Hardcarb®

# High performance welding consumables

- Repair
- Special joining
- Rebuilding
- Hardfacing
- Cladding

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*This manual is designed to help in the understanding, selection and use of* ***Hardcarb®*** *and* ***Nicrolloy®*** *welding alloys for repair & maintainance applications. It includes common terms, important wear mechanisms as well as the metallurgical and wear characteristics of hardfacing deposits.*

# Hardcarb® + Nicrolloy®
# Repair and Maintenance solutions

Hardcarb® and Nicrolloy® series of repair and maintenance welding consumables have been developed after decades of practical wear-related experience in various Industries. These welding alloys are available in a variety of forms such as covered electrodes, flux-cored wires, tubular electrodes etc. to suit specific requirements.

## Hardcarb® Series

These include iron, nickel, cobalt, tungsten, chromium, niobium and vanadium bearing alloys. They have been engineered to withstand the demands of high impact wto-metal or metal-to-earth applications that may also be accompanied by high temperatures or corrosion.

Powerful tungsten carbide and nanostructured superalloys for extreme wear environments also form a part of this alloy portfolio.

## Nicrolloy® Series

These include high alloys (nickel and chrome based) for special joining, buffering and cladding requirements such as welding of

- stainless steels
- cast irons
- dissimilar steels
- difficult-to-weld steels
- steels for high temperature applications
- steels for high corrosion applications



# Products & Services

### Welding Consumables

Complete range of specialized surfacing consumables in a variety of forms to suit various welding processes.

### Automation + Robotics

Hardfacing and cladding automation solutions to carry out repetitive or complex overlay jobs

### Welding Services

„In-situ“ as well as workshop welding services are available from our team of expert welding technicians.

» Flux-cored wires

» Tubular electrodes

» Bare, composite rods

» Flexiclad automated hardfacing equipment for vertical mills, pipe surfacing, screw flights etc.

» Wire feeders, servo positioners

» System integration

» In-situ welding services at client site using flexiclad equipment

» Workshop hardfacing and cladding

# Welding Automation

## for semi and fully automatic hardfacing and cladding



# Wear and its mechanisms

Wear can be defined as the progressive loss of material from the operating surface of the body, occurring as a result of relative otion of the surface with respect to another body. The concept embraces metal to metal, metal to other solids and metal to fluid contact, and the definition clearly associates the process with the surfaces of materials.

It is a significant problem faced in many industries, and replacement of worn parts can result in considerable costs arising from

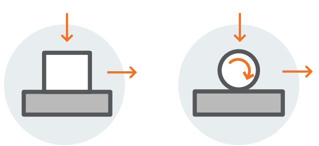
» cost of the replacement component
» cost of labour
» loss of production time
» reduced productivity from capital equipment due to higher energy consumption and lower yield.

To minimize these costs and downtime, hardfacing materials are commonly used in high wear environments. This is a subject of great importance to industry, which relies on long, trouble-free operation of plant to obtain uniform product quality and lowest possible product cost.

The following aspects have to be considered in identifying the appropriate wear modes of various wear problems. Their combination defines the wear situation and determines particular wear mode(s) involved.

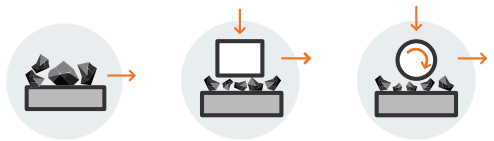
| Aspect | Description |
|---|---|
| Operating surfaces | The nature (e.g. composition, hardness, surface finish etc.) of the surface (or surfaces for metal to wear) that is being worn and so requires maintainance. |
| Mating component | The nature of the mating component whose wear is either not directly related to the wear of the operating surface or whose wear is of no concern. the main function of the mating surface is to transfer load to the operating surface. |
| Process material / interfacial material | The nature of the material being processed that wear and/or nature of lubricants or foriegn matter between two mating surfaces. |
| Mechanical motion | The nature of relative motion between surfaces and materials (e.g. sliding, rolling, oscilation, impact, flow). |
| Mechanical severity | The severity of the mechanical interaction (pressure, velocity, impact energy etc). |
| Environmental | Temperature and the nature and action of corrosive materials (e.g. pH, conductivity, chloride on concentration). |

# Common modes
# of Industrial wear



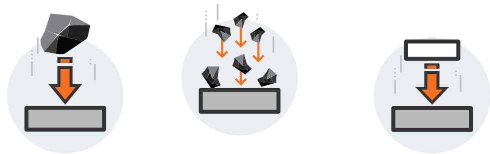
**Metal - Metal Friction**

Metal surfaces in relative motion forced into contact with or without lubricant. Degradation by the formation of micro-welds between the contacting surfaces.



**Mineral Abrasion**

Wear by relative movement of mineral particles of suitable hardness, shape and texture to remove material from the metal surface.

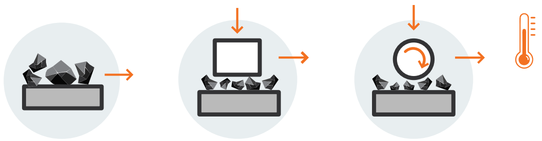


**Impact**

Impact between two materials, one of which provokes deformation or rupture of the surface of the other. This phenomenon is controlled by the toughness or ductility of the two materials.

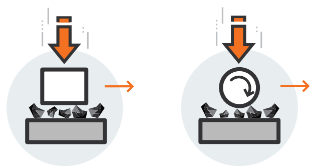
**Mechanical fatigue**

Fatigue and formation of cracks in surface regions due to tribological stress cycles that result in the separation of material.



**Hot Abrasion**

Mineral abrasion in a high-temperature environment, leading generally to softening of the metal or its constituents.

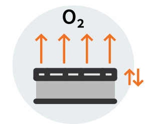


**Abrasion under pressure**

Wear by relative movement under pressure of mineral particles of suitable hardness, shape and texture to remove material from the metal surface, leaving superficial deformation.

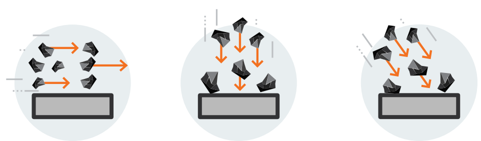
**Thermal fatigue**

Cyclic exposure to high temperatures leading to permanent deformation by alternate expansion and contraction. Alteration of the structure and properties of the material.



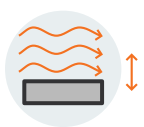

**Hot oxidation**

Creation of a poorly adhering oxide layer that reforms constantly. Degradation by loss of material thickness.



**Erosion**

Repeated high-speed impacts between mineral particles and a material surface. Local destruction by tearing out of metallic grains.



**Cavitation**

Tearing out of grains from the metal surface by the formation and implosion of bubbles in a liquid in rapid motion.

**Corrosion**

Degradation of the material by chemical reaction with its environment. Complex phenomenon involving numerous parameters.

# Common terms
## used in maintenance, repair and hardfacing

### Build-up, Rebuilding

Seriously worn areas should be rebuilt close to its initial dimensions using tough, crack-resistant welding materials which can be deposited in an unlimited number of layers. Normally, homogeneous filler materials are used such that their chemical composition and mechanical properties are similar to those of the base metal. However, in some cases, heterogeneous alloys can also be used, provided their characteristics are compatible with those of the base material.

### Buffer layer, Buttering

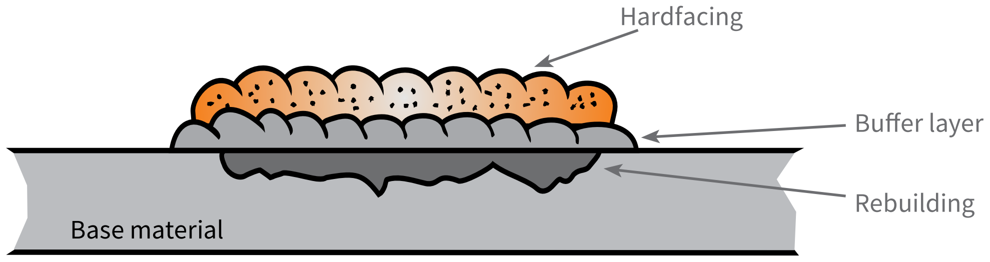
The term 'buffer layer' is used to describe the presence of an intermediate deposit between the base metal and the hardfacing weld material. The use of more than one type of hardfacing alloy may be necessary in some circumstances to reduce stress, to prevent cracking or to improve wear life of heavy deposits. There are a number of applications where this practice occurs:

» Hardfacing on a soft material for high load service
When harder surfacing alloys are used on a soft base material, e.g. mild steel, there is a tendency for the hardfacing layer to sink under high load conditions. Under extreme conditions this may result in the surfacing material spalling off. To overcome this, a layer of strong, tough material is deposited on the work piece before the hardfacing.

» Hardfacing on components with specific design requirements
With gas welding techniques, if differences in thermal expansion are significant and the surface hardness exceeds 50 HRC, it may be useful to apply an alloy of compatible composition, hardness 25-30 HRC, underneath to prevent cracking of the hard overlayer. Where the design calls for a heavy build-up, full thickness may be achieved using alternate layers of hardfacing alloy and buffer material. In arc welding processes, natural dilution from the base metal usually provides the necessary gradation of properties.

» Hardfacing on components subject to heavy impact / flexing
If a component is subject to heavy impact or flexing, there is a risk that deposits that do not relief-check during welding will develop fine transverse cracks. These are not detrimental to the hardfacing but there is a danger that in service the cracks will act as stress concentrators and progress through into the base material. This tendency is most pronounced when the base metal is a high strength steel. Use of a buffer layer prevents such crack propagation.

» Hardfacing over partly worn components
In many instances components which have been hardfaced and put into service wear unevenly and when presented for hardfacing again there are areas of the original hardfacing deposit still existing. For the softer, multilayer deposits and/or deposits which have not fractured under impact, hardfacing can be re-applied directly. However for fractured and very hard deposits it is necessary they be removed by grinding, gouging etc. prior to re-hardfacing. If this is not possible the use of buffer layer will secure the existing hardfacing and provide a tough base for subsequent hardfacing layers.




# Hardfacing

**Hardfacing is the deposition of a special alloy material on a metallic part, by various welding processes, to obtain more desirable wear properties and/or dimensions. The property usually sought is greater resistance to wear from abrasion, impact, adhesion (metal-to-metal), heat, corrosion or any combination of these factors.**

A wide range of surfacing alloys is available to fit the need of practically any metal part. Some alloys are very hard, while others are softer with hard abrasion resistant particles dispersed throughout. Certain alloys are designed to build a part up to a required dimension, while others are designed to be a final overlay that protects the work surface. Because of the large number of these materials it is convenient to classify them into groups (e.g. DIN EN 14700).

### Rebuilding worn metal parts to usable dimensions.

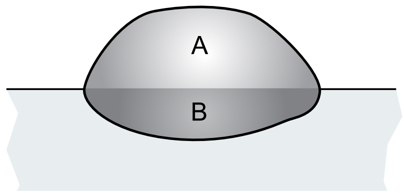
This is accomplished with build-up or with build-up and overlay. In both cases, the rebuilt part is usually superior to the original part. Worn parts that remain basically sound can be surfaced again and again provided that correct weld procedures are used.

### Protecting new metal parts against the loss of metal

Hardfacing overlay is used on both new and/or original equipment where the part is most susceptible to wear. The higher alloy overlay offers much better wear resistance than that of the original base material. This usually increases the work life of the component multiple times that of a part which is not surfaced. Although the added hardfacing material may add to the price of the equipment, usually a less expensive base material may be used.

## Dilution

A feature of weld-deposited coatings is the strong bond with the substrate, and temperatures required to achieve this always result in some melting of the substrate.




Dilution is defined as the change in chemical composition of a welding filler metal caused by the admixture of the base metal or previous weld metal in the weld bead. It is measured as the ratio between the base metal to the filler metal in the weld deposit. That means the dilution percentage is the amount of base metal (or previous weld metal) that ends up in weld deposit.

$$\% \text{ dilution} = \frac{B}{A + B} \times 100$$

During surfacing operations, dilution should be limited to optimise deposit characteristics, whilst ensuring a good fusion with the substrate.

### Weld Process Dilution Factors

| | | |
|---|---|---|
| 1. | Oxy-Acetylene | 0 - 5 % |
| 2. | Covered Electrode | 20 - 45% |
| 3. | Flux-cored Wire | 20 - 45% |
| 4. | TIG | 5 - 15% |
| 5. | Submerged Arc | 25 - 50% |
| 6. | Plasma Transferred Arc | 5 - 10% |

### Factors other than the welding process that influence dilution:

**Preheat temperatures**
Higher preheats give higher deposit dilution. Keep preheat temperatures within recommended ranges

**Welding speed**
The slower the welding speed, the higher the dilution rate.

**Welding current**
The higher the current, the higher the dilution

**Welding position**
In order of decreasing dilution: vertical-up (highest dilution), horizontal, uphill, flat, downhill (lowest)

**Welding technique**
Greater width of electrode oscillation increases dilution. Stringer beads give minimum dilution. Greater overlap of previous bead also reduces dilution

**Number of layers**
As more layers are deposited, the dilution decreases

**Electrode stick-out (wires)**
Longer electrode extension decreases dilution (for wire processes).

**Type of welding current and polarity**
Greatest dilution is encountered using DC positive (DC+); AC has an intermediate effect and DC negative (DC-) gives lowest dilution.

## Contraction cracking

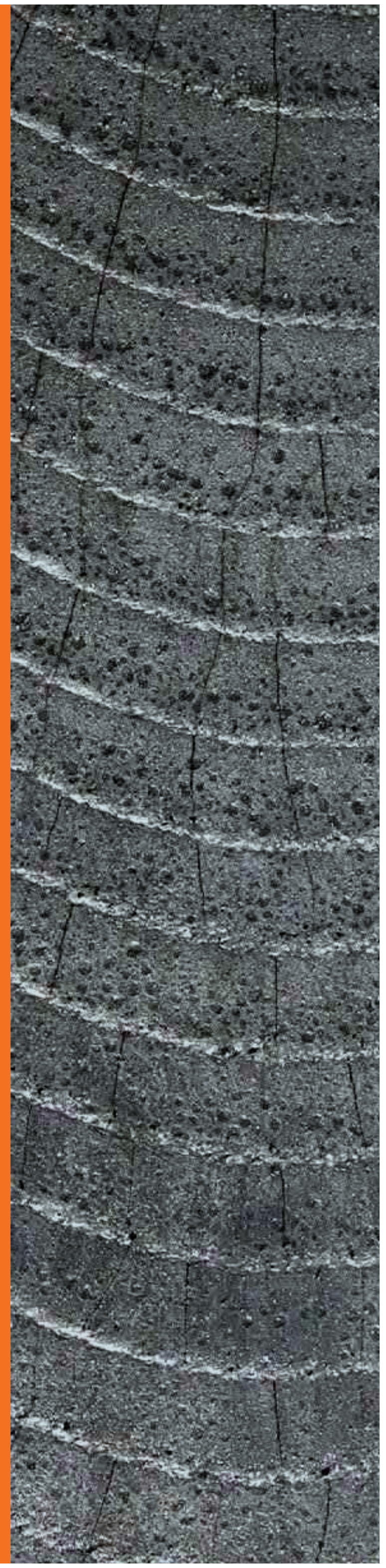
**(check cracking, stress relief cracking, shrinkage cracking)**

*Contraction cracking occurs in high hardness and carbide bearing hardfacing alloys as a result of a large difference between the rate of expansion and contraction between it and the base material. It is normally visible to the naked eye and may not necessarily affect the performance of the component adversely.*

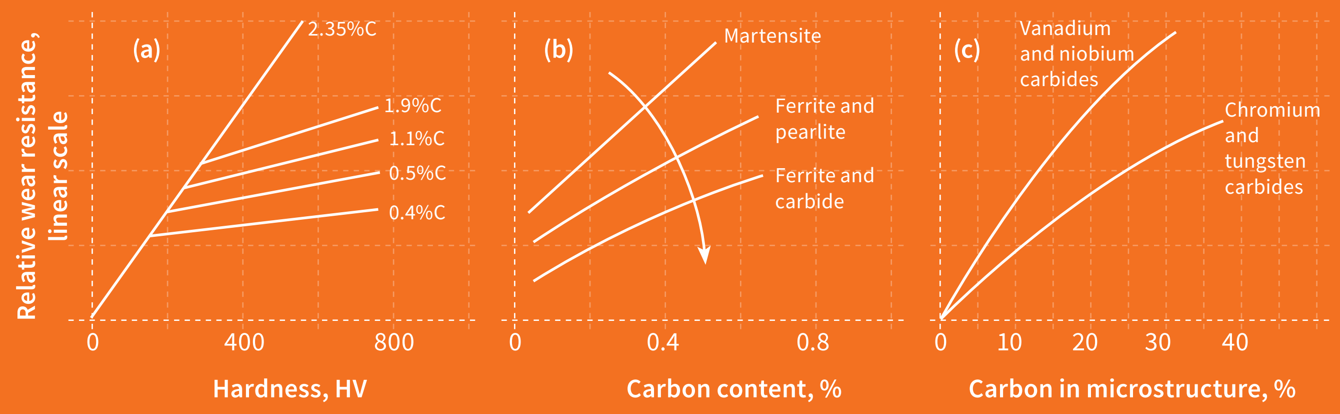
In the harder surfacing materials providing maximum wear resistance, such cracking (relief cracking) may be encouraged to release locked-in tensile stresses. Such cracking rarely involves the risk of the coating breaking away from the base metal, provided there is no hardening of the heat affected zone, and a satisfactory bonding to the substrate has been achieved.

However, cracks cannot normally be tolerated in applications such as:

- Sealing surfaces of valves, mechanical seat rings, printing rolls, etc.
- Surfaces subject to fine particle erosion such as flow control valves
- Surfaces designed to provide both wear and corrosion resistance
- Surfaces subject to severe fatigue stresses in service
- Surfaces that must not pick up any process material that could contaminate subsequent batches, such as in plastic extrusion



# Hardness and wear




It is possible to think that wear rate should be inversely related to the hardness of hardfacing alloys. However, practical results on abrasive wear tend not to confirm this. In materials of simple microstructure, there may be a simple relation between hardness and wear rate, as has been shown for example for commercially pure metals. However, with materials of more complex microstructure (typified by most engineering alloys), this is not so. In steels, the relation of wear to hardness is affected by the carbon content and by the microstructure of the matrix. The presence of secondary phases in the structure is also important. Carbides especially, but also borides, are widely used with success to provide resistance to abrasion. The degree of improvement depends on the composition, amount and morphology of the hard phases (as well as upon the operating environment).

In considering hardness, the difference between the abrading body and the other surface is important from a wear perspective.

