highly caustic substances. It is therefore essential that protective gear such as rubber gloves, rubber aprons, eye protection and possibly breathing protection are used. Local environmental protection regulations must also be observed. Blasting with quartz, corundum or glass beads is used when grinding or pickling are not possible. This method must only be applied using the said materials. The method does yield a clean, metallic surface, but one that is somewhat rough. Passivation should also be carried out after blasting.

Welding consumables

The following table provides examples of various El kadesia™ welding consumables that are appropriate for welding the materials under discussion:

Material	Designation
X5CrNi18-9	El kadesia™ 308L-17
X2CrNi18-9	El kadesia™ 308L-17
X5CrNiMo18-12	El kadesia™ 316L-17
X2CrNiMo18-10	El kadesia™ 316L-17
X10CrNiNb18-9	El kadesia™ 347
X10CrNiMoNb18-10	El kadesia™ 318

Instructions for preheating materials

Steel hardening during welding

Due to the fact that, during welding, certain regions of the base material in the heat affected zone will always be heated above Ac1 or Ac3, there is a risk that hardenable steels will harden and therefore develop cracks. The tendency of unalloyed and alloyed steels to harden depends in particular on the carbon content, but also on the alloy contents. During welding, the rate of cooling out of the austenite region can be so great, that it corresponds very much to hardening in water. The rate of cooling is greater when

• Less heat is introduced during welding,

• The material is thicker,

• The material is colder.

If the critical rate of cooling is reached, the formation of martensite must be expected. The magnitude of the hardness figure depends largely on the carbon content.
The hardness rises linearly as the carbon content rises up to about 0.45% C, reaching a value of around 650 HV. The impact energy in hardened steel with up to 0.12% carbon is more than 78 joules, and drops off steeply at higher C-contents. Above 0.2% C it is less than 32 joules. It can be seen from this that the value of 0.2% C is approximately the limit up to which steels can be welded without preheating and without taking special precautions.
If the filler and cover passes are welded on top of the root pass, the zones underneath are normalized or tempered, and the peaks of hardness close to the root seam are reduced. However, if cracks have already formed in the transition zone due to the hardening that follows the welding of the root pass, these remain even after the further passes are applied to the welded joint, and in some circumstances can cause the welded component to fracture.
In zones that have been hardened in this way, welding shrinkage leads to high stresses, since the material is prevented from dispersing it through plastic deformation. In addition, particularly when the cross sections are thick, multi-axis stress develops in this region, further encouraged by the fact that the formation of martensite is accompanied by an increase in volume. If the stresses reach the cohesion strength, cracks will occur in the transition region. Hydrogen can play a large part in the creation of these under bead cracks. In order to have some certainty of avoiding under bead cracks, a hardness value of 350 HV should not be exceeded if possible. In order to avoid under bead cracks, and therefore to guarantee the safety of a welded construction, an accurate knowledge of the hardening processes in the heat affected zone of the steel is, for the reasons mentioned above, of great importance. It also appears very important that, with a given steel having a known chemical composition prior to welding, predictions can be made about the possibility of hardening.

Conducting a Preheating of the material

The preheating temperature is the temperature to which the workpiece must be brought in the region of the welded joint before welding the first bead.

Arguments for preheating

The heat introduced into the workpiece; during welding, and thus the steepest temperature gradient that occurs in the zone between the weld metal and the unaffected base material, can result in changes in the material (risk of cracking). Preheating reduces the temperature gradient, and ensures slow cooling. This means that the critical cooling rate, which can lead to disadvantageous changes in the microstructure, is not reached (hardening is slight or non-existent - no risk of cracking). In addition, the shallower temperature gradient reduces shrinkage, and fewer distortions therefore occur. The internal stresses caused by welding are reduced, and at the higher temperatures the hydrogen has more time to diffuse out (lower hydrogen content - lower risk of hydrogen-induced cracking). A steel must always be preheated before welding if there is a risk of critical changes in the microstructure. This applies in particular to tack welding. The necessity of preheating results from the tendency of certain steels to harden in the heat affected zone, as described before. If the welding process happens to be interrupted, the preheating temperature must be achieved again before welding continues. It is, however, a general rule that critical seams in particular are to be welded in one pass – i.e. without interruption.

