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voestalpine Böhler Welding Mission Spark

Mission Spark

Become an electric arc welding expert!

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Contents

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Onward to our major mission!

Welding is not for sissies. It's for tough people like me. I finished school when I was 15 and immediately started training to become a certified welder. Join me on Mission Spark.

It's a welded world
A modern world like we have today would be unimaginable without electric arc welding – it is one of the oldest processes for joining metals and used all over the world. Electric arc welding with stick electrodes is the oldest arc welding process around. It is generally known as MMA (manual metal arc welding). Today, around 25 to 30% of the world's welded products are produced with electric arc welding with stick electrodes. Take a look around and you will see how much this process is still used in steel construction today. It is used to weld almost all types of metals. Stick electrodes are even used for underwater welding.

Let's get started
In the next eight chapters, I will teach you everything you need to know about arc welding with stick electrodes so that you will be ideally prepared. At the end of each chapter I will ask you a few questions to test your knowledge. The answers will give you the solution we are looking for. All correct solutions will be entered into a drawing with super prizes. All other information you need can be found at www.voestalpine.com/welding/mission-spark! Let's get started on this mission together. You won't regret it.

Regards,
Your Miss Spark

Chapter 1

History of electric arc welding

It all started 135 years ago ...

They are tough men, the Russians. Just as tough as I am. So it comes as no surprise that electric arc welding was invented by a Russian. More precisely, by Nikolai Benardos. I've collected all the other hard facts here for you.

Who invented what when?

- **4000 B.C.** Welding (gold with gold) – Sumerian
- **2700 B.C.** Hard soldering – Egyptians, Mesopotamians; Forge welding – Egyptians
- **1825** Butt welding – C. Whithouse
- **1840** Gas welding
- **1881** Electric arc welding – Nikolai Benardos
- **1886 - 1900** Resistance welding – Elihu Thomson
- **1900** Thermite welding – Hans Goldschmidt; Oxy-fuel welding – Edmund Fouche, Charles Picard
- **1907** Coated stick electrodes – Oscar Kjellberg
- **1909** Plasma welding – Schonner
- **1920** TIG welding (early form) – Charles Coffin
- **1930** Submerged arc welding – Robinoff
- **1940** Electroslag welding – Robert Hopkins
- **1941** Tungsten Inert Gas Welding – H. M. Hobart
- **1953** Gas metal arc welding – Lyubavskii and Novoshilov
- **1957** Ultrasonic welding
- **1960** First arc welding robot (Germany)
- **1970** Laser welding – Martin Adams
- **1980** Industrial welding robots
- **1990** New high-performance MAG welding
- **2003** Arc welding in dentistry

1881 At the first International Exposition of Electricity in Paris, the Russian Nikolai Benardos was the first to present the arc welding method by creating an arc between a coal electrode and a workpiece.

1890 Another Russian, Nicolai Slavianoff, used a metal stick instead of a coal electrode. The electrode melted and acted as both a heat source and a filler metal. But the welding points were not airtight and had many pores and holes.

Nikolai Benardos – the inventor of arc welding

1907 Oscar Kjellberg from Sweden patented the coated stick electrode. He dipped the metal sticks into thick mixtures of carbonates and silicates such as limestone and fluorspar. As the metal stick melted in the electric arc, a slag formed that covered the liquid weld metal. Most of the holes and pores caused by oxygen and nitrogen in the air disappeared.
To make them airtight, Kjellberg had to hammer the welds.
This method allowed him to repair riveted steam boilers on board ships, a major advance at that time.

Oscar Kjellberg – the inventor of the coated stick electrode

1910 to 1920

» **Coated stick electrodes** based on Oscar Kjellberg's patent used for the first time.

» **Wound extruded electrodes** were invented in England by pressing a paste between the asbestos threads wound around the electrode core wire.

» **Paper-coated electrodes** were introduced in the USA by R. S. Smith. This offered gas protection for the melted weld metal. That was the beginning of the cellulose electrode.

1930 to 1939

» **Extrusion** was the usual, more economical production method for producing stick electrodes. It is still the standard production method used today.

» Metals were added to the coating to compensate for burn-off.

» The first electrodes for stainless steel were introduced.

» Ship classification societies introduced the first approv-als.

1940 to 1945

» The use of cellulose electrodes became common due to the shortage of material.

» Ships totally welded with stick electrodes were common.

1945 to 1950

» P.C. van den Willigen in the Netherlands added large amounts of iron powder to rutile and acid electrodes to improve their performance. The **high recovery electrode** was born.

» K. K. Hansen in Denmark developed gravity arc welding. In this welding process, a nearly extinguished electrode ignites the next electrode. The welder then fills the container with fresh electrodes.

today

» Electric arc welding with stick electrodes is still indispensable today, especially in steel and pipeline construction.

» Welding is relatively tolerant to material flaws. A major advantage: It can be used under all weather conditions, even under water.

Mission accomplished! Now you know exactly how the different welding processes came about.

■□□□□□□□

At the end of each chapter, enter the correct solution and collect all the answers. At the end of chapter 8, enter all the answers again to determine the solution we are looking for. Enter this solution at www.voestalpine.com/welding/mission-spark and with a bit of luck you will win one of our top prizes!

What was the name of the Russian who first invented electric arc welding?

□□□□□□□ □□□□□□□□

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Chapter 2

Electric arc welding with stick electrodes

Here's how it works

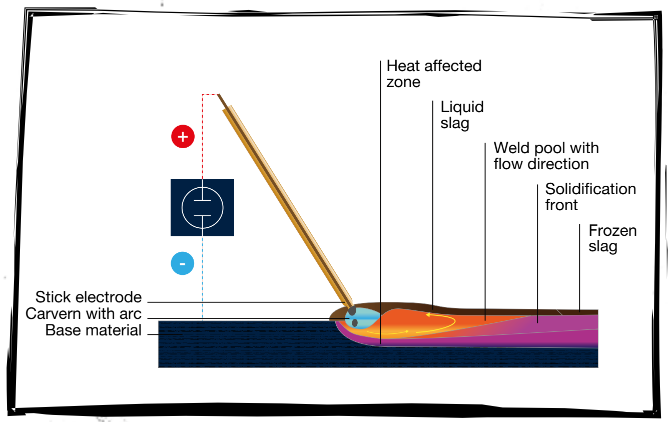
When you know how it works, it is simple. In this chapter, I will explain the exact steps involved in electric arc welding with stick electrodes and the different power sources you can use. Let's get started.

