# Blended laser-assist gases: Recipe for successful materials processing

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*Now processing a greater variety of materials with their lasers, fabricators are exploring new assist gas blends of up to four gases. What's the best way to blend and deliver these gases? For some, on-site blending systems can help optimize cost savings and improve quality.*

Blended Gas System
*Photo courtesy of WITT Gas Controls LP*

The industrial laser has been used to process materials since the early 1970s, predominantly to cut and weld. Originally used to process steel, stainless steel, and aluminum, lasers now can cut and weld other materials, such as nickel alloys, titanium and titanium alloys, and copper and copper-based alloys.

Assist gases are critical to laser processing. Advancements in laser technology have increased demands on these gases to achieve the desired process speeds and quality.

Various gases can be used in laser processing. Among the determining factors in gas selection are the chemical and mechanical effects on the material you are cutting and the desired surface finish.

### Materials and Gases

Certain gases are used to process specific materials:

| Material | Possible Assist Gases |
|---|---|
| Steel | Oxygen, Nitrogen, Air |
| Stainless Steel | Nitrogen, Air |
| Aluminum | Nitrogen, Air |
| Titanium | Argon, Helium |
| Nickel Alloys | Argon, Helium, Nitrogen |

In some cases, such as using air or oxygen as the assist gas, the gas aids in the exothermic cutting process. Inert gases, such as nitrogen, argon, and helium, act primarily to remove the molten metal from the heat-affected zone (HAZ).

## Cutting Gases

Laser cutting introduces contaminant in the HAZ that sometimes require secondary processes to achieve the necessary surface finish quality. Blended air helps reduce these contaminates and eliminates the need for a secondary process. Argon and helium blends are being used to laser-cut titanium and other alloys.

Shielding gas blends typically have been limited to argon and helium, but recently mixes of two, three, and sometimes four gases have been experimented with based on the type and thickness of the material to be processed; hydrogen, nitrogen, or carbon dioxide have been added to the mix.

## Welding Gases

Assist gases used in laser welding have three main functions:

1. Primarly, to protect the HAZ from oxidation
2. To minimize the effect of the formation of plasma in the weld area
3. To expel the plasma from the weld joint area

Because of its high ionizing potential and heat conductivity, plus the fact that it doesn't cause any metallurgical problems, helium has been the assist gas of choice for welding. However, helium's high cost has always motivated fabricators to look for alternative welding assist gases.

A lower-cost choice is argon, which also does not create any metallurgical problems. But argon's ionizing performance is not as good as helium's.

Nitrogen can cause metallurgical problems with certain materials and should be used only in selected applications. Carbon dioxide is not suited for welding with a $CO_2$ laser, because the gas's as high absorption rate prevents maximum power delivery to the workpiece.

Hydrogen, when mixed with inert gases, may be used only for certain grades of stainless steel, and the hydrogen content normally does not exceed 10 percent of the total gas mixture.

## Three-gas Blends

**Figure 1**
Microbulk Cylinders
*Photo courtesy of Chart Industries*

The accepted mixture of 50 percent argon and 50 percent helium has been used for many years to lower the overall assist gas costs. Today three-gas mixtures are becoming more common.

Among the three-gas mixtures for laser welding are:

1. Argon (50%), Helium (35%), and $CO_2$ (15%)
2. Hydrogen (8%), Helium (20%), and Argon (72 %)
3. Hydrogen (10%), Helium (40%), and Argon (50%)

While blended gases typically are chosen to reduce the purchase price of the gas, the actual cost of the blended gas in blended cylinders usually is the same as the higher-priced gas.

With laser assist gases requiring pressures of 300 pounds per square inch (PSI) and flows rates of 1,000 standard cubic feet per hour (SCFH) or greater, and laser welding gases approaching flow rates of 250-300 SCFH, an on-site gas blender may be a more cost-effective method of supplying mixed gases.

Microbulk gas systems (**Figure 1**), a popular method for pure gas delivery during laser cutting, can be used to deliver a blend of argon, nitrogen, and oxygen, an approach that is significantly more efficient than handling multiple high-pressure or liquid cylinders of blended gases. Storage tanks range in size from 230 to 1,500 liters and are equipped with internal vaporizers and pressure-build regulators than enable gas delivery at pressures up to 450 pounds per square inch gauge (PSIG). These systems are well-suited for supplying the lower-cost gas to a gas blending system that incorporates helium and hydrogen supplied in high-pressure-cylinder systems.

### Worth the Investment?

Is an automatic gas blending system right for your operation? What factors should you consider to determine its worth?

**Reduced Assist Gas Costs**—Distributors often purchase gas mixtures in premixed cylinders and pass the blending costs on to users. Premix gas pricing typically is based on the price of the most expensive gas in the mix, which raises the price of the lower-cost gas. For example, in a mixture of helium and argon, the price of the lower-cost argon can equal that of the more costly helium.

Some fabricators buy pure gases and blend their own mixtures, sometimes based on a fixed-orifice sizing that produces a single, nonadjustable concentration. A better strategy would be to use an adjustable gas blender that can optimize the mixture concentration and conserve gases.

**Improved Gas Blending Technology**—Original gas blenders used a fixed-orifice and volumetric method to blend gases and were very sensitive to process variations. Today's gas mixers are based on modern mixing and measurement technology and are less sensitive to gas density, pressure, and temperature variations. Consequently, they offer enhanced precision and greater flow turndown capability than fixed-orifice gas mixers.

**Optimized Mixture**—With premixed cylinders, gases may separate or even stratify if you are using a fixed-orifice, volumetric mixer equipped with a surge tank. This has a negative effect on your product quality. Online gas mixers help ensure that the mixture is correct and facilitate consistent quality.

**Ease of Operation and Maintenance Procedures**—Automating the gas mixing process with an adjustable blender eliminates the need for frequent flow, pressure, and gas concentration adjustments typical in laser and shielding gas operations. Using only flow controllers, valves, or pressure regulators to achieve the proper mix leads to process variations