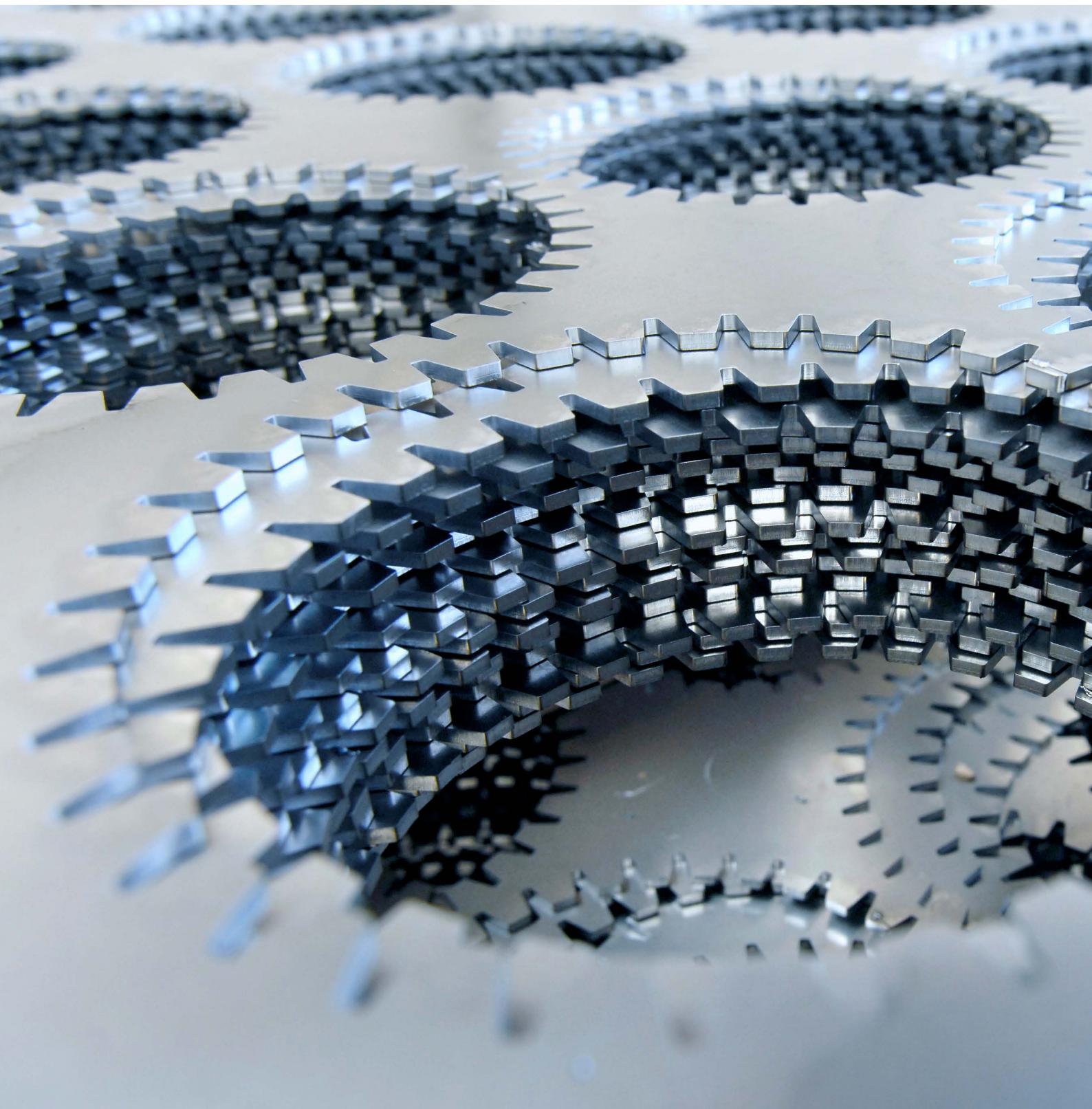


Lasline, Nitrocut, Oxycut

Gases for laser cutting





Laser technology – high-tech that has made its mark

Increasing demands on productivity, cost-effectiveness and quality require new solutions. One such solution – laser technology – has become indispensable in many areas of production, research and medicine. The number of applications and process technology solutions here is growing continuously. The use of lasers to process materials offers a whole range of advantages over conventional processing techniques: high product flexibility, excellent quality and reliability, and low unit costs.