Optimum of the preheating temperature

The optimum preheating temperature depends on a large number of factors. These include: the chemical composition of the base material, carbon equivalent values(CEV), the welding procedure, the diameter and type of the welding consumable, the speed of welding, the thickness of the workpiece, the orientation of the welded joint on the component, the possibility of heat dissipation, the nature of the design, the external temperature, and so on. For structural steels, fine-grained structural steels and creep resistant steels, EN 1011-2 offers ways of calculating and estimating the preheating temperature. This possibility is, however, only available within certain analytical limits. It is also possible to estimate the preheating temperature with the aid of the corresponding time-temperature-transformation curve. The martensite start temperature, the fields for the bainite stage in the pearlite stage, provide orientation.

Conducting the preheating

Once the preheating temperature has been determined, the area that is to be welded must be appropriately heated. It must be remembered that the heat flows away into the cold material. The heat input must be large enough for the specified temperature to be reached throughout the entire cross-section, i.e. both at the front and the back. Relatively short seams are usually preheated with the welding torch. Special torches with air intake, or fuel gas/compressed air torches are also used. In addition to preheating in a furnace, inductive preheating or resistance heating are also possibilities. Nowadays the latter two are preferred, since accurate control is possible here, which is essential for many materials. Notes on the size of the zone to be heated, and on measuring the preheating and interpass temperatures, are found in EN ISO 13916.

Instructions for tack welding

In essence, tack welding is subject to the same quality rules as welding itself. This applies both to the heat control (preheating) and to the selection of the welding consumable. In many cases, due to the rapid dissipation of heat, it is advisable to preheat the workpiece even if the base material itself does not normally require preheating. Non-identical welding consumables, generally with lower strength and higher toughness, can be used, depending on the material. These tacking sites then usually have to be ground out at a later stage, and can only be left if a consideration of the design conditions allows it. Tacking sites should always be sufficiently long and thick, in relation to the thickness of the base material, so that they can accept the internal stresses that arise in the course of assembly. Cracked tack welds must always be ground out. Tack welds used for assembly aids must be removed and ground smooth. If materials are sensitive, the ground regions should be checked for absence of cracks. In austenitic materials, the tacks must be carried out using the same conditions as the welding itself (forming). More tacks are necessary here due to the greater shrinkage.

Instructions for avoiding welding defects

Faults in welded joints are unwelcome, and in some cases can be the cause of very expensive rework. In many cases, faults and damage can be avoided through taking simple precautions. These precautions can be implemented at various stages in design and manufacture. They can range from the optimum selection of welding consumable, can include proper control of the welding process, and regular servicing of the electrical power source. This subsection does not give a complete overview of all possible welding defects, but restricts itself to types of fault that can be avoided through relatively simple precautions. In addition to a description of faults and causes, the following tables contain possible countermeasures that can have a favourable effect. For more detailed information, standards, welding guidelines (e.g. those of the DVS – the German Welding Society) and other literature shall be consulted.

The occurrence and avoidance of cracks

The following list provides explanations of possible adverse effects that can occur when welding steels, and suggests measures for avoiding these faults. Fundamentally, the majority of the effects listed can be avoided by optimizing the chemical composition of the steel and of the welding consumable. The list is not sorted according to the importance of the faults described.