Process

Actually, it is quite easy …

Electric arc welding with stick electrodes is one of the oldest and most versatile welding processes. And it is also considered one of the simplest and safest methods.

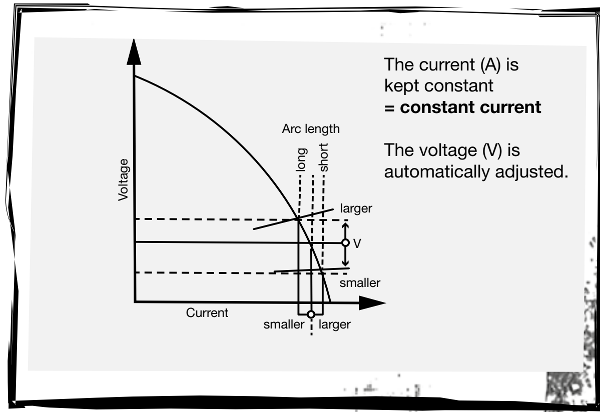
For electric arc welding with stick electrodes, an electric arc is ignited between a coated stick electrode and the workpiece; the electrode acts as the conductor and also as a depositing filler material.
In the high temperature of the arc, the electrode melts and drips into the weld pool. Gases form that stabilize the arc and protect the weld pool from oxidation.
Slag also forms. It floats on the weld pool as a protective layer and fulfills several functions.
It protects against the influences of the surrounding atmosphere (especially oxidation), binds impurities, and since the weld pool cools off more slowly, it reduces residual stresses.



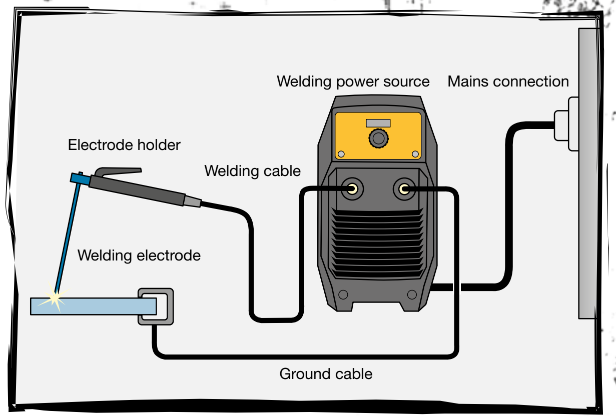
For electric arc welding with stick electrodes, the current must be kept constant

The current is delivered from a power source. The current used in electric arc welding with stick electrodes has a constant output current. This ensures that the current (and therefore the heat) remains relatively constant, even when the arc length and thereby the voltage changes. This is important because electric arc welding is usually a manual process where a welder holds the welding torch. That's why a constant current source is required.

But even with a constant current power source, the current is never absolutely constant; it varies with the length of the arc. Qualified welders make use of this fact to produce slight current fluctuations.



Basic principle



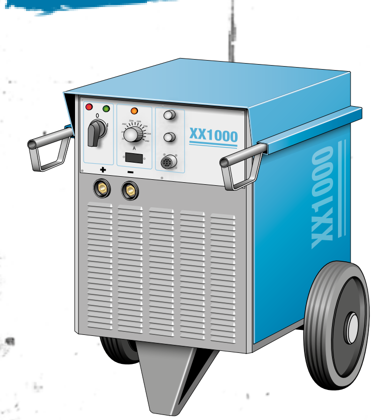
Process setup

Tip!

With a little practice, over time you will be able to vary the length of the arc and use the higher or lower current to play with the heat input.

Power source
technology...

What power source can you use?



Welding rectifier
A welding rectifier converts three-phase current (AC) into DC for welding. It consist of a power transformer and a downstream rectifier.

Welding transformer
In the welding transformer, the network's AC current with its high voltage and low current level is converted to AC current with low voltage and high current level as is needed for welding. The welding current is regulated by tapping the primary coil of the power transformer.

Welding inverter
The welding inverter is an electronic welding current source. Depending on the needed power, the inverter is connected to one-phase or three-phase power.
First the supply voltage is rectified, then a power semiconductor is used to bring it back to alternating current with a frequency between 20 kHz and 150 kHz and a relatively small transformer transforms it to a low voltage. Finally, the welding current is rectified using suitable diodes. The result is a high power direct current with a low voltage.

That was pretty easy, wasn't it? We have completed part two of our mission.

What power source converts three-phase current (AC) into DC for welding?

8 14

Chapter 3

Coating of stick electrodes

All stick electrodes are not the same

Now you know quite a bit about electric arc welding with stick electrodes. In this chapter, I will explain why stick electrodes have to be coated, how the coating thickness influences the welding characteristics, what materials are used to coat stick electrodes, and for what type of welding the different electrode types are suited. Off we go.

