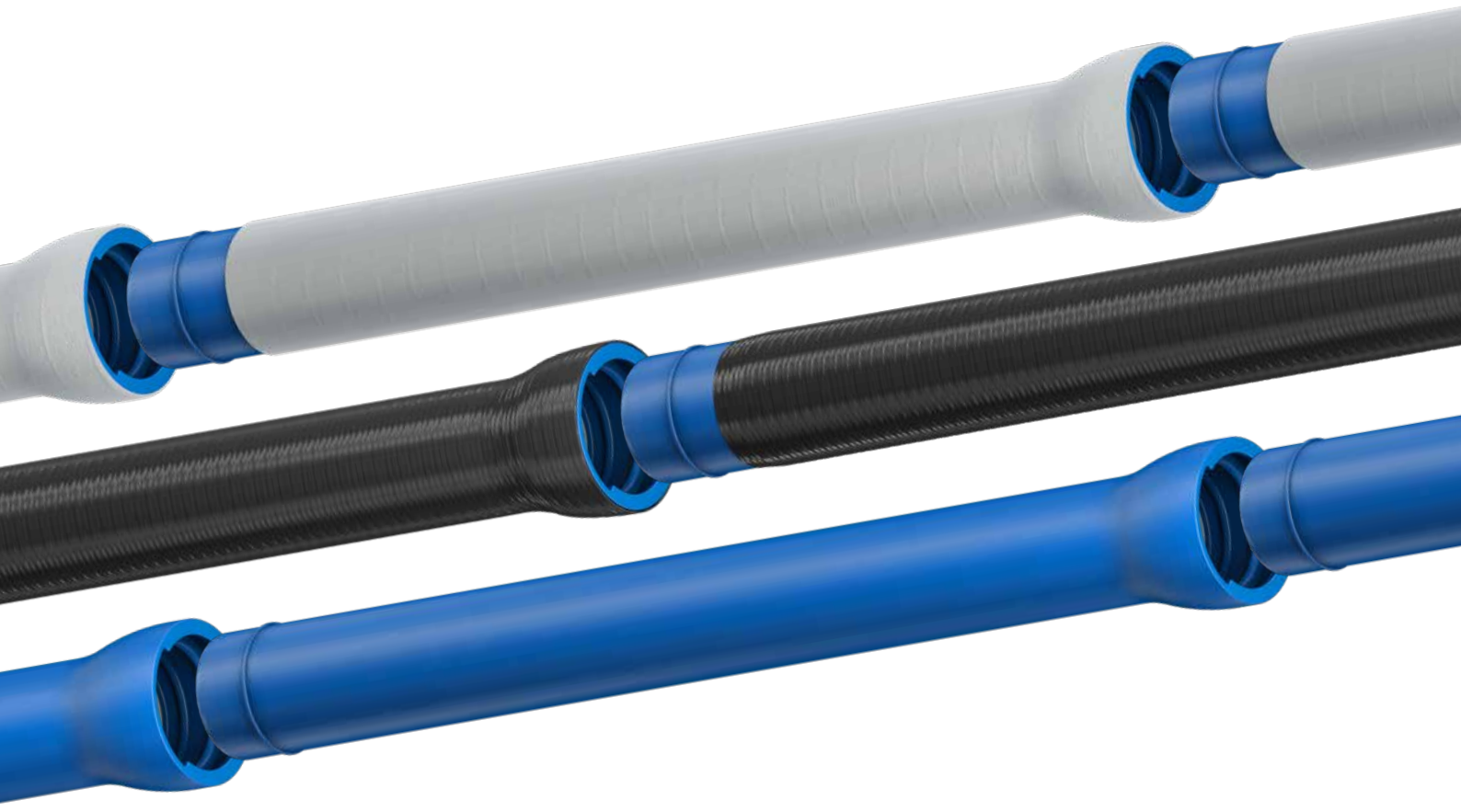
PIPE SYSTEMS



Coatings

Long-term protection and safety

ductile iron solutions
www.trm.at

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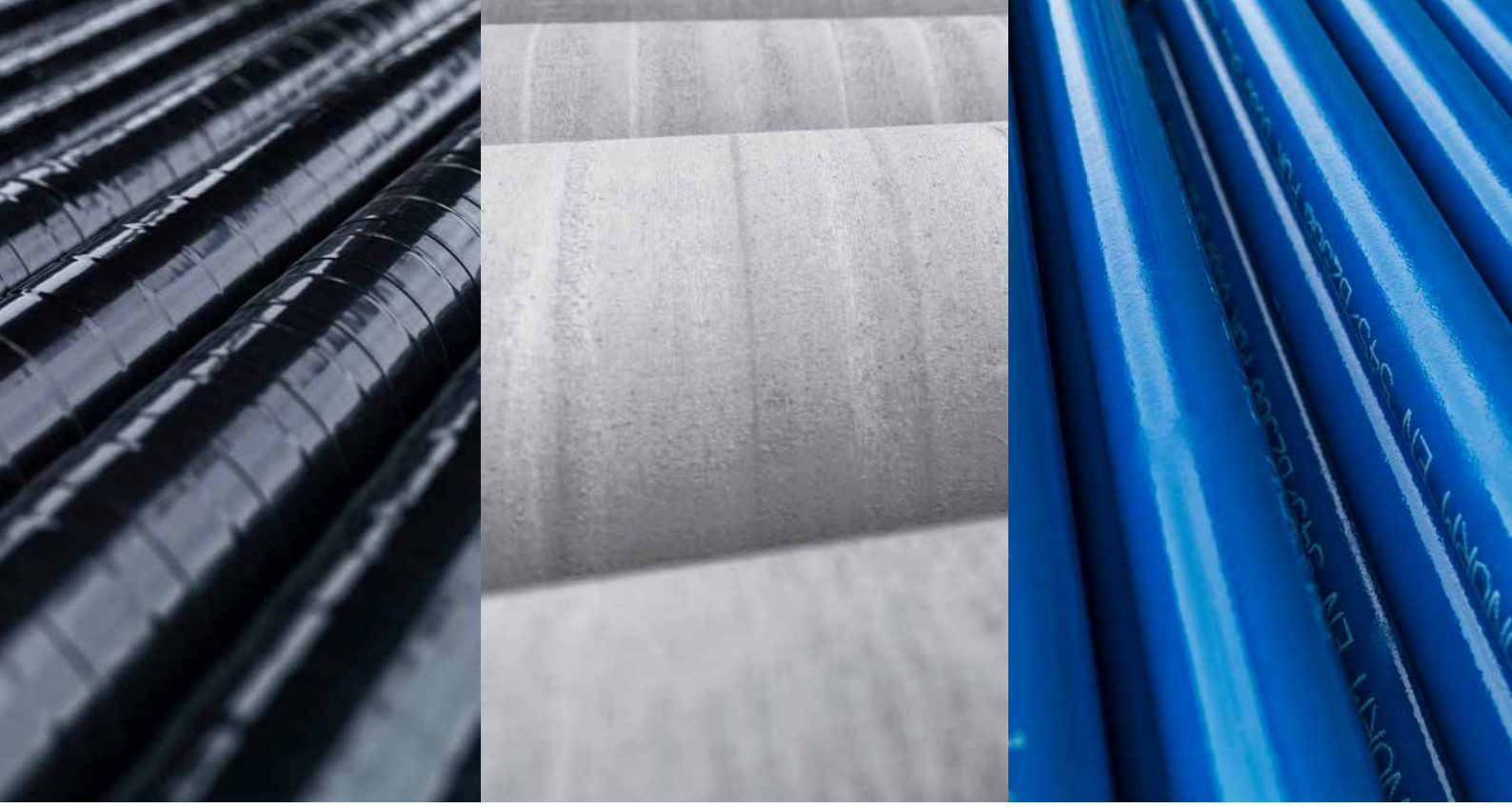


Coatings

Coatings for long-term protection

In contrast to many other materials, such as plastics, ferrous materials (which of course includes ductile iron pipes) retain their outstanding mechanical properties, such as their load-bearing capacity, over their entire service life.To ensure these properties, all ductile products made by Tiroler Rohre GmbH are treated to provide high-quality external and internal corrosion protection.

Choosing the right coating

The following factors are key:

+ Soil and groundwater aggressiveness
+ Type and grain size of embedding soil
+ Flow-through medium
+ Temperature of the medium
+ Ambient temperature
+ Installation method

Choosing the external coating

The choice of the external coating depends primarily on the aggressiveness of the surrounding soil and the bedding. The external pipe coating and the bedding material must be selected according to DIN 30 675 Section 2.

⚠ Recommendations for our pipe coatings (see tables).

⚠ For bedding material, see the section on pipe trenches and filling.

