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by voestalpine

Tailor-Made Protectivity™

Cladding Solutions for the Waste to Energy Industry

voestalpine Böhler Welding
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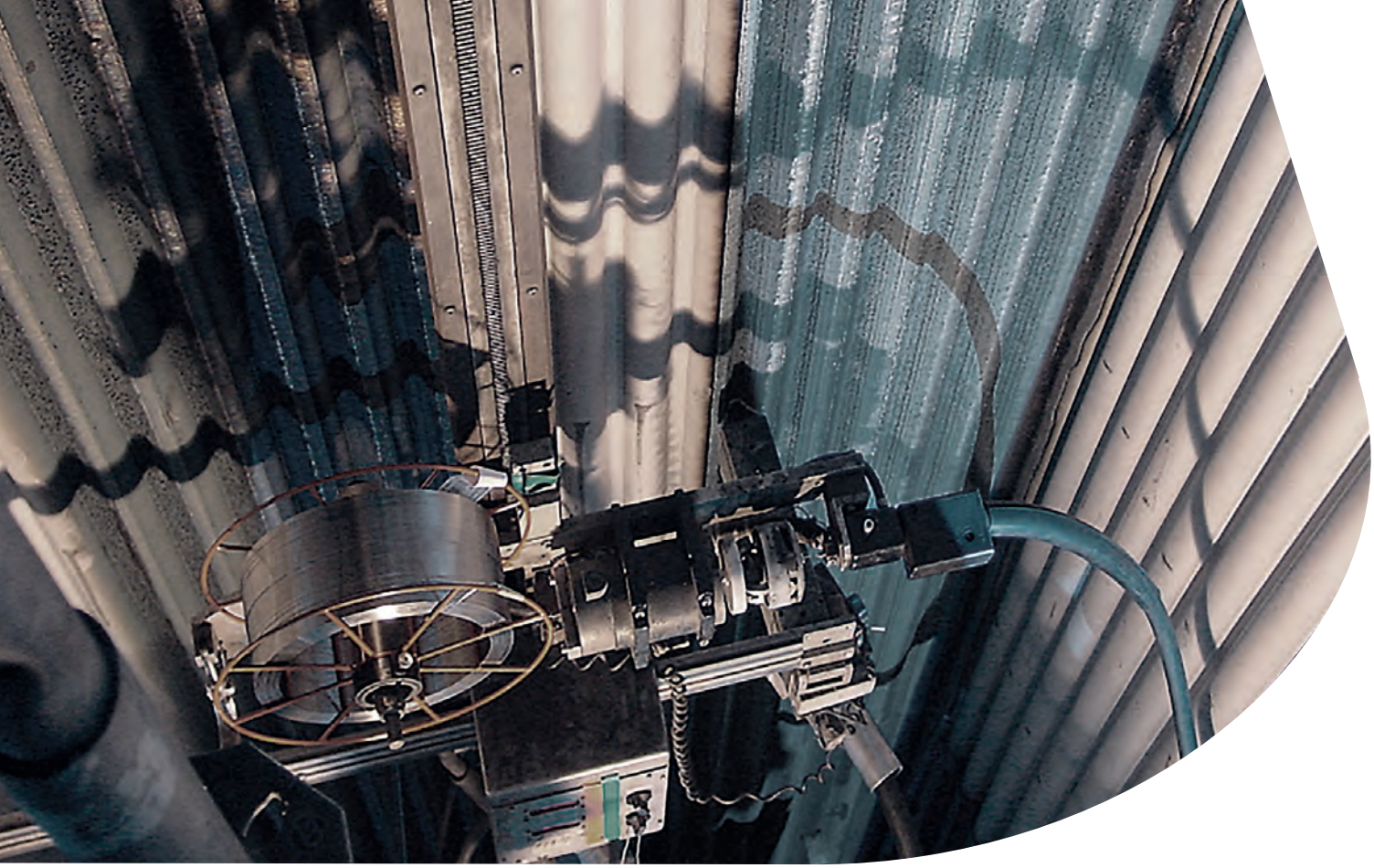


Tailor-Made Protectivity™ for Waste Incineration Cladding Applications

UTP Maintenance stands for decades of industry experience and application know-how in the areas of wear and surface protection. Innovative and customer-tailored products guarantee users increased productivity and protection of their components. This tradition is continued by our range of special arc welding consumables for the cladding of boiler tubes and other components in waste incineration plants.