Tasks of the coating

» Ionization of the air path (stable arc)

» Protecting the arc and the welding bath from unwanted contact with air (O_2, N_2)

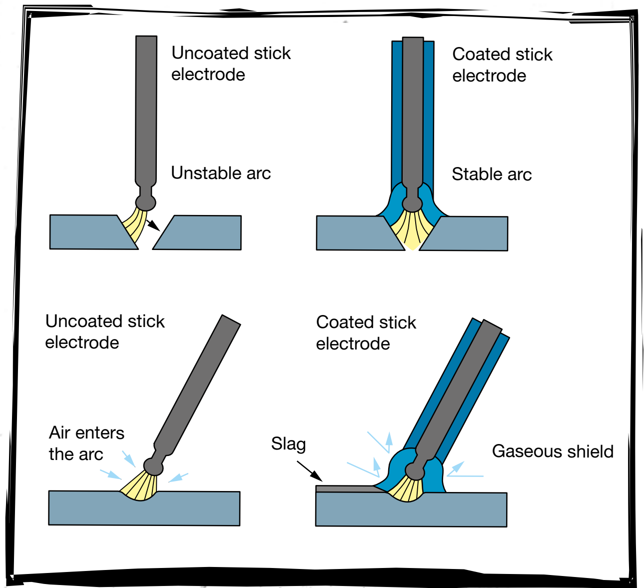
» Slag formation on the surface (slow cooling, minimizing pore formation)

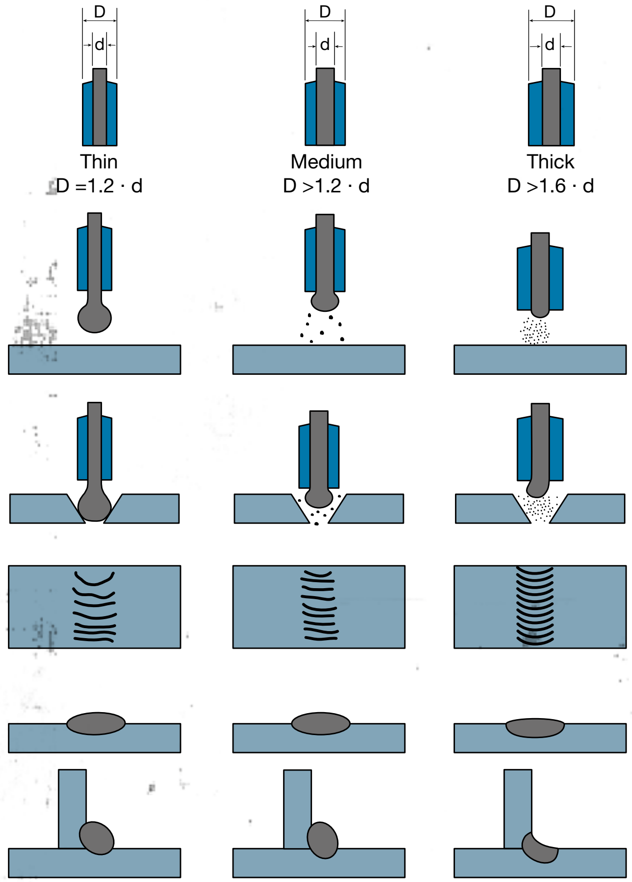
» Metallurgical effect on the weld metal due to de-oxidation and binding of impurities such as sulfur and phosphorus

» Alloying of elements to compensate for burn-off

» Increasing the deposition rate and recovery by adding iron powder

Recovery:
The ratio of molten weld metal to molten core stick and percent of weight.





Coating thickness

It's all in the thickness...

As the coating thickness increases

» the metal droplet transfer becomes finer

» the suitability for gap bridging and out of position welding lessens

» the seam appearance improves, i.e. the weld seam is more finely rippled and smoother

» the penetration of the weld increases

Coating types

Fourth time's the charm...

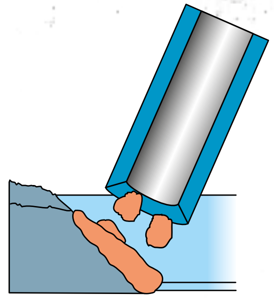
A	Acid
C	Cellulose
R	Rutile
RR	Thick rutile
RC	Rutile cellulose
RA	Rutile acid
RB	Rutile basic
B	Basic

Classification according to EN ISO 2560

According to the European Norm DIN EN ISO 2560, there are a total of eight different types of coated stick electrodes for arc welding of unalloyed steels and fine-grained steel. The four main types are named after their main components:

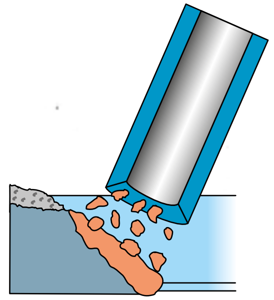
C (Cellulose)	cellulose electrodes
A (Acid)	acid electrodes
R (Rutile)	rutile electrodes
B (Basic)	basic electrodes

Today however, acid electrodes can hardly be found anymore and have been almost completely replaced by rutile electrodes.



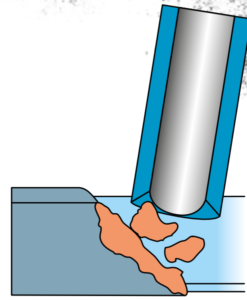
Cellulose type

Cellulose	40
Rutile (TiO_2)	20
Silicate	15
Magnetite (Fe_3O_4)	15
Fe-Mn	15
Water glass	



Rutile type

Rutile (TiO_2)	50
Silicate	25
Calcite ($CaCO_3$)	8
Fe-Mn	17
Sodium silicate	



Basic type

Fluorspar (CaF_2)	30
Calcite ($CaCO_3$)	30
Fe-Mn	5
Fe-Ti	3
Fe-Si	7
Iron powder	25
Sodium silicate	

Here you will learn about the main types of stick electrodes and their chemical components.

Cellulose-coated stick electrodes: Due to the high level of cellulose in the coating, they have excellent properties for out-of-position welding, but poor properties for horizontal welding. They are therefore mainly used for vertical-down welding on large pipes.

Rutile-coated stick electrodes: These electrodes are very popular due to their good welding properties. The welding arc is stable and calm and is easy to reignite, the seams are finely rippled, and most of the slag comes off by itself. Rutile-coated electrodes have sufficient toughness properties, but are only suitable for out-of-position welding to a limited extent (high-alloy).
BÖHLER electrodes for under water welding are a special type namely rutile acid (RA). They have a special sealing to protect against the water.

