utp maintenance
by voestalpine

Cast iron electrodes for highest demands

UTP 8 | UTP 83 FN | UTP 86 FN

voestalpine Böhler Welding
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UTP Maintenance

Tailor-Made Protectivity™

High-quality industrial-use welding filler metals for maintenance, repair, and overlay welding. By adding the UTP and Soudokay brands to the voestalpine Böhler Welding brand network, the UTP Maintenance can look back on a proud history spanning 60 years as an innovative supplier of welding technology products. UTP Maintenance is the global leader in the repair, maintenance, and overlay welding segment.

With roots both in Bad Krozingen (Germany) and Seneffe (Belgium), UTP Maintenance offers the world's most unique product portfolio for filler metals from its own production facilities. The Soudokay brand was established back in 1938, while the UTP brand began operations in 1953. Each of these brands therefore respectively look back on a long history of international dimension.

By merging into the UTP Maintenance brand, the collective know-how of both brands – gathered over decades in the fields of metallurgy, service, and applications engineering – is now united under one umbrella. As a result, a truly unique portfolio of solutions for welding applications has been created in the fields of repair, maintenance, and overlay welding.

Tailor-Made Protectivity™

Industry experience and applications know-how – combined with innovative and custom (tailor-made) products – guarantee that our customers obtain the ideal combination of productivity and protection, within the shortest operating times and up to the maximum performance capacity of their products. This explains UTP Maintenance's guiding principle – "Tailor-Made Protectivity™" – which puts the focus on the customer.

Research and Development for Customized Solutions

At UTP Maintenance, research and development, conducted in collaboration with customers, plays a crucial role. Because of our strong commitment to research and development, combined with our tremendous innovative capacity, we are constantly engineering new products, and improving existing ones on an ongoing basis.
The result is a vast number of innovative products for solving individual problems and complex matters.

Customized Products of Superior Quality

We continuously adapt our product portfolio of about 600 products to customer and industry specifications, while ensuring that we meet the highest quality specifications.

From its in-house production facilities, UTP Maintenance delivers innovative, tailor-made welding filler metals for: unalloyed and fine-grained structural steel, low-grade alloyed steels, stainless and heat-resistant steels, nickel-based alloys, cast iron, copper and copper alloys, manganese steels, tool steels, and cobalt steels. The product portfolio comprises:

- Stick electrodes
- Solid wires and rods
- Flux cored wires
- Submerged arc wires and fluxes
- Submerged arc strips and fluxes
- Spraying- and PTA-powders

Solutions at Every Point on the Globe

UTP Maintenance provides products and services through the global branches of voestalpine Böhler Welding and its dealer network in more than 150 countries throughout the world. A team of welding engineers stands at the customer's side, providing advice and support in all matters related to the challenges of welding technology.

Welding of cast iron materials

This brochure provides an overview of the different types of cast iron and the UTP Maintenance welding consumables for production, repair and construction.

Cast iron is an iron-carbon alloy with a carbon content of more than 2.06 %. The metallurgical composition of cast iron is adjusted according to the application. In general, cast iron parts exhibit high compression strength, absorb vibration well and can be machined. Because of this properties cast materials are often used for large housings or machine beds. On the other hand, cast iron has relatively low tensile strength and toughness, which has an influence on the welding properties. By oversizing the components, these properties can be mitigated with modest economic consequences, making cast iron suitable as a building material.

UTP Maintenance Special Electrodes for Cast Iron Welding

Pure nickel stick electrode

Pure nickel electrodes are suitable for cold welding of grey cast iron, malleable cast iron and cast steel as well as for joining these materials to steel, copper and copper alloys. Due to its high nickel content, the soft and tough weld metal is especially suitable for welding cast iron which is brittle or old. The electrodes have excellent welding properties and can be used in any position (except vertical down) with no spattering or undercuts. Slag can be removed easily. To eliminate stresses, the weld metal should be hammered whilst it is warm (see page 12).