Soil classes and soil aggressiveness

for ferrous materials according to DIN 50929-3 in comparison to the attack classes and aggressiveness levels of ÖNORM B 5013-1

Evaluation number	Assessment according to DIN 50929-3		Assessment according to ÖNORM B 5013-1	
	Soil class	Soil aggressiveness	Attack level	Level of aggressiveness
≥ 0	I a	practically non-aggressive	non-invasive	AS0
-1 to -4	I b	slightly aggressive	slightly invasive	AS1
-5 to -10	II	aggressive	highly invasive	AS2
< -10	III	highly aggressive	very highly invasive	AS3

Areas of application according to soil aggressiveness
Non-aggressive to aggressive soils – AS0 – AS2

Coating system for pipes	Maximum grain size of the embedding soil	Socket protection	
	AS0–AS2	Clamping ring from AS2	each socket
PUR-Longlife	according to ÖNORM B 2538	yes	no
PUR-TOP	according to ÖNORM B 2538	yes	no
ZMU-Austria	Up to 100 mm	yes	no
Epoxy resin coating (fittings)	according to ÖNORM B 2538	–	no

Highly aggressive soils – AS3

Coating system for pipes	Maximum grain size of the embedding soil	Socket protection	
	AS3	Clamping ring	each socket
PUR-Longlife	Corrosion-resistant bedding[1]	yes	yes
PUR-TOP	0–16	yes	yes
ZMU cement-mortar coating	Up to 100 mm	yes	yes
Epoxy resin coating (fittings)	0–32	–	yes

[1] Not suitable for permanent exposure to eluates with pH <6 or peat, swamp, mud or marsh soil.

The soil aggressiveness must be assessed according to ÖNORM B 5013-1 or DIN 50 929-3 or according to DVGW Code of Practice GW9. For construction projects where a detailed evaluation is considered too costly or complex, empirical values can provide initial indications for a rough evaluation, for example using old ductile iron pipes in the same area. If there is doubt, or if the high organic content or contamination provides certainty that the soil is aggressive, the protection shall be designed for very aggressive soil.

- ⚠ In certain soils, the joint area (socket to spigot) must be provided with sleeves. For more details about protecting connections using sleeves, see the section on accessories.
- ⚠ Tiroler Rohre GmbH's experienced employees can also provide on-site support.

Thermal zinc spraying

DUPLEX Coating

Active corrosion protection for 40 years

The DUPLEX system was introduced by Tiroler Rohre GmbH 40 years ago and consists of a zinc coating which acts electrochemically and a passive finishing layer which acts in synergy with it. Decades of practical experience and many years of testing in Tiroler Rohre GmbH's corrosion laboratory form the basis of the coatings used today.

Active corrosion protection can slow down the onset of corrosion on the pipe by an aggressive medium (e.g. moisture and atmospheric oxygen). Special DUPLEX coatings (zinc coating + top coating) are used for this purpose, as they protect pipes for decades by supplying a potential damage area with sufficient protective current for years and thus prevent major damage to the ductile iron pipe.

The large "sacrificial anode" is an electrochemical base zinc coating applied to the entire pipe surface by thermal spray galvanizing and sealed by the top coat as protection against self-corrosion. This combination of functional layers (active and passive) is called an active DUPLEX top coat.

Top coat for passive protection

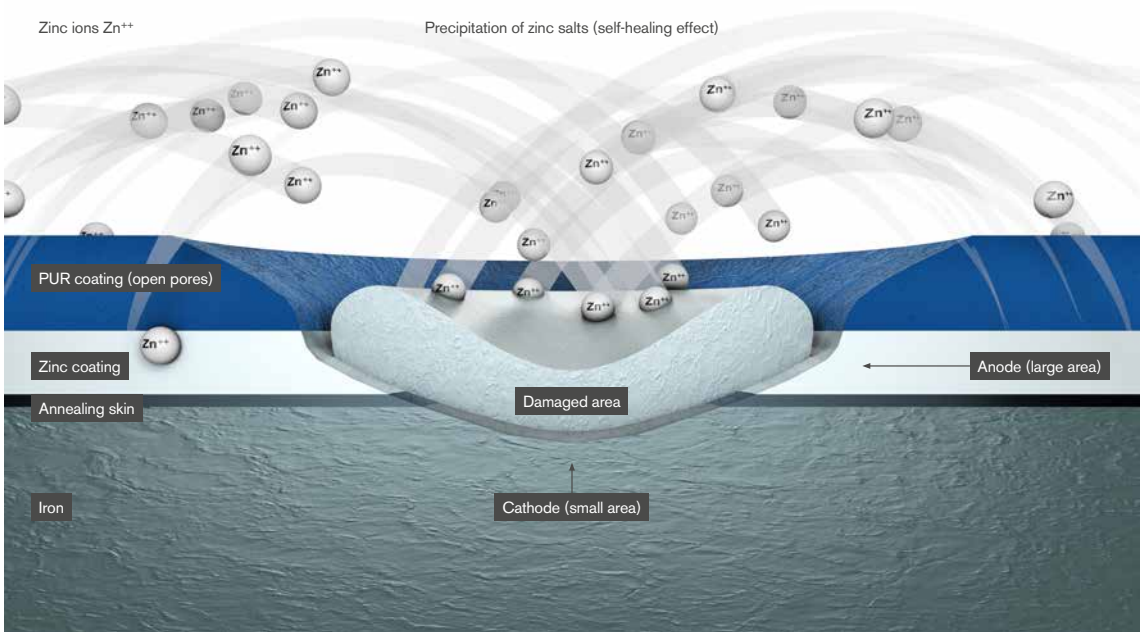
The top coat provides passive corrosion protection, as it prevents electrolyte connection between the soil and pipe or zinc. As long as the surface layer is intact, most of the zinc remains inactive and the pipe is protected.