One of the keys to the optimal application of laser technology is the selection of the operating and process gases. With **Lasline®**, **Nitrocut®** and **Oxycut®**, Messer provides all of the gases and gas mixtures you need in order to process materials successfully using lasers.

Flexibility for many applications

Laser cutting is characterized by high precision, high cutting speeds, low heat input and less distortions.

Many materials can be cut perfectly with a laser:

- steel
- aluminum
- non-ferrous metals
- wood
- glass
- plastics
- all kinds of textiles

Application areas span many industrial sectors, including:

- automotive construction
- aircraft construction
- metalworking
- sheet metal working
- shipbuilding
- textile industry
- medical technology

Lasline®, **Nitrocut®** and **Oxycut®** play a major role here in terms of essential factors such as quality and cost-effectiveness.



View inside a custom cutting operation



Stent, approx. 1 mm in diameter

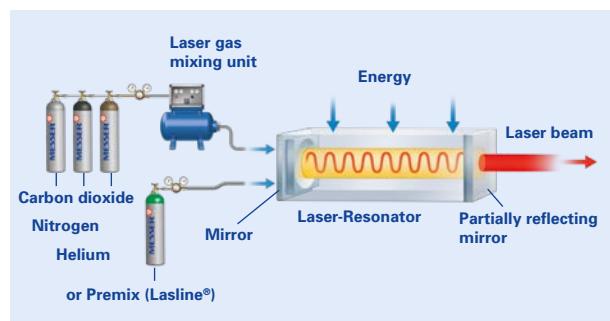
Types of lasers – no universal solution

The requirements of laser beams vary just as widely as the range of processes and applications that make use of them as a tool. Suppliers of laser equipment respond to those requirements with different configurations and power classes. Most systems can be classified into one of three main groups: **CO₂ lasers, diode lasers** and **solid-state lasers** – depending on the medium in which the laser light is generated.

CO₂-Laser – the ultimate beam quality

The CO₂-Laser is characterized by its high beam quality. A gas mixture consisting of more components (at least three) is implemented in order to generate the laser beam. The wavelength of the CO₂ laser is between 9,4 to 10,6 um and it is invisible to the human eye. Mirrors and lenses are used to direct and shape it. One of the special configurations used is the particularly efficient, diffusion-cooled CO₂ laser.

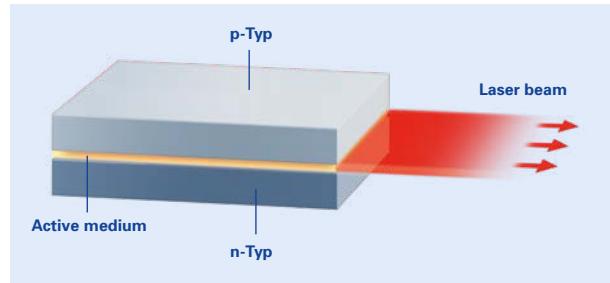
Depending on the equipment configuration, either the laser gas is produced from the three components in an internal mixer or else a pre-mixed product is used. The better reproducibility of the latter approach has made it the preferred option. The **Lasline®** product range offers a suitable selection here.



CO₂ laser

Diode lasers – the economical alternative

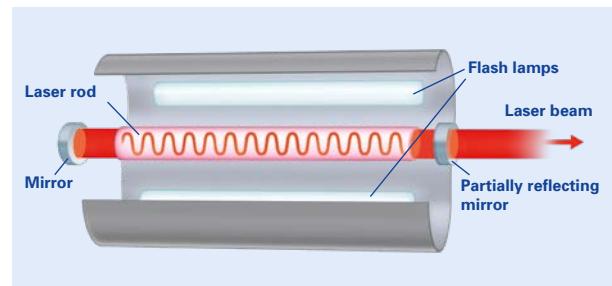
This type of laser is based on high-power diodes. The diode laser achieves its high power output through the arrangement of many electronic components in a block. Due to their comparatively poor beam quality, high-performance diode lasers are less suitable for cutting – but they are perfectly acceptable for welding, brazing or hardening applications.