Basic-coated stick electrodes: The main advantages of basic electrodes are the outstanding toughness properties of the weld metal and its resistance to hot and cold cracks. Basic-coated electrodes have a coarse droplet material transfer, can be used to weld in all positions and have somewhat coarsely rippled seams. The slag can be relatively easily removed, but not as easily as with rutile-coated electrodes.

Tip!

The coating material should be selected based on what you want to weld. Always clarify this before starting to weld.

Question a:

What type of stick electrode is especially suitable for pipeline construction?

Requirements: Good vertical-down welding properties

Answer a:

Explanation: Due to its suitability for vertical-down welding (pos. PG), this electrode type (C) is used to weld circumferential seams on large diameter pipes (pipelines). Relatively thick electrodes (4 mm) can even be used when welding the root.

Example: BÖHLER FOX CEL

Question b:

What type of stick electrode is especially suitable for steel construction?

Explanation: Good bead appearance, easy-to-remove slag, easy to reignite.

Answer b:

Explanation: The special properties of the electrodes (R, RR) are their good bead appearance, easy-to-remove slag and they are easy to reignite.

Example:
R: BÖHLER FOX ETI
RR: Phoenix Grün T

Example:
BÖHLER FOX EV 50
BÖHLER FOX EV 85
Phoenix 120 K

Question c:

What type of stick electrode is especially suitable for offshore applications?

Requirements: Very high toughness properties

Answer c:

Explanation: This electrode (B) is suitable for all positions, and as a special type also for vertical-down positions. Of all the electrode types, it has the best toughness properties, even at low temperatures, and the highest resistance to cracking. It is used for difficult base materials and thick-walled parts. The low hydrogen content makes it possible to weld high-strength, fine-grained steels.

Stick electrode quiz

Which type of stick electrode is suitable for which type of welding application? Test your knowledge.

Question d:

What type of stick electrode is especially suitable for container construction?

Requirements: Good vertical-up properties

Answer d:

Explanation: This electrode (RB) is especially good for welding on the root pass and in the vertical-up position (PF) in pipeline and container construction. It is also easy to handle in out-of-position welding.

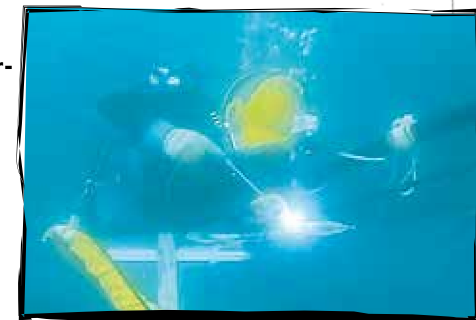
Example:
BÖHLER FOX SPE, Phoenix SH Gelb R

Question e:

What type of stick electrode is especially suitable for underwater welding?

Requirements: Good underwater properties

Answer e:



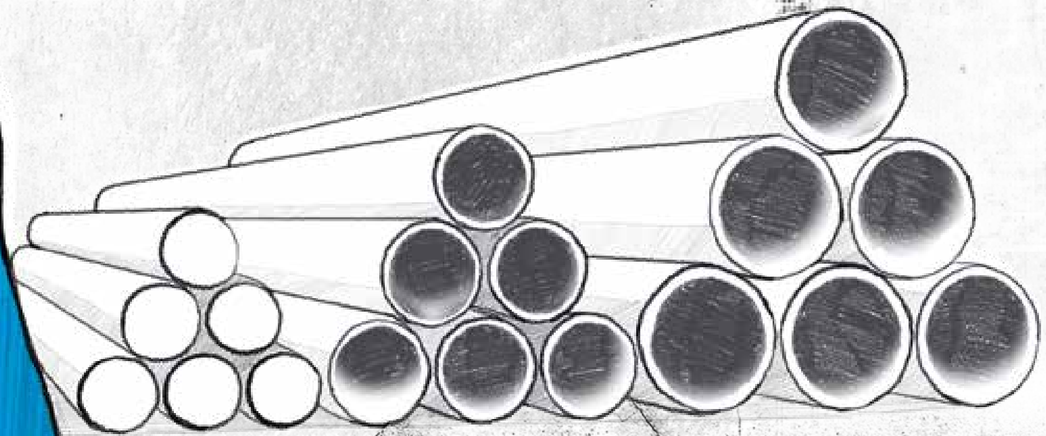
Explanation: For underwater welding, you need a stick electrode (RA) with good seam quality to weld in wet environments in order to economically produce quality underwater welding connections.

Example:
Phoenix Nautica 20
Phoenix Nautica 100
Phoenix Nautica Cut (use for joining and separating)

Wow, you are becoming quite an electrode expert. Let's move onto the next part of the mission.

Chapter 4

Stick electrode portfolio



There is a stick electrode that is right for each type of steel

In the last three chapters, you learned a lot about electric arc welding with stick electrodes. In this chapter, I will show you that each type of steel needs a different stick electrode. Let's get going.

Welding pros differentiate between the following steel types

- Stick electrodes for unalloyed steels
- Stick electrodes for high-strength steels
- Stick electrodes for creep resistant steels
- Stick electrodes for stainless steels
- Stick electrodes for nickel and nickel alloys
- Stick electrodes for cast iron

Stick electrodes for unalloyed steels

Rutile coating:
BÖHLER FOX OHV
BÖHLER FOX ETI
Phoenix Grün T
Phoenix SH Gelb R

Basic coating:
BÖHLER FOX EV 50
Phoenix 120 K

Stick electrodes for high-strength steels

BÖHLER FOX EV 65 / EV 70 / EV 75 / EV 85
Phoenix SH Ni 2 K 90
Phoenix SH Ni 2 K 130

For pipeline construction–cellulose-coated electrodes:
BÖHLER FOX CEL 85
BÖHLER FOX CEL 90

Basic electrodes:
BÖHLER FOX EV 70 Pipe
BÖHLER FOX BVD 85
BÖHLER FOX BVD 90

Stick electrodes for creep resistant steels

BÖHLER FOX DCMS Kb
BÖHLER FOX DCMS Kb
BÖHLER FOX CM 5 Kb
BÖHLER FOX C 9 MV
Thermanit MTS 3-LNi
Thermanit MTS 616-LNi

Tip!