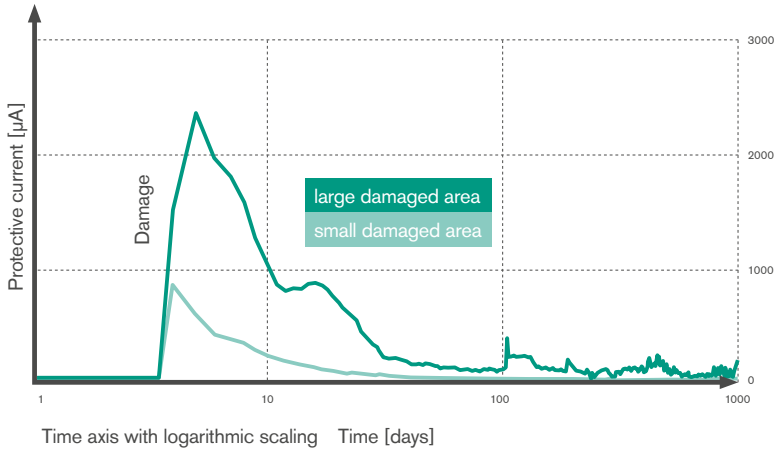
⚠ Tiroler Rohre GmbH DUPLEX coatings are free from solvents and bisphenol A.

Zinc coating for active protection

There are three factors on which the protective action of the zinc coating with a finishing layer is based:

+ the electrochemical action of the zinc
+ a reduction of post-diffusion of the invasive medium due to the insoluble zinc reaction products that are formed
+ the antibacterial action of zinc salts





Actual protective current curve in laboratory tests

Antibacterial action of zinc salts

The low solubility of zinc salts means that they adhere to the damaged pipe surface even in wet environments. In anaerobic soils, where bacterial corrosion by sulfate-reducing bacteria can occur, these zinc salts prevent sulfate-reducing bacteria from multiplying on the pipe surface and biocorrosion from occurring.

⚠ The requirements for the zinc coating are defined in ÖNORM B 2555, and the requirements for the top coat are defined in ÖNORM B 2560, ÖNORM EN 545, ÖNORM EN 598 and ÖNORM EN 15 542.

Effect at damaged areas

If the top coating is damaged, the ductile iron comes into contact with conductive soil (electrolyte). Corrosion-promoting circumstances (potential and concentration differences in the soil) can lead to corrosion on the cast pipe, and this is exactly when the active corrosion protection provided by the zinc comes into effect. In the event of corrosion, electrons are removed from the iron, and without corrosion protection this would result in the formation of iron ions and thus corrosion products. The base zinc sacrificial anode prevents this by releasing sufficient electrons to the iron and converting (sacrificing) itself into ionic form (zinc ions). A protective current flows from the zinc anode to the iron cathode, which can be measured in laboratory tests and represents the protection in practice. Insoluble zinc compounds crystallize on the damaged pipe surface and form a passive layer (scarred layer) – a mechanism which is also known as the self-healing effect. Depending on the size of the damage, this can either hugely reduce the level of corrosion or, in the case of minor damage, completely prevent it.

PUR-Longlife

Zinc coating with PUR-Longlife coating

PUR – short for polyurethane – is a three-dimensionally cross-linked plastic consisting of polyol and isocyanate which is extremely dimensionally stable and chemically resistant to a variety of inorganic and organic media.

These beneficial product properties make PUR an ideal coating material for a wide range of applications. The high pressure resistance provided by the cross-linking means that PUR is much more effective than thermoplastics such as PE or PVC and increases its range of applications as a high-quality coating material for piping systems.

PUR primarily serves as a top layer to protect the metallic zinc, which provides effective electrochemical protection from corrosion attacks on the iron pipe as a so-called "sacrificial anode".
The zinc layer with the PUR top coat above it thus forms synergistic active and passive corrosion protection that perfectly meets the long-term requirements of underground ductile iron pipes.

Production

A fully automatic coating machine is used to apply a 120 µm PUR layer to the outside and inside of the socket in an airless process after zinc spraying and all quality tests have been carried out.
Since 2019, the coating has been applied by an innovative coating robot, which raises the process stability and thus the quality of the products to a new level.