Their chemical composition is designed to withstand the severe high-temperature corrosion attack at different incineration temperatures. They cover all commonly applied variants of the arc welding processes SMAW/MMA, GTAW/TIG and GMAW/MIG, as well as arc spraying, for cladding both new and corroded components walls in waste to energy power stations.

Metallurgical Challenges in Waste Incineration

The incineration and thermal treatment of municipal, medical and bio solids is an effective way to solve waste management issues and is a forward-looking practice to produce energy.
The efficient use of waste to energy (WTE) technology requires technical solutions to reduce detrimental high temperature corrosion. Vital components, such as membrane walls and super heaters must be protected against corrosive attack to extend their lifetime and avoid unplanned downtime for repairs.

Accelerated corrosion from waste streams

Waste streams involve a great variety of combustibles such as plastics, paper, wood, biomass and industrial waste. They can be rich in chlorine, sulfur and other potentially hazardous chemical compounds and can form corrosive gases, molten salts and ashes, when incinerated. Examples are sulfur bearing wood chips and chlorination promoting waste from the plastics industry. In the form of cackings, these adhere to the surface of waste incineration plant components creating often local corrosion systems that may cause very rapid corrosion attack. Many types of corrosion systems can occur simultaneously, but most prominent in WtE plants are high temperature chlorine corrosion and saltmelt corrosion. Under these conditions, carbon steels and low-alloyed (ferritic) tube materials used for membrane walls and super heaters – such as P235, 16Mo3 or 13CrMo 4-5 – are rapidly consumed by localized corrosion caused by different chemical reactions.

It is difficult to exactly evaluate the corrosive medium and resulting wear in waste incineration plants, due to the changing composition of the waste and despite sorting procedures to stabilize its caloric value.

The service life of unprotected surfaces is influenced by following factors:

- composition of deposits and flue gases
- flue gas temperature
- tube wall temperature
- reducing atmosphere

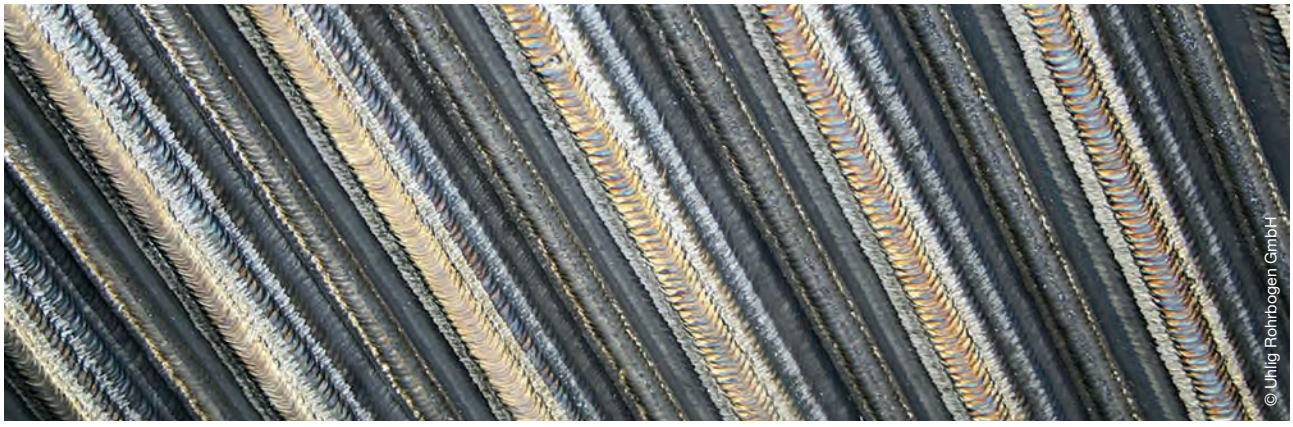
The table on the next page shows examples of typical and high corrosion rates observed on boiler parts in waste incineration plants. Under high corrosion rates, critical components may have a service life of no longer than 6–9 months, depending on temperature and corrosive media.