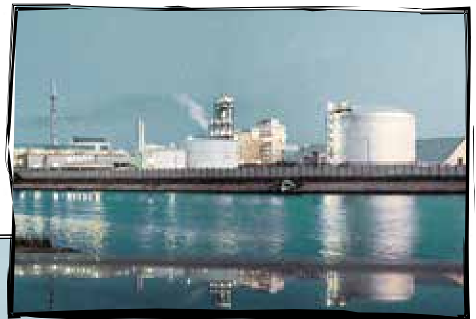
Drop by
www.vabw-service.com/voestalpine/.
There you will find all the voestalpine Böhler Welding products at a glance

Stick electrodes for stainless steels

BÖHLER FOX EAS 2-A
BÖHLER FOX EAS 4 M-A
BÖHLER FOX EASN 25 M
BÖHLER FOX CN 20/25 M

Duplex:
Avesta 2205
Avesta 2205 basic

Super duplex:
Avesta 2507 P100
Avesta 2507 P100 rutile



Stick electrodes for nickel and nickel alloys

Thermanit Nicro 82
Thermanit 625
Thermanit 617

Stick electrodes for cast iron

UTP 8
UTP 83 FN
UTP 86 FN
UTP GNX-HD

Back when I was a teenager, I had to figure out which stick electrode to use to weld which metal, but it's actually pretty easy isn't it? We've completed the fourth part of our mission.

What properties do the steels have that we mentioned second in this chapter?

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Chapter 5

European classification

Organization is half the battle

The EU's EN classification system standardizes different products, including welding consumables. In chapter 5 of our mission, I will show you the different stick electrode classes. What are we waiting for?

How stick electrodes are classified

Most welding consumables are classified in accordance with an EN ISO standard. There are a number of different EN ISO standards that apply for different areas:

» Stick electrodes for unalloyed steels and fine-grained steels (EN ISO 2560)

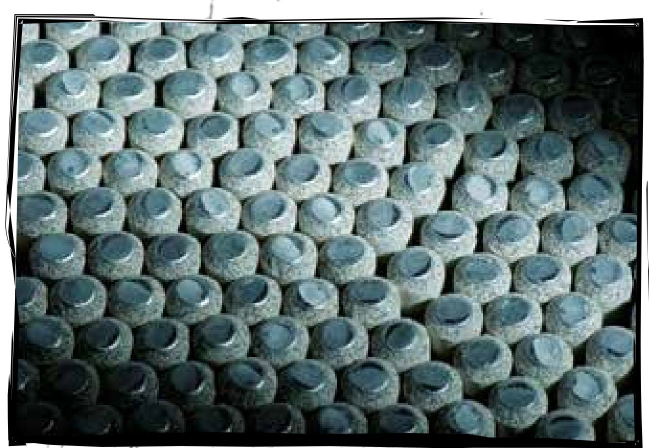
» Stick electrodes for high-strength steels (EN ISO 18275)

» Stick electrodes for creep-resistant steels (EN ISO 3580)

» Stick electrodes for stainless and heat-resistant steels (EN ISO 3581)

» Stick electrodes for nickel and nickel alloys (EN ISO 14172)

» Stick electrodes for cast-iron (EN ISO 1071)



For each type of steel, there is an especially suitable type of electrode.

How the EN ISO 2560-A standard works

Code for the toughness and elongation properties of the welding metal

Code	Minimum yield strength MPa	Tensile strength MPa	Minimum elongation at fracture in %
35	355	440 to 570	22
38	380	470 to 600	20
42	420	500 to 640	20
46	460	530 to 680	20
50	500	560 to 720	18

Code for the absorbed impact energy of the weld metal

Code	Temperature for minimum absorbed impact energy at 47 J° C
Z	no requirements
A	+20
0	0
2	-20
3	-30
4	-40
5	-50
6	-60

Code for the coating type

Type	Coating
A	acid
C	cellulose
R	rutile
RR	thick rutile
RC	rutile cellulose
RA	rutile acid
RB	rutile basic
B	basic

BÖHLER FOX EV 50 E 42 5 B42 H5

Code	Output in %		Current type
1	≤ 105		AC and DC
2			DC
3	> 105	≤ 125	AC and DC
4			DC
5	> 125	≤ 160	AC and DC
6			DC
7	> 160		AC and DC
8			DC

1 all positions

2 all positions except vertical-down

3 butt weld in pos. PA, fillet weld in pos. PA and PB

4 butt weld in pos. PA, fillet weld in pos. PA

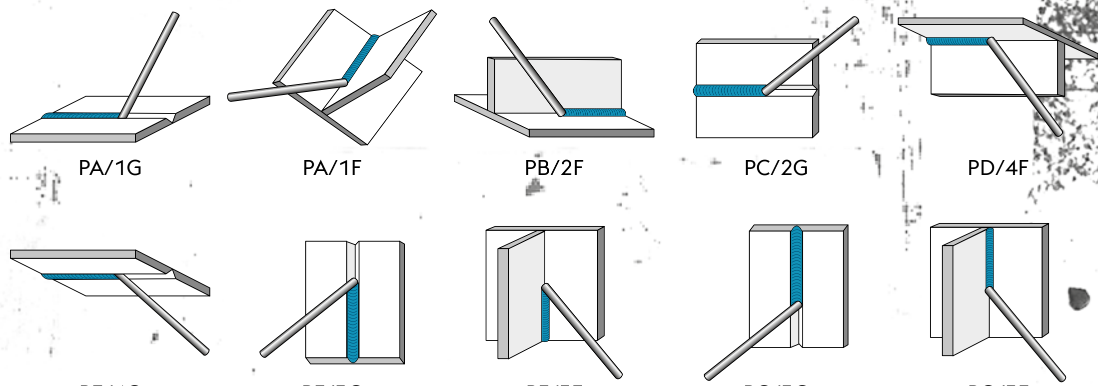
5 Positions such as 3. plus pos. PG

Code	Max. hydrogen content in ml/100 g weld metal
H5	5
H10	10
H15	15

Tip!