Range of application

according to ÖNORM EN 545 Annex D or ÖNORM EN 598 Annex B

Ductile iron pipes with PUR-Longlife coating can be laid in all common soils up to AS2.

Tiroler Rohre GmbH recommends a higher quality coating (PUR-TOP or ZMU-Austria) for highly aggressive soils (AS3) and sites where stray currents occur.

⚠ For more details, see the standards mentioned above.

Labeling Application

Application	Color
Drinking water	Blue
Wastewater	Reddish-brown
High pressure	Black

Structure

Coating	Requirement
Zinc coating according to ÖNORM EN 545 and ÖNORM B 2555	200 g/m²
Polyurethane top coat according to ÖNORM EN 545 and ÖNORM B 2560	120 µm

PUR-TOP

Zinc coating with PUR-Longlife coating and PE impact protection tape

PUR-TOP is the further development of the PUR-Longlife coating and features an active zinc coating, a polyurethane outer coating of at least 400 µm and an impact-protection tape consisting of a water- and vapor-proof isobutyl rubber layer and a polyethylene cover layer.

The top coat is thus designed as a fully protective coating. What makes PUR-TOP special is that it also includes a DUPLEX coating (zinc + PUR), which can be relied on to protect the pipe from corrosion in the event of subsequent damage.

⚠ This coating combination is therefore suitable for particularly aggressive soils.

⚠ Rubber or shrink-on sleeves in the area around the joints complete the protection.

Production

A fully automatic coating machine is used to apply a 400 µm PUR layer to the outside and inside of the socket in an airless process after zinc spraying and all quality tests have been carried out. A wrapping machine is then used to wrap the pipe with the impact protection tape.

Range of application

according to ÖNORM EN 545 Annex D or ÖNORM EN 598 Annex B

Ductile iron pipes with PUR-TOP coating can be laid in soils of any corrosivity.

⚠ For more details, see the standards mentioned above.

Socket protection

Soil aggressiveness according to ÖNORM B 5013-1

+ AS2 – aggressive soil – socket protection must be used for clamping rings.
+ AS3 – very aggressive soil – socket protection must be used for each joint.

⚠ For more information about socket protection, see the section on accessories.

Labeling Application

Application	Color
Drinking water	Blue
Wastewater	Reddish-brown
High pressure	Black

Structure

Coating	Requirements
Zinc coating according to ÖNORM EN 545 and ÖNORM B 2555	200 g/m²
Polyurethane top coat according to EN 545 Annex D.2.3.	400 µm
PE impact-protection tape	–

ZMU-Austria

Zinc coating with cement-mortar coating

ZMU-Austria offers optimum protection during transport, storage and in open trench as well as in trenchless installation. This coating also provides enhanced protection during operation.

We developed the polymer-modified cement ourselves, and its sulfate-resistant cement clinker together with a special slag means it offers very high sulfate resistance, enormous strength and high impact protection. In practice, this means that no other bedding is required and the pipe can be used in all types of soil.

- Existing soil material up to a grain size of 100 mm can therefore be used.

The protective effect is based primarily on the alkalinity of the mortar that is used. The hydration of the cement creates highly alkaline calcium hydroxide which suppresses any corrosion with a pH-value of more than 10.

- Rubber or shrink-on sleeves in the area around the joints complete the protection.

Labeling Application

Application	Color[1]
Drinking water	Blue
Wastewater	Reddish-brown
High pressure	Black

Structure

Coating	Requirement
Zinc coating according to ÖNORM EN 545 and ÖNORM B 2555	200 g/m²
Cement-mortar coating according to EN 15542	5 mm
Polyurethane top coat on spigot and inside of socket according to ÖNORM EN 545 and ÖNORM B 2560	120 µm

Production

The cement mortar is applied onto the pipe with a mesh bandage by extrusion and is smoothed at the same time. The entire pipe is coated with zinc before the cement coating is applied. The spigot and socket areas are free from cement mortar and are provided with our proven PUR-Longlife coating.

In 2019, an automated coating center with two independent systems was put into operation to produce this coating, enabling a particularly consistent high product quality to be achieved.

Range of application

according to ÖNORM EN 545 Annex D or ÖNORM EN 598 Annex B

Ductile iron pipes with ZMU-Austria coating can be laid in soils of any corrosivity.

- For more details, see the standards mentioned above.
- Use without soil exchange and without any additional pipe bedding.
- Virtually any excavation material can be used (the inclusion of stones of up to 100 mm is permitted).

Coating robots in use at the location Hall location in Tyrol

Coating of Fittings

Corrosion protection for fittings

Tiroler Rohre GmbH applies an epoxy resin powder coating to all fittings. This coating protects the ductile iron component, and its smooth and pore-free surface ensures very low friction. This prevents the formation of incrustations by salts or other substances.