UTP 8

graphite-basic coated stick electrode

Standard designation		Typical weld metal composition (%)			Hardness	Welding position	Dimensions	Current	Current type
EN ISO 1071	AWS A5.15	C	Ni	Fe	HB		mm	A	
E C Ni-CI 1	E Ni-CI	1,2	Rest	1,0	ca. 180	PA / PB / PC PE / PF	2,0 x 300 2,5 x 300 3,2 x 350 4,0 x 350	45 – 60 60 – 80 80 – 100 110 – 140	= – ~

Nickel-Iron stick electrode

Nickel-iron electrodes are suitable for joining and hardfacing of grey cast iron, nodular cast iron (spheroidal graphite cast iron) and malleable cast iron as well as for joining with steel. The welding electrodes are universally applicable for cold welding in repair, production or construction. They have excellent mechanical and welding properties, do not cause spattering or undercuts and the slag can easily be removed. The use of bimetallic core wires (e.g. UTP 86FN) provides good current carrying capacity and melting characteristics, since the electrical resistance is less than for alloyed core wires (UTP 83 FN).

UTP 83 FN

graphite-basic coated stick electrode

Standard designation		Typical weld metal composition (%)			Hardness	Welding position	Dimensions	Current	Current type
EN ISO 1071	AWS A5.15	C	Ni	Fe	HB		mm	A	
E C NiFe-1 1	E NiFe-CI	1,3	52,0	Rest	ca. 190	PA / PB	2,5 x 300 3,2 x 350 4,0 x 350	50 – 70 70 – 100 100 – 130	= + ~

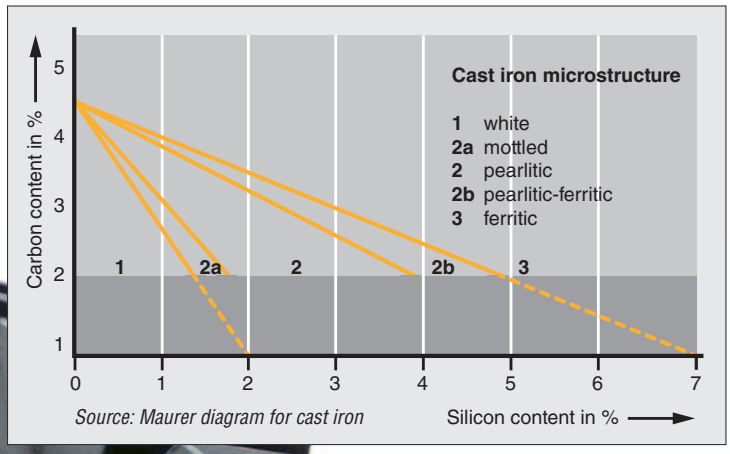
UTP 86 FN

graphite-basic coated stick electrode

Standard designation		Typical weld metal composition (%)			Hardness	Welding position	Dimensions	Current	Current type
EN ISO 1071	AWS A5.15	C	Ni	Fe	HB		mm	A	
E C NiFe-1 3	E NiFe-CI	1,2	Rest	45,0	ca. 220	PA / PB / PC PE / PF	2,5 x 300 3,2 x 350 4,0 x 350	60 – 90 90 – 140 100 – 170	= – ~

