Inert gas welding of high-alloy materials

Process engineering and selection of shielding gases

The right shielding gas for the right material

Rapid developments in base and filler metals demand a correspondingly wide-ranging program of shielding gases. This applies equally to TIG and to MIG/MAG welding.

TIG Welding

For welding, argon is the gas predominantly used. Hydrogen admixtures raise the performance appreciably, but some mixtures are only suitable for automated application. For duplex steels, the addition of nitrogen may be beneficial in order to safeguard the austenite content. For full austenites, too, the addition of nitrogen can ensure compliance with low delta-ferrite limits. Hydrogen admixtures cannot be used for duplex steels.

MIG/MAG Welding

Austenitic steels are generally welded using an argon gas mix with 2.5% CO_2 added. Oxygen can also be used, but this results in a more oxidized weld surface. Helium admixtures of 15%, for example, also prove extremely effective in many cases. This is true, in particular, both for duplex steels and for full austenites.

Backing gases

As a rule, so-called forming gases, nitrogen-hydrogen mixtures, are used. The hydrogen component gives more protection against residual atmospheric oxygen. Under construction site conditions, higher hydrogen contents tend to be used than in the workshop. According to known studies, hydrogen admixtures in the backing gas are unlikely to lead to negative effects, even on duplex steels.

Shielding gases for welding of corrosion resistant materials according as DIN EN ISO 14175

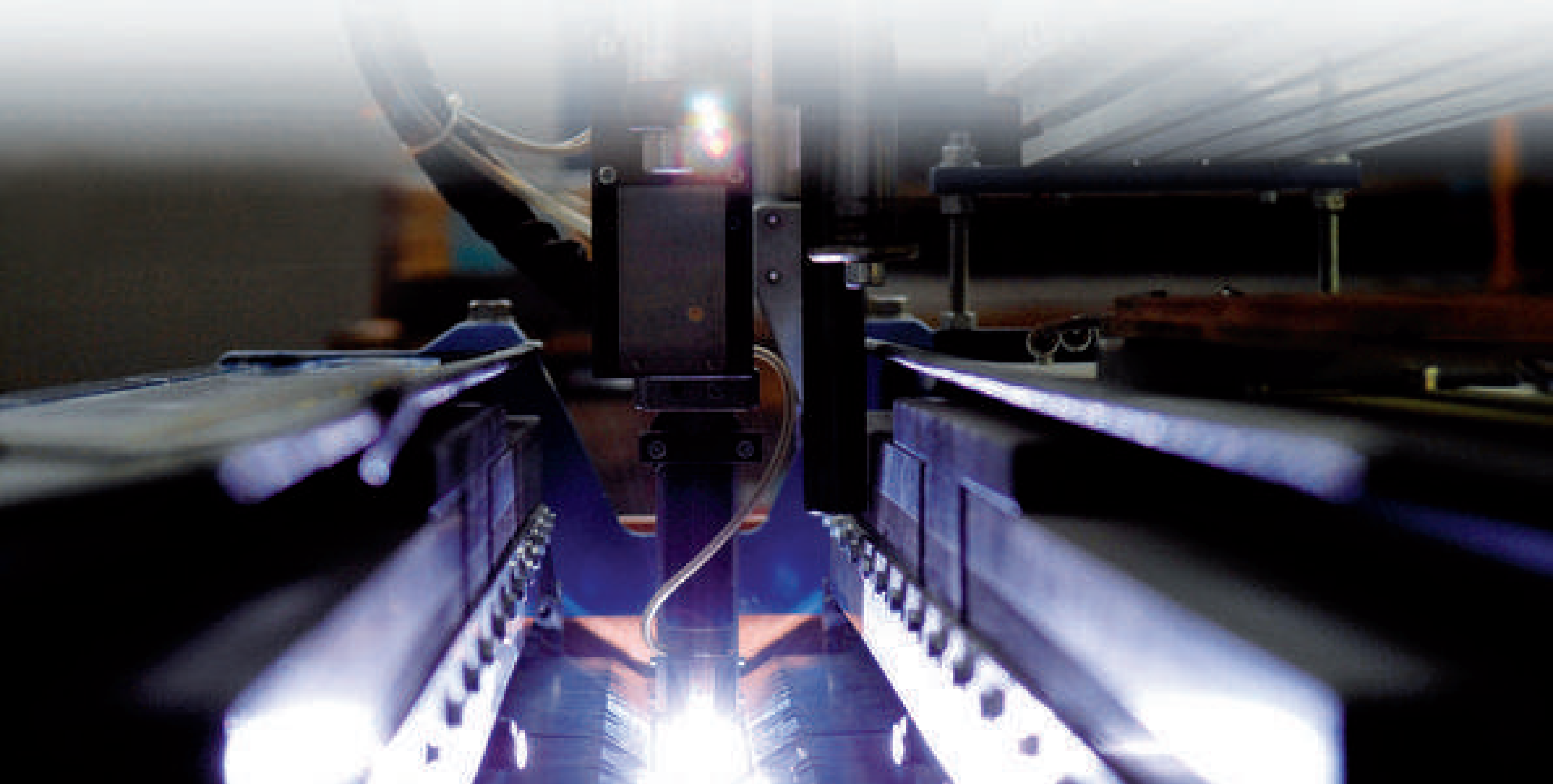
Welding argon 4.6	I1	TIG
Welding argon special 4.8	I1	TIG
Helium 4.6	I2	TIG
Inoxmix H2	R1	TIG
Inoxmix H5	R1	TIG
Inoxmix H7	R1	TIG
Inoxmix H20	R2	TIG
Inoxmix H35	R2	Plasma cutting
Inoxmix He3 H1	R1	TIG
Inoxmix N1	N2	TIG
Inoxmix N2	N2	TIG
Inoxmix He15 N1	N2	TIG