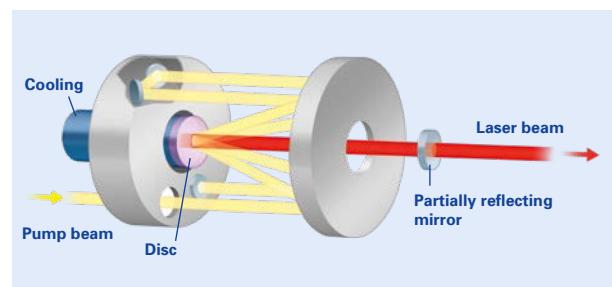
Diode laser

Solid-state lasers – rod, disk or fiber?

As a rule, YAG crystals (YAG = yttrium aluminum garnet) are used as a laser active medium in case of rod and disk lasering. In case of fiber laser, the laser beam is generated through a laser active fiber core. The most widespread dopant here is erbium.



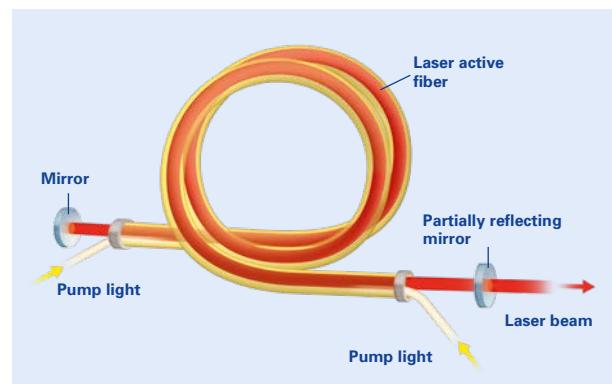
Rod laser



Disk laser

The laser beam is generated without the need for operating gases. Process gases such as shielding gases have a significant effect on the welding process. Due to the short wavelength of between 1030-1080 nm (red laser beam) the laser light can be transmitted through fiber optic cables. This makes it easier to implement automation solutions using articulated robots, for example.

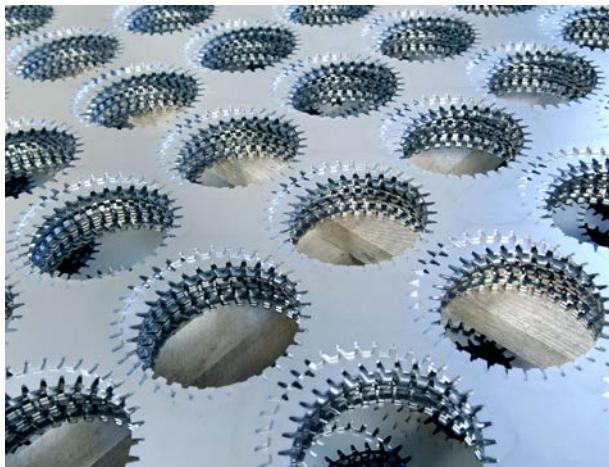
For highly reflective materials, such as copper or silver, for instance, there is diodes and all-solid laser with an even shorter wavelength. Here it comprises the green (515-535 nm) and the blue (450 nm) laser beams.