You need a different type of stick electrode depending on the type of metal you want to weld. The EN standard gives you precise information about which stick electrode you can use for which metal.

Overview of welding positions in accordance with Euronorm and the AWS (American Welding Society)



The EN classification system is not so difficult once you understand it, don't you think?

What does the abbreviation RB in the EN code mean?

7

Chapter 6

UTP Maintenance welding electrodes – welding of cast iron materials

Cast from the same mold

In this chapter, I want to teach you more about a very special welding material – cast iron. I was excited the first time I welded cast iron because it has a lot of very special advantages. I will show you what those are in this chapter.

A very special material

Most cast iron grades have a carbon content between 2 to 5 percent. Depending on the other alloying elements, cooling conditions and heat treatment, carbon can precipitate into different shapes, which determine the properties of the cast iron.

Compared to steel, cast iron has a lower melting point of around 1,150 °C for near-eutectic alloys (C-content approx. 3.5 %) and very low viscosity. As a result, it has excellent “form filling” properties. It can therefore be used to produce complex geometries and thin-walled parts.

Cast iron is generally classified according to how the carbon is present in the microstructure after solidification. Carbon in white cast iron is bound as iron carbide (cementite). Depending on the heat treatment, or tempering, this malleable iron can be used to make white (GJMW) or black (GJMB) malleable cast iron.

Cast iron				
White cast iron (malleable cast iron)		Grey cast iron		
„White“ mottled cast iron EN 1562 GJMW	„Black“ mottled cast iron EN 1562 GJMB	Nodular cast iron (spheroidal graphite cast iron) EN 1563 GJS	Lamellar graphite cast iron (grey cast iron) EN 1561 GJL	Vermicular graphite cast iron EN 16079 GJV

Unlike malleable iron, the carbon in grey cast iron is precipitated directly as graphite in a ferritic or pearlitic matrix. A distinction is made between the different forms of graphite. There are three forms: lamellar (GJL), spheroidical (GJS) and vermicular (GJV). The graphite form is the main determinate of the properties of the cast iron.

Most cast iron grades are not considered to be suitable for welding, but it is possible with the correct welding technology. This is the case for grey cast iron with lamellar graphite (GJL), nodular graphite (GJS) or vermicular graphite and for malleable cast iron (GJMW, GJMB).

The weldability of a part depends on the welding suitability of the material, production welding capabilities and the welding reliability of the design. Weldability mainly depends on the material’s chemical properties and mechanical-technological properties. Other influences include the microstructure and the part’s degree of impurity caused by sulfur and oxides, for instance, or the production process (age, temperature, chemical media, etc.).

Suitable for welding

» Cast steel
» Spheroidal nodular cast iron
» Vermicular cast iron

Limited weldability

» Lamellar graphite cast iron
» Malleable cast iron

Difficult to weld or not suitable for welding

» Special cast iron

Cold welding of cast iron

Nickel and iron-nickel stick electrodes are generally used for cold welding cast iron.

Temperature control is vital. Do not preheat before welding unless moisture or condensation needs to be removed from the surface of the part. To keep the thermal stress low while welding, use the smallest possible electrode diameter and keep the arc as short as possible. Always keep the welding beads short (max. 30 mm) and hammer them out while the weld metal is warm. Use a hammer with a rounded head. Hammering introduces compressive stresses, which counteracts the shrinkage stresses of the cooling weld metal. The interpass temperature should not to exceed 60 °C. When repairing large surface areas, change the welding location often to prevent heat build-up.

Short stringer bead before slag is removed

Hammering

Short stringer bead after slag is removed

Cast iron

Name	Classification	Mechanical properties of the weld metal		Application
UTP 8	AWS A5.15 E Ni-CI EN ISO 1071 E C Ni-CI 1	yield strength $R_{p0,2}$ around 220	hardness HB around 180	UTP8 is suitable for cold welding of grey cast iron, malleable cast iron and cast steel as well as for joining these base materials to steel, copper and copper alloys, especially in repair and maintenance.
UTP 83 FN	AWS A5.15 E NiFe-CI EN ISO 1071 E C NiFe-11	hardness HB around 190		UTP 83 FN is suitable for cladding and repair welding on all common cast iron types such as cast iron with lamellar graphite, nodular graphite, malleable cast iron as well as for joining to steel and cast steel.
UTP 86 FN	AWS A5.15 E NiFe-CI EN ISO 1071 E C NiFe-13	yield strength $R_{p0,2}$ around 340	hardness HB around 220	UTP 86 FN is suitable for repair, joining, and cladding welding on lamellar grey cast iron GJL 10 - GJL 40, on spheroidal graphite cast iron GJS 40 - GJS 70, on malleable cast iron GJMB 35 - GJMB 65 as well as for joining these materials to each other or to steel and cast steel.

The most important cold welding rules

- Only weld with short stringer beads (max. 1 to 3 cm).
- Weld with as low a current as possible.
- Hammer off the stringer beads while they are warm. This introduces compressive stresses, which counteracts the shrinkage stresses.
- Avoid heat build-up.
- If possible, start on already welded beads to avoid hardness peaks in the heat affected zone.

In this chapter you have learned all you need to know about cold welding. Our journey won't last much longer.

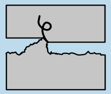
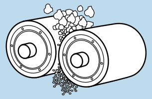
What current do you need for cold welding?