Shielding gases for MAG welding of austenitic steels according as DIN EN ISO 14175

Inoxmix He30 H2C	Z	MAG M
Inoxmix He15 C2	M12	MAG M
Inoxmix C2	M12	MAG M
Inoxmix X2	M13	MAG M
Ferromix X4	M22	MAG M

Backing gases according as DIN EN ISO 14175

Forming Gas H5	N5
Forming Gas H8	N5
Forming Gas H12	N5
Forming Gas H25	N5
Inoxmix H2	R1
Welding argon	I1



Practical Notes

Materials Science Background

Austenites contain close to 20% chromium and about 10% nickel. As a rule, the typical structure has a ferrite content of 5 to 8%. Materials frequently used: 1.4301, 1.4541, 1.4571. Austenitic chrome-nickel steels are either stabilized against intercrystalline corrosion by admixtures (usually titanium) or have a particularly low carbon content (LC qualities).

Duplex steels have high corrosion resistance, especially against media containing chlorides and, at the same time, have greater mechanical strength. Most important material: 1.4462. Duplex steels have a mixed structure with a 50% ferrite content. Superduplex steels have an increased resistance to pitting.

Fully austenites have a maximum ferrite content of 2%. This leads to an increased sensitivity to hot cracking. On the other hand, fully austenites have higher resistance to corrosion and to heat. Because of the extremely low ferrite content, these materials are non-magnetic. Typical materials: 1.4435 and 1.4439.

Nickel base materials are used for maximum corrosion resistance requirements at high temperatures of more than 1000 °C. They can no longer be classified as steel materials and are correspondingly identified by material numbers beginning with 2. When working with them, extreme cleanliness must be observed.

TIG or MAG?

Extremely high weld qualities can be achieved with TIG, as the non-metallic oxygen influences are extremely small. The welding speed is comparatively slow and the heat input high. Plasma welding, a variety of TIG welding, guarantees constant values and is used mainly for fully automated applications. MAG welding is often used for fillet welds. Particularly in the case of fully automated applications, it is also increasingly used for highly stressed welds.

Pulse technique

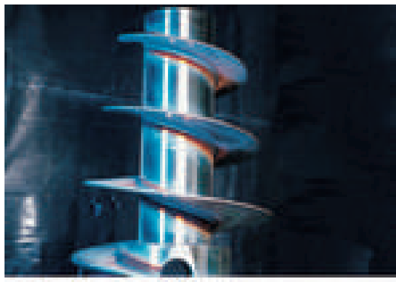
In TIG welding, the pulse technique is used in the context of orbital technology to achieve a perfect weld, even with out-of-position welds. In MAG welding, on the other hand, the aim is low spatter or spatter free welding, even in the lower setting range. The safety of the process with regard to the penetration is also increased. Modern power sources provide customised programs, adapted to the shielding gases, allowing wide variation of the welding parameters. For high alloy materials, pulse welding can be generally recommended.

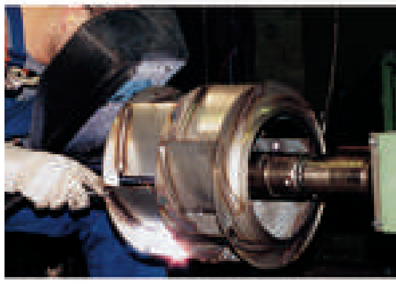
Backing gas

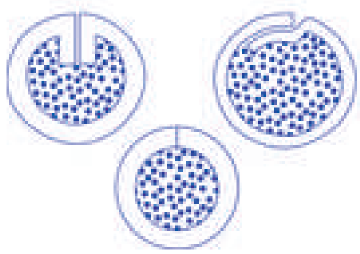
A backing gas is essential for TIG welding. A backing gas is also frequently used for MAG welding. As a rule, a residual oxygen content of <20 ppm is required at the weld root. The degree of tarnish permissible depends on the purpose of the component. Small pipes are purged, the matching of the outlet aperture being important. In the case of larger pipes, the backing gas is directed on to the weld by auxiliary devices. It is important to ensure that the pre-purging time is long enough.