Cast Iron

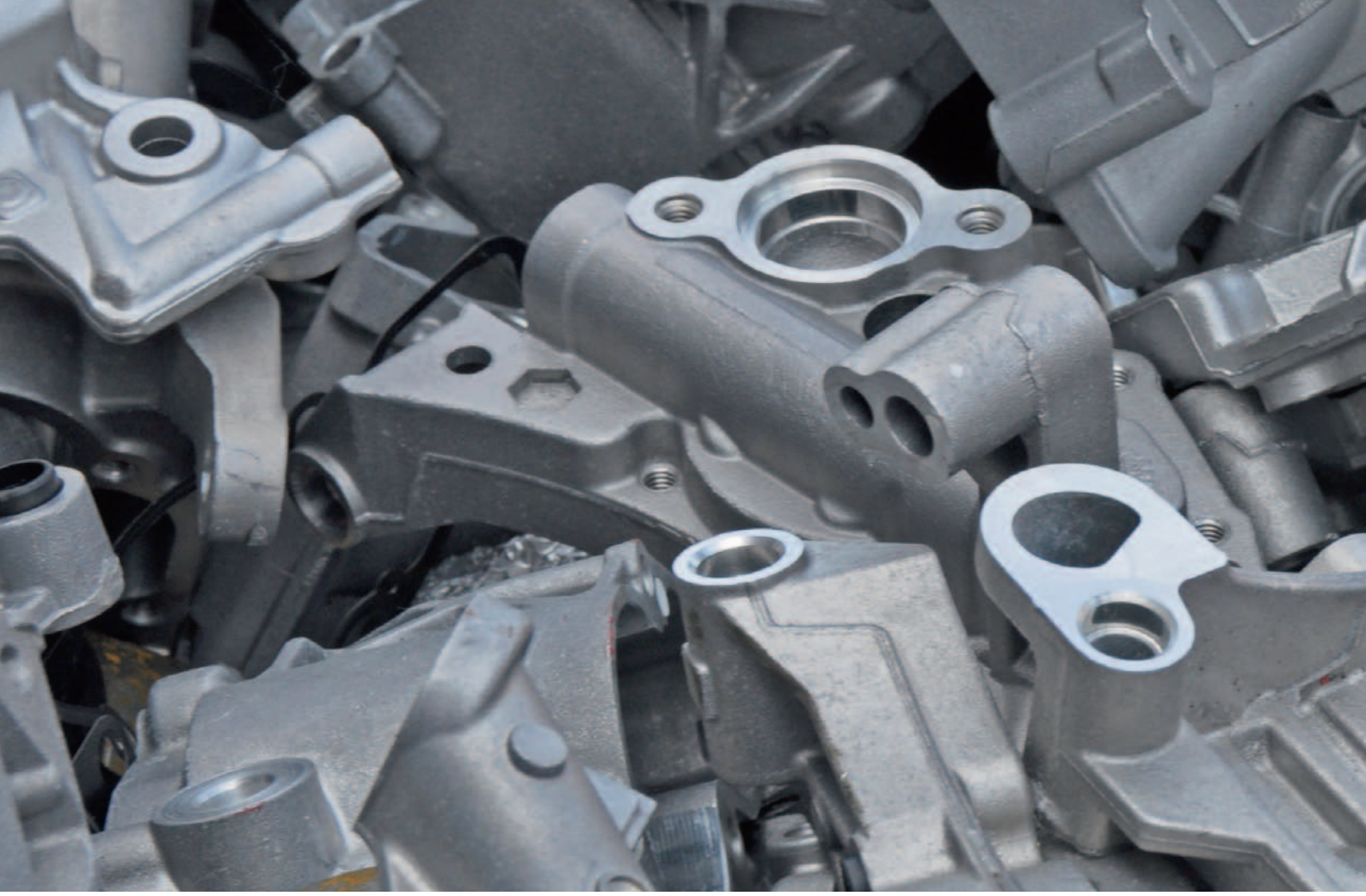
Most cast iron grades have a carbon content between 2 to 5 percent. Depending on the other alloying elements, cooling conditions and heat treatment, carbon can precipitate into different shapes, which determine the properties of the cast iron. Compared to steel, cast iron has a lower melting point of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



Source: Maurer diagram for cast iron

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. 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.

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



Cast Iron Welding Applications

Repair Welding

During repair welding, cracks, breakage and surface wear are welded so that the lifetime of these cast parts can be prolonged.

Production Welding

Production welding is the process when cast parts are welded during the casting process to ensure that mechanical properties and surface appearance meet the required quality levels. Typical production welding jobs are e. g. to repair casting defects, to correct undersized parts, weld cladding-, or hardfacing layers.