Corrosion resistant alloy protection

Replacement of affected components is costly and may take several months, while waste storage capacity may be limited. The use of corrosion resistant alloys for critical components increases their life cycle enormously. There are various candidate materials, mostly nickel-base and alloyed with substantial amounts of chromium and molybdenum e.g. Alloy 622 (Ni-22Cr-13Mo-W), Alloy 625 (Ni-22Cr-9Mo-3.5Nb) and Alloy 686 (Ni-21Cr-16Mo-4W). Alloy 625 is characterized by its good resistance to pitting and crevice corrosion combined with high heat resistance.

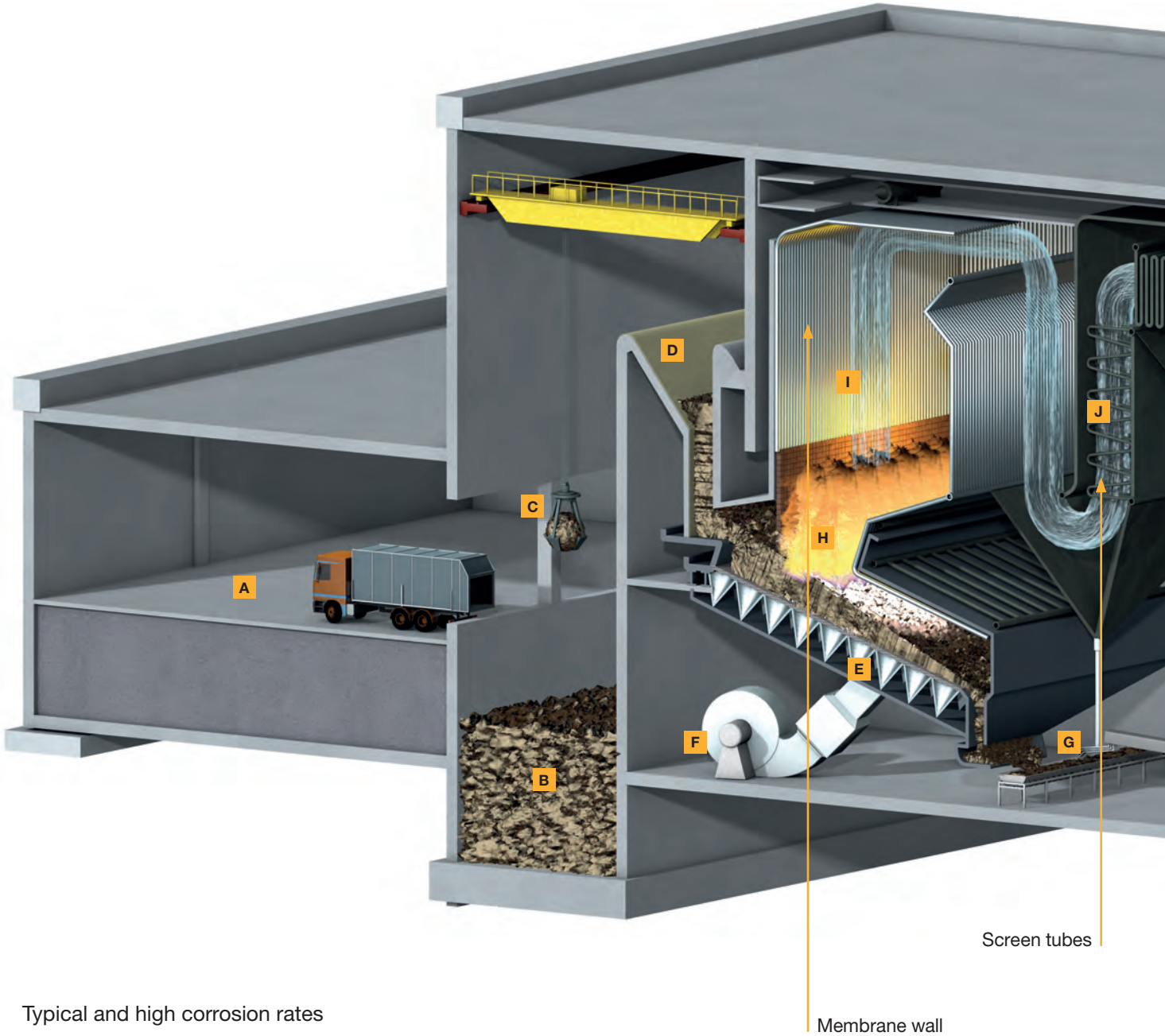
Use of these base materials, however, comes with often unacceptably high material costs. Overlay cladding of new and corroded components is therefore generally seen as a viable alternative – both from a technological and cost efficiency point of view.