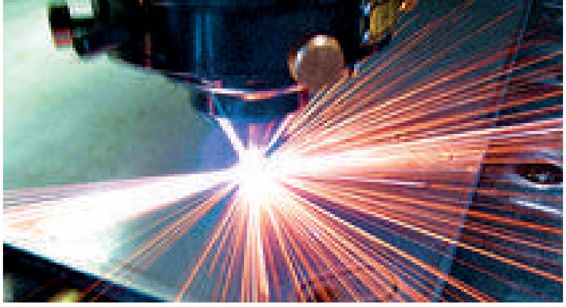
Flux-cored wires

High alloy steels are mostly welded with solid wire electrodes. However, there are also applications for flux-cored wires. Here, the use of the rutile slag type dominates. Because of the slag covering, very smooth welds are formed, little pickling is necessary and there are practically no spatter problems. A distinction is made between slowly setting slag for normal position and rapidly setting slag for vertical welding. In special cases, metal powder wires are used, for example inside containers where the slag would cause problems. The spray arc is reached more quickly with these wires than with solid wires.









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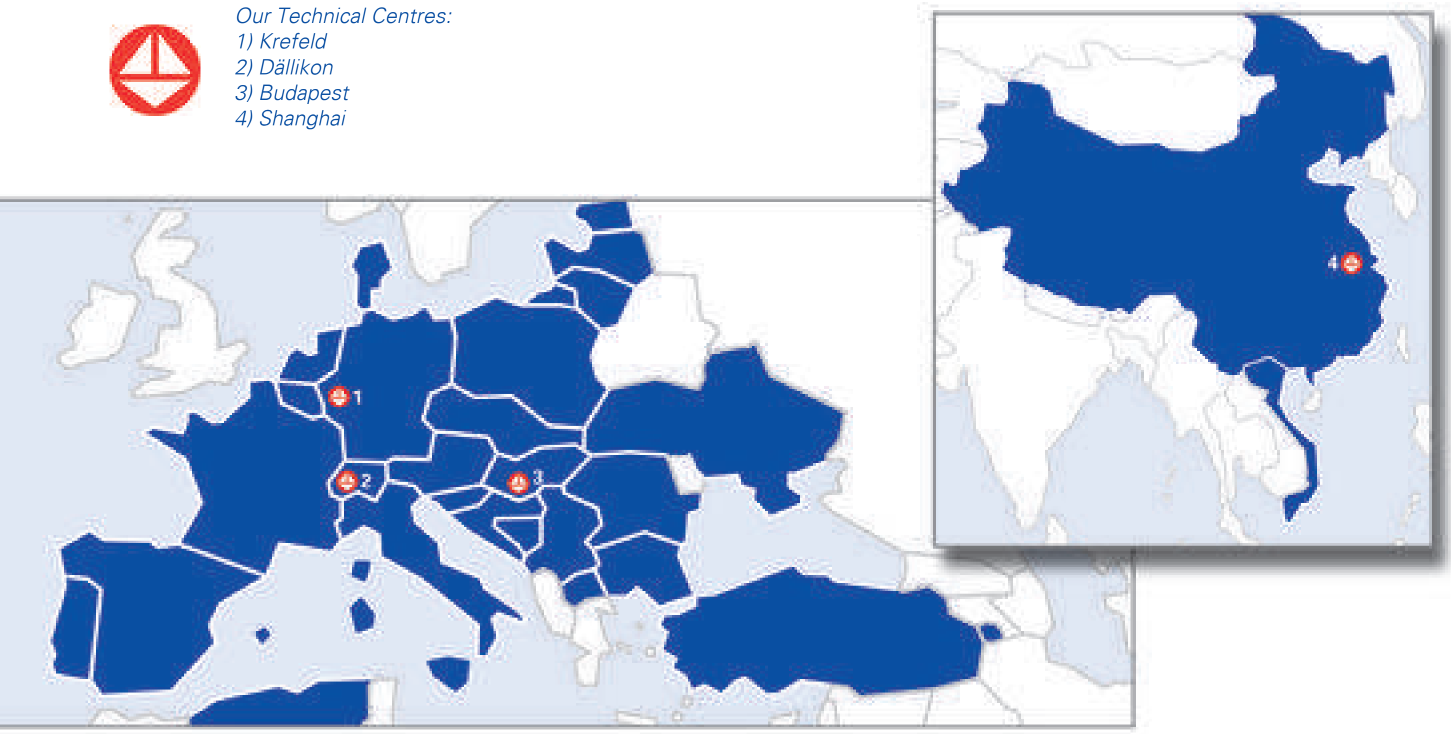

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