Construction Welding

During construction welding, several cast parts are welded together with other parts made of the same or dissimilar nature. Cast iron with nodular graphite (GJS), vermicular graphite (GJV) or malleable iron are usually used for construction welding. UTP 86 FN, for example, can be used to join cast iron or steel pipes with cast iron flanges.

Weld Preparation

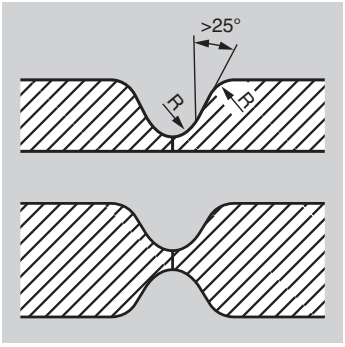
Remove the cast skin in the entire welding area.

Use dye penetrant testing to localize cracks in the material. At both ends, cracks should be drilled-out to prevent them from spreading into undamaged material.

Drill-out the crack or cracks to an open tulip shape. Round off the edges. Use a double U shape for thick walled components if they can be reached from both sides.

Before welding, remove the residues from the dye penetrant test and any other contamination e. g. oil, grease, dust or paint so that the welding area is metallically bright.

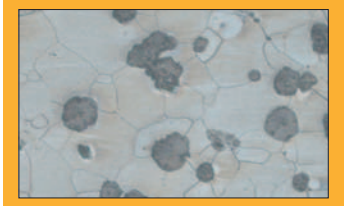
If the component is old and oiled, then an oxygen-acetylene flame can be used to remove the oil to prevent the formation of pores in the weld metal. Singe the part to burn off the oil or grease, but do not exceed a temperature of 150 °C. Before welding, cool the area down to 60 °C or less and make sure it is metallically bright.



Cast Iron Types

Nodular Cast Iron

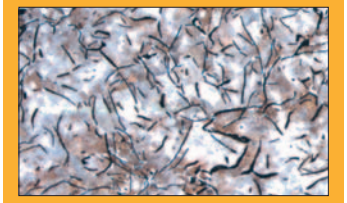
Nodular cast iron (spheroidal graphite cast iron/GJS) is a cast iron material in which the carbon is present in nodular form. This is achieved by adding small amounts of Magnesium as a spherodising agent to the molten cast iron. The nodular graphite minimises the notch effect, giving GJS the best strength and ductility properties within the group of cast iron materials. Due to its excellent mechanical properties, GJS can be used in a wide variety of automotive, machine and pipeline construction applications.



Spheroidal Graphite Cast Iron
(Nodular Cast Iron)
Standard (DIN EN 1563): GJS

Lamellar Cast Iron

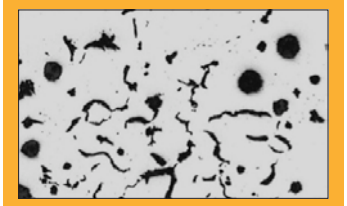
Lamellar graphite cast (GJL), commonly known as grey cast iron, has been successfully used in machinery construction for decades. The carbon in these alloys is present in the form of graphite flakes in a ferritic or perlitic matrix. Since graphite cannot bear stresses and due to its lamellar form, it acts as a severe inner notch, GJL has low tensile strength and practically no ductility. Grey cast iron has good damping properties and can easily be cast. GJL is the preferred material for manufacturing machine beds and machine bases.



Lamellar Cast Iron
Standard (DIN EN 1561): GJL

Vermicular Graphite Cast Iron

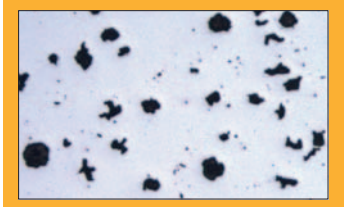
In vermicular graphite cast iron (GJV), the precipitated graphite has a vermicular (worm-shaped) form, though in general it can consist of up to 20 % nodular graphite. However, it cannot contain lamellar graphite. The properties of GJV lie between those of GJL and GJS. Vermicular graphite cast iron has better strength properties and higher ductility than GJL. Compared with GJS, it responds better to high temperatures and temperature changes and has a better castability. Due to these properties, it is predominantly used for engine construction applications, where, for example, GJV is used to pour crankcases and exhaust manifolds. Other industries such as mold manufacturing also benefit from this material.