# Hardness Chart
## of common abrasives and mineral phases

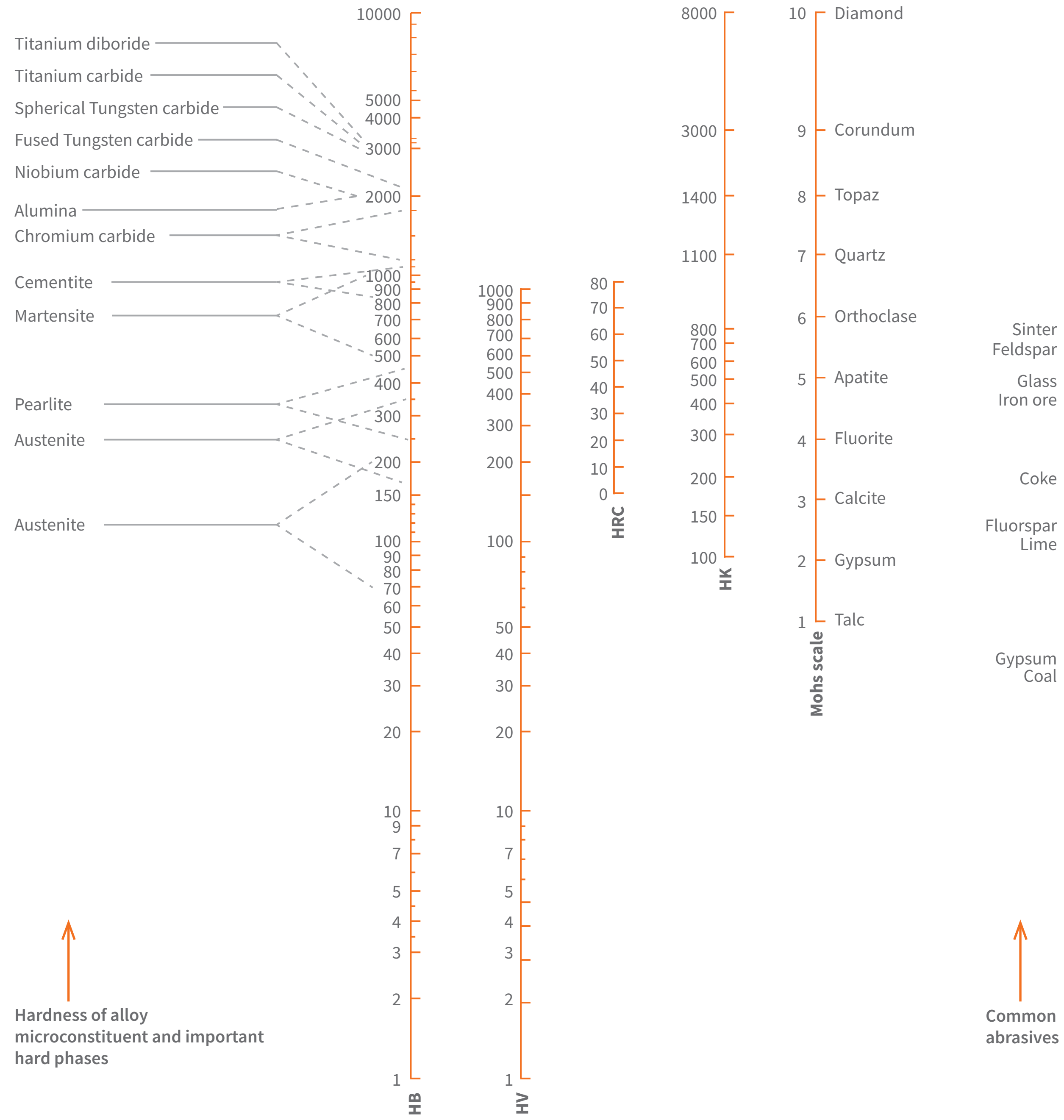



Chart for understanding various hardness scales and hardness of important minerals.
Note the limited range of most scales. Becouse of many factors involved, these conversions are approximate.

# Preheat and interpass temperature

The combination of alloy content, carbon content, massive size and part rigidity creates a necessity to preheat in many build-up and hardfacing operations. Slow cooling may also be needed. Preheating before welding can have several benefits for steels (other than manganese steels):

- It softens the structure of the heat-affected zone by slowing the cooling rate.
- Slower cooling distributes the post-welding stresses.
- Slower cooling improves hydrogen degassing.
- Preheating increases penetration of the base metal and thus improves the bond strength.

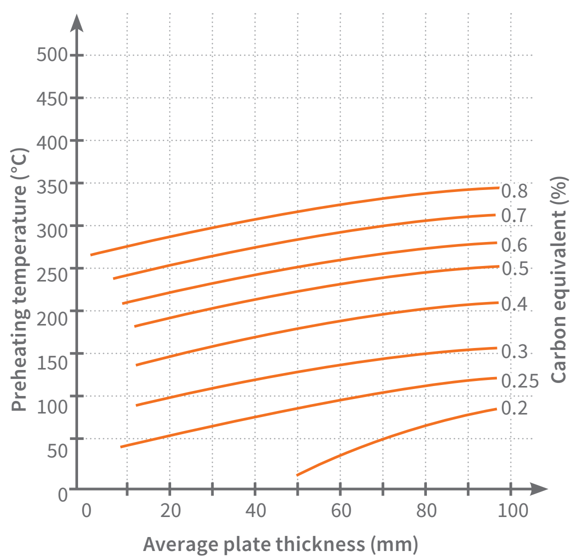
To determine the correct preheating temperature, it is essential to know the chemical composition of the base metal, plus the geometry of the part to be welded. The latter factor influences the distribution of heat. In the case of a very thick substrate, even if it has a low carbon equivalent, light preheating may be required to limit the cooling rate and the risk of "hardening".

Several methods can be used to calculate the theoretical preheating temperature. The Séférian method is illustrated below for reference.

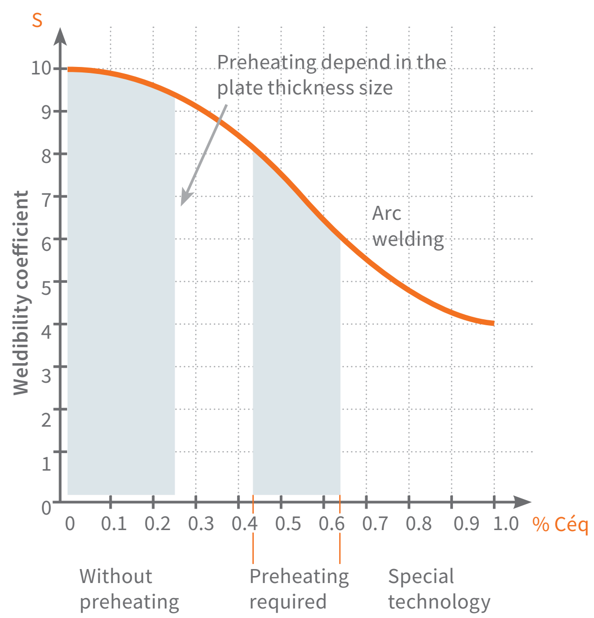
CAUTION !

» Austenitic 11% - 14% manganese steel becomes brittle if overheated. While a 50°C to 80°C preheat may be required, do not allow interass temperatures to exceed 200°C. Low or minimum preheat, low heat input, and low interpass temperatures are recommended on such manganese steels.

» Some alloy steel components require a specific heat treatment to perform properly in service. This must be considered when preheating and welding.



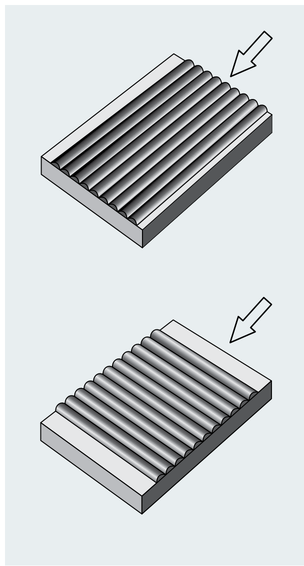

Séférian Model for Preheating Temperature Calculation

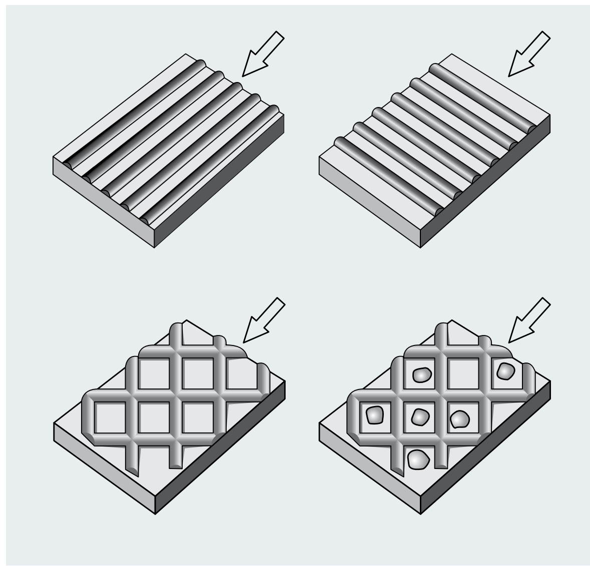


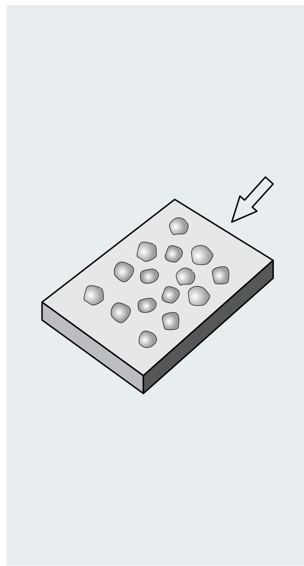

Séférian Model for Weldibility

# Hardfacing deposit patterns

The amount of hard surfacing and the pattern of coverage will be determined by a number of factors including the function of the component, service conditions and the state of repair. The three main patterns used are:







## Continuous coverage

Used for re-building and hardfacing parts that have a critical size or shape, such as rolls, shafts, tracks, crusher jaws and cones. It is also required on parts subject to a high degree of fine abrasion or erosion. Typical examples would be pump and fan impellers, sand chutes, valve seats, mixer paddles and dredge bucket lips. Sufficient over-lapping of each bead is necessary to ensure adequate coverage.

## Stringer Beads

Other than complete coverage, stringer beads are widely used for many applications including, ripper teeth, buckets/bucket teeth, rock chutes etc.

For teeth working in coarse rocky conditions the bead is deposited in the direction of the material travel, allowing the large lumps of rock etc. to slide along the top of the hardfacing bead.

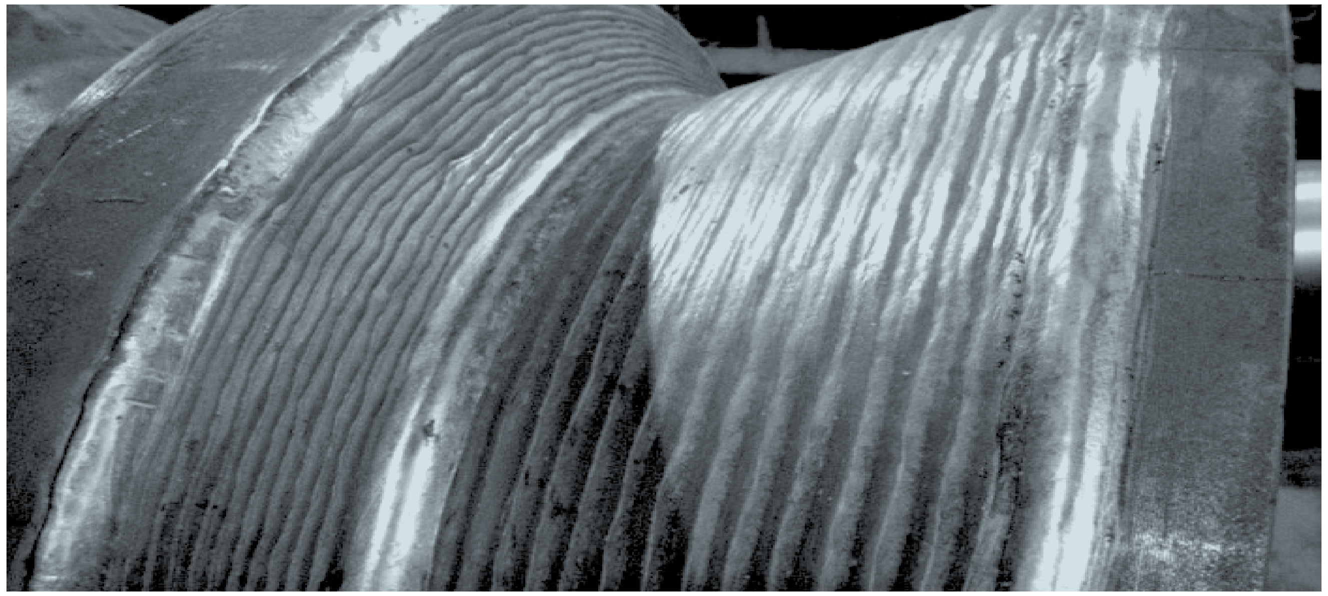
In fine sandy conditions the stringer beads should be transverse (across) the path of material travel, this allows the fine materials to compact between the beads and so give self protection.

For conditions where there is a combination of coarse and fine material the "checker" or "waffle" pattern is generally used with or without dots.

## Dot pattern

For less critical areas such as the sides/ends of buckets, shovels etc. the dot pattern is used. It is useful in keeping the heat input down, particularly for the 11%-14% austenitic manganese steels. The dot size is generally 15-20mm diameter by 8mm high and placed at about 50mm centres.

# BUFFER LAYERS, BUILD-UP, CLADDING, JOINING



| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |

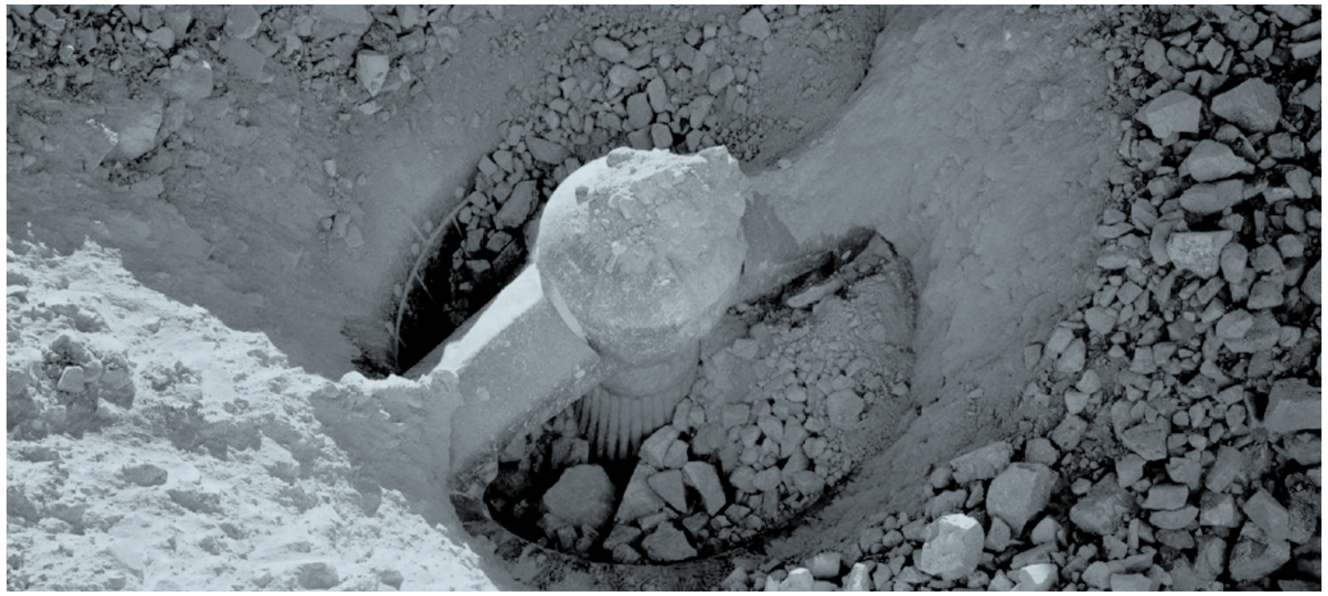
## 1.1 build-up & joining / carbon steel

| Alloy Grade | Classification | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hardcarb® BU10** | AWS A 5.1 | E7018-1 | | | | o | | | | | | | | | | | | ● | |
| **Hardcarb® BU25** | DIN EN 14700 | E Fe1 | | | | o | | | | | o | | ● | | | | | ● | |
| **Hardcarb® BU30** | DIN EN 14700 | E Fe1 | | T Fe1 | | o | | | | | o | | ● | | | | | ● | |
| **Hardcarb® BU32** | DIN EN 14700 | E Fe1 | | | | o | | | | | o | | ● | | | | | ● | |

o suitable ● extremly suitable

Alloy Details

| Alloy Grade | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® BU10 | High pressure piping, rails with upto 0.6% carbon content, hoists, steel casting defects, steel gears, sprockets, loco frames, pumps etc. | + | + | + | | | | | | | | Base | | | • Recommended for X-ray quality welds on a variety of medium carbon and low alloy high-tensile steels, providing unique hydrogen free deposits with superior impact resistance at normal and sub-zero temperatures.<br>• Deposits exhibit very high strength and provide unique resistance to hydrogen-induced embrittlement.<br>• TS = 600 MPa, YS ≥ 460 MPa, Elongation > 22%, IV ≥ 47 J at 40°C |
| Hardcarb® BU25 | For build-up of shovel and bucket lips, pump impellers and housings, pulverizer plows, mill hammers etc. For Hardfacing of trunnions, roller guides, slideways, cranes and gears | + | + | + | + | | | | | | | Base | | ~ 250 HB | • Build-up with moderate hardness to resist shock and metal-to-metal wear, as in rolling and sliding.<br>• Can be used as underbase for other hardfacing deposits or as final overlay on parts to be machined or forged<br>• Good resistance to cavitation, highly resistant to shocks.<br>• Sound, crack free deposit, machinable with standard tools. |
| Hardcarb® BU30 | Mainly used for heavy build up and as a cushion layer on crane wheels, shafts, slide ways, wheel rims, conveyor screws and bars. | + | + | + | + | | | | | | | Base | | ~ 300 HB | • Tough and wear resistant surfacing on equipment parts and tools which are subjected to medium wear only<br>• The dense and crack-free deposit is resistant to medium friction and compression and highly resistant to shocks<br>• Weld metal can be machined with metal-cutting tools.<br>• Surface layer hardening can be performed on machined areas<br>• Ideal as an underbase prior to hardfacing |
| Hardcarb® BU32 | Hardfacing of tracks, shafts, rolls, rails and rail-crossing sections; as well as components in rolling mills, such as grooved rollers and clutches and large cog wheels made of cast steel. | + | + | + | + | | | | | | | Base | | ~ 320 HB | • Tough and wear resistant surfacing on equipment parts and tools which are subjected to medium wear only<br>• The dense and crack-free deposit is resistant to medium friction and compression and highly resistant to shocks<br>• Weld metal can be machined with metal-cutting tools.<br>• Surface layer hardening can be performed on machined areas<br>• Ideal as an underbase prior to hardfacing |



| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| Hardcarb® BU35 | DIN EN 14700: E Fe1 | | | | ○ | | | | | ○ | | ● | | | | | ● | |

| Alloy Details: Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Particularly suited for wear resistant surfacings on Mn-Cr-V alloyed parts such as frogs, track rollers, chain support rolls, sprocket wheels, guide rolls etc. | + | + | + | + | | | | | | | Base | | ~ 350 HB | • Tough and wear resistant surfacing on equipment parts and tools which are subjected to medium wear only<br>• The dense and crack-free deposit is resistant to compression and rolling strain<br>• Weld metal can be machined with metal-cutting tools.<br>• Surface layer hardening can be performed on machined areas<br>• Ideal as an underbase prior to hardfacing | Hardcarb® BU35 |