Faults and causes	Counter-measures
HYDROGEN induced CRACKING	
Atomic hydrogen diffuses into the weld metal and into the heat affected zone during welding. This can result in cracking during and after cooling, particularly in regions of higher internal stress and high dislocation density (e.g. at the grain boundaries in martensite).	Use of welding consumables that yield a very low hydrogen content in the weld metal. Redrying the welding consumable. Preheating the joint. Application of low-hydrogen annealing straight from welding heat
INADEQUATE TOUGHNESS	
In general, the toughness of certain parts of the heat affected zone is impaired with respect to the base material through the formation of coarse grains or through hardening. Unfavorable crystallization in the weld metal can lead to poor figures.	Selection of the optimum welding temperature cycle, layer structure and/or bead geometry.
SOLIDIFICATION CRACKS (hot cracks)	
Solidification cracks are predominantly associated with trace elements such as sulphur or phosphorus. These can precipitate in the center of the bead during solidification. They are the result of the formation of low-melting films around the grain boundaries. These films reduce the ability of the weld metal to deform, and longitudinal cracks can then develop as a result of the shrinkage stresses as the weld metal solidifies.	Modifying the welding parameters so that the individual beads are broader and atter, i.e. reducing the depth-width ratio of a bead. Reducing dilution with the base material. Lowering the welding speed. Note: Solidification cracks rarely occur in steels with low sulphur and phosphorus contents.
Faults and causes	**Counter-measures**
LAMELLAR TEARING	
If no special measures are taken during manufacture of the steel, the toughness of at products or sections can be significantly less in the direction of the thickness than in the longitudinal direction. This is caused by the presence of non-metallic inclusions which are lengthened by the rolling process. Shrinkage stresses in the weld metal that act in the direction of the thickness can cause these inclusions to open, so causing fractures parallel to the surface of the plate. Highly stressed T-butt joints and cruciform joints tend to exhibit this fault.	Use of steels with specified properties in the direction of the thickness. Avoidance of susceptible arrangements of welded seams Preheating Observing DAST Guideline 01

STRESS RELIEF CRACKS	
Carbide or nitride precipitation can occur during stress-relief annealing if the annealing itself and/or the composition of the steel are unfavorable. This can reduce the ability of the steel to deform to such an extent that the stress relief does not just lead to plastic deformation, but also to the formation of cracks.	Reduction of the stress concentration by grinding the weld toes. Reducing the proportion of coarse grains in the heat affected zone through a correct sequence of weld beads. Use of the optimum heat treatment process.
CORROSION – GENERAL ATTACK	
Differences in the chemical composition, grain size and stress between the weld and the base material can result in different corrosion rates. In the majority of cases it is the weld and the heat affected zone that are preferentially attacked.	Selection of a suitable welding consumable (in some cases of a higher alloy content than the base material) Reduction of the internal welding stresses Proper subsequent treatment of welded seams (e.g. pickling).
STRESS CORROSION CRACKING	
A critical combination of stress, microstructure and surrounding medium can lead to this form of corrosion. All three of these factors must be present at the same time.	Avoiding stress concentrations. Reducing stress in all welds. Stress-relief annealing

The occurrence and avoidance of pores

In contrast to the effects described above, the chemical composition of the base material and of the weld metal only have a small effect on the formation of pores during welding. Pores can generally form in two ways. Gases such as hydrogen, nitrogen and oxygen can be dissolved in liquid steel. In metallurgical pore formation, these gases precipitate as gas bubbles during the solidification process due to the abrupt change in solubility between the liquid and solid phases (H2, N2, CO, O2). If the rate of solidification is greater than that with which the gas bubbles rise, they are enclosed („frozen in)", and are left behind, mostly as spherical pores in the welded seam. Depending on the amount of gas found, these pores can also take a tubular form. Gas bubbles arise at the boundary between the liquid and solid phases and in the slag particles floating in the melt. Mechanical pore formation occurs when cracks or cavities filled with gases – such as air – are welded over. If the gases, as they expand under the influence of the welding heat, cannot completely escape in a different direction, a pressure develops which is released through the formation of bubbles in the liquid weld pool. This effect can be reinforced by materials in the cracks and cavities that release gases (moisture, grease and oils, paint residues, metallic coatings). Mechanically formed pore usually have a connection to the hollow spaces that caused them.