Membrane wall clad with Alloy 625



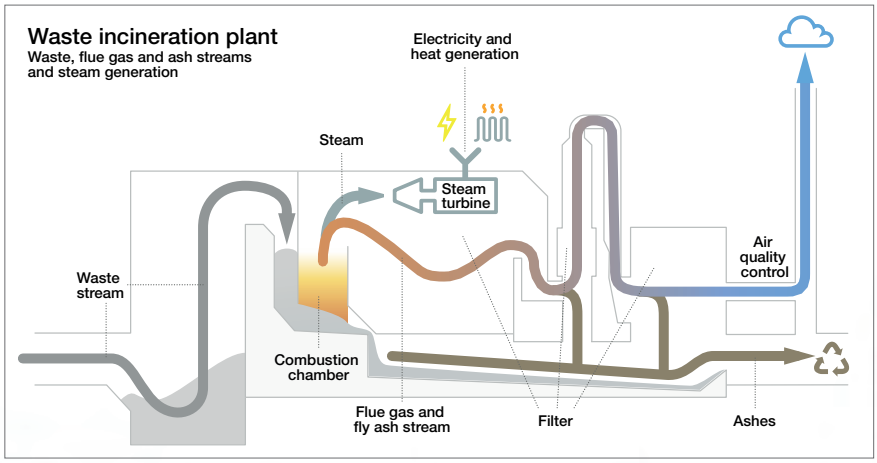
Waste Incineration Plant

Waste incineration plant with principal components.
The membrane walls, in the combustion chamber (H) the screen tubes (J) and the superheater pipes (K) are typical components to be protected by overlay cladding.



Typical and high corrosion rates

Boiler part	Evaporator tubes	Super heater tubes
Tube wall temperature	250 – 300 °C	400 – 530 °C
Tube arrangement	Membrane wall	Bundles
Material	CMn steel (St. 35.8)	Low-alloyed steel (15Mo3)
Typical corrosion rates	0.15 – 0.30 mm/y	0.20 – 0.40 mm/y
High corrosion rates	0.30 – 2.0 mm/y	0.40 – 4.0 mm/y



A	Tipping floor
B	Refuse holding pit
C	Feed crane
D	Feed chute
E	Martin stoker grate
F	Combustion air fan

G	Martin residue discharger and handling system
H	Combustion chamber
I	Radiant zone (furnace)
J	Convection zone
K	Superheater

L	Economizer
M	Dry gas scrubber
N	Baghouse or electrostatic precipitator
O	Fly ash handling system
P	Induced draft fan
Q	Stack

Overlay Cladding

Overlay cladding of new or corroded parts has become the primary solution to combat characteristic corrosion in waste incineration plants. Due to the high chloride containing atmosphere, nickel-base filler materials need to be used and numerous alloys have been tested for this purpose. Important for adequate corrosion resistance are sufficient amounts of the elements:

- nickel: generally improves resistance to surface corrosion
- chromium: offers resistance to oxidation, pitting and crevice corrosion
- molybdenum: offers resistance to reducing conditions, pitting and crevice corrosion.

Alloy 625 type filler and cladding material

has a single phase austenitic structure and a chemical composition comparable to Alloy 625 – nominally 22%Cr, 9%Mo, 3.5%Nb and balance Ni. It has excellent heat and corrosion resistance and is commonly used for components used in steam generation with service temperatures up to 450°C. In waste incineration plants it is frequently applied for the cladding of membrane walls, evaporators and preheaters. At prolonged service temperatures above 450°C increased corrosion rates are observed under waste incineration conditions. For this reason, use of Alloy 625 type cladding material in waste incineration plants is limited to service temperatures below 450 °C.

Alloy 686 type filler and cladding material

has a single phase austenitic structure and a chemical composition comparable to Alloy 686 – nominally 23%Cr, 16%Mo, 3.8%W and balance Ni. It has a very high Pitting Resistance Equivalent PREN. The increased sum of Ni and Mo gives excellent resistance to corrosion in a reducing environment, but also increased resistance to oxidising media. It is especially suited for the joining and cladding of super heater pipes with temperatures above 450 °C, in waste incineration plants.