## 1.2 build-up & joining / manganese steel

| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® BU50 | DIN EN 14700: E Fe9 | | T Fe9 | | ● | | | | | ○ | ● | ○ | | | | ● | ○ | |
| Hardcarb® BU55 | DIN EN 14700: E Z Fe9 | | T Z Fe9 | | ● | | | | | ○ | ● | ○ | | | | ● | ○ | |

| Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Primarily used for surfacing and building up manganese steel components such as crusher jaws, crushing hammers, excavator teeth, gyratory mantles, blowbars, dredge pump cutters, rail switch cores, etc. | + | + | + | + | + | | | | | | Base | | 200 - 250 HB (as welded)<br>400 - 500 HB (work hardened) | • Highly suited for tough and crack resistant joinings and surfacings on parts of high Mn-steel subject to extreme impact, compression and shock.<br>• Frequently used as a cushion layer before hardfacing in case of heavy reclaiming. It produces a fully austenitic deposit which hardens during service from originally 200–250 HB to 500 HB.<br>• Weld metal can be machined with tungsten carbide tools. | Hardcarb® BU50 |
| Designed specifically for building up manganese frogs and manganese crossing diamonds in the railroad industry. Other applications include crusher jaws, hammers, gyratory mantles, blowbars etc. | + | + | + | + | | | | | | | Base | | 200 - 300 HB (as welded)<br>400 - 500 HB (work hardened) | • Highly suited for tough and crack resistant joinings and surfacings on parts of high Mn-steel subject to extreme impact, compression and shock.<br>• Provides a high strength, high alloy austenitic manganese deposit to handle the increased loading of railroad cars.<br>• Weld metal can be machined with tungsten carbide tools. | Hardcarb® BU55 |

## 1.3 build-up & joining / both carbon steel and manganese steel

| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nicrolloy® 18.8.6 | DIN EN 14700: E Fe10 | | T Fe10 | | ● | | | | | ○ | ○ | | | ○ | ○ | ● | ○ | |

| Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Especially suited for buffer layer before hardfacing. Also used for joining of wear plates, manganese steels, scale-resisting steels, higher carbon materials, dissimilar joints and difficult-to-weld materials. | + | + | + | + | + | | | | | | Base | | 180 - 200 HB (as welded)<br>340 HB (work hardened) | • Fully austenitic stainless steel deposit with a high manganese content. The alloy is non-magnetic, highly resistant to cracking and work hardens strongly<br>• Excellent heat resistance upto 900°C and resistance to corrosion caused by atmosphere, seawater and weak acids.<br>• Weld metal can be machined with metal-cutting tools.<br>• TS = 600 MPa, YS ≥ 400 MPa, Elongation > 32%, IV ≥ 32 J at 40°C | Nicrolloy® 18.8.6 |

○ suitable ● extremly suitable

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## 1.4 joining and cladding / dissimilar, “difficult-to-weld” and stainless steels

| Product | Available product forms and Classification | | | | Mechanical Properties | | | |
|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Tensile strength Rm [Mpa] | Yield strength $R_p$ 0.2% [Mpa] | Elongation A5 [%] | Impact Strength KV [J] |
| Nicrolloy® 19.9.6 | DIN EN 14700 E Fe10 | | T Fe10 | | 600 - 750 | > 400 | > 32 | > 70 J at +20°C |
| Nicrolloy® 28.10 | DIN EN 14700 E Fe11 | | | | 700 - 800 | > 500 | > 20 | > 30 J at +20°C |
| Nicrolloy® 30.10 | DIN EN 14700 E Fe11 | | T Fe11 | | 800 - 850 | > 550 | > 20 | > 30 J at +20°C |
| Nicrolloy® 29.9 | DIN EN 14700 E Fe11 | | T Fe11 | | 700 - 800 | > 500 | > 20 | > 30 J at +20°C |
| Nicrolloy® 30.9 | DIN EN 14700 E Fe11 | | T Fe11 | | 800 - 850 | > 550 | > 20 | > 30 J at +20°C |
| Nicrolloy® 20.10 | DIN EN 14700 E Fe12 | | | | 600 - 750 | > 400 | > 25 | > 55 J at +20°C |

| Alloy Details | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Typical Applications / Alloying Basis | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties | |
| Suited for welding difficult-to-weld, crack-sensitive steels with > 0.7 % carbon. Also used for welding buffer layers prior to hardfacing and for repair welding of manganese steels. | + | + | + | + | + | | | | | | Base | | 180 - 200 HB (as welded)<br>400 - 500 HB (work hardened) | • Fully austenitic stainless steel deposit with a high manganese content. The alloy is non-magnetic, highly resistant to cracking and work hardens strongly<br>• Stainless, heat resistant weld metal, non-scaling up to 850° C and resistant to sulphurous waste gases at temperatures up to 500° C.<br>• Weld metal can be machined with metal-cutting tools. | Nicrolloy® 19.9.6 |
| For repair and maintenance of machine and drive components such as gears, cams, shafts, hot cuts, hot trim plates and dies. Also ideally suited as an elastic cushioning layer for very hard surfacings. | + | + | + | + | + | | | | | | Base | | 180 - 200 HB (as welded)<br>360 HB (work hardened) | • High-alloyed material which deposits a ferritic-austenitic duplex weld metal with high ferrite content.<br>• It is extremely crack-resistant when joining steels of difficult weldability, such as hard manganese steels, tool steels, spring steels, high speed steels as well as dissimilar metal joints. | Nicrolloy® 28.10 |
| For repair and maintenance of machine and drive components such as gears, cams, shafts, hot cuts, hot trim plates and dies. Also ideally suited as an elastic cushioning layer for very hard surfacings. | + | + | + | + | + | | | | | | Base | | 180 - 200 HB (as welded)<br>360 HB (work hardened) | • High-alloyed material which deposits a ferritic-austenitic duplex weld metal with high ferrite content.<br>• It is extremely crack-resistant when joining steels of difficult weldability, such as hard manganese steels, tool steels, spring steels, high speed steels as well as dissimilar metal joints. | Nicrolloy® 30.10 |
| Used for joining dissimilar steels, steels with reduced weldability and buffer layers prior to hardfacing. Applications include rolls, forging dies, hotwork tools, dies for plastics etc. | + | + | + | + | + | | | | | | Base | | 180 - 200 HB (as welded)<br>360 HB (work hardened) | • High-alloyed material which deposits a ferritic-austenitic duplex weld metal with approx. 40% ferrite.<br>• It is resistant to stress corrosion, highly insensitive to dilution and extremely crack resistant.<br>• Plastic weld metal of high tensile strength, impact proof, tough, and acid and heat resistant up to 1,000° C. | Nicrolloy® 29.9 |
| Used for joining dissimilar steels, steels with reduced weldability and buffer layers prior to hardfacing. Applications include rolls, forging dies, hotwork tools, dies for plastics etc. | + | + | + | + | + | | | | | | Base | | 180 - 200 HB (as welded)<br>360 HB (work hardened) | • High-alloyed material which deposits a ferritic-austenitic duplex weld metal with approx. 40% ferrite.<br>• It is resistant to stress corrosion, highly insensitive to dilution and extremely crack resistant.<br>• Plastic weld metal of high tensile strength, impact proof, tough, and acid and heat resistant up to 1,000° C. | Nicrolloy® 30.9 |
| Can be used for joining austenitic to ferritic steels, especially when base metal is at risk of cracking. Same suitability for joint welding heat treatable steels, stainless Cr-steels, manganese steels to each other and to dissimilar steel types. | + | + | + | + | + | + | | | | | Base | | | • Suitable for joining corrosion-proof CrNiMo steels of low carbon content as well as stabilised and non-stabilised steels of identical or similar characteristics which are resistant to chemical agents. | Nicrolloy® 20.10 |

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| Product | Available product forms and Classification | | | | Mechanical Properties | | | |
|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Tensile strength Rm [Mpa] | Yield strength $R_p$ 0.2% [Mpa] | Elongation A5 [%] | Impact Strength KV [J] |
| **Nicrolloy® 25.12** | DIN EN 14700<br>E Fe12 | | | | 650 - 800 | > 450 | > 25 | > 45 J at +20°C |
| **Nicrolloy® 25.20** | DIN EN 14700<br>E Fe11 | | | | 540 - 640 | > 300 | > 30 | > 70 J at +20°C |
| **Nicrolloy® 13.04** | DIN EN 14700<br>E Fe7 | | | | > 850 | > 650 | > 15 | > 40 J at +20°C |
| **Nicrolloy® Inco82** | AWS A 5.11 / A 5.34<br>E NiCrFe-2 / Mod | | | | 620 - 720 | > 380 | > 35 | > 80 J at -196°C |
| **Nicrolloy® Inco625** | AWS A 5.11 / A 5.34<br>E NiCrMo-3 | | | | 750 - 850 | > 500 | > 35 | > 50 J at -196°C |

| Alloy Details | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nicrolloy® 25.12** | For joining difficult-to-weld steels and for corrosion-proof claddings. Also suitable for buffer layers on plated metal sheets and for joining austenitic to ferritic steels which are subject to service temperatures of up to 300°C. | + | + | + | + | + | + | | | | | Base | | | • An austenitic weld metal (CrNiMo 18/ 10/ 2) is obtained already in the first layer<br>• Due to its high alloy level, crack-proof welds are produced.<br>• The addition of molybdenum ensures higher corrosion resistance and higher tensile-strength at elevated temperatures<br>• The weld metal is heat resistant and non-scaling up to 1050° C |
| **Nicrolloy® 25.20** | For joining corrosion-proof, highly heat-proof and non-scaling 25Cr20Ni steels which are subject to service temperatures up to 1200° C. Mainly used in furnace construction, for fittings and pipelines. | + | + | + | + | + | | | | | | Base | | | • Also suitable for joint welding Cr-, CrSi- and CrAl steels and for cladding low alloy base metals.<br>• The weld metal alloy is highly hot-crack-proof.<br>• Annealing to 250°C and post-weld tempering to 700°C is required on ferritic base materials. |
| **Nicrolloy® 13.04** | For welding of 12-14% Cr and 3-4% Ni martensitic stainless and heat resistant chromium steels or cast steels. | + | + | + | + | + | + | | | | | Base | | 410 HB | • The Alloy is highly suitable for corrosion and abrasion resistant surfacing of contact surfaces of gas, water, sea water and steam fan, fan blades and fittings, continuous casting rolls.<br>• Apart from corrosion resistance, it also has a further capability in protecting against cavitation and erosion. |
| **Nicrolloy® Inco82** | For welding Inconel 600 and similar alloys, cryogenic steels (e.g. 9Ni and 5Ni steels), martensitic to austenitic steels, dissimilar steels, heat-resistant steel castings with limited weldability and so on. | + | + | | + | Base | + | + | | | | + | | | • The austenitic deposit is insensitive to hot-cracking and free of embrittlement at high as well as at low temperatures, non-scaling up to 1000° C, and cold tough down to -196° C.<br>• No diffusion of carbon into the weld metal at high temperatures. |
| **Nicrolloy® Inco625** | A NiCrMoNb-based alloy for welding nickel alloys of the same or similar type, like Inconel 625, and for welding 5Ni and 9Ni steel. Used in Chemical and Petrochemical Industry, glassworks, repair and maintenance workshops. | + | + | + | + | Base | + | + | | | | + | | | • The austenitic deposit is insensitive to hot-cracking and free of embrittlement at high as well as at low temperatures, non-scaling up to 1000° C, and cold tough down to -196° C.<br>• No diffusion of carbon into the weld metal at high temperatures.<br>• Suitable for joining and cladding stainless, heat resistant and cold tenacious steels as well as welding dissimilar materials such as low alloyed steels with Ni-base or Cu-base alloys |

## 1.5 build-up & joining / cast iron

| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Tensile strength Rm [Mpa] | Yield strength $R_p$ 0.2% [Mpa] | Elongation A5 [%] | Impact Strength KV [J] |
|---|---|---|---|---|---|---|---|---|
| **Nicrolloy® 201** | ISO 1071<br>E C FeC - GF 1 | | | | | | | |

| Alloy Details | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nicrolloy® 201** | For the repair welding of difficult to weld, heavily contaminated and poor quality cast iron with and without the application of preheat. It enables high-quality final welds to be deposited using other selected cast iron products. It is also suitable for wear resistant overlays on cast iron parts. | + | + | + | | | | | | | | Base | Ti | 350 HB | • Non-machinable Iron-based alloy designed to provide high arc force and cleaning action on contaminated cast iron.<br>• Finishing of the weld metal and heat affected zone can only be achieved by grinding.<br>• Deposits will rust and match the base casting in color.<br>• The electrode has a soft, spatter-free running characteristic, with good penetration and an easily removable slag. |

# Understanding Cast Irons

## Types

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, nodular cast iron and for mealleable cast iron.

### Grey Cast Iron

Grey cast iron is characterized by its graphitic microstructure, which causes fractures of the material to have a grey appearance. It is the most commonly used cast iron and the most widely used cast material based on weight. Most cast irons have a chemical composition of 2.5–4.0% carbon, 1–3% silicon, and the remainder iron. Grey cast iron has less tensile strength and shock resistance than steel, but its compressive strength is comparable to low- and medium-carbon steel.

### White Cast Iron

White iron is of similar composition to grey iron but having most of the carbon present in the form of intensely hard and brittle cementite or iron carbide. The silicon content is made lower by rapidly cooling the casting with ‚chills'. It derives its name from the white, crystalline crack surface observed when a casting fractures.

### Malleable irons

These are white cast irons which have been heat treated to render them more ductile than normal cast iron.

### Spheriodal graphite cast iron (S.G. iron, ductile cast iron, nodular cast iron)

Again very similar in composition to gray cast iron, but the free graphite in these castings precipitates from the melt as spherical particles rather than flakes. The spherical graphite particles do not form a continuous crack-like network in the matrix like graphite flakes, resulting in higher strength and toughness compared with gray cast iron of similar composition.

### Alloy cast irons

These are made for wear, corrosion and heat resistance and for extra strength. Examples are: ‚Ni-resist' (corrosion resistance). ‚Nicrosilal' (heat resistance) and ‚Ni-hard' (abrasion resistance). Some of these cast irons contain sufficient alloys to make them austenitic.

## Reasons for welding

### » Production welding

In order to guarantee configurational and dimensional specifications together with aesthetic properties, welds are made during the production of cast components. The elimination of casting defects (such as porosity, sand inclusions, cold shuts, washouts etc.) and the correction of fabrication errors or undersize components come under this heading particularly. In this respect, many successful welds with outstanding mechanical properties have been made on austenitic and ferritic nodular cast iron grades.

### » Repair welding

Cast iron machine components cracked due to mechanical overloading, fatigue and aging, broken-off and worn surfaces, can be repaired permitting their continued use.

### » Construction welding

Cast components are joined together or to other components made from dissimilar alloys (steels) by welding to make up an integral fabrication. The joining of steel tubes or wear-resistant austenitic manganese steel parts to components made from cast iron can be considered under this heading.

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| Product | Available product forms and Classification | | | | Mechanical Properties | | | |
|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Tensile strength Rm [Mpa] | Yield strength $R_p$ 0.2% [Mpa] | Elongation A5 [%] | Impact Strength KV [J] |
| **Nicrolloy® 210** | ISO 1071<br>E C NiFe-1 1 | | T C NiFe-2 | | > 450 | > 300 | 12 | |
| **Nicrolloy® 211** | ISO 1071<br>E C NiFe-1 1 | | | | > 450 | > 300 | 10 | |
| **Nicrolloy® 222** | ISO 1071<br>E C NiFe-1 1 | | | | > 480 | > 330 | 18 | |
| **Nicrolloy® 230** | ISO 1071<br>E C Ni-CI 1 | | | | > 400 | > 200 | 8 | |
| **Nicrolloy® 233** | ISO 1071<br>E C Ni-CI 1 | | | | > 400 | > 200 | 8 | |

| Alloy Details | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Typical Applications / Alloying Basis | | | | | | | | | | | | | Hardness | Typical properties |
| | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | | | |
| **Nicrolloy® 210** | Specially designed for the strength welding of high duty cast iron, such as meehanite, malleable and spheroidal graphite or nodular irons. It is ideal for welding thick sections of different types of cast irons to each other or to steel. It can be used to weld high-phosphorous castings and to join thin sections of grey cast iron to themselves or to other ferrous materials.<br>e.g. Repairing of defects in foundries, repairing of engine blocks, houses of tool machines, gearboxes, reducing parts, pump bodies, cast pieces, valve bodies etc. | | | | | | | | | | | | | 170 HB | • Suitable for joining all types of grey cast iron and also for joining cast iron with steel, but especially for nodular cast iron.<br>• The colour of the deposit is very similar to the base material, and corrosion will be identical to the base material later on.<br>• Very high crack-resistance and high tensile strength of weld metal.<br>• Even in refined zones the seam is still machinable |
| | + | + | + | | Base | | | | | | + | | | | |
| **Nicrolloy® 211** | Specially designed for the strength welding of high duty cast iron, such as meehanite, malleable and spheroidal graphite or nodular irons. It is ideal for welding thick sections of different types of cast irons to each other or to steel. It can be used to weld high-phosphorous castings and to join thin sections of grey cast iron to themselves or to other ferrous materials.<br>e.g. Repairing of defects in foundries, repairing of engine blocks, houses of tool machines, gearboxes, reducing parts, pump bodies, cast pieces, valve bodies etc. | | | | | | | | | | | | | 190 HB | • Suitable for joining all types of grey cast iron and also for joining cast iron with steel, but especially for nodular cast iron. A copper cladded corewire enables exceptional resistance against overheating during welding.<br>• The colour of the deposit is very similar to the base material, and corrosion will be identical to the base material later on.<br>• Very high crack-resistance and high tensile strength of weld metal.<br>• Even in refined zones the seam is still machinable |
| | + | + | + | | Base | | | | | | + | | | | |
| **Nicrolloy® 222** | Specially designed for the strength welding of high duty cast iron, such as meehanite, malleable and spheroidal graphite or nodular irons. It is ideal for welding thick sections of different types of cast irons to each other or to steel. It can be used to weld high-phosphorous castings and to join thin sections of grey cast iron to themselves or to other ferrous materials.<br>e.g. Repairing of defects in foundries, repairing of engine blocks, houses of tool machines, gearboxes, reducing parts, pump bodies, cast pieces, valve bodies etc. | | | | | | | | | | | | | 200 HB | • An all-position electrode having a bimetal core wire which allows very fast fusion on direct current as well as on alternating current without any risk of overheating.<br>• Suitable for joining all types of grey cast iron and also for joining cast iron with steel, but especially for nodular cast iron.<br>• The colour of the deposit is very similar to the base material, and corrosion will be identical to the base material later on.<br>• Very high crack-resistance and high tensile strength of weld metal.<br>• Even in refined zones the seam is still machinable. |
| | + | + | + | | Base | | | | | | + | | | | |
| **Nicrolloy® 230** | Suitable for cold welding (joining and surfacing) on all common cast iron qualities, such as grey cast iron, malleable cast iron, and cast steel. It is also well suited for repair welding on castings showing symptoms of fatigue. | | | | | | | | | | | | | 160 HB | • Basic-graphite special coated electrode with a pure nickel core wire.<br>• Excellent welding properties also for welding with low amperage.<br>• Quietly and intensely flowing weld metal, very little spattering, easily removable slag.<br>• The weld seam is file-soft and machinable even in the transitional zone between the seam and the base material. |
| | + | + | + | | Base | | | | | | | Cu | | | |
| **Nicrolloy® 233** | Suitable for cold welding (joining and surfacing) on all common cast iron qualities, such as grey cast iron, malleable cast iron, and cast steel. It is also well suited for repair welding on castings showing symptoms of fatigue.<br>E.g. Repairing of engine blocks, frames of tool machines, gearboxes, reducing pieces, valve and pump bodies etc. | | | | | | | | | | | | | 160 HB | • Basic-graphite special coated electrode with a pure nickel core wire.<br>• Excellent welding properties also for welding with low amperage and well suited for welding on DC- and AC.<br>• Quietly and intensely flowing weld metal, very little spattering, easily removable slag.<br>• The weld seam is file-soft and machinable even in the transitional zone between the seam and the base material. |
| | + | + | + | | Base | | | | | | | Cu | | | |