Faults and causes	Counter-measures
METALLURGICAL PORES	
High nitrogen content in the base material and the welding consumable	Use of welding consumables appropriate for the base material, having an increased capacity to dissolve nitrogen (e.g. higher Cr and Mn contents in austenitic alloys)
Nitriding through plasma cutting	**Grind the cutting edge**
Inadequate screening of the arc region from the atmosphere by: - arc too long - incorrect angle of attack of the electrode - damaged electrode covering - blowing effect	Weld with a short arc Weld with a steep angle of attack Ensure that the electrode covering is undamaged and centralized Ensure a symmetrical contact with the material, weld with AC if possible
Too little shielding gas through: - setting too low - leaking line - capillary hole too small - not enough input pressure to the pressure reducer	Change the setting suitably Look for and remedy leaks Correct association of capillary and pressure Reducer The pressure in the bottle and in the line must correspond to the necessary input pressure to the pressure reducer
Inadequate gas shield through: - draughts through open windows, doors etc. - gas quantity too low at the beginning or end of welding - gas nozzle distance too great - wire electrode outlet off-center - wrong gas nozzle shape - wrong gas nozzle adjustment	Avoid draughts, position the suction unit differently Allow the gas to flow for a longer time before or after welding Reduce the gas nozzle distance Align the wire electrode better, arrange the contact tube centrally Match the gas nozzle shape to the prepared seam Arrange the gas nozzle behind the torch (seen in the welding direction) if possible
Turbulence due to: - shielding gas flow rate too high - spatters on the gas nozzle or contact tube - unsteady arc	Reduce the gas quantity Clean the gas nozzle and the contact tube during welding pauses Clean the gas nozzle, rectify faults in the wire feed, increase the voltage of spluttering wire electrode, ensure good current transfer in the contact tube, proper ground connection, remove slag from previously welded seams

Faults and causes	Counter-measures
Thermal up-current or chimney effect due to: - weld pool temperature being too high - workpiece temperature being too high - unimpeded draft in pipelines	Reduce size of weld pool Reduce preheat or interpass temperature (if possible metallurgically) Seal pipes
Moisture due to: - moist electrode coating (increased H contents) - condensation on wire electrode - moisture on base metal - leaking water-cooled torch - condensation on shielding gas nozzle	Re-dry electrodes according to manufacturer's instructions Equalize temperature of filler metal, store in a dry place Dry weld area by skin-drying or preheating Look for leaks and remedy, dry wire transport hose in case water has got in Check torch cooling for excess capacity Weld over arc strikes
Incorrect handling of basic electrodes	Use basic electrode with higher Mn content
Rounding of segregation zones	Reduce penetration by decreasing the arc power or increasing the welding speed.
Rusty and scaly surfaces	Clean weld area prior to welding
MECHANICAL PORES	
Inclusion of air in the area immediately surrounding the weld	Create opportunities for entrained air to escape e.g. increase welding gap, use butt welds instead of fillet or lap welds
Moisture in welding gap, possibly chemically bonded to rust	Remove moisture by preheating, remove rust or layers of scale, use butt welds instead of fillet or lap welds
Layers of grease in welding gap, present either as contamination or to prevent corrosion or applied intentionally for lubrication purposes	Remove grease using solvents, increase welding gap and dry well, use butt welds instead of fillet or lap welds
Metallic coatings (e.g. tin, zinc)	Comply with recommended layer thicknesses, remove metal coatings if necessary, increase welding gap, use butt welds instead of fillet or lap welds
Coating materials (e.g. production coatings)	Choose favorable coating material, comply with prescribed coating thickness, remove any layers that are too thick if necessary, ensure good degasification in the gap, use butt welds to replace fillet or lap welds