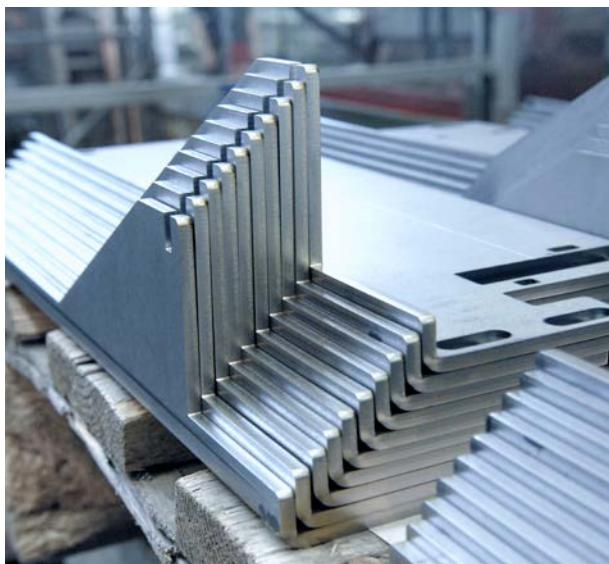
Fiber laser

Cutting processes – three approaches

All laser cutting processes essentially fall essentially into one of three categories: **laser oxygen cutting**, **fusion cutting** and **sublimation cutting**.



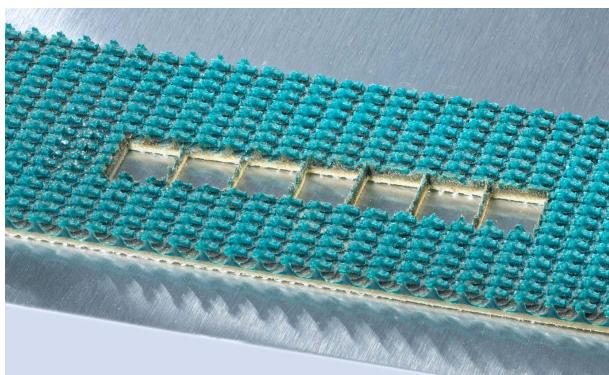
The right process to use for any given application depends on the material, the quality requirements and business considerations along with the cutting gas used.



Laser oxygen cutting

Materials that can be cut	Un- and low-alloyed steels
Cutting gas	Oxycut® (oxygen 3.5)

Laser oxygen cutting with pure oxygen is similar to oxy-fuel cutting: the material is heated up to the ignition temperature and then burned in a pure stream of oxygen. This requires that the material is suitable for flame cutting – its ignition temperature must be below the melting point. This is the case with un- and low-alloyed steels. It is not the case, however, with high-alloyed steels and non-ferrous metals. Here flame cutting with oxygen is possible, but for qualitative and economic reasons it is not recommended.



Fusion cutting

Materials that can be cut	CrNi steel, non-ferrous metals, glass, plastics
Cutting gas	Nitrocot® (nitrogen 5.0), argon

Materials which are unsuitable for flame cutting are cut with the fusion cutting process. To do so, the material is heated up to the melting point and forced out of the kerf by a high-pressure stream of cutting gas (up to 25 bar). The cutting gas used is usually nitrogen; argon is also used in special cases. This is the case, for example, of titanium, tantalum, zircon and magnesium, as these materials form chemical bonds with nitrogen. For quality reasons, the fusion cutting process can also be used to cut un- and low-alloyed steels. This creates oxide-free cutting surfaces, however, cutting speeds are considerably slower.

Sublimation cutting

Materials that can be cut	Plastic, paper, wood, ceramics
Cutting gas	Nitrocot® (nitrogen 5.0), argon

Materials without a melting point, such as wood, plastics, composites, Plexiglas (PMMA), ceramics or paper are cut by sublimation cutting. In this case, the material changes directly from the solid to the gaseous state. The cutting gas keeps the particles and vapours away from the optical elements.