Typical life cycle times of waste incineration plant components – non-clad versus clad with Alloy 625

Component	Non-clad steel	Steel clad with Alloy 625
Membrane wall in combustion room – lower area	6 - 9 months	3 - 4 years
Membrane wall in combustion room – higher area	2 years	> 8 years
Reheater	3 - 4 years	> 4 years

Welding Processes

Following applications are common practice in waste incineration plants for the overlay welding of new and corroded components:

- Weld overlay on new pipe walls in the workshop with stationary equipment
- Weld overlay on single tubes in the workshop with stationary equipment
- Weld overlay on new and corroded pipe walls with mobile welding equipment on site in the combustion chamber

The mostly applied method for the cladding of membrane walls is vertical-down welding with the pulse GMAW process with an overlap of 50 % for lowest dilution. It is the most productive method to obtain an Fe content of max. 5 % in a clad layer with a nominal thickness of 2 mm. Boiler tubes are clad with the tubes rotating in the PG position. Ar/He base 4-components shielding gas gives optimal weld quality. Manual SMAW and GTAW welding iare widely used for components whose shape, size or number does not justify mechanization, such as elbows and tube-to-tube connections.

Fe content

An essential objective in the overlay welding with nickel-base materials is to obtain lowest possible Fe content at the surface of the clad overlay. Important in waste incineration cladding practice are:

- To use welding wires with as low as possible Fe content – preferably below 1 %
- To limit dilution with the non or low-alloyed parent material of membrane walls, evaporators, preheaters and super heaters by:
  - Selecting an adequate welding process
  - Controlling the welding parameters to limit the heat input
  - Welding vertical down, if possible
  - Welding overlapping
  - By applying water circulation in the tubes.

Welding procedure details for GMAW with pulsed power source

Base material	■ Pipe walls and single tubes in P235GH, 15Mo3, 13CrMo44, 10CrMo910
Welding materials	■ Alloy 622 (US), alloy 625, alloy 686 (super heater tubes) ■ Coating alternatives under investigation: metal powder, ceramic, galvanizing
Shielding gas	■ 4-component shielding gas: He = 32 %, H_2 = 2 %, CO_2 = 0.05 %, remainder Ar ■ Alternative choices of shielding gas
Welding equipment	■ GMA welding equipment with pulsed-current power sources ■ Automatic burner processing
Welding position	■ Vertical down position preferred, layer width 15 - 20 mm
Option for application	■ On-site in the boiler with mobile welding equipment, minimum wall thickness 3 mm ■ Welding in the workshop weld metal overlay on new pipe walls and single tubes
Technical requirements	■ Overlay thickness 2 mm ■ Two layers preferred ■ Sand blasting of the welding surface ■ Water circulation in the tubes ■ Content of Fe in welding surface < 5 % ■ Content of Fe in welding material < 1 % ■ Consider shrinkage ■ End of cladding round-welded with TIG, notch-free

Wire volume drums and accessories

UTP wires for waste to energy cladding applications are also available in drums with a filling content of 250 kg. Special accessories for easy installation and smooth decoiling can be ordered.

UTP Eco Drum 250 kg


Soft Liner Stainless Connect


De-coiling hood

UTP and Böhler consumables for cladding, joining and arc spraying applications in waste to energy stations

Stick electrodes for cladding	Classification EN ISO	Classification AWS	Mat.-No.	Typical chemical composition wire (wt%) C	Si	Mn	Cr	Mo	Ni	Fe	Nb	W	Al
UTP 722 Kb	14172: E Ni 6022 (NiCr21Cr13W3)	A5.11: E NiCrMo-10 (mod)	2.4638	< 0.02	< 0.2	0.8	21.0	13.5	bal.	3.0		3.0	
UTP 6222 Mo	14172: E Ni 6625 (NiCr22Mo9Nb)	A5.11: E NiCrMo-3	2.4621	0.03	0.4	0.6	22.0	9.0	bal.	< 1.0	3.3		