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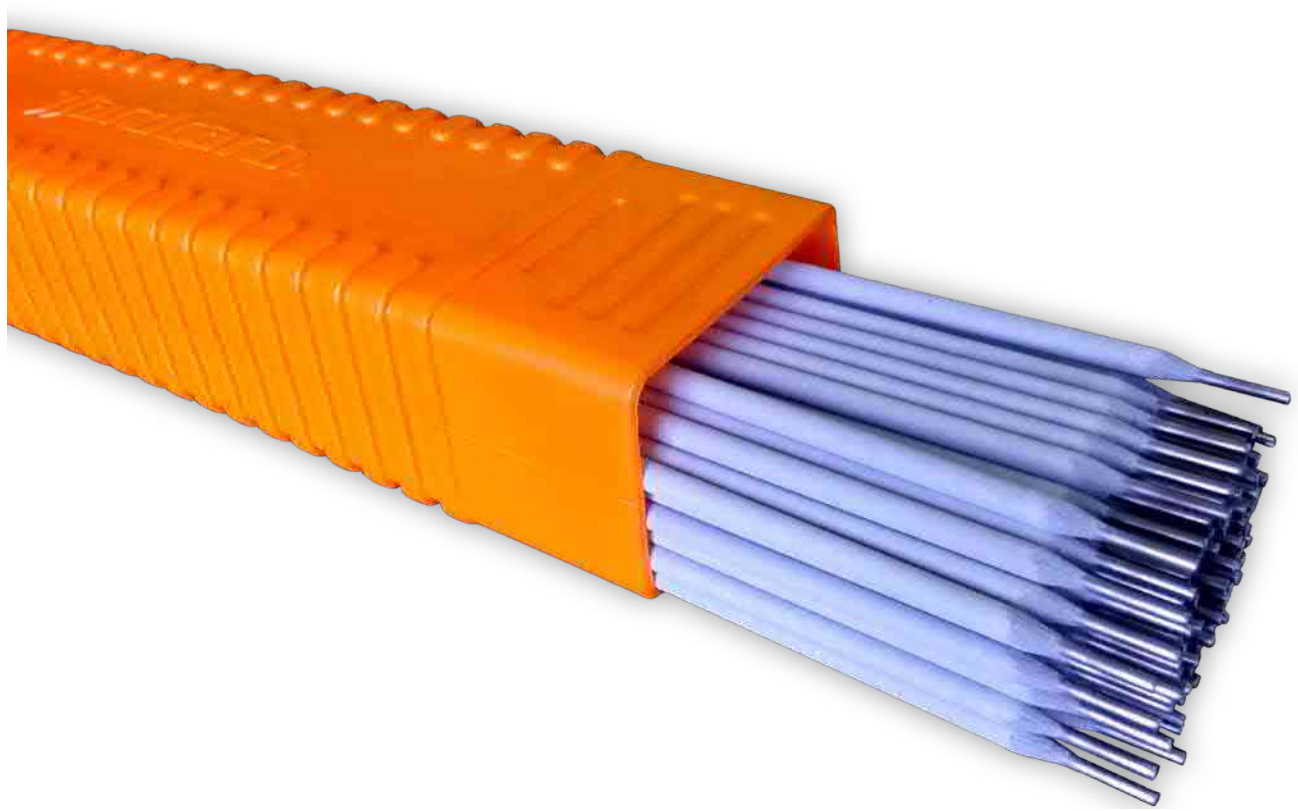
| Product | Available product forms and Classification | | | | Mechanical Properties | | | |
|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Tensile strength Rm [Mpa] | Yield strength $R_p$ 0.2% [Mpa] | Elongation A5 [%] | Impact Strength KV [J] |
| Nicrolloy® 235 | ISO 1071 E C Ni-CI 1 | | | | > 300 | > 180 | 8 | |
| Nicrolloy® 250 | ISO 1071 E C NiCu-B | | | | > 400 | > 250 | 15 | |

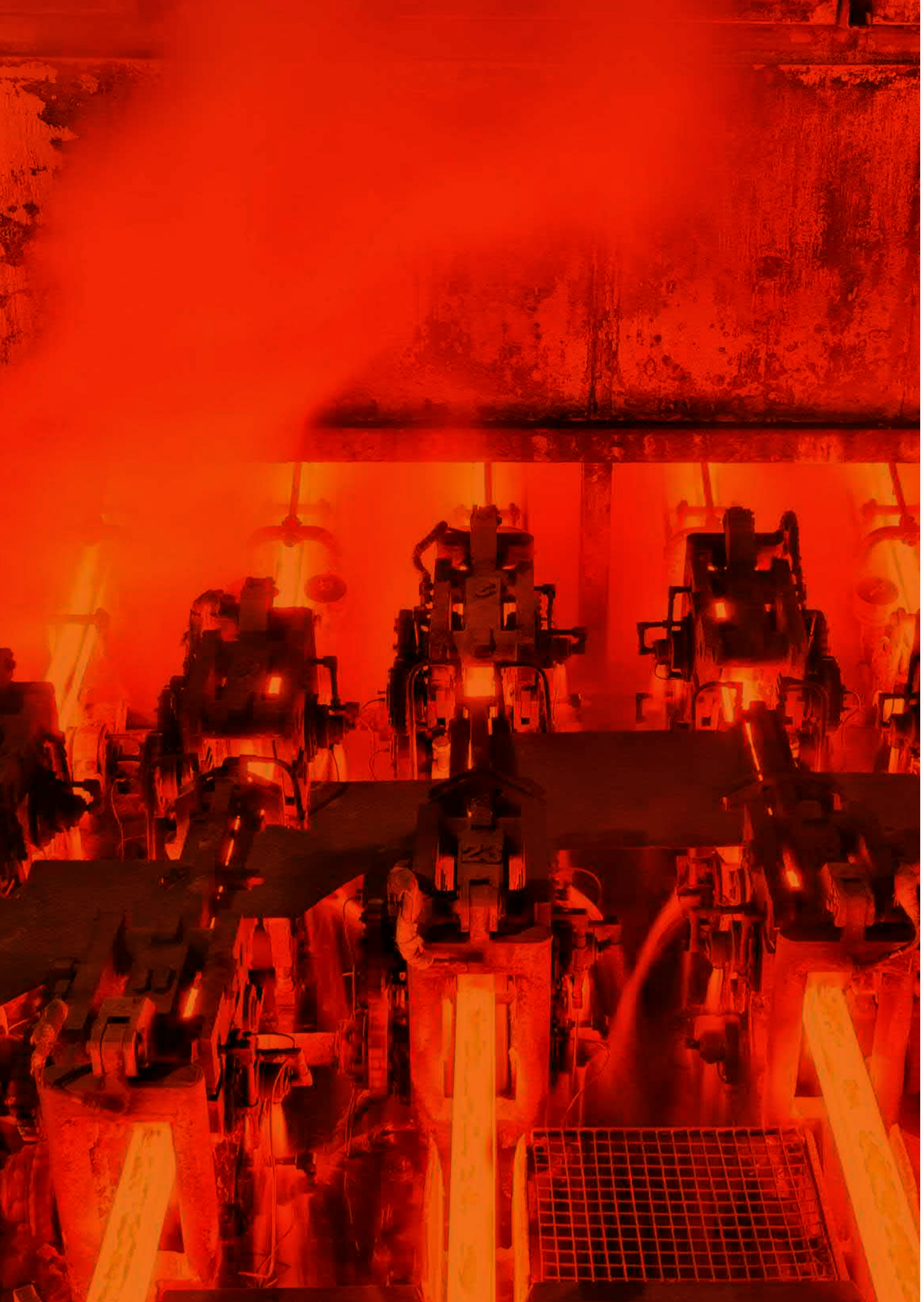
| Alloy Details | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Typical Applications | | | | | | | | | | | | Hardness | Typical properties | |
| Alloying Basis | | | | | | | | | | | | | | | |
| C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | | | |
| Suitable for cold welding on grey and malleable cast iron, cast steel as well as repair welding on castings showing symptoms of fatigue. Especially designed to weld in deep holes or on parts where the coating may touch the casting. | | | | | | | | | | | | 170 HB | • Barium free non-conductive coating, electrode with a pure nickel core wire<br>• Excellent welding properties also for welding with low amperage.<br>• Quietly and intensely flowing weld metal, very little spattering, easily removable slag.<br>• The weld seam is file-soft and machinable even in the transitional zone between the seam and the base material. | Nicrolloy® 235 |
| + | + | + | | Base | | | | | | + | Cu | | | |
| Particularly suitable for safe cold welding and repairing of grey cast iron, cast steel and malleable cast iron. Perfectly suited for repairing casting or machining defects on new castings. | | | | | | | | | | | | 170 HB | • Special coated electrode with a NiCu-alloyed core wire.<br>• Due to a near colour matching deposit and its good welding properties this electrode is suited especially for repairing casting defects.<br>• The weld metal has good stress-relieving properties and can easily be machined with cutting tools. | Nicrolloy® 250 |
| + | + | + | | Base | | | | | | + | Cu | | | |



## Selection chart for cast iron consumables

| | Nicrolloy® 201 | Nicrolloy® 210 | Nicrolloy® 211 | Nicrolloy® 222 | Nicrolloy® 230 | Nicrolloy® 233 | Nicrolloy® 235 |
|---|---|---|---|---|---|---|---|
| Buffer layer for old cast irons | ○ | ◑ | ◑ | ○ | ○ | ○ | ○ |
| "Unknown" cast iron | × | ○ | ○ | ○ | ● | ● | ● |
| Worn cast-iron | × | ◑ | ◑ | ◑ | ● | ● | ● |
| Grey cast iron | × | ○ | ◑ | ○ | ● | ● | ● |
| Nodular cast iron | × | ● | ● | ● | ○ | ○ | ○ |
| Dissimilar assemblies | × | ◑ | ● | ● | × | × | × |
| Mechanical properties of deposit | × | ◑ | ◑ | ● | ○ | ○ | ○ |
| Cracking resistance | × | ◑ | ◑ | ● | ○ | ○ | ○ |
| No overheating | × | ○ | ◑ | ● | ◑ | ○ | ○ |

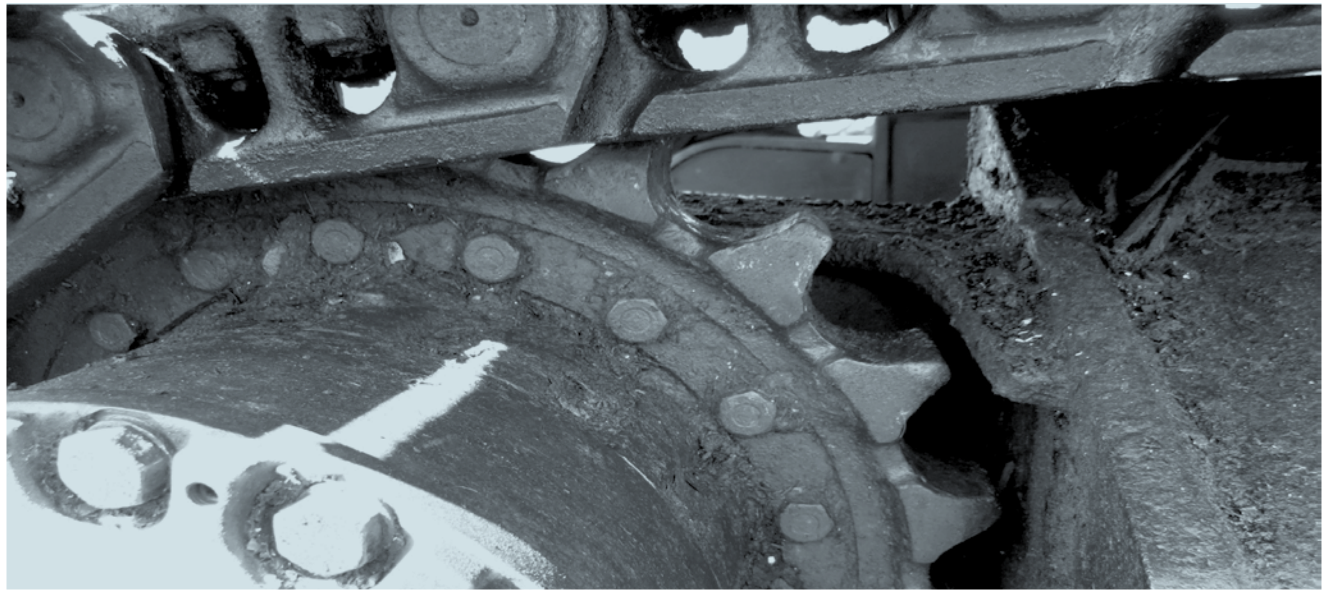
○ Satisfactory ◑ Good ● Excellent × Not suitable

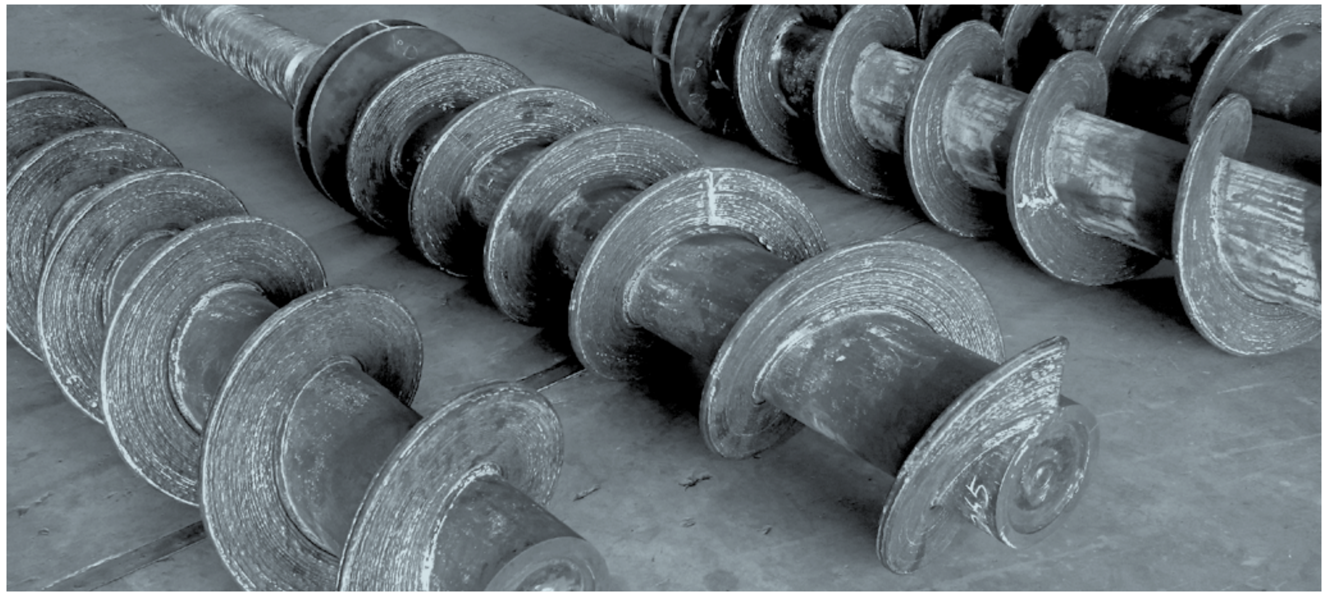


# HARDFACING / METAL-TO-METAL



2





| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |

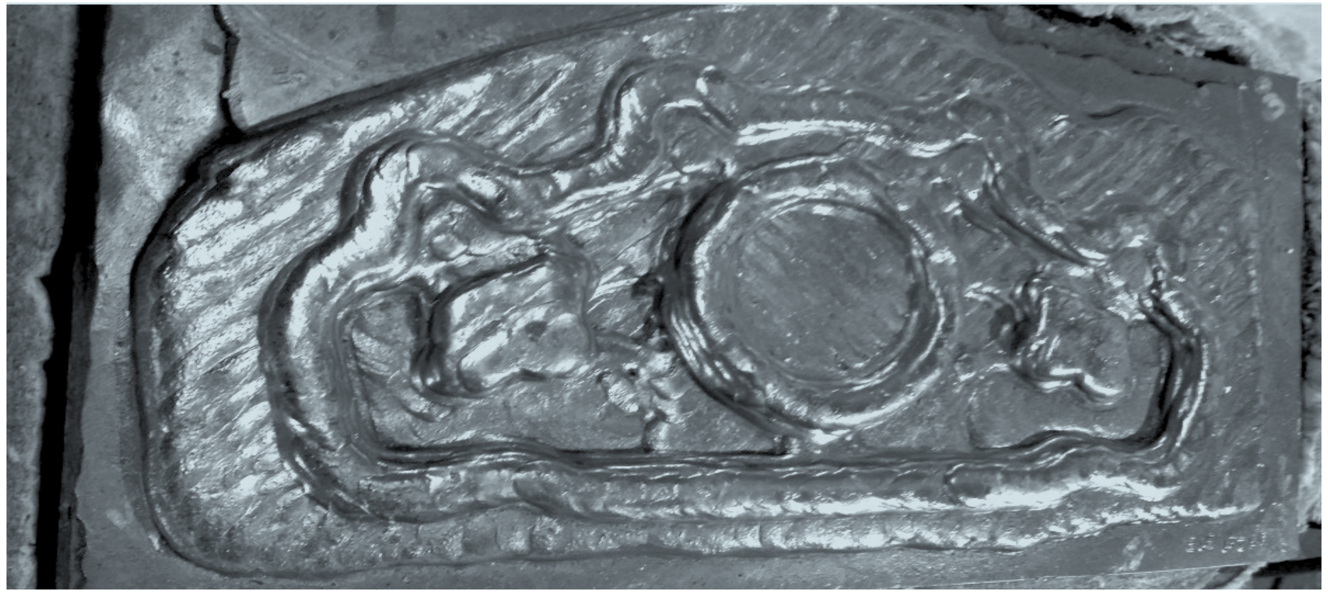
## 2.1 metal-to-metal / cold wear

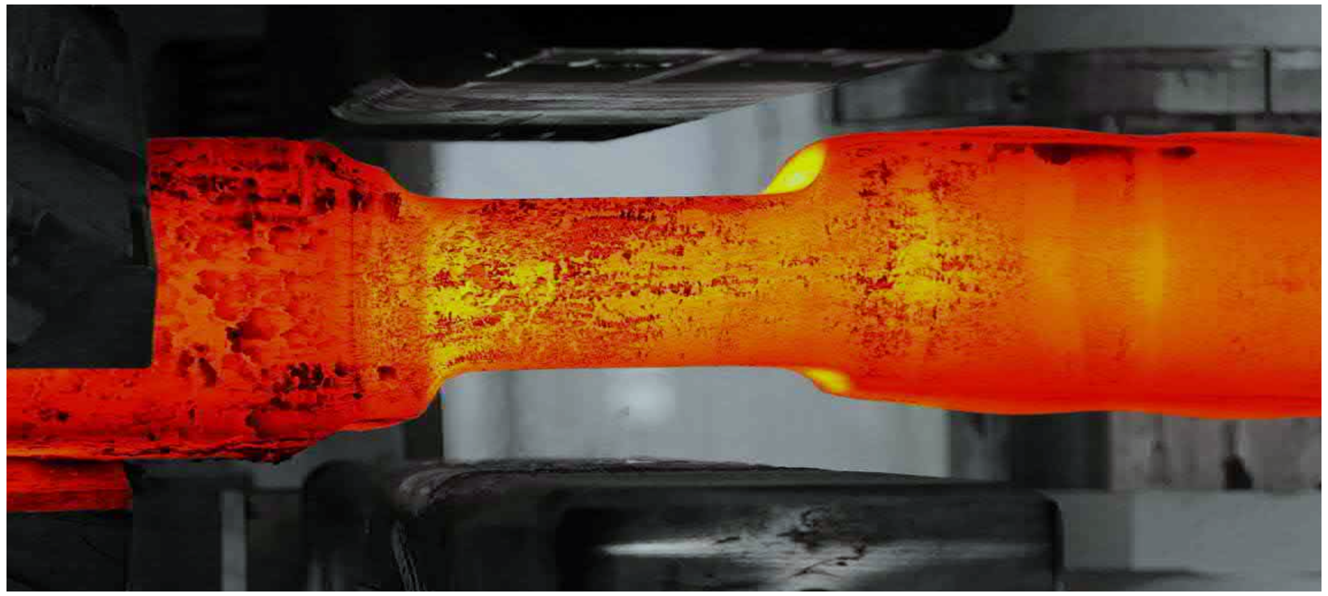
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hardcarb® MM40** | DIN EN 14700: E Fe7 | | T Fe7 | | ● | ○ | | ● | | | ● | | | | | | | |
| **Hardcarb® MM50** | DIN EN 14700: E Fe8 | | T Fe8 | | ○ | ○ | | ○ | | | ○ | | | | | | | |
| **Hardcarb® MM55** | DIN EN 14700: E Fe8 | | T Fe8 | | ● | ○ | ○ | ○ | | | ○ | | | | | | | ○ |
| **Hardcarb® MM60** | DIN EN 14700: E Z Fe8 | | T Z Fe8 | | ● | ○ | ○ | ○ | | | ○ | | | | | | | ○ |