Gases and gas supply – reliable and application-based

Gases are needed at several points in the process. Depending on the system, they perform the following functions:

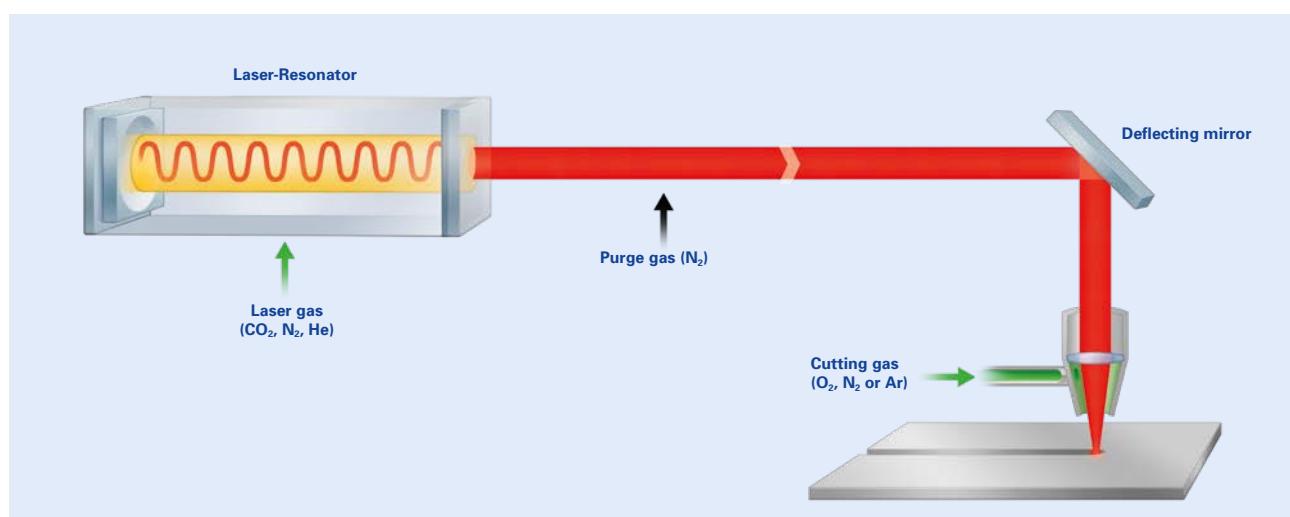
- gases used as operating gases to generate the laser beam (CO_2 laser)
- cutting gas
- purge gas

Laser (operating and) process gases

Laser or operating gases are required in order to operate the resonator. Process gases are fed into the laser beam in the workspace, e.g. as welding shielding gas or cutting gas. The purity, quality and mixing consistency of the operating gases for CO_2 lasers are subject to the highest standards – and for good reason.

- Even traces of moisture or hydrocarbons can impair operation.
- Hydrocarbons can damage sensitive and expensive optical components.
- Moisture disturbs the excitation discharge and disables the laser from achieving its full efficiency.
- The formation of acid molecules can lead to corrosion damage.
- Dust particles can scatter the laser light, thereby disrupting the process.

For perfect laser operation, therefore, it is absolutely essential that the gases used are extremely pure and free of disruptive contaminants.



Laser cutting: principle of operation



Gases and gas supply – reliable and application-based

Operating gases

The term "operating gases" refers to gases required to generate the laser light. These gases, too, must be extremely pure and free of disruptive contaminants in order to guarantee perfect operation of the laser. They are either supplied in pre-mixed form or their separate components are mixed in the laser unit.

Gas	Purity
CO ₂	4.5
N ₂	5.0
He	4.6

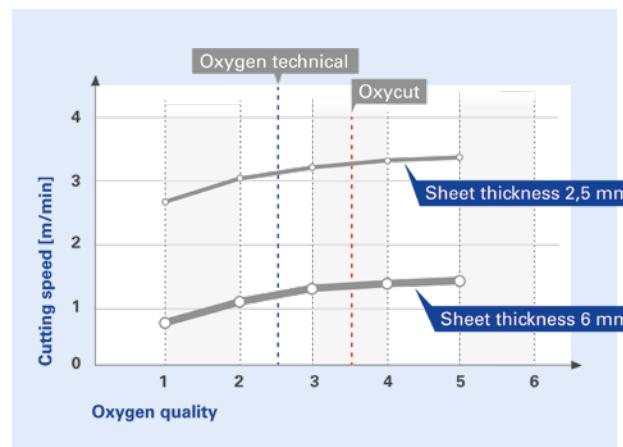
The gas supply system must also satisfy the purity requirements. The composition of the gas mixture depends on the type of laser. The exact composition is specified by the manufacturer. A change in the composition can impair performance or damage the resonator.