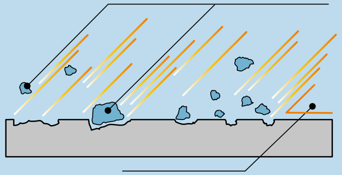
Chapter 7

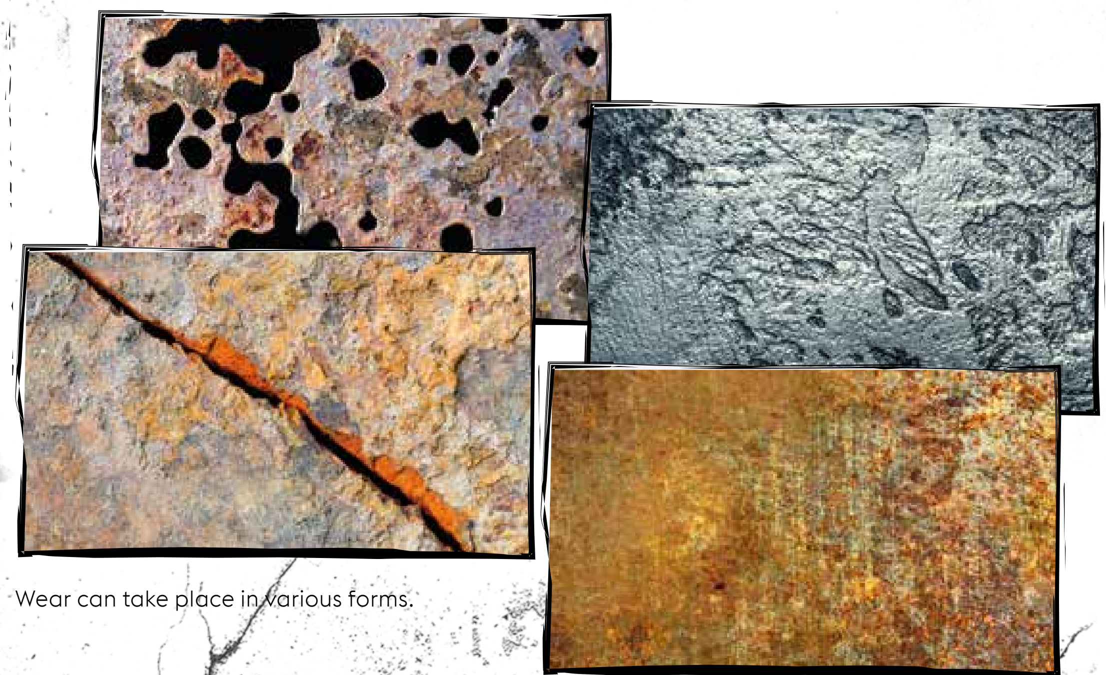
Types of wear

Not all types of wear are alike

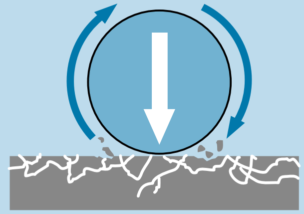
Abrasive wear, erosive wear, corrosive wear: there are many different types of wear. Here you will learn what they are.

Type of wear	Description	Surface damage	Sliding abrasion example	Pressure sliding abrasion example	Stick electrode
Abrasive wear	Abrasive wear is considered material loss and usually occurs due to mechanical influences and sliding contact due to solids or particle contamination	Scratches, notches, furrows, grooves, highly polished surfaces	Hard surface  Soft surface		UTP DUR 600 UTP Ledurit 61 UTP Ledurit 65

Type of wear	Description	Surface damage	Erosion example	Example stick electrodes
Erosion wear	Erosion wear is the material loss caused by the repeated impact of small hard particles. These are carried in a gas or fluid medium and hit the material surface at a very high speed	Notches, furrows, grooves	Erosion caused by hard particles carried in a gas or fluid  Erosion worsens as the angle of impact increases	UTP 73 G2 UTP DUR 600 UTP HydroCav



Wear can take place in various forms.

Type of wear	Description	Surface damage	Surface fatigue example	Example stick electrodes
Surface fatigue	Surface fatigue often begins through hard or soft particles that cause small dents in the surface. Repetitive, changing stresses lead to cracks in the material over time.	Cracks, notches, surface material breaks out		UTP BMC

Type of wear	Description	Surface damage	Pitting corrosion example	Intergranular corrosion example	Example stick electrodes
Corrosive wear	Corrosive wear is caused by surface damage due to a chemical or electrochemical reaction. Metal + environment: air, humidity, acids, electrolytes, chemicals, lubricants, etc. Additional mechanical stress leads to corrosive wear	Material degradation (erosion), cracks, rust, surface pitting			UTP 068 HH UTP 6222 Mo

You need a different type of stick electrode depending on the type of wear. I hope I was able to demonstrate that in this chapter.

Which type of wear can lead to rust?

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Chapter 8

Who we are

voestalpine Böhler Welding at a glance

In the last chapter, we are going to really step on the gas. Here you will find out more about the product portfolio and the voestalpine Böhler Welding brands, what types of electrode packaging are available, and the contact data for our locations. Let's go!

Product portfolio
voestalpine Böhler Welding

Böhler Welding
Joint welding

- Stick electrodes
- TIG welding rods
- Solid wires
- Flux cored wires
- SAW wires
- SAW fluxes
- Ceramic backings
- Chemicals for surface treatment

UTP Maintenance
Repair, wear and corrosion protection

- Stick electrodes
- TIG welding rods
- Solid wires
- Flux cored wires
- SAW wires
- SAW fluxes
- Welding strips
- Thermal spray powder
- SAW and ESW strip cladding heads
- Battery-powered welding devices

Fontargen Brazing
Soldering

- Rods
- Wires
- Brazing fluxes
- Pastes
- Formed parts
- Brazing foils

Member of the voestalpine Group
The voestalpine Group is a steel-based technology and capital goods group that operates worldwide. With its top-quality flat steel products, the Group is one of the leading partners to the automotive and domestic-appliance industries in Europe and to the oil and gas industries worldwide. As a member of the voestalpine Group, voestalpine Böhler Welding is part of a global network of metallurgy experts.