○ suitable ● extremly suitable

| Alloy Details | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |

| Alloy Grade | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® MM40 | Mainly used for heavy build up and as a cushion layer on crane wheels, shafts, slide ways, wheel rims, conveyor screws, railroad frogs and switch points, tractor undercarriage idlers and rollers, etc. | + | + | + | + | | + | | | | | Base | | 38 - 40 HRC | • Weld deposit is a martensitic alloy with good toughness and abrasion resistance designed for all weldable steels other than austenitic stainless or manganese steels.<br>• The dense and crack-free deposit is resistant to medium friction and compression and highly resistant to shocks<br>• Deposits are within machinable range using metal-cutting tools.<br>• Surface layer hardening can be performed on machined areas. |
| Hardcarb® MM50 | For dipper shovels, dipper lips, bulldozer trunnions, drag line bucket lips, classifier screens, conveyor screws, hammers, mud pumps, buckets and impellers. | + | + | + | + | | + | | | | | Base | | 50 - 55 HRC | • Provides a martensitic deposit with considerable retained austenite.<br>• General purpose electrode, a good compromise for metal-to-metal wear, high impact and moderate abrasion.<br>• Can be used on carbon and low alloy steel parts.<br>• Deposits tend to cross check crack and are usually best limited to two layers. |
| Hardcarb® MM55 | For rollers, dredger chains, conveyors, hammers, dredger equipment, mining and earth-moving equipment | + | + | + | + | | + | | + | | | Base | | 55 - 60 HRC | • Suitable for rebuilding of machine parts (mild steel, steel castings as well as manganese steel) subject to abrasion combined with impact.<br>• The main applications are tools in the earth moving industry and crushing plants as well as cold and hot working tools.<br>• The deposit is only machinable by grinding. |
| Hardcarb® MM60 | Especially suited for crane wheels, rollers, chain links, sprocket wheels, gliding surfaces, screw conveyors, beaters, edge runners, guide wheels, baffle plates etc. | + | + | + | + | | + | | + | | | Base | | 57 - 61 HRC | • Provides a martensitic structure and is suited to hardfacings resistant to wear by impact, compression and slight abrasion.<br>• In tool shops this electrode is especially suitable for repair welding of cutting knives, stamps, punches, shear blades or forming tools.<br>• The deposit is only machinable by grinding. |





## 2.2 metal-to-metal wear / with heat (Tool Steels)

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| Hardcarb® 510 | AWS A 5.6<br>E CuSn-C | | | | ● | | | ○ | | ● | ○ | | | | ● | | ● | |
| Hardcarb® 520 | AWS A 5.6<br>E CuMnNiAl | | | | ● | | | ○ | | ● | ○ | | | | ● | | ● | |
| Hardcarb® 532 | DIN EN 14700<br>E Fe1 | | | | ○ | | ○ | ○ | | | ○ | ○ | | | | | ● | ○ |
| Hardcarb® 535 | DIN EN 14700<br>E Fe3 | | | | ○ | | ○ | | | | ○ | ○ | | | | | ● | ○ |

○ suitable ● extremly suitable

| Alloy Details | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Typical Applications / Alloying Basis | | | | | | | | | | | | Hardness | Typical properties | |
| C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | | | |
| Suitable for welding and overlaying copper and copper alloys, phosphor and tin–bronzes and copper blades in mechanical and plant engineering and also for shipbuilding. | | | | | | | | | | | | 110 HB | • Special tin bronze electrode for repairing copper and copper tin bronzes, brasses, and phosphor bronzes.<br>• Also suitable for dissimilar joints.<br>• Recommended for surfacing on brasses, wrought bronzes (CuSn), mild steel and cast steel.<br>• Good sliding and emergency running properties for bearings and contact surfaces of grey iron. | Hardcarb® 510 |
| | + | | | | | | | | | + | Sn, Cu: Base | | | |
| The low friction rate make it suitable for surfacing on slide faces, bearings, dies, ship propellers, valves, pumps shafts, pipings, evaporators, Kaplan-turbine-blades, Francis-turbines, Pelton-wheels. | | | | | | | | | | | | 210 HB | • A universal alloy to be used for joining, surfacing and building up brass, bronze, copper and normal steels.<br>• The deposits have high mechanical quality values, are resistant to corrosion, cavitation, erosion and friction.<br>• Due to good resistance against seawater and general corrosion the electrode is used mostly in the ship building and chemical industry. | Hardcarb® 520 |
| | + | | | + | | | | | | + | Al, Cu: Base | | | |
| For slab shears, hot shear blades, drawing blocks, hot forging dies, impact moulding dies, containers, swages etc. | | | | | | | | | | | | 30 - 37 HRC | • Specially developed for the repair of hot working tools, which have a high carbon content. It leaves a very hard deposit that is impact, crack and abrasion resistant.<br>• The alloy is especially suited for edge retention and for overlaying on carbon, manganese, chromium, molybdenium as well as cast steels.<br>• Hardness can be increased by thermal treatment. | Hardcarb® 532 |
| + | + | + | + | | + | | | | | Base | | | | |
| Suitable for repair and manufacturing welding of slab shears, hot-forging dies, drawing dies, containers, crushing equipment and depressions created by forging, pressure and impact stress. | | | | | | | | | | | | 34 - 38 HRC | • For high-strength, heat treatable fusion and overlay welding. Also suitable as filler for difficult to weld steels.<br>• The weld metal is highly crack resistant and is extremely suitable to resist compressive and impact stress.<br>• The alloy is used for repair and maintenance welding of all kinds of low alloyed high density steel tools. | Hardcarb® 535 |
| + | + | + | + | | + | | | | | Base | | | | |

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| **Hardcarb® 545** | DIN EN 14700: E Fe3 | | T Fe3 | | ○ | | ○ | | | | ○ | ○ | ○ | | | | ● | |
| **Hardcarb® 547** | DIN EN 14700: E Fe3 | | T Fe3 | | ○ | | ○ | | | | ● | ● | ● | ○ | | | ● | ● |
| **Hardcarb® 548** | DIN EN 14700 | | T Fe3 | | ○ | | ○ | ○ | | | ○ | ● | ● | ○ | | | ○ | ● |
| **Hardcarb® 550** | DIN EN 14700: E Z Fe3 | | T Z Fe3 | | ● | | ○ | | ○ | ○ | | | ● | ● | ○ | ○ | ○ | ● |
| **Hardcarb® 551** | DIN EN 14700: E Fe3 | | | | ○ | | ○ | | | | ○ | ○ | ○ | | | | ○ | ● |
| **Hardcarb® 554** | DIN EN 14700: E Fe3 | | T Fe3 | | ○ | | ○ | | | | ○ | ○ | ○ | ○ | | | ○ | ● |
| **Hardcarb® 555** | DIN EN 14700: E Fe3 | | | | ○ | | ○ | | | | ○ | ○ | ○ | ○ | | | ○ | ● |

○ suitable ● extremly suitable

| Alloy Details | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Typical Applications / Alloying Basis | | | | | | | | | | | | | Hardness | Typical properties |
| | | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | | |
| Hardcarb® 545 | Well suited for bells and hopper seats in blast furnaces, moulds for light alloys, forging tooling, chain links, rolling mill guides, pulleys, ingot tongs, etc. | + | + | + | + | + | + | | | + | | Base | | 45 - 50 HRC | • Produces a martensitic deposit giving good resistance to metal-to-metal wear and low stress abrasive wear with impact up to 600°C.<br>• Specially developed for rebuilding and buffering on very large components and alloyed steels which are subjected to high pressures and abrasion.<br>• Crack free multiple layer deposits are achievable. |
| Hardcarb® 547 | Hot and cold forging tools, hot work extrusion mandrels, drills, cutting edges on hot cutting tools. E.g. slab shears, hot shear blades, drawing blocks, hot forging dies, impact moulding dies, containers, swages etc. | + | + | + | + | + | | | + | + | | Base | | 45 - 50 HRC (as welded)<br>50 - 55 HRC (heat-treated) | • Deposits a medium hardness martensitic alloy of hard, tough tool steel composition offering exceptional oxidation resistance and hot toughness up to 600°C.<br>• Used for surfacing parts subjected to heavy compressive stresses and moderate abrasion or metal-to-metal wear, combined with mechanical and thermal shocks. |
| Hardcarb® 548 | For build-up of tool steel dies and edges, or applying wear resistance surface on carbon or low alloy steels. E.g. Moulds for moulded glass, pressure casting of light alloys and impact forging tools etc. | + | + | + | + | | + | | + | + | | Base | | 48 - 52 HRC (as welded)<br>55 - 57 HRC (heat-treated) | • Deposits a premium martensitic alloy of hard, tough tool steel composition. Excellent resistance to adhesive (metal-to-metal) wear and good resistance to abrasion and impact.<br>• Offers exceptional oxidation resistance and hot toughness up to 600°C.<br>• Because of its high hardenability, proper preheat may be required for crack-free deposits. |
| Hardcarb® 550 | Hardfacing of forging presses, hot piercing dies, valves for diesel engines, steam valves, moulds for ceramic tiles, screws for filled plastic, stretching rolls, pinch rolls, hot strip mill table rolls and back-up rolls. | + | + | + | + | + | + | | | | + | Base | | 47 - 51 HRC (as welded)<br>55 HRC (work-hardened) | • Superalloy offering similar performance to cobalt based alloys.<br>• The weld metal exhibits high resistance to metal-to-metal friction, cavitation, corrosion and fatigue wear and provides an extremely high level of oxidation resistance when exposed to high temperatures.<br>• High cracking resistance little affected by dilution; may be polished and keeps its properties to 550°C. |
| Hardcarb® 551 | Well suited for slab shears, hot-forging dies, drawing dies, containers, crushing equipment and depressions created by forging, pressure and impact stress. | + | + | + | + | + | + | | + | + | | Base | | 51 - 55 HRC | • Produces a martensitic deposit giving good resistance to metal-to-metal wear and low stress abrasive wear with impact up to 600°C.<br>• Specially developed for rebuilding large components and alloyed steels which are subjected to high pressures and abrasion.<br>• Suitable for repair welding as well as new production of hot work tools operating in service temperatures up to 600°C. |
| Hardcarb® 554 | For overlays on cutting edges of hot shearing tools, plier heads, cutting edges of deburring tools, punching tools, continuous cast rollers. Hardfacing of cylinders and rolls of plate levelling devices. | + | + | + | + | | + | | | | | Base | Ti | 52 - 56 HRC | • Forms a martensitic weld deposit highly resistant to metal-to-metal wear up to 550°C, to pressure and to impacts.<br>• Suitable for repair welding as well as new production of hot work tools operating in service temperatures up to 550°C.<br>• In order to improve the toughness of weld metal and heat affected zone of the base material, a post weld heat treatment is recommended. |
| Hardcarb® 555 | Particularly recommended for hardfacing hot and cold working trimming dies, pressing and blanking dies, hot and cold shear blades like hot billet shears, rotary-shear-knives, hot and cold forming and drawing dies. | + | + | + | + | | + | | + | + | | Base | | 50 - 55 HRC | • Specially designed alloy for high wear resistant hardfacings on hot and cold working tools.<br>• The deposit has a crack-free martensitic structure containing high wear-resistant chromium, molybdenum, tungsten and other carbides. |

hardcarb

| Product | Available product forms and Classification | | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| Hardcarb® 556 | DIN EN 14700 | E Fe5 | | T Fe5 | | ● | | | ○ | | ○ | ○ | ● | ● | | ○ | | ● | ● |
| Hardcarb® 559 | DIN EN 14700 | E Fe3 | | T Fe3 | | ○ | | ○ | | | | ○ | ○ | ○ | | | | ○ | ● |
| Hardcarb® 560 | DIN EN 14700 | E Z Fe5 | | | | ● | | ○ | | | | ● | | ● | | | | ○ | ● |
| Hardcarb® 561 | DIN EN 14700 | E Fe4 | | T Fe4 | | ● | | ● | ○ | ○ | ○ | ● | | ● | ● | ○ | | ○ | ● |
| Hardcarb® 5555 | DIN EN 14700 | E Ni2 | | | | ○ | | ○ | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| Hardcarb® 5566 | DIN EN 14700 | E Ni2 | | | | ○ | | ● | | | ○ | ○ | ○ | ○ | ● | ○ | ○ | ○ | |
| Hardcarb® 5577 | DIN EN 14700 | E Ni2 | | | | ○ | | ● | | | ○ | ○ | ○ | ○ | ● | ○ | ○ | ○ | |

○ suitable ● extremly suitable

| Alloy Details | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Typical Applications / Alloying Basis | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
| Hardcarb® 556 | Used for repair, preventive maintenance and production of highly stressed cold and hot working tools, such as punching tools, cold shears for thick materials, drawing, stamping and trimming tools, etc. | + | + | + | | + | + | | | | + | Base | Ti | 34 - 37 HRC (as welded)<br>50 - 54 HRC (heat-treated) | • Forms a martensitic weld deposit highly resistant to metal-to-metal wear up to 350°C. Designed for repairing die steels specifically huge volume pressing tools with particular reference to H 13 and maraging steels.<br>• The weld deposit is easily machinable and subsequent age hardening opitmises the resistance to wear and alternating temperatures. |
| Hardcarb® 559 | For shear blades, dies, upper and lower dies, mandrel plugs, hammer mills, swages, crushing and pulverising plants, cutting edges etc. | + | | | + | | + | | | + | | Base | | 55 - 59 HRC (as welded)<br>59 - 62 HRC (heat-treated) | • Produces a martensitic weld deposit giving good resistance to metal-to-metal wear and low stress abrasive wear with impact up to 450°C.<br>• Suited for repairing hot working tools made of steels of same or similar type.<br>• The alloy excels by good edge-holding quality and the weld metal structure can be further improved by heat treatment. |
| Hardcarb® 560 | Slotting and threading tools, spiral drills, reamers, milling cutters (for materials over 880 $N/mm^2$), repair work on blades, cold working punches and dies. | + | + | + | + | | + | | + | + | | Base | | 60 - 64 HRC (as welded)<br>64 - 66 HRC (heat-treated) | • Produces a martensitic weld deposit with C-Cr-Mo-V-W that is is highly resistant to friction, compression and impact, also at elevated temperatures up to 600° C.<br>• Desgined for hardfacing high-speed steel tools and low alloyed base materials and for reinforcing cutting edges.<br>• The weld metal has good tempering properties and allows heat treatment like other high-speed steels. |
| Hardcarb® 561 | Slotting and threading tools, spiral drills, reamers, milling cutters (for materials over 880 $N/mm^2$), repair work on blades, cold working punches and dies. | + | + | + | + | | + | | + | + | + | Base | | 60 - 64 HRC (as welded)<br>64 - 66 HRC (heat-treated) | • Designed for hardfacing high-speed steel tools and low alloyed base materials and for reinforcing cutting edges.<br>• The weld metals high tungsten content provides excellent edge-holding quality.<br>• The weld metal has good tempering properties and allows heat treatment like other high-speed steels of similar composition. |
| Hardcarb® 5555 | For hot working tools such as hot forging dies, hot shear blades, punches, swages, hammer saddles, dies, press tools, milling rolls and valves. | + | + | + | + | Base | + | | | + | | + | | 230 HB (as welded)<br>400 HB (work-hardened) | • Nickel-based super-alloy for welding NiMoCr alloys such as Hastealloy C 276. The resulting deposit is resistant to corrosion under oxidising and reducing atmospheres.<br>• Weld metal is designed to withstand impact, compression, abrasion, oxidation, corrosion and heat up to 1100°C.<br>• Excellent thermal shock resistance<br>• Can be machined without previous heat treatment |
| Hardcarb® 5566 | Surfacing of hot working tools as hot forging dies, hot shear blades, punches, swages, dies, press tools, milling rolls and valves, etc | + | + | + | + | Base | + | | | + | + | + | | 230 HB (as welded)<br>400 HB (work-hardened) | • Cobalt hardened super-alloy of the NiCrMoW type that is particularly resistant to corrosion under oxidising and reducing atmospheres.<br>• Weld metal is designed to withstand impact, compression, abrasion, oxidation, corrosion and heat up to 1100°C<br>• Excellent thermal shock resistance<br>• Can be machined without previous heat treatment |
| Hardcarb® 5577 | Chemical, petrochemical, oil and gas, process, and marine industries | + | + | + | + | Base | + | | | + | | + | | 200 HB | • High NiCrMoW alloyed nickel based electrode for joining duplex, super-duplex and super austenitic stainless steels as well as similar nickel alloys. The resulting deposit is resistant to corrosion on a high level.<br>• Overlays of the alloy are extraordinarily tough and harden with impact stress and high temperatures to about 400 HB without deforming the deposit. |

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| Hardcarb® 5588 | E Z Ni4 (DIN EN 14700) | | | | ○ | | ● | | | ○ | ○ | ● | ● | ● | ○ | ● | ○ | |

| Alloy Details: Typical Applications / Alloying Basis | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot forging dies and the exposed areas of tooling for hot upsetting, shearing and extrusion. | | | | | | | | | | | | | 250 HB (as welded)<br>400 HB (work-hardened) | • Nickel based superalloy offering extreme resistance to high temperature stress and thermal shock.<br>• The deposits provide optimum strength and oxidation resistance above 900°C up to 1250°C, especially when welding on NiFeCr-base alloys.<br>• Hardenable by heat treatment and by cold work<br>• Machinable using carbide tools | Hardcarb® 5588 |
| Alloying Basis | + | + | + | + | Base | + | | | | + | + | Al | | | |

## 2.3 metal-to-metal wear / with corrosion & thermal fatigue

| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® 5410 | | | T Fe7 (DIN EN 14700) | | ● | | | | | ○ | | ● | ● | ○ | ○ | | ○ | |
| Hardcarb® 5414 | | | T Z Fe7 (DIN EN 14700) | | ● | | | | | | | ● | ● | ○ | ○ | | ● | |
| Hardcarb® 5414N | | | T Z Fe7 (DIN EN 14700) | | ● | | | | | | | ● | ● | ○ | ○ | | ● | |
| Hardcarb® 5420 | | | T Fe8 (DIN EN 14700) | | ● | | | | | | | ● | ● | ○ | | | ○ | |
| Hardcarb® 5430 | | | T Fe7 (DIN EN 14700) | | ● | | | | | ○ | | ● | ● | ○ | ○ | | ● | |