Solid wires for GMAW cladding	Classification EN ISO	Classification AWS	Mat.-No.	Typical chemical composition wire (wt%) C	Si	Mn	Cr	Mo	Ni	Fe	Nb	W	Al
UTP A 722	18274: S Ni 6022 (NiCr21Mo13Fe4W3)	A5.14: ER NiCrMo-10	2.4635	< 0.01	< 0.1	< 0.5	21.0	13.0	bal.	3.0		3.0	
UTP A 6222 Mo-3	18274: S Ni 6625 (NiCr22Mo9Nb)	A5.14: ER NiCrMo-3	2.4831	≤ 0.02	≤ 0.2	0.1	22.0	9.0	bal.	< 0.5	3.5		
UTP A 786	18274: S Ni 6686 (NiCr21Mo16W4)	A5.14: ER NiCrMo-14		0.01	0.08	< 0.5	22.8	16.0	bal.	< 1.0		3.8	0.3

Solid wires for GMAW joining	Classification EN ISO	Classification AWS	Mat.-No.	Typical chemical composition wire (wt%) C	Si	Mn	Cr	Mo	Ni	Fe	Nb	W	Al
Thermanit 22	18274: S Ni 6022 (NiCr21Mo13Fe4W3)	A5.14: ER NiCrMo-10	2.4635	< 0.01	< 0.1	< 0.5	21.0	13.0	bal.	3.0		3.0	
Thermanit 625	18274: S Ni 6625 (NiCr22Mo9Nb)	A5.14: ER NiCrMo-3	2.4831	0.03	0.25	0.2	22.0	9.0	bal.	< 0.5	3.6		
Thermanit 686	18274: S Ni 6686 (NiCr21Mo16W4)	A5.14: ER NiCrMo-14		0.01	0.08	< 0.5	22.8	16	bal.	< 1.0		3.8	0.3

Rods for GTAW joining + cladding	Classification EN ISO	Classification AWS	Mat.-No.	Typical chemical composition wire (wt%) C	Si	Mn	Cr	Mo	Ni	Fe	Nb	W	Al
UTP A 722	18274:S Ni 6022 (NiCr21Mo13Fe4W3)	A5.14: ER NiCrMo-10	2.4635	< 0.01	< 0.1	< 0.5	21.0	13.0	bal.	3.0		3.0	
UTP A 6222 Mo	18274: S Ni 6625 (NiCr22Mo9Nb)	A5.14: ER NiCrMo-3	2.4831	≤ 0.02	< 0.2	0.1	22.0	9.0	bal.	< 0.5	3.5		
UTP A 786	18274: S Ni 6686 (NiCr21Mo16W4)	A5.14: ER NiCrMo-14		0.01	0.08	< 0.5	22.8	16.0	bal.	< 1.0		3.8	0.3

Arc spraying cored wires*	Description
SK-825-M	Arc-spraying Ni-base cored wire with addition of 5% molybdenum and 6.5% aluminium, designed to produce a high quality, high tensile bondcoat. The alloy gives a tough and dense coating, resistant to high temperature oxidation, thermal shock and abrasion.
SK-OXY-M	Arc-spraying Ni-base arc spraying cored wire filled with a special blend of ceramic oxydes. This cermet alloy gives a dense coating resistant to both abrasive and erosive wear, to wet corrosion and to oxydation at high temperatures. Typical applications: coating of water walls of waste incinerators, boiler pipes.
SK-WiNi-WiCo	Combination of arc spraying cored wires providing a NiCrCoB overlay with an extreme resistance to corrosion caused by high temperature combustion gases. The coating resists scaling and oxidation up to 1000°C. Water walls of waste incinerator, boiler pipes.

*For more information on thermal spraying we refer to the UTP brochure “Thermal Spraying Powders and Arc Spraying Cored Wires”.

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voestalpine Böhler Welding

Welding know-how joins steel

With over 100 years of experience, voestalpine Böhler Welding is the global top address for the daily challenges in the areas of joint welding, wear and corrosion protection as well as brazing. Customer proximity is guaranteed by more than 40 subsidiaries in 25 countries, with the support of 2,200 employees, and through more than 1,000 distribution partners worldwide. With individual consultation by our application technicians and welding engineers, we make sure that our customers master the most demanding welding challenges. voestalpine Böhler Welding offers three specialized and dedicated brands to cater for our customers' and partners' requirements.

böhler welding by voestalpine

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

utp maintenance by voestalpine

Tailor-Made Protectivity™ – Decades of industry experience and application know-how in the areas of repair of cracked material, anti-wear and cladding, combined with≈innovative and custom-tailored products, guarantee customers an increase in the productivity and protection of their components.

fontargen brazing by voestalpine

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

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