The voestalpine Group
Headquartered in Linz, voestalpine has around 500 Group companies and sites in more than 50 countries on all five continents. The company group consists of four divisions. voestalpine Group is the world market leader in turnout technology, tool steel and special sections. In the business year 2015/16, the voestalpine Group reported revenue of EUR 11.1 billion and an operating result (EBITDA) of EUR 1.6 billion; it had around 48,500 employees worldwide.

Member of the Metal Engineering Division
The Metal Engineering Division bundles all steel activities within the voestalpine Group. voestalpine is the global market and technology leader in the railway system sector.

This division produces the world's largest range of high-quality rail and turnout products, rolled wire, drawn wire and pre-stressed wire, seamless tubes, welding consumables and semi-finished products. The division also offers a complete service portfolio for railway track construction, including planning, transport, logistics, installation, and recycling.
The Metal Engineering Division also has its own steel production.

Tip!
When it comes to joint welding, repair, wear and corrosion protection, or brazing, voestalpine Böhler Welding with its three brands definitely has the right product. You can find a list of them at www.vabw-service.com/voestalpine/.

Brief description of the brands

böhler welding
by voestalpine

Lasting Connections – As a pioneer in innovative welding consumables, Böhler Welding offers a unique product portfolio for joint welding worldwide. More than 2000 products are adapted continuously to the current industry specifications and customer requirements, certified by well-respected institutes and thus approved for the most demanding welding applications. As a reliable partner for customers, „lasting connections“ are the brand‘s philosophy in terms of both welding and people.

utp maintenance
by voestalpine

Tailor-Made Protectivity™ – UTP Maintenance ensures an optimum combination of protection and productivity with innovative and tailor-made solutions. Everything revolves around the customer and their individual requirements. That is expressed in the central performance promise: Tailor-Made Protectivity™.

fontargen brazing
by voestalpine

In-Depth Know-How – As a leading manufacturer of soldering and brazing consumables, Fontargen Brazing offers proven solutions based on 50 years of industrial experience, tried and tested processes and methods. This In-Depth Know-How has made Fontargen Brazing an internationally preferred partner for every soldering and brazing task.

Electrodes – Types of packaging

The cardboard folding box is used for most types of electrodes – protection against dirt and splash water.

Tin can – protection against humidity, e.g. pipeline electrodes

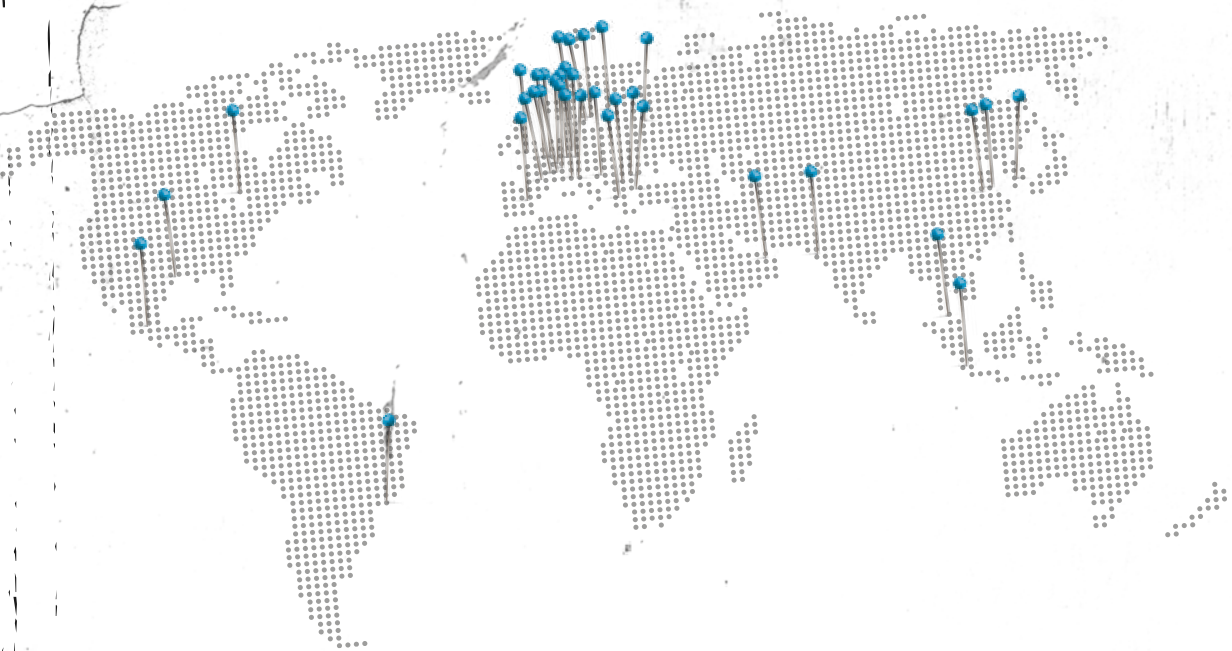
Vacuum packaging for hydrogen-sensitive use – e.g. offshore production

UTP Maintenancepackaging types

Our locations

With our company's network of more than 40 subsidiaries in 25 countries, with the support of 2,200 employees, and through more than 1,000 distribution partners we are a customer-oriented partner with an international presence.

Find all our locations & contact information on
http://www.voestalpine.com/welding/contact/locations



We've reached the end. It was an exciting mission and we completed it together. I would say that when it comes to electric arc welding, no one can lead you astray. Soon you will be as fit as I am. You only need a little practice. I hope you enjoyed our adventure as much as I did. Keep on rocking and see you soon.

Which voestalpine Böhler Welding brand offers products for repair, wear and corrosion protection?

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Here you can enter all the quiz answers to determine the solution.
Visit **www.voestalpine.com/welding/mission-spark.**
There you can enter your solution and find all other information.

Question 1 — 2
Question 2 — 8, 14
Question 3a — 5
Question 3b — 3, 11
Question 3c — 1
Question 3d — 10
Question 3e
Question 4 — 4, 6
Question 5 — 7
Question 6
Question 7 — 12
Question 8 — 13, 9

Solution
1 2 3 4 5 6 7 8 9 10 11 12 13 14

Notes