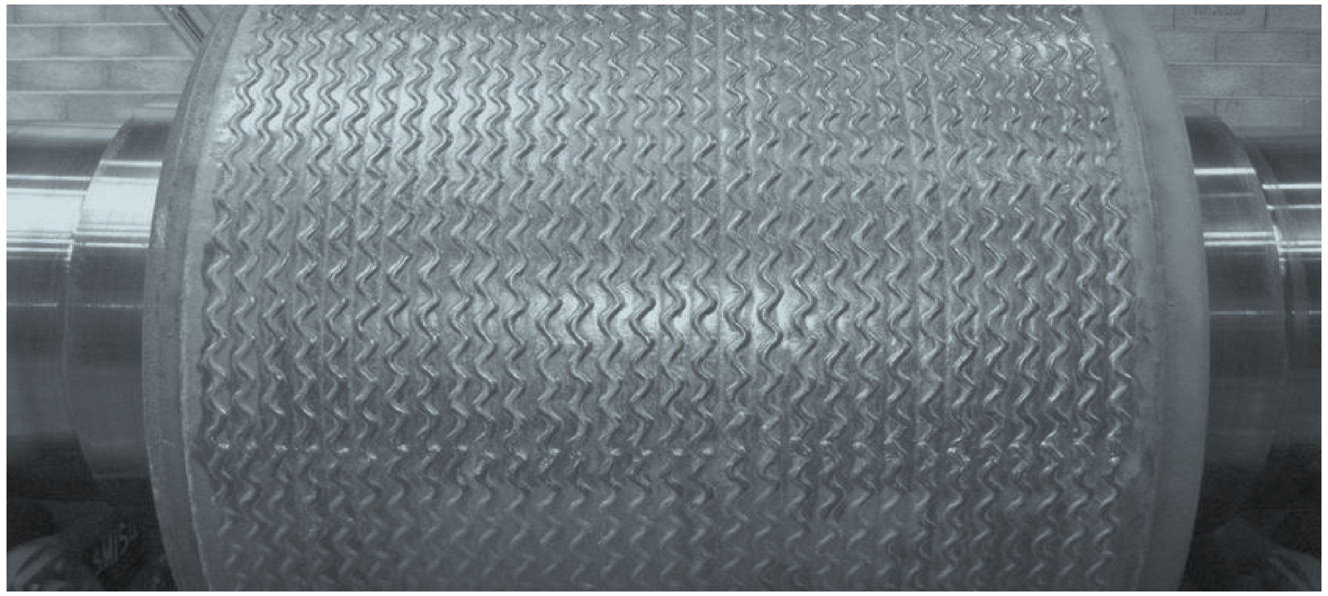
| Typical Applications / Alloying Basis | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Used for hardfacing continuous casting rolls, steam turbine components, centrifugal pump impellers, valve seats, valve gates, valve wedges, safety valves etc. | | | | | | | | | | | | | 40 - 43 HRC | • A 13% chromium martensitic stainless steel deposit for plating and joining equal and similar ferritic Cr-steels and cast steels. Proper weldings are subject to the recommended heat treatment.<br>• The deposit is resistant to seawater, thin acids and scale resistant in air and oxidizing gases up to 950°C. The deposits can be tempered. | Hardcarb® 5410 |
| Alloying Basis | + | + | + | + | | | | | | | Base | | | | |
| Typical applications include cladding of continuous caster rolls and certain rolls used in hot rolling applications, steam turbine components, valve seats, valve gates, valve wedges, safety valves etc. | | | | | | | | | | | | | 38 - 42 HRC | • A Ferritic-martensitic stainless steel weld deposit with additions of Nickel and Molybdenum.<br>• Highly suitable for cladding of continuous casting rolls, pinch rolls and wrapper rolls subject to repetitive thermal stresses, corrosion and metal-to-metal wear. .<br>• The alloy has high hardness and excellent wear and galling resistance | Hardcarb® 5414 |
| Alloying Basis | + | + | + | + | + | + | | | | | Base | | | | |
| Typical applications include cladding of continuous caster rolls and certain rolls used in hot rolling applications, steam turbine components, valve seats, valve gates, valve wedges, safety valves etc. | | | | | | | | | | | | | 40 - 44 HRC | • Nitrogen bearing martensitic stainless steel alloy containing nickel, molybdenum and other grain refining additions.<br>• The material has excellent thermal fatigue, corrosion and metal-to-metal wear resistance at elevated temperatures.<br>• The alloy is specially designed for cladding continuous casting rolls. | Hardcarb® 5414N |
| Alloying Basis | + | + | + | + | + | + | | | | | Base | N | | | |
| Extensively used as a cladding alloy on many types of steel industry rolling mill rolls such as table rolls, pinch rolls, scale breaker rolls, coiler rolls, leveller rolls and runout table rolls. | | | | | | | | | | | | | 48 - 52 HRC | • A 13% chromium martensitic stainless steel deposit.<br>• Attractive combination of corrosion, oxidation, scaling and wear resistance.<br>• Used for hardfacing and reclaiming components subject to moderate corrosion and metal-metal wear.<br>• The deposited alloy also has excellent gouging and abrasion resistant properties. | Hardcarb® 5240 |
| Alloying Basis | + | + | + | + | | | | | | | Base | | | | |
| For anti-corrosion coatings or buffer layer before martensitic stainless steel coatings. Examples: continuous casting rolls, valves seats, shafts, pump bodies and rotors | | | | | | | | | | | | | 220 HB | • 17% chromium ferritic stainless steel deposit.<br>• Optimum combination of corrosion, frictional wear and temperature resistance. Resists sea water and dilute organic acids.<br>• Can be polished | Hardcarb® 5430 |
| Alloying Basis | + | + | + | + | | | | | | | Base | | | | |

○ suitable ● extremly suitable

## HARDFACING / METAL-TO-EARTH



3



| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| **3.1 metal-to-earth wear / severe impact** | | | | | | | | | | | | | | | | | | |
| Hardcarb® 60 (DIN EN 14700) | E Fe9 | T Fe9 | T Fe9 | | | | | | | ○ | ● | | | | ○ | ● | ○ | |
| Hardcarb® 65 (DIN EN 14700) | E Fe9 | | T Fe9 | | | | | ○ | ○ | | ● | | | | | ● | ○ | |
| **3.2 metal-to-earth wear / high stress, high abrasion** | | | | | | | | | | | | | | | | | | |
| Hardcarb® 70 (DIN EN 14700) | E Fe8 | | T Fe8 | | | ○ | | ● | ○ | | ● | | | | | | | |

○ suitable ● extremly suitable

| Alloy Details: Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hardcarb® 60**: Primarily used for surfacing and building up manganese steel components such as crusher jaws, crushing hammers, excavator teeth, gyratory mantles, blowbars, dredge pump cutters, rail switch cores, etc. | + | + | + | + | | | | | | | Base | | 250 HB (as welded)<br>500 - 550 HB (work hardened) | • Due to the weld metals' high tenacity and hardness, the electrode is suitable for hardfacing on parts which are subject to extreme impact stress and cavitation.<br>• Excellent for build-up on carbon steel prior to chromium carbide hardfacing deposit. Unlimited layers are possible.<br>• Machinable with metallic carbides or Cubic Boron Nitride (CBN) tipped tools. |
| **Hardcarb® 65**: Crusher hammers, gyratory crusher mantles, crusher rolls, automobile shredder hammers. | + | + | + | + | | | + | | | | Base | Ti | 250 HB (as welded)<br>500 - 550 HB (work hardened) | • High Chromium-Manganese alloy enriched with Niobium, designed to resist abrasion and solid erosion wear combined with heavy impact.<br>• Machinable with metallic carbides or Cubic Boron Nitride (CBN) tipped tools. |
| **Hardcarb® 70**: Crushing of hard materials, shredders, asphalt kneaders, crusher hammers, vertical shaft impact crusher rotors, roller presses, bucket teeth and lips, screws, etc. | + | + | + | + | | + | | | | | Base | Ti | 55 HRC | • Martensitic Chromium-Titanium alloy designed to resist a combination of abrasion, high pressure and high impact. Contains extremely hard finely dispersed titanium carbides.<br>• The weld deposit is crack resistant, magnetic and cannot be machined as-welded.<br>• Applicable in thick layers on large parts. |

| Product: Alloy Grade | Available product forms and Classification | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Anti-Wear Suitability: Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Workability: Work Hardening | Machining | Edge retention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hardcarb® 72** | DIN EN 14700 | E Fe8 | | T Fe8 | | | ○ | | ○ | ○ | | ● | | | | | | | |
| **Hardcarb® 75** | DIN EN 14700 | | | T Fe8 | | | ○ | | ○ | ○ | | ○ | | | | | | | |
| **Hardcarb® 77** | DIN EN 14700 | E Fe8 | | T Fe8 | | ○ | | ○ | ○ | | | ○ | | | | | | | |

| Alloy Grade | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® 72 | Crushing of hard materials, shredders, asphalt kneaders, crusher hammers, vertical shaft impact crusher rotors, roller presses, bucket teeth and lips, screws, etc. | + | + | + | + | | + | + | + | + | | Base | | 55 HRC | • Martensitic Chromium-Niobium alloy designed to resist abrasion with heavy impact. Contains extremely hard niobium carbides.<br>• The weld deposit is crack resistant, magnetic and cannot be machined as-welded.<br>• Applicable in thick layers on large parts. |
| Hardcarb® 75 | Hardbanding of drilling pipes, crushing of hard materials, roller presses, bucket teeth and lips, screws, etc. | + | + | + | + | | | + | | + | | Base | B | 60 HRC | • Special crack-free martensitic Chromium-Niobium alloy enhanced with boron to resist high stress abrasive wear.<br>• The weld deposit is crack resistant, magnetic and cannot be machined as-welded. |
| Hardcarb® 77 | Crusher Rolls, dredge pump impellers, impact breaker bars, hammermill hammers, dipper teeth and lips, dippers/dragline buckets, muller tires, scraper cutter and sides | + | + | + | + | | + | | | | | Base | | 40 - 52 HRC | • An all-position welding hardfacing electrode which provides good resistance to abrasion, impact and some metal-to-metal wear<br>• Good hot forging properties and can be forged readily without affecting its mechanical properties<br>• It bonds well with carbon, low alloy and manganese steels and resists spalling.<br>• Deposits should be limited to three layers and cannot be machined |

## 3.3 metal-to-earth wear / high impact, high abrasion

| Product: Alloy Grade | Available product forms and Classification | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Anti-Wear Suitability: Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Workability: Work Hardening | Machining | Edge retention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hardcarb® 105** | DIN EN 14700 | E Fe6 | | T Fe6 | | ○ | ○ | | ○ | ○ | | ○ | | | | | | | |
| **Hardcarb® 110** | DIN EN 14700 | E Fe13 | | T Fe13 | | ○ | ○ | ○ | ○ | ○ | | ○ | | | | | | | ○ |
| **Hardcarb® 180** | DIN EN 14700 | E Fe14 | | T Fe14 | | | ○ | | | | | ○ | | | | | | | |
| **Hardcarb® 185** | DIN EN 14700 | E Fe15 | | T Fe15 | | | ○ | | | | | ○ | | | | | | | |

| Alloy Grade | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® 105 | Typical applications are hardfacing of dredging bucket front edges, top coats of pick hammers, repair of cyclone and sifter components, repair of installed wear parts. | + | + | + | + | | | | | | | Base | B | 58 - 63 HRC | • Perfectly suited for parts subjected to strong abrasion and moderate shock stresses as well as metal-to-metal wear.<br>• Particularly suited for the hardfacing of edges.<br>• The various possible welding positions enable also regeneration of installed parts.<br>• The weld deposit is magnetic and cannot be machined. |
| Hardcarb® 110 | Component parts for crushing of minerals, dredger teeth, briquetting press tools, moulds for the ceramic and brick industry, mixing wings, feed screws, shredders, hammer mills, crushing bars | + | + | + | + | | + | | + | | | Base | B | 61 - 65 HRC | • Martensitic weld material with embedded Cr- V- Mo- carbides.<br>• The weld deposit is crack resistant, has a high hardness and is creep resistant up to 500 ° C.<br>• Well suited for the hardfacing of edges.<br>• The various possible welding positions enable easy regeneration of installed parts.<br>• The weld deposit is magnetic and cannot be machined. |
| Hardcarb® 180 | Cone crushers, garbage shredders, pick hammers, dredger teeth, crusher rolls and guide rails. | + | + | + | + | + | + | | | | | Base | | 50 - 55 HRC | • Sub-eutectic hard alloy specially designed to resist abrasion with high impact.<br>• The weld material exhibits cracks and cannot be machined. However, machining of the annealed material is possible. |
| Hardcarb® 185 | Pumps, mixer parts, conveyer screws, shovel-bucket, scrapers, fan blades | + | + | + | + | | | | | | | Base | B | 56 - 62 HRC | • Martensitic matrix with a high content of Cr-Carbides having good resistance to high abrasion and medium-high impact up to 350°C.<br>• The weld material exhibits cracks and cannot be machined. |

○ suitable ● extremly suitable

## 3.4 metal-to-earth wear / severe abrasion

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| Hardcarb® 190 | DIN EN 14700: E Fe15 | T Fe15 | T Fe15 | | | ● | | | | | | | | | | | | |
| Hardcarb® 200 | DIN EN 14700: E Fe15 | T Fe15 | T Fe15 | | | ● | | | | | ○ | | | | | | | |
| Hardcarb® 210 | DIN EN 14700: E Fe15 | | T Fe15 | | | ● | ○ | | | | ○ | | | | | | | |

○ suitable ● extremly suitable

Alloy Details:

| Alloy Grade | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® 190 | Screws, wearplate manufacturing, dredging bucket front edges, vibro-screens, mixer blades, sand slingers, fan blades, top coats on earth engaging tools, crushing rolls, slurry pipes and elbows, etc. | + | + | + | + | | | | | | | Base | | 58 - 63 HRC | • Austenitic, primary carbide-containing weld deposit designed to resist severe mineral abrasion with low-to-moderate impact.<br>• The material cannot be flame cut and cannot be machined.<br>• The weld deposit exhibits stress-relieving cracks |
| Hardcarb® 200 | Mixer blades, wearplate manufacturing, screws, agitator arms, concrete pumps, pulverizor mill parts, bucket teeth, fan blades, top coats on earth engaging tools, crushing rolls, slurry pipes and elbows, etc. | + | + | + | + | | | | | | | Base | B | 60 - 64 HRC | • Highly versatile austenitic, primary carbide-containing weld deposit designed for applications subject to strong abrasive wear by minerals, combined with moderate impact, medium shocks and compression.<br>• The material cannot be flame cut, offers good resistance to scaling and cannot be machined.<br>• The weld deposit exhibits stress-relieving cracks |
| Hardcarb® 210 | Mixer blades, wearplate manufacturing, screws, agitator arms, concrete pumps, pulverizor mill parts, bucket teeth, fan blades, top coats on earth engaging tools, crushing rolls, slurry pipes and elbows, etc. | + | + | + | + | | + | | | | | Base | B | 60 - 64 HRC | • Austenitic, primary carbide-containing weld deposit designed for applications subject to strong abrasive wear by minerals, combined with moderate impact, medium shocks and compression.<br>• Highly suitable for hardfacing thick sections.<br>• The material cannot be flame cut, offers good resistance to scaling and cannot be machined. Suitable upto 450°C.<br>• The weld deposit exhibits stress-relieving cracks |

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| **3.5 metal-to-earth wear / abrasion with corrosion** | | | | | | | | | | | | | | | | | | |
| Hardcarb® 300 | DIN EN 14700 E Fe14 | | T Fe14 | | ○ | ○ | ○ | | | | ○ | | | | ○ | | | |
| Hardcarb® 310 | DIN EN 14700 E Fe14 | | T Fe14 | | ○ | ● | | | | | ○ | | | | ○ | | | |
| Hardcarb® 320 | DIN EN 14700 E Fe14 | | T Fe14 | | | ● | ○ | | ○ | | | | | | ○ | | | |
| **3.6 metal-to-earth wear / severe abrasion with erosion** | | | | | | | | | | | | | | | | | | |
| Hardcarb® 400 | DIN EN 14700 E Fe15 | | T Fe15 | | | ● | | | ○ | | | | | | | | | |
| Hardcarb® 410 | DIN EN 14700 E Fe15 | | T Fe15 | | | ● | | | ● | | | | | | | | | |
| Hardcarb® 415 | DIN EN 14700 E Fe15 | | T Fe15 | | | ● | | | ● | | | | | | | | | |
| Hardcarb® 420 | DIN EN 14700 E Z Fe13 | | T Z Fe13 | | | ● | | | ● | | | | | | | | | |

○ suitable ● extremly suitable

| Alloy Details | Typical Applications / Alloying Basis | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® 300 | Low-cost Stellite-6 substitute for parts subjected to shock and wear. Widely used in the meat processing industry, food industry for vegetable oil extrusion presses, chemical industry, agitator parts in the pulp and paper industry, etc. | + | + | + | + | + | + | | | | | Base | | 36 - 43 HRC | • A high carbon - chromium austenitic plus carbide alloy steel suited to overlay surfaces subjected to light abrasion accompanied by impact, heat and corrosion.<br>• It has excellent metal-to-metal frictional wear resistance, and the deposit retains hardness at temperatures up to 650 °C.<br>• Depending on the part geometry and the preheating temperature, the weld material can be deposit crack-free under slow cooling. |
| Hardcarb® 310 | Particularly suitable for roughening the wet mill rollers used in the sugar cane crushing process. Can also be used for pump bodies, mixer blades and agitator arms. | + | + | + | + | | | + | | | | Base | | 50 - 60 HRC | • Suitable for applications subject to strong abrasive wear combined with moderate impact, medium shocks and compression as well as humidity or wetness.<br>• The alloy has excellent weldablity in dry arcing as well as in wet condition when roller is soaked in cane juice.<br>• Higher co-efficient of friction provides extremely good gripping properties for the roller. |
| Hardcarb® 320 | Especially suited for components prone to wear in coke ovens employing wet-quenching process. Also suitable for pumps, impeller screws, mixer blades and agitator arms. | + | + | + | + | + | | | | | | Base | B | 58 - 63 HRC | • Suitable for applications subject to strong abrasive wear combined with moderate impact, medium shocks, elevated temperature and corrosion.<br>• Recommended for use over stainless steel base materials.<br>• Weld material exhibits low shock resistance and deformation of the parts after hardfacing is only limited.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 400 | Recommended for compressing and conveying screws, dust ducts, parts of sifters and cyclones, chutes, fans etc. Suitable for single layer hardfacing due to high hardness in the first layer itself. | + | + | + | + | | | | | | | Base | B | 62 - 66 HRC | • Recommended particularly for the hardfacing of parts subjected to high abrasion and erosion with little or no shock stress.<br>• Boride and carbide inclusions generate a high resistance against abrasion and fine particle erosion.<br>• Weld material exhibits low shock resistance and deformation of the parts after hardfacing is only limited.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 410 | Concrete-industry, mixer parts, scrapers, fans, dust ducts, parts of sifters and cyclones, etc. | + | + | + | + | + | + | | + | + | | Base | B | 60 - 65 HRC | • Recommended particularly for the hardfacing of parts subjected to high abrasion and erosion with moderate shock stress.<br>• Complex carbides in combination with borides generate a high resistance against abrasion and fine particle erosion.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 415 | Concrete-industry, mixer parts, scrapers, fans, dust ducts, parts of sifters and cyclones, etc. | + | + | + | + | + | + | + | + | + | | Base | B | 60 - 65 HRC | • Recommended particularly for the hardfacing of parts subjected to high abrasion and erosion with moderate shock stress.<br>• Complex carbides in combination with borides generate a high resistance against abrasion and fine particle erosion.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 420 | Dredges, concrete pumps, driving Screws, fan blades, fine particle wearing parts, etc. | + | + | + | | + | | | | | | Base | B | 65 - 68 HRC | • The weld deposit is ideal for parts subjected to moderate impact, metal-to-metal friction and severe fine particle abrasion as well as erosion.<br>• It gives a full martensitic deposit which is rich in iron-borides and iron carbides.<br>• The weld deposit exhibits cracks and cannot be machined. |


N-3

hardcarb.