Vermicular Graphite Cast Iron
Standard (DIN EN 16079): GJV

Malleable Cast Iron

There are two types of malleable cast iron: white (GJMW) and black (GJMB). White malleable cast iron has a carbon content of 2.8 to 3.4 % and black malleable cast iron a carbon content of 2.3 to 2.6 %. In the “as-cast” condition, carbon is chemically bound as iron carbide. By a subsequent heat treatment (or tempering) the iron – carbide precipitates into tempered carbon (graphite). The microstructure of GJMW changes with the wall thickness – from a ferrite edge zone to a ferritic-pearlitic transition area to a pearlitic core zone with tempered carbon in the transition area and part in the core zone. The microstructure of GJMB remains practically identical as the wall thickness changes. Malleable cast iron is used, for instance, in automobile construction, e.g. for the vehicle axis.



Malleable Cast Iron
(graphite flakes)
Standard (DIN EN 1562):
GJMW / GJMB

Welding of Cast Iron Materials

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 mealleable cast iron (GJMW, GJMB).

The weldability of a part depends on the weldability of the base material, the facilities of the welding shop and the construction of the component. Weldability mainly depends on the material's chemical- and mechanical properties. Other influencing facts are the microstructure, the level of contamination resulting from e.g. sulfur or oxides and the exposure from service (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 of cast iron. Temperature control is vital. Do not preheat before welding unless dampness and condensation needs to be removed from the surface of the part. To keep the thermal stress low while welding, the smallest possible electrode diameter should be used and the arc should be kept as short as possible. Always keep the welding beads short (max. 30 mm) and hammer the beads while the weld metal is warm. Use a hammer with a rounded head. The hammering introduces compressive stresses, which counteracts the shrinkage stresses of the cooling weld metal. The interpass temperature should not exceed 60 °C. When repairing large areas, change the welding location often to prevent heat accumulation.

The most important rules for cold welding

- Weld with stringer beads only (max. 1 to 3 cm).
- Weld with the lowest possible heat input.
- Hammer off the beads whilst they are warm. This introduces compressive stresses, which counteract the shrinkage stresses.
- Avoid heat accumulation.
- If possible, start on already welded beads to avoid hardness peaks in the heat affected zone.

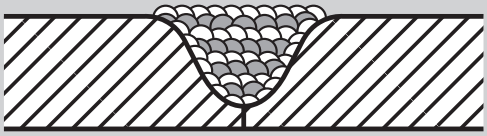
Short stringer bead before slag is removed

Hammering

Short stringer bead after slag is removed

Observe the following when welding cast iron:

- If pores appear in the first layer, e.g. when welding old, oiled cast iron, then this first layer has to be removed and welded again to ensure a defect-free weld metal.
- If old cast iron needs to be welded, UTP 81 can be used for the first layer to get sufficient bondage to the base metal.
- When joining difficult-to-weld cast materials, first clad the edges with the UTP 8 and then use UTP 86 FN to weld the joint.
- The mechanical properties can be improved by welding with UTP 8 pure nickel electrode (as an intermediate layer) and then using UTP 86 FN nickel-iron electrode.
- Start welding with the smallest possible electrode diameter to keep the heat input low.
- Keep the arc as short as possible.
- The weld seam should not be longer than ten times the electrode diameter and not wider than twice the diameter of the core wire.
- Use a (jack) hammer with a rounded head to immediately hammer off each stringer bead whilst these are still warm.



Drawing of a combination weld on grey cast iron that was welded using UTP 8 ◠ pure nickel electrode and UTP 86 FN ◠ nickel-iron electrode.