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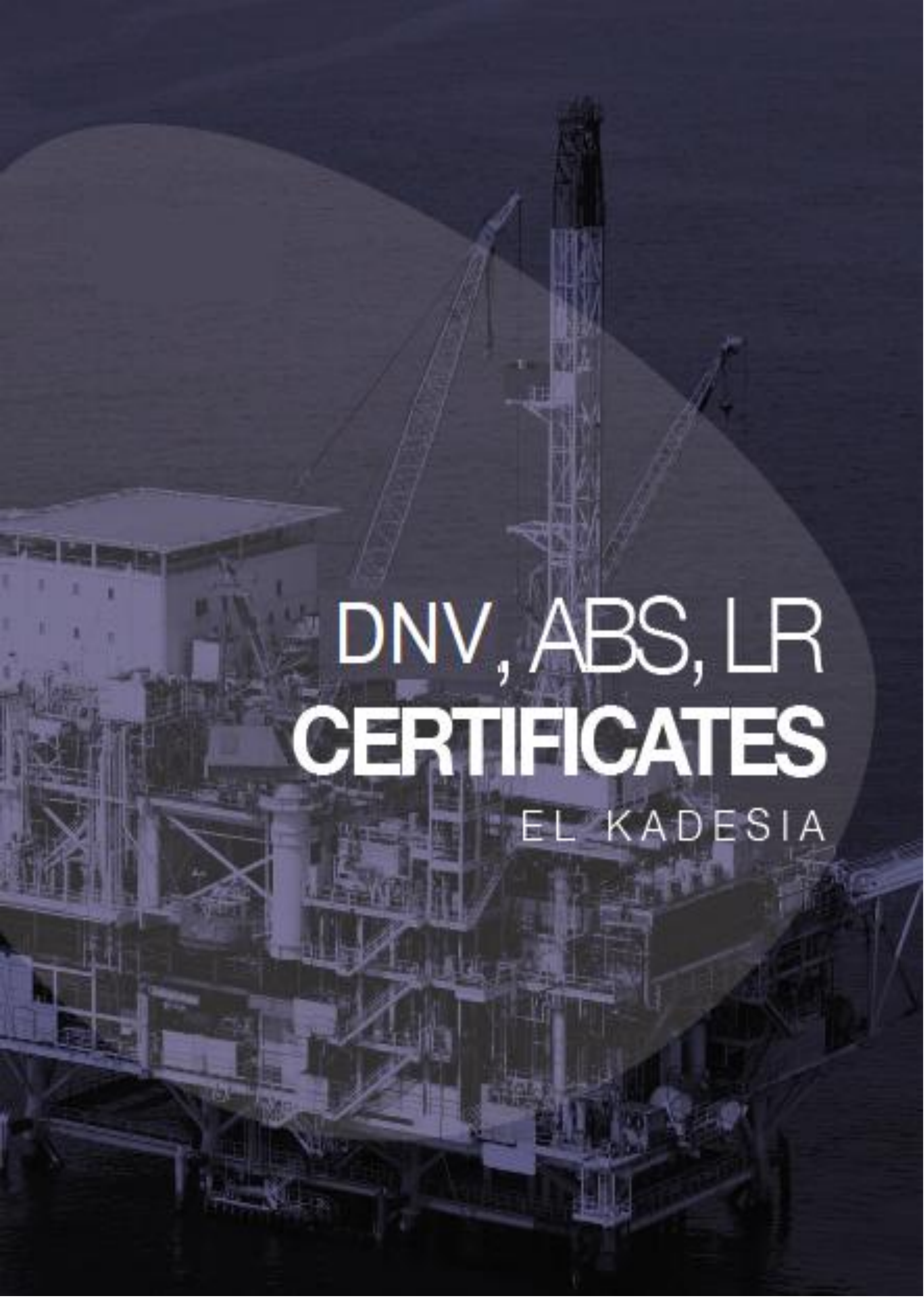
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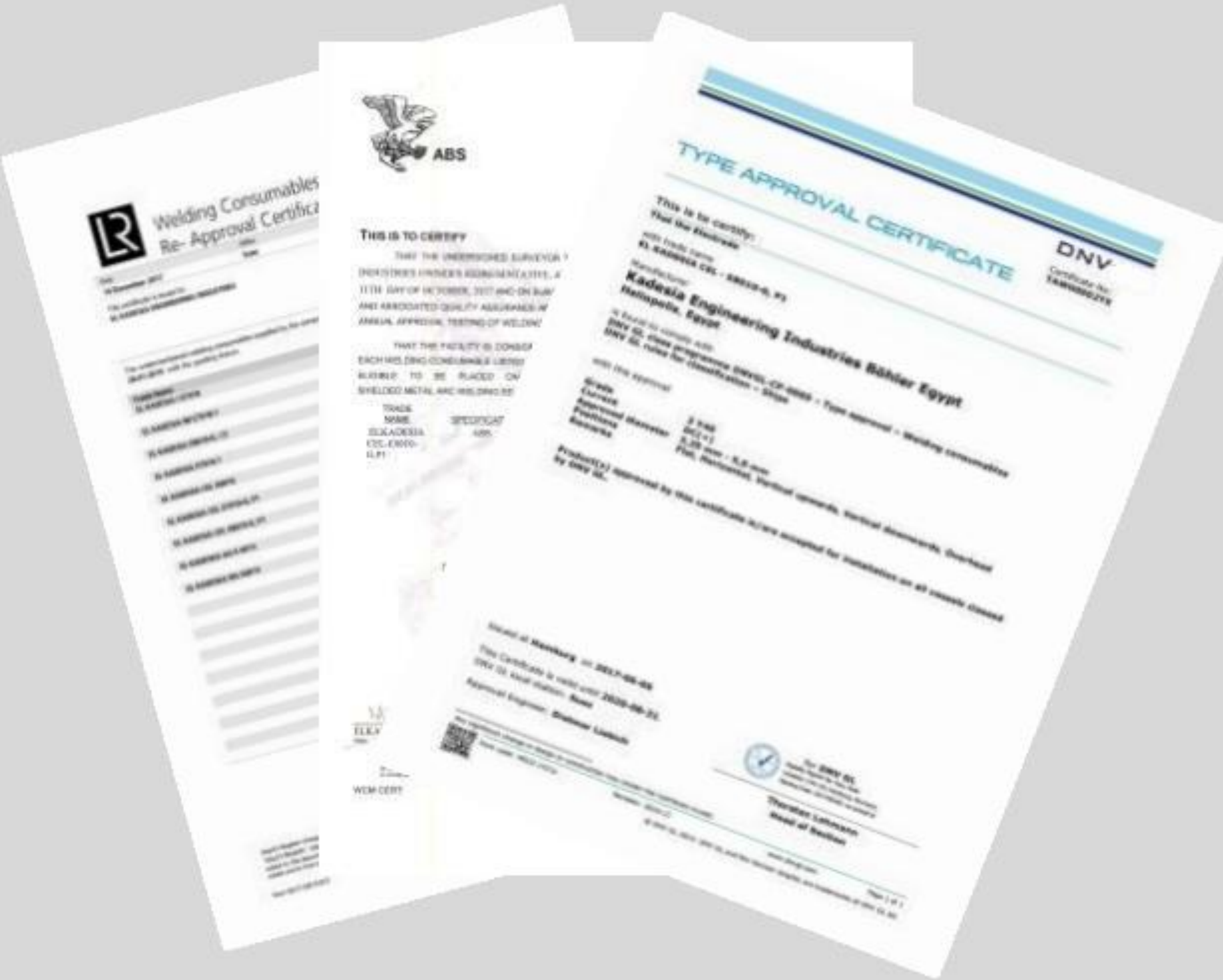

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- Giza shipyard
- Global steel Company (Anquestal)

- Abu Qir Fertilizers Company
- Egyptian Fertilizers Company (EFC)
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