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| **Hardcarb® 430** | DIN EN 14700 E Fe15 | | T Fe15 | | | ● | | | ● | | | | | | | | | |
| **Hardcarb® 433** | DIN EN 14700 E Fe15 | | T Fe15 | | | ● | | | ● | | | | | | | | | |
| **Hardcarb® 440** | DIN EN 14700 E Fe15 | T Fe15 | T Fe15 | | | ● | | | ● | | | | | | | | | |
| **Hardcarb® 450** | DIN EN 14700 E Fe16 | | T Fe16 | | | ● | ○ | | ● | | | | | | | | | |
| **Hardcarb® 460** | DIN EN 14700 E Fe16 | | T Fe16 | | | ● | ○ | | ● | | | | | | | | | |

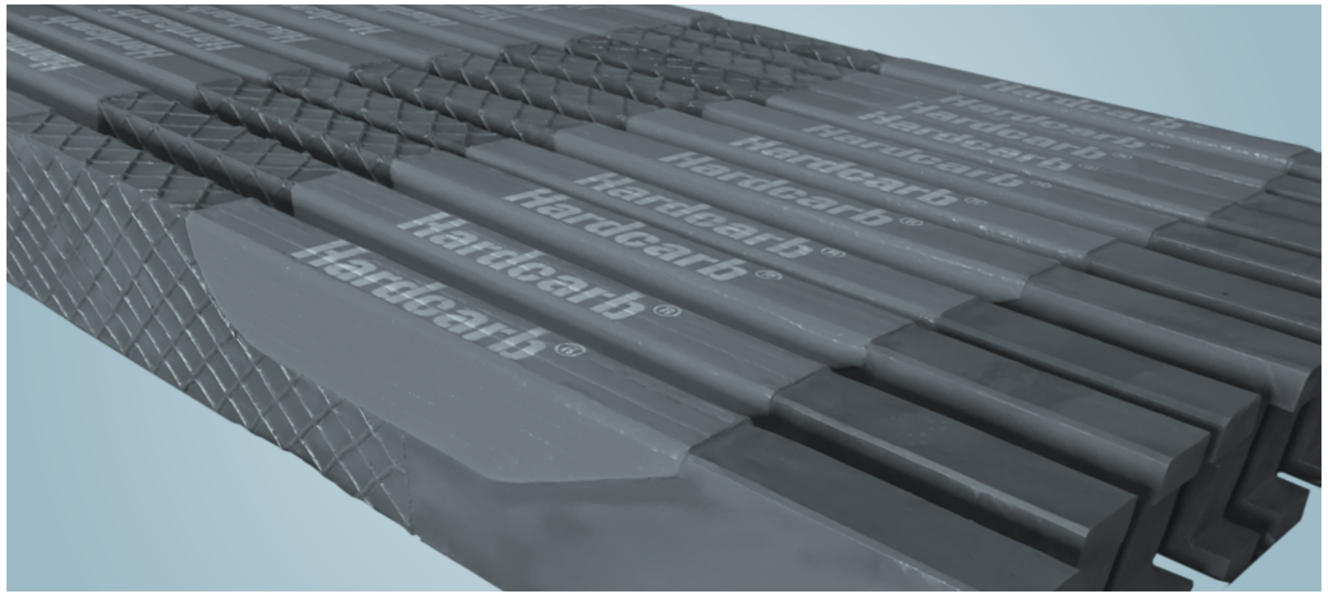
### 3.7 metal-to-earth wear / severe abrasion accompanied with erosion and heat

| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hardcarb® 700** | DIN EN 14700 E Fe14 | | T Fe14 | | | ● | ○ | | ○ | | | | | | | | | |
| **Hardcarb® 705** | DIN EN 14700 E Fe14 | | T Fe14 | | | ● | ○ | | ○ | | | | | | | | | |

○ suitable ● extremly suitable

**Alloy Details**

| Alloy Grade | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® 430 | Dredging bucket front edges, sieves, sand slingers, top coats on dredger teeth and pulverizor rolls in vertical mills. | + | + | + | + | | | + | | | | Base | | 61 - 65 HRC | • High C - Cr - Nb based primary carbide-containing weld deposit which is extremely resistant to abrasion and erosion due to the finely dispersed hard niobium carbides.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 433 | Worm conveyer screws, sand-preparing plants, dredgers, mixers, ceramic industry, fan baffles, pump casings, briquetting plants etc. | + | + | + | + | | | + | | | | Base | B | 61 - 65 HRC | • High C - Cr - Nb - B based primary carbide-containing weld deposit which is extremely resistant to abrasion and erosion due to the finely dispersed hard niobium carbides and borides.<br>• A hardness of 67 HRc in the first layer is possible.<br>• It is suitable for hardfacing of applications requiring temperature resistance of up to 450° C.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 440 | Ash plows, coke crusher segments, screw conveyers, exhaust fans, agitator blades, mill guides, mixer paddles, rake teeth in furnaces, slag ladles, elevator bucket-tips, top coats on dredger teeth and pulverizor rolls in vertical mills, etc. | + | + | + | + | | | + | | | | Base | | 61 - 65 HRC | • High complex carbide containing weld deposit which is extremely resistant to abrasion and erosion due to the finely dispersed hard niobium carbides and borides.<br>• It is suitable for hardfacing of applications requiring temperature resistance of up to 450° C.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 450 | Dredge and dragline bucket lips and teeth, hammers, ripper teeth, expeller screws, agitator blades, wear plates, screens in the coal industry, exhaust fans, top coats on pulverizor rolls in vertical mills, etc. | + | + | + | + | | + | + | + | + | | Base | B | 62 - 66 HRC | • High complex carbide containing weld deposit which is extremely resistant to abrasion and erosion due to the finely dispersed hard niobium-vanadium-tungsten carbides and borides.<br>• It is suitable for hardfacing of applications requiring temperature resistance of up to 480° C.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 460 | Mixer blades, armour plates of crushers, concrete pumps, slurry pumps, tile and brick making equipment, etc. | + | + | + | + | | | | + | | | Base | | 62 - 66 HRC | • High C-Cr-V alloy for extreme abrasive wear even at elevated temperatures.<br>• The fine grain structure of the weld deposit prevents a washout of the matrix and therefore the deposit has an extreme high scratch hardness<br>• Ideally suited for final layer on conventional chromium carbide deposits. |
| Hardcarb® 700 | Screws, screens, fan impellers and linings, grate bars, coke pushers, sinter and slag crushers, etc. | + | + | | + | + | | | | | | Base | | 58 - 62 HRC | • Austenitic, primary carbide-containing weld deposit that is highly resistant to abrasion at elevated temperatures up to 550°C.<br>• The increased Cr concentration and addition of Ni give the weld deposit an increased scale and heat resistance.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 705 | Mineral and brick industry, impeller, mixer parts, scrapers etc. | + | | | + | | | | + | + | | Base | B | 60 - 65 HRC | • Complex carbide alloy that deposits a very hard martensitic microstructure with carbides.<br>• The deposit is resistant against strong mineral abrasion at higher temperatures.<br>• The hardness decreases about 15 % at 400°C and about 25% at<br>• 600°C.<br>• The weld deposit exhibits cracks and cannot be machined. |




| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| **Hardcarb® 710** | DIN EN 14700<br>E Fe14 | | T Fe14 | | | | | | | | | | | | | | | |
| **Hardcarb® 715** | DIN EN 14700<br>E Fe14 | | T Fe14 | | | ● | ○ | | ○ | | | | | | | | | |
| **Hardcarb® 720** | DIN EN 14700<br>E Fe8 | | T Fe8 | | | ● | ○ | | ● | | | | | | | | | |
| **Hardcarb® 735** | DIN EN 14700<br>E Fe16 | | T Fe16 | | | ● | ● | ○ | ○ | | ○ | | | | | | | |

○ suitable ● extremly suitable

Alloy Details

| Typical Applications / Alloying Basis | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dredge and dragline bucket lips and teeth, hammers, ripper teeth, expeller screws, agitator blades, wear plates, screens in the coal industry, exhaust fans, top coats on pulverizor rolls in vertical mills, etc. | + | + | + | + | | + | + | + | + | | Base | B | 62 - 66 HRC | • High complex carbide containing weld deposit which is extremely resistant to abrasion and erosion due to the finely dispersed hard niobium-vanadium-tungsten carbides and borides.<br>• It is suitable for hardfacing of applications requiring temperature resistance of up to 550° C.<br>• The weld deposit exhibits cracks and cannot be machined. | Hardcarb® 710 |
| Screws, screens, fan impellers and linings, sinter crushers, etc. | + | + | + | + | + | | + | + | | | Base | B | 61 - 65 HRC | • Austenitic, primary carbide-containing weld deposit that is highly resistant to abrasion at elevated temperatures up to 600°C.<br>• The increased Cr concentration give the weld deposit an increased scale and heat resistance.<br>• The weld deposit exhibits cracks and cannot be machined. | Hardcarb® 715 |
| Feed screws, sand preparation plants, wear plates, ceramic industry, mixer parts etc | + | + | + | + | | | | | | | Base | B | 63 - 66 HRC | • Fe-B-Cr weld metal with a martensitic carbide structure suitable for highly abrasion resistant hardfacings that are exposed to minor impact and high wear at temperatures of up to 500°C.<br>• Due to its high hardness the hardfacing should not exceed 4 mm thickness. | Hardcarb® 720 |
| Wear plates, thick deposits for sinter processing in steelmaking (Crash decks, sinter stars, sinter bars), exhaust fan blades in pellet plants and boilers, burden area in blast furnace bells, etc. | + | + | + | + | | + | + | + | + | | Base | | 62 - 66 HRC | • C-Cr-Nb-Mo alloy with addition of Tungsten and Vanadium designed to resist high stress grinding abrasion with moderate impact and solid erosion at service temperatures up to 700 °C.<br>• The weld deposit exhibits cracks and cannot be machined. | Hardcarb® 735 |

hardcarb

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| Hardcarb® 750 | DIN EN 14700 E Fe16 | | T Fe16 | | | ● | ● | ○ | ● | | ○ | | | | | | | |
| Hardcarb® 760 | DIN EN 14700 E Fe16 | | T Fe16 | | | ● | ● | | ● | | | | | | | | | |
| Hardcarb® 770 | DIN EN 14700 E Fe16 | | T Fe16 | | | ● | ● | | ● | | | | | | | | | |

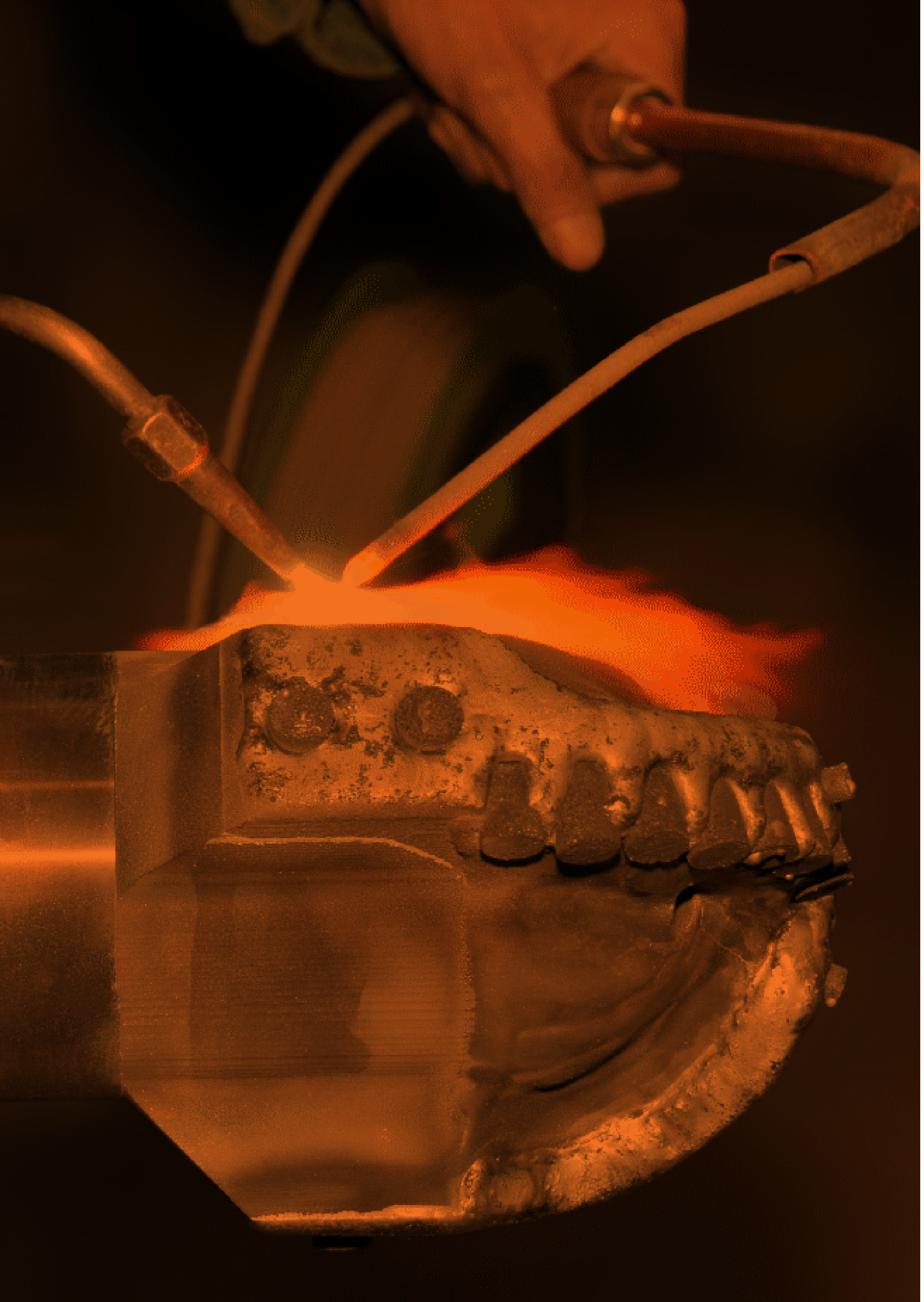
## 3.8 metal-to-earth wear / overalloyed complex carbide solutions

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Other | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| Hardcarb® 1000 | DIN EN 14700 E Z Fe16 | | T Z Fe16 | | | ● | | | ● | | ○ | | | | | | | |
| Hardcarb® 1500 | DIN EN 14700 E Z Fe16 | | T Z Fe16 | | | ● | | | ● | | ○ | | | | | | | |

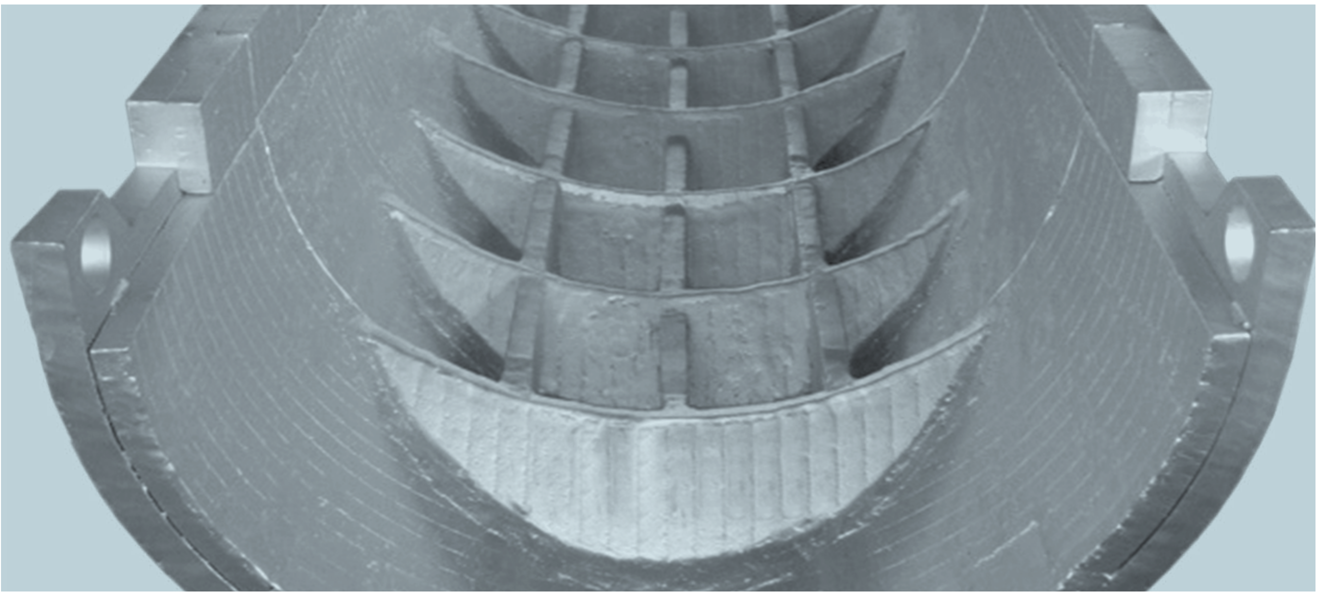
Alloy Details

| Alloy Grade | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® 750 | Sinter crushers, exhaust fan blades in pellet plants, boiler fan blades in the sugar cane industry, burden area in blast furnace bells, wear plates in blast furnace bell-less top charging systems, hot sinter sieves, etc. | + | + | + | + | | + | + | + | + | | Base | | 63 - 66 HRC | • C-Cr-Nb-Mo alloy with addition of Tungsten and Vanadium designed to resist high stress grinding abrasion with moderate impact and solid erosion at service temperatures up to 750°C.<br>• The hardness reduction at a temperature of 400°C is approximately 4% and at 650°C approximately 10 %.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 760 | Chutes, conveyor screws, mixers, rotating excavator bucket, lignite crushers-fans, homogenisers for coal or coke, clinker crushers, etc. | + | + | + | + | | | + | + | | | Base | B | 65 - 70 HRC | • C-Cr-V-Nb alloy designed to surface parts subject to high stress grinding abrasion without impact up to high temperatures (up to 650 °C).<br>• Hardness Reduction at 400°C app 7%.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 770 | Screws, screens, fan impellers and linings, grate bars, coke pushers, sinter and slag crushers, etc. | + | + | + | + | | + | | | | | Base | B | 65 - 70 HRC | • Very high C-Cr-B alloy for hardfacing against very high mineral wear also at high temperatures up to 800°C.<br>• The weld deposit has a ledeburitic structure with large percentage of hypereutectic carbides.<br>• A max. deposit thickness of 6 mm (1-2 layers) is recommended.<br>• Hardness Reduction at 400°C is approximately 5% and at 600°C is approximately 10%. |
| Hardcarb® 1000 | Dredge and dragline bucket lips and teeth, hammers, ripper teeth, agitator blades, wear plates, screens in the coal industry, exhaust fans, top coats on pulverizor rolls in vertical mills, etc. | + | + | + | + | | | + | | + | | Base | | 65 - 70 HRC | • High C-Cr-Nb-W alloy for hardfacing against very high mineral wear and erosion.<br>• The weld deposit has a large percentage of hypereutectic carbides.<br>• The weld deposit exhibits cracks and cannot be machined. |
| Hardcarb® 1500 | Dredge and dragline bucket lips and teeth, hammers, ripper teeth, agitator blades, wear plates, screens in the coal industry, exhaust fans, top coats on pulverizor rolls in vertical mills, etc. | + | + | + | + | | + | + | | + | | Base | | 65 - 70 HRC | • High C-Cr-Nb-W alloy for hardfacing against very high mineral wear and erosion at elevated temperatures up to 550°C.<br>• The weld deposit has a large percentage of hypereutectic carbides.<br>• The weld deposit exhibits cracks and cannot be machined. |