Production

Before coating, the surfaces of the fittings are cleaned by abrasive blasting and the surface is compacted. The blasted parts are preheated in a continuous-flow furnace and then coated with at least 250 µm epoxy resin powder by a fully automated robot in a whirl-sintering basin.

⚠ Conforms to the specifications of EN 14 901 and RAL-GZ 662 “Quality-Assurance Association for Heavy-Duty Corrosion Protection" (GSK)

Structure

Coating	Requirement
Epoxy resin coating according to ÖNORM EN 545, ÖNORM EN 14 901 and RAL-GZ 662 (GSK)	250 µm (pore-free)

Range of application according to ÖNORM EN 545 Annex D or ÖNORM EN 598 Annex B and ÖNORM EN 14 901

Ductile iron fittings with epoxy resin powder coating can be laid in soils of any corrosivity.

\+ Suitable for media with a pH value of 1 to 13

\+ Resistant to chemicals

⚠ For more details, see the standards mentioned above.

⚠ The ÖVGW-GRIS and DVGW quality certifications confirm that the requirements for drinking water suitability have been met.

Internal Lining

Cement-mortar lining

Ductile iron pipes are provided as standard with a cement-mortar lining. This applies to pipes for use both in drinking-water supply and in wastewater disposal. Pipes almost 40 years old lined with cement mortar have shown that as a mineral lining cement mortar is superior in terms of working life and effectiveness than all the other coatings or linings which have been used to date.

The protective effect of the cement-mortar lining is based on a chemical process: water penetrates into the pores of the cement mortar, dissolves free lime and assumes a pH value of over 12 on the iron. With a pH of this level, it is impossible for ductile iron to corrode. At the same time, the lime and carbon dioxide react to create a stable and sealed calcium-carbonate layer on the surface which ensures that the pH value of the drinking water is not affected.

Production

A mixture of sand, cement and water is introduced into the pipe as it rotates and flung at high speed against the internal surface of the pipe by centrifugal force. The centrifuging process acts powerfully to drive out the water mechanically and compact the cement mortar tightly (water/cement ratio ~ 0.35). The cement-mortar lining is then cured in the curing chamber at a defined relative humidity and temperature.
The result of these processes is firstly high strength for the cured cement and secondly extremely high resistance to any possible corrosive attacks by the transported medium (e.g. wastewater).

- The thickness of the ZMA is 4 to 6 mm, depending on the nominal diameter, and meets the ÖNORM B 2562 and ÖNORM EN 545 or ÖNORM EN 598 standards as shown in the following table.
- For manufacturing reasons, it cannot be guaranteed that there will be no hairline cracks in the surface area of the cement-mortar lining. During contact with water and the associated soaking of the cement, these hairline cracks close so that they have no negative influence on the functioning of the pipe system.
- The maximum crack widths of the cement-mortar lining are governed by ÖNORM EN 545 or ÖNORM EN 598. For both drinking water and wastewater, the cement-mortar lining is largely insensitive to impacts and sudden forces on the pipe.

Internal lining Layer thickness

DN	Lining thickness		Maximum crack width and maximum radial misalignment [mm]
	Nominal value	Limiting deviation	
	[mm]		
80 – 300	4	-1.5	0.4
400 – 600	5	-2.0	0.5
700 – 1000	6	-2.5	0.6

The right choice of internal lining

For transporting all types of water for human consumption, ductile iron pipes are lined with cement mortar based on a special Portland composite cement. For particularly high attack classes, e.g. for wastewater or soft water, an internal lining based on high-alumina cement suitable for drinking water is available.

⚠ The application limits of the internal linings are given in the following table.

Application limits of internal linings[a]

Water properties	Portland composite cement	High-alumina cement
Minimum value for pH	5	4
Maximum content [mg/l]		
Aggressive CO_2	15	unlimited
Sulfate SO_4^-	3,000	
Magnesium Mg^{++}	500	
Ammonium NH_4^+	30	

[a] Range of application for special cases on request

Supply of drinking water

When supplying drinking water, the hygienic properties of the internal lining and the potential influence on the drinking water are of decisive importance. The Portland composite cement-mortar lining has no plastic additives and meets this requirement to an extraordinarily high degree. Continuous quality monitoring of the finished products by internal tests and external testing bodies ensures the high quality standards are met and, as well as guaranteeing drinking-water suitability, ultimately forms the prerequisite for ÖVGW-GRIS and DVGW quality certification.

When newly laid pipes are put into operation, in certain circumstances the pH value may rise slightly in the first weeks of operation due to the natural reaction of the drinking water with the cement, especially in cases of low water consumption in branch pipes or stubs.

In these cases, it is recommended to check and flush the pipe during the first two weeks of operation.