- Remove the slag residue with a wire brush.
- Restriking should be performed on previously welded beads and not on the base material.
- Choose a welding sequence that best prevents stresses due to distortion.
- Always weld open cracks from the inside to the outside.

Rounded hammer head

Hammered out weld metal

UTP Maintenance Special Electrodes for Cast Iron Welding

UTP 8 ■ graphite-basic coated stick electrode for cold welding cast iron

UTP 8 is suitable for cold welding of grey and malleable cast iron, cast steel and for joining these base metals to steel, copper and copper alloys.

UTP 8 has excellent welding properties. The easily controllable flow permits spatterfree welding in all positions with minimal amperage. The weld deposit and the transition zones are can be filled. No undercutting. Ideally suited for the combined welding with the ferro-nickel type UTP 86 FN (buttering with UTP 8 and build-up with UTP 86 FN).

EN ISO 1071: E C Ni-CI 1
AWS A5.15: E Ni-CI

UTP 83 FN ■ graphite-basic coated nickel-iron stick electrode with high melting rate and 115 % weld metal recovery

UTP 83 FN is suitable for cold-welding many commercial cast iron grades, such as lamellar or and nodular cast iron, malleable cast iron and for joining these materials to steel or cast steel. This stick electrode is particularly used if a high deposition rate is needed.

UTP 83 FN has excellent welding properties and the easily controllable transfer provides a spatter-free deposit of perfect appearance. The weld deposit is easily machinable with cutting tools. The weld metal is tough and crack-resistant.

EN ISO 1071: E C NiFe-1 1
AWS A5.15: E NiFe-CI

UTP 86 FN ■ graphite-basic coated nickel-iron stick electrode with bimetallic core wire for excellent mechanical properties for repair and construction

UTP 86 FN is suitable for joining and surfacing of lamellar grey cast iron EN GJL 100 - EN GJL 400, nodular cast iron (spheroidal cast iron) EN GJS 400 - EN GJS 700 and malleable cast iron grades EN GJMB 350 - EN GJMB 650 as well as for joining these materials with each other or with steel or cast steel. Universally applicable for repair, construction and production welding.

UTP 86 FN has excellent wetting characteristics on cast iron. The stick electrode has a stable arc and produces a flat bead without undercutting.

Particularly for fillet welds, an optimal bead structure is achieved (e.g. welding GJS-flanges or sockets to GJS-tubes). Due to the bimetallic core wire, the current carrying capacity and the deposition rate are excellent. The bead appearance is smooth. The weld deposit is highly crack resistant and easily machinable with cutting tools.

EN ISO 1071:	E C NiFe-1 3
AWS A5.15:	E NiFe-CI

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voestalpine Böhler Welding

Welding know-how joins steel

Customers in over 150 countries join the expertise of voestalpine Böhler Welding. Focused on filler metals, voestalpine Böhler Welding offers extensive technical consultation and individual solutions for industrial welding and soldering applications. Customer proximity is guaranteed by 40 subsidiaries in 28 countries, with the support of 2,200 employees, and through more than 1,000 distribution partners worldwide. voestalpine Böhler Welding offers three specialized and dedicated brands to cater our customers' and partners' requirements.

böhler welding by voestalpine

Böhler Welding – More than 2,000 products for joint welding in all conventional arc welding processes are united in a product portfolio that is unique throughout the world. Creating lasting connections is the brand's philosophy in welding and between people.

utp maintenance by voestalpine

UTP Maintenance – Decades of industry experience and application know-how in the areas of repair as well as wear and surface protection, combined with innovative and custom-tailored products, guarantee customers an increase in the productivity and protection of their components.

fontargen brazing by voestalpine

Fontargen Brazing – Through deep insight into processing methods and ways of application, Fontargen Brazing provides the best brazing and soldering solutions based on proven products with German technology. The expertise of this brand's application engineers has been formulated over many years of experience from countless application cases.

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