○ suitable ● extremly suitable



# HARDFACING / SUPERALLOYS



## 4.1 superalloys / near-nanostructured

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Bare / Composite rod | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| Hardcarb® 3000 (DIN EN 14700) | E Fe16 | | T Fe16 | | ○ | ● | ○ | ○ | ● | | ○ | | | | | | | |
| Hardcarb® 3100 (DIN EN 14700) | E Z Fe16 | | T Z Fe16 | | | ● | ● | | ● | | ○ | | | ○ | | | | |
| Hardcarb® 3200 (DIN EN 14700) | | | T Z Fe16 (arc spray) | | | ● | ● | | ● | | ○ | | | ● | ○ | | | |
| Hardcarb® 3500 (DIN EN 14700) | E Z Fe16 | | T Z Fe16 | | | ● | ● | | ● | | ○ | | | ● | | | | |

arc spray ○ suitable ● extremly suitable

**Hardcarb.**

| Alloy Details | | | | |
|---|---|---|---|---|
| Typical Applications | Alloying Basis – Matrix | Alloying Basis – Hard Phase | Hardness | Typical properties |
| Hardcarb® 3000: Wearplates, crusher rolls, chutes, screw augers, screens etc. | Fe based | Special | 58 - 62 HRC | • Iron based steel superalloy featuring medium hardness, high toughness and high wear resistance.<br>• The alloy is extremely abrasion resistant, contains high volume of hard phases and exhibits superior high temperature hardness.<br>• Should not be used over conventional high carbon hardfacing material or alloys containing high Mn+Ni content. |
| Hardcarb® 3100: Exhaust fans, furnace top bell facing, hot dust ducts, screens, sinter crushers. Recommended for single layer hardfacing as overalloying enables high hardness and good properties in first layer itself. | Fe based | Special | 66 - 69 HRC | • Iron based steel superalloy with a near nanoscale (submicron) microstructure.<br>• The alloy is extremely abrasion and erosion resistant, contains high volume of hard phases and exhibits superior high temperature hardness.<br>• Provides exceptional wear resistance lasting significantly longer than most chrome and complex carbide alloys. |
| Hardcarb® 3200: Boiler walls, economizer tubes, exhaust fans, agricultural parts, air baffles, etc. | Fe based | Special | | • Chrome and boride rich iron based steel superalloy specially designed for arc-spraying.<br>• The alloy is extremely abrasion and erosion resistant, contains high volume of hard phases and exhibits superior high temperature hardness.<br>• High amounts of chromium and molybdenum increase the high temperature corrosion resistance. |
| Hardcarb® 3500: Exhaust fans, furnace chutes, cyclones, paddles, mixer blades, transport and press screws, waste recycling components, sinter crushers and bars, vibro-screens, etc. | Fe based | Special | 67 - 70 HRC | • Iron based steel superalloy with a near nanoscale (submicron) microstructure.<br>• The alloy is extremely abrasion and erosion resistant, contains high volume of hard phases and exhibits superior high temperature hardness.<br>• Designed to be a low cost replacement of iron-based tungsten carbide materials for relevant applications. |

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Bare / Composite rod | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| Hardcarb® 4000 (DIN EN 14700) | E Z Fe16 | | T Z Fe16 | | | ● | ● | | ● | | ○ | | | ● | | | | |
| **4.2 superalloys / tungsten carbide based** | | | | | | | | | | | | | | | | | | |
| Hardcarb® 6100 (DIN EN 14700) | | T Fe20 | | | | ● | | | ○ | | | | | | | | | |
| Hardcarb® 7100 (DIN EN 14700) | | T Fe20 | | | | ● | | | ○ | | | | | | | | | |
| Hardcarb® 6200 (DIN EN 14700) | E Fe20 | | | | | ● | | | ○ | | | | | | | | | |
| Hardcarb® 6400 (DIN EN 14700) | | | T Fe20 | | | ● | | | ○ | | | | | | | | | |
| Hardcarb® 6555 (DIN EN 14700) | | | T Fe20 (arc spray) | | | ● | ● | | ● | | | | | | ● | | | |
| Hardcarb® 6600 (DIN EN 14700) | | | | Composite rod | | ● | | | | | | | | | | | | |

arc spray ○ suitable ● extremly suitable

Hardcarb.

| Product | Alloy Details: Typical Applications | Alloying Basis: Matrix | Alloying Basis: Hard Phase | Hardness | Typical properties |
|---|---|---|---|---|---|
| Hardcarb® 4000 | Exhaust fans, furnace chutes, cyclones, paddles, mixer blades, transport and press screws, waste recycling components, sinter crushers and bars, vibro-screens, etc. | Fe based | Special | 69 - 72 HRC | • Iron based steel superalloy with a near nanoscale (submicron) microstructure. • The alloy is extremely abrasion and erosion resistant, contains high volume of hard phases and exhibits superior high temperature hardness. • Designed to be a low cost replacement of nickel-based tungsten carbide materials for relevant applications. |
| Hardcarb® 6100 | Core drilling tips, roller bore tips, deep well drilling tools, agitator blade webs, sand separators, plough blades, clay grinding disks, strippers. | Fe matrix: 40.00 | FTC: 60.00 | 50 - 60 HRC (Matrix) ~ 2200 HV (FTC) | • It is a special pre-alloyed tube filled with fused tungsten carbides (FTC) for oxy-acetylene welding. • The weld metal consists in a tungsten-steel-matrix with embedded fused tungsten carbides having an extraordinary hardness of approx. 2300 HV. • Well suited for the hardfacing of edges. |
| Hardcarb® 7100 | Core drilling tips, roller bore tips, deep well drilling tools, agitator blade webs, sand separators, plough blades, clay grinding disks, strippers. | Fe matrix: 40.00 | STC: 60.00 | 50 - 60 HRC (Matrix) ~ 3000 HV (STC) | • It is a special pre-alloyed tube filled with spherical tungsten carbides (STC) for oxy-acetylene welding. • The weld metal consists in a tungsten-steel-matrix with embedded spherical tungsten carbides having an extraordinary hardness of approx. 3000 - 3500 HV. • Well suited for the hardfacing of edges. |
| Hardcarb® 6200 | For hardfacing tools and machine parts that are exposed to wear in mining, excavation, digging, road construction and deep drilling applications. | Fe matrix: 40.00 | STC: 60.00 | 60 - 66 HRC | • It is a steel tube filled with medium sized fused tungsten carbides developed for manual welding application. • The weld metal consists in a tungsten-steel-matrix with embedded fused tungsten carbides having an extraordinary hardness of approx. 2300 HV. |
| Hardcarb® 6400 | For hardfacing tools and machine parts that are exposed to wear in mining, excavation, earth moving, road construction, tunneling shields, well drilling and deep drilling applications | Fe matrix: 50.00 | FTC: 50.00 | 66 - 69 HRC | • Open arc tubular wire filled with Fused Tungsten Carbide for semi-automatic application, where extreme abrasive wear is anticipated |
| Hardcarb® 6555 | For repairing and hard facing ferritic and austenitic steel tools and machine parts. Specially developed for semi and fully automatic welding on tool joints and stabilizers in the petroleum industry | NiCrBSi matrix: 50.00 | FTC: 50.00 | 50 - 60 HRC (Matrix) ~ 2200 HV (FTC) | • Open-arc tubular wire filled with Fused Tungsten Carbide and matrix alloy containing NiCrBSi for semi-automatic welding application. • Protects surfaces against a combination of extreme abrasive and corrosive attacks. • Available for open-arc welding as well as arc-spray wires. |
| Hardcarb® 6600 | Recommended particularly for the hardfacing of drilling tools including reamers, openers, fishing tools, casing cutters, milling tools, coring tools, stabilizers, construction drilling etc. | CuNiZn- Matrix: 40.00 | CTCP: 60.00 | 20 HRC (Matrix) ~ 1500 HV (CTCP) | • A nickel silver (CuNiZn) based composite welding rod containing cemented tungsten carbide pellets (CTCP) grit for oxyacetylene welding process. • Contains specially selected grits either with sharp edges for cutting or rounded edges for wear applications. • The grit (approx. 60% - 70%) is embedded in a matrix having a tensile strength of 100,000 psi. |

## Typical examples of mixing augers, scrapers and screws








hardcarb

| Product | Available product forms and Classification | | | | Anti-Wear Suitability | | | | | | | | | | | Workability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alloy Grade | Covered Electrode | Tubular electrode | Flux-cored wire | Bare / Composite rod | Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Work Hardening | Machining | Edge retention |
| Hardcarb® 6700 | DIN EN 14700 | T Fe20 | | | | ● | | | ○ | | | | | | | | | |
| Hardcarb® 6999 | DIN EN 14700 E Ni20 | | | | | ● | ● | | ● | | | | | | ● | | | |
| Hardcarb® 7999 | DIN EN 14700 E Ni20 | | | | | ● | ● | | ● | | | | | | ● | | | |

| Alloy Details | | | | |
|---|---|---|---|---|
| Typical Applications / Alloying Basis: Matrix | Hard Phase | Hardness | Typical properties | |
| Coal crusher blades, scraper blades, concrete mixer blades, brick and clay mill augers, oil drill tool joints, exhaust fan blades etc. — Fe matrix: 45.00 | FTC: 55.00 | 64 - 68 HRC | • It is a specially formulated tubular electrode containing tungsten carbide grains in excess of 50% for achieving high abrasion and erosion resistance.<br>• The tubular electrode operates on low currents thus reducing dilution and distortion.<br>• It exhibits no slag, no burnthrough, high deposition rate and very good yield. | Hardcarb® 6700 |
| Hardfacing on tools and parts made of ferritic and austenitic steels, e.g. mixing blades, grinding plates, stabilizers in petroleum exploration, slurry pump valves, sand preparation plants, etc. — NiCrBSi matrix: 37.00 | FTC: 63.00 | 45 HRC (Matrix)<br>~ 2200 HV (FTC) | • Nickel core flexible rod coated with Fused Tungsten Carbide and Ni-Cr-B-Si developed for oxy-acetylene welding.<br>• It excels by producing smooth, clean seams and by its excellent flow characteristics which are due to the alloys' low melting-point of 950°- 1050° C.<br>• The Ni-base matrix alloy provides excellent resistance to acids and alkaline-corrosive media. | Hardcarb® 6999 |
| Hardfacing on tools and parts made of ferritic and austenitic steels, e.g. mixing blades, grinding plates, stabilizers in petroleum exploration, slurry pump valves, sand preparation plants, etc. — NiCrBSi matrix: 37.00 | STC: 63.00 | 45 HRC (Matrix)<br>~ 3000 HV (STC) | • Nickel core flexible rod coated with Spherical Tungsten Carbide and Ni-Cr-B-Si developed for oxy-acetylene welding.<br>• It excels by producing smooth, clean seams and by its excellent flow characteristics which are due to the alloys' low melting-point of 950°-1050° C.<br>• The Ni-base matrix alloy provides excellent resistance to acids and alkaline-corrosive media. | Hardcarb® 7999 |

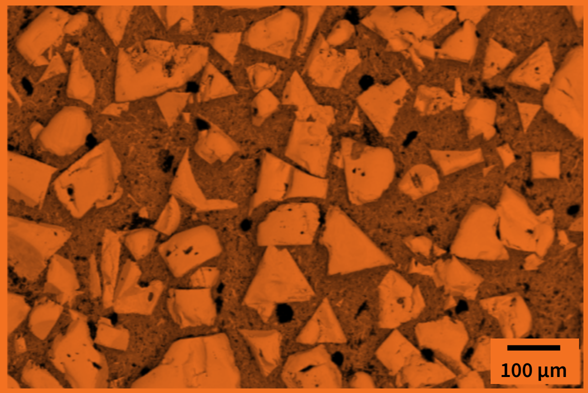
## Surfacing rods containing tungsten carbide

Surfacing rods containing tungsten carbide produce different microstructures between arc weld and gas weld deposits. Higher heat input in arc weld depositing takes much more of the carbide into solution, hardening the matrix and reducing the amount and the size of the carbide particles. The structure is also greatly influenced by the initial particle size of the carbide grains.

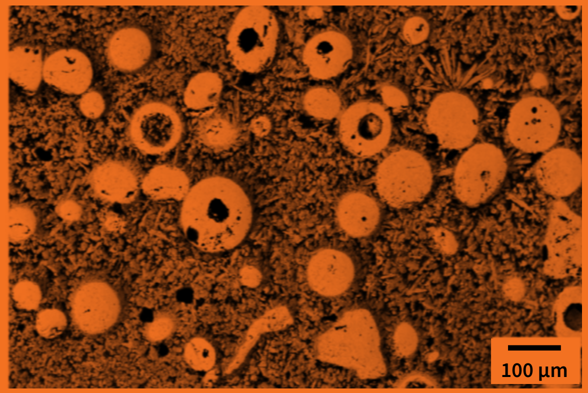
Coarse particles give a better cutting action on rock, finer grades give better and more uniform resistance to wear. The filler metals comprise steel tubes filled with tungsten carbide particles and are deposited with an oxyacetylene torch or the usual arc processes. The melting steel takes up the tungsten and carbon from the carbide to form a matrix anchoring the remainder of the carbide particles. The amount of carbide that dissolves in the steel depends on the temperature and the length of time the weld pool is molten. The extreme is reached when surfacing with a very fine carbide using a high amperage electric arc. In this case all the carbide may dissolve, giving a very hard brittle tungsten steel liable to weld cracking and containing few, if any, carbide particles. Much less solution occurs with gas welding, and the carbide distribution remains more uniform.

## Important microstructures

**Hardcarb® 6999** (fused tungsten carbide)




**Hardcarb® 7999** (spherical tungsten carbide)




○ suitable ● extremly suitable

hardcarb

## 4.3 superalloys / cobalt based

## 4.4 superalloys / nickel based

| Product: Alloy Grade | Available product forms and Classification: Covered Electrode | Tubular electrode | Flux-cored wire | Bare / Composite rod | Anti-Wear Suitability: Metal-Metal Friction | Mineral Abrasion | Hot Abrasion (>500°C) | Abrasion + Pressure | Erosion | Cavitation | Impact | Mechanical Fatigue | Thermal Fatigue | Hot oxidation | Corrosion | Workability: Work Hardening | Machining | Edge retention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **4.3 superalloys / cobalt based** | | | | | | | | | | | | | | | | | | |
| Hardcarb® 5001 (DIN EN 14700) | E Co3 | | T Co3 | R Co3 | ○ | | ● | | ● | | | | | ● | ● | | | ● |
| Hardcarb® 5006 (DIN EN 14700) | E Co2 | | T Co2 | R Co2 | ○ | | ○ | | ○ | | | | | ● | ● | | ○ | ● |
| Hardcarb® 5012 (DIN EN 14700) | E Co2 | | T Co2 | R Co2 | ○ | | ● | | ● | | | | | ● | ● | | ○ | ● |
| Hardcarb® 5021 (DIN EN 14700) | E Co1 | | T Co1 | R Co1 | ● | | | | | ● | ● | ○ | ● | ● | ● | | ○ | ● |
| **4.4 superalloys / nickel based** | | | | | | | | | | | | | | | | | | |
| Hardcarb® 5040 (DIN EN 14700) | | | T Z Ni1 | | ○ | | ○ | | ○ | | | | ○ | ● | ● | | ○ | ○ |
| Hardcarb® 5050 (DIN EN 14700) | | | T Z Ni1 | | ○ | | ○ | | ● | | | | ○ | ● | ● | | ○ | ○ |
| Hardcarb® 5060 (DIN EN 14700) | | | T Ni3 | | ○ | | ● | | ● | | | | ○ | ● | ● | | | ○ |

○ suitable ● extremly suitable

**Alloy Details**

| Alloy | Typical Applications | C | Mn | Si | Cr | Ni | Mo | Nb | V | W | Co | Fe | + | Hardness | Typical properties |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardcarb® 5001 | Pump sleeves, rotary seal rings, wear pads, expeller screws and bearing sleeves | + | + | + | + | | | | | + | Base | + | + | 55 HRC | • The deposit is a cobalt base alloy of austenitic ledeburitic structure with embedded CrW carbides.<br>• It is the hardest of the standard Cobalt base alloys.<br>• The weld metal is highly resistant to corrosion, impact, abrasive wear as well as thermal shocks and heavy mechanical impact.<br>• The deposits are only machinable by grinding. |
| Hardcarb® 5006 | Steam valves, hot shear blades, hot pressing dies, pumps for high-temperature liquids, etc | + | + | + | + | | | | | + | Base | + | + | 42 HRC | • The weld metal is highly resistant to corrosion, impact, abrasive wear as well as thermal shocks and heavy mechanical impact.<br>• Most widely used of the wear resistant cobalt-based alloys and exhibits good all-round performance.<br>• Weld metal can be machined with carbide tools. |
| Hardcarb® 5012 | Hardfacing of cutting edges of long knifes and other tools used in the wood, plastic, paper, carpet and chemical industry. It is also used for hardfacing of engine valves, pinch rollers and rotor blade edges. | + | + | + | + | | | | | + | Base | + | + | 46 HRC | • Good resistance to metal and mineral abrasion combined with corrosion and high temperature up to 700°C, in the presence of moderate shocks. Highly resistant to erosion and cavitation.<br>• Highly recommended for deposits stressed by temperature, corrosion, abrasion and impact.<br>• Weld metal can be machined with carbide tools. |
| Hardcarb® 5021 | Industrial valve work, forging dies and hot shearing blades. | + | + | + | + | + | + | | | | Base | + | + | 300 - 330 HB (as welded)<br>45 HRC (work hardened) | • Alloy is resistant to abrasion, cavitation, galling, and corrosion and retains these properties at high temperatures.<br>• Excellent metal-to-metal sliding wear resistance, but is not recommended for severe hard particle abrasion.<br>• The weld metal is highly resistant to impact and is work-hardening up to 45 HRC. |
| Hardcarb® 5040 | Fittings, drilling, chemical industry, food industry, nuclear technology, extrusion screws, fertilizer industry etc. | + | | + | + | Base | | + | | | | + | B | 42 HRC | • The weld deposit consists of a tough NiCrBSi deposit.<br>• The essential characteristics correspond to cobalt-base alloys, especially the hardness, corrosion resistance, heat resistance, wear resistance and thermal shock resistance. |
| Hardcarb® 5050 | Fittings, drilling, chemical industry, food industry, nuclear technology, extrusion screws, fertilizer industry etc. | + | | + | + | Base | | | | | | + | B | 50 HRC | • The weld deposit consists of a tough NiCrBSi deposit.<br>• The essential characteristics correspond to cobalt-base alloys, especially the hardness, corrosion resistance, heat resistance, wear resistance and thermal shock resistance. |
| Hardcarb® 5060 | Fittings, drilling, chemical industry, food industry, nuclear technology, extrusion screws, fertilizer industry etc. | + | | + | + | Base | | | | | | + | B | 58 HRC | • The weld deposit consists of a tough NiCrBSi deposit.<br>• The essential characteristics correspond to cobalt-base alloys, especially the hardness, corrosion resistance, heat resistance, wear resistance and thermal shock resistance. |

Notes

Authorized Distributor

## Contact Us

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