Process gases / cutting gases

Cutting gases are selected according to the material to be cut. Materials which are suitable for flame cutting are cut with pure oxygen. Here the purity of the gas can have a strong influence on the cutting speed. With the high purity of **Oxycut®**, for example, the cutting speed can be increased by up to 20% – depending on the thickness of the sheet or plate.

Most materials which are not suitable for flame cutting are cut with nitrogen. Its inertization effect results in oxide-free cutting surfaces. Here slight contamination by oxygen or moisture cause discolorations on the cut surfaces. **Nitrocut®** ensures high quality cut surfaces. Titanium, tantalum and magnesium are examples of materials that form nitrides, as they react strongly with nitrogen. In order to be able to weld these materials

without having to perform post-processing operations such as milling, grinding or pickling, it is recommended to use argon when cutting them.



Gas supply

Depending on the quantity needed and on the intended use, Messer offers various supply concepts which have proven themselves in practice. Smaller quantities such as in the supply of laser gases (operating gases) are handled with gas cylinders. Individual 10-litre or 50-litre cylinders are most commonly used. For cutting, oxygen or nitrogen is provided in tanks.

Process	Pressure (bar)	Quantity (m ³ /h)
Oxygen cutting	1-5	2-5
Fusion cutting	15-25	30-50



Installation

For optimal gas supply, gases have to be transported to their destination without becoming contaminated. This requires proper installation of the hardware, appropriate selection of gas fittings and a need-based supply of gases in the purity needed. The installation of a particle filter provides additional security. The supply of gas to the resonator also demands extremely high purity, both in the resonator gases themselves and also for the pipes and hoses used as supply lines.

The degree of purity of the gases is indicated in percent – a figure given to several decimal places. In order to simplify labelling, an international index system has

been established. The indices consist of a digit, a point and a second digit. The first digit indicates the number of nines, and the digit to the right of the point represents the last digit of the complete value.

Example:

2.5 = 99,5 %
3.5 = 99,95 %
4.6 = 99,996 %
5.0 = 99,9990 %

For the supply lines in the fixed part of the equipment, pipes made of copper or CrNi steel are ideal. Hoses always carry the risk that nitrogen, oxygen and especially moisture will diffuse into them. The use of special materials can minimize this problem.

Safety – without compromise

Equipment used in the laser processing of materials requires consideration of several special work safety aspects which are typical of laser-based processes. First and foremost, there is the laser beam itself: its potential risks differ depending on the type of laser, and so the protective measures also differ accordingly. Moreover, emissions generated during welding or cutting must be appropriately extracted and filtered. For the safe use of laser systems and their peripheral equipment, the applicable guidelines and regulations have to be followed.



For medium and small requirements Messer offers cutting gases also in cylinder bundles, such as the new MegaPack.

Advice, Delivery, Service



Technical centers – sources of innovation

For the development of new technologies in the field of welding and cutting, Messer operates technical centers in Europe, Asia and the Americas. These facilities provide ideal conditions for innovative projects as well as customer presentations and training courses.

Portfolio of gases – comprehensive and clear

Messer offers a spectrum of gases that extends well beyond the standard fare: it ranges from just the right gas for each application, and clear, application-oriented product designations to the continuous introduction of new gas mixtures designed to address current trends.

Specialized on-site consulting – right where you need it

Specifically, in the context of your particular application, we can show you how to optimize the efficiency and quality of your processes. We support you with troubleshooting and process development.

Cost analyses – fast and efficient

We will be glad to analyze your existing processes, develop optimization proposals, support process modifications and compare our results with the previous situation – because your success is also our success.

Training courses – always up to date

Our training courses demonstrate the application of our various shielding gases and outline the safe handling with them. These also include the storage of the gases as well as the safe transport of small quantities. Information and training material for your company also belong to this service. We offer regular webinars on the usage of our products.



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