⚠ The cement-mortar linings for drinking water pipes are resistant to all types of drinking water with a given water hardness of more than 2° dH.

⚠ For extremely soft water under 2° dH, it is recommended to consult the manufacturer regarding the possible resistance of the cement-mortar lining.

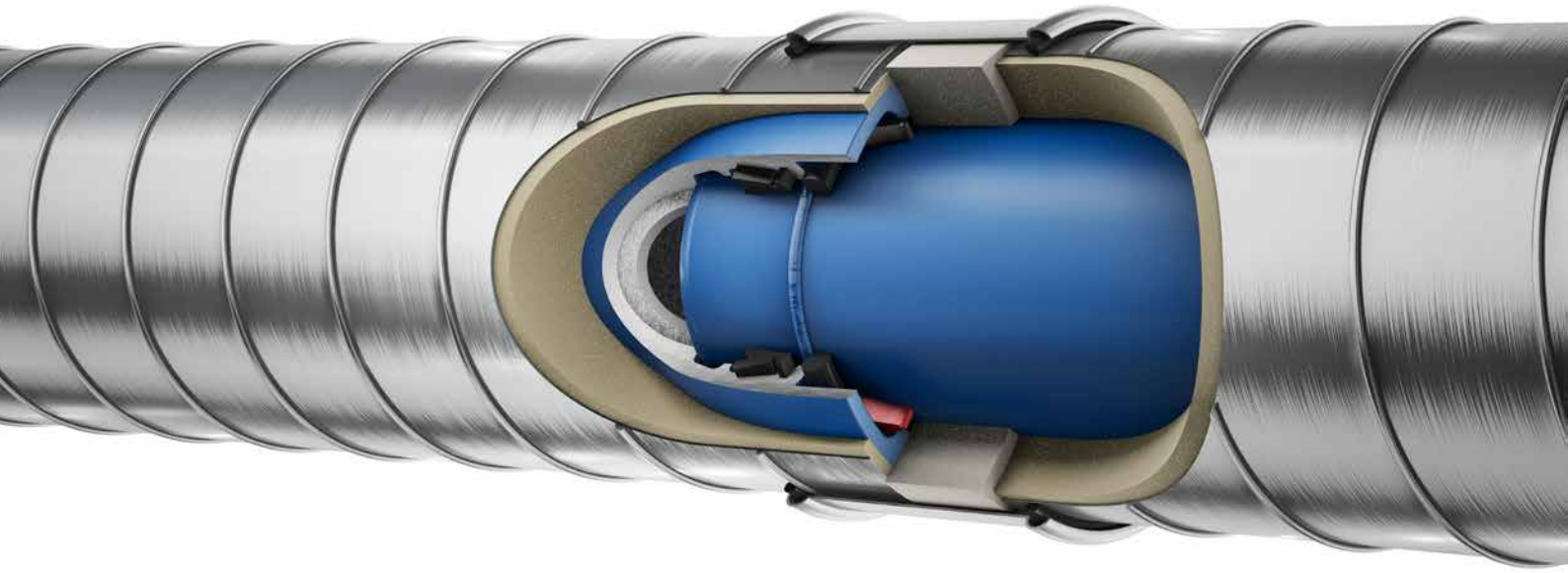
⚠ Tiroler Rohre GmbH can offer the right cement-mortar lining with drinking water approval for all water hardnesses.

Wastewater supply

Municipal wastewater pipes allow an application range from pH 4 to pH 12. The cement-mortar lining also has the best abrasion resistance properties, making the ductile iron pipe insensitive to high flow velocities of the medium, such as in steep sections, glacial grinding and mountain drainage.

⚠ Furthermore, sewer flushing with high-pressure nozzles at flushing pressures of up to 250 bar and the addition of solid substances (gravel, etc.) will not cause any damage.

⚠ The high quality standards, both of the base material and the internal lining, are in accordance with the requirements of the Quality Association for Pipes in Housing Water Installations and are GRIS 131 certified.



WKG Coating

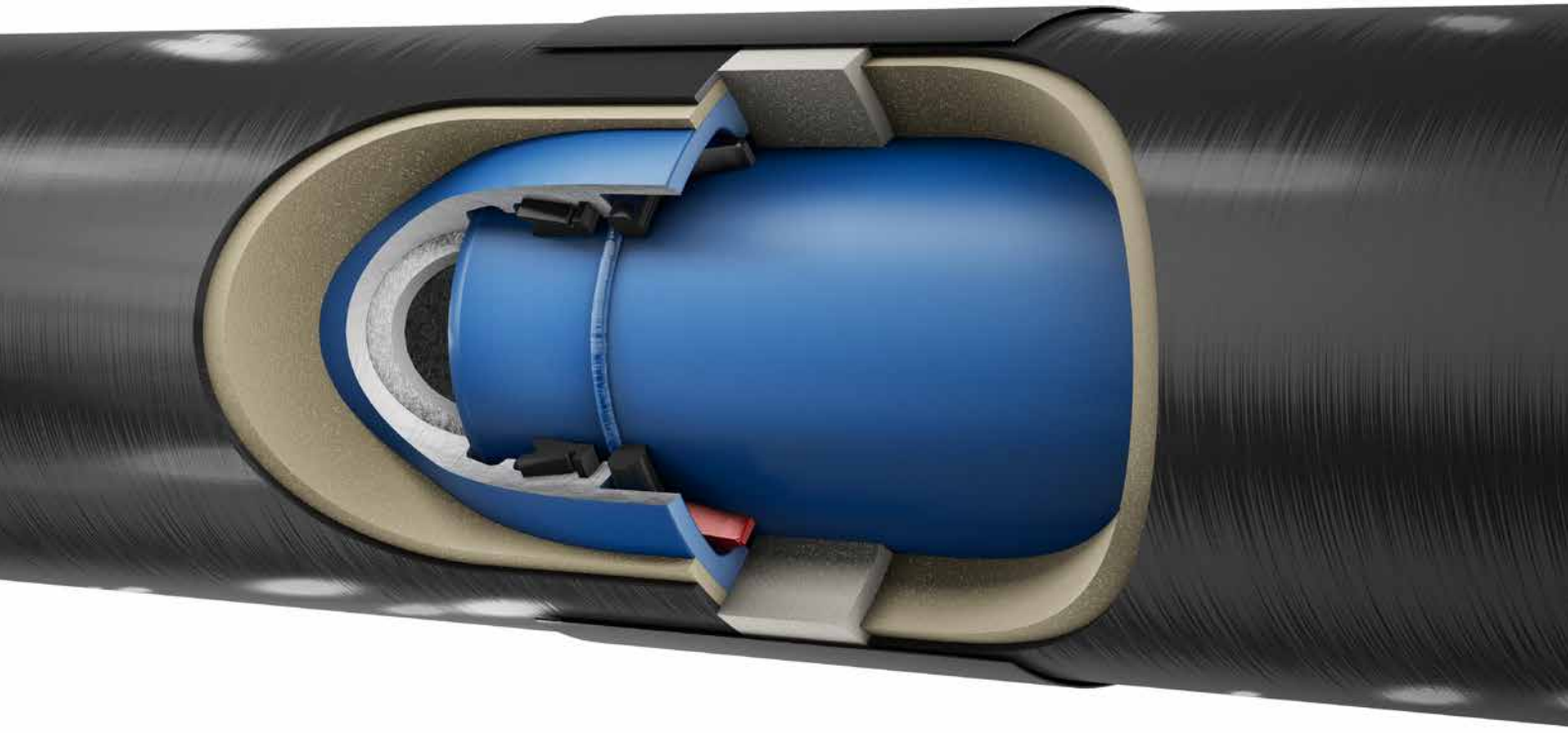
Thermally insulated ductile iron pipes and fittings

The WKG pipe system is a special external coating that is used when heat and cold losses have to be prevented.

The insulation reduces the heat loss of the pipe and consequently of the drinking water. This allows longer stagnation times, especially with smaller diameters, to be bridged without the pipe freezing. The exact time periods depend on various factors:

+ Ambient temperature
+ Water temperature
+ Insulation thickness
+ Local conditions

If these times are not sufficient, trace heating can be integrated. This essentially consists of a self-limiting heating cable glued to the pipe, which switches on at the desired temperature via a thermostat. The number and heat output of the cables must be adapted to the conditions.



Production

The thermal insulation is applied to the PUR-Longlife coated pipe or epoxy resin coated fitting. The pipes and fittings are lined with thermal insulation made from CFC-free polyurethane (PUR) rigid foam with an average overall density of 80 kg/m³. The rigid foam is protected by an appropriate casing pipe.

A distinction is made between two systems:

+ **Above-ground pipes:** FL spiral casing pipe according to ÖNORM EN 1506 made from galvanized sheet steel or stainless steel. The joints are protected by a soft polyethylene (WPE) ring and a sheet metal sleeve (300-mm wide).
+ **Buried pipes at risk from frost:** EL-PE-HD casing pipe according to ÖNORM EN 253 made from PE-HD. The joints are protected by a PE shrink strap and PUR components.

⚠ For more information, see the "Accessories and special components" brochure

PIPE SYSTEMS

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April 2019 All information is supplied without liability.

Publisher: Tiroler Rohre GmbH
Design: LŒWENZAHM.at
Printing: Alpina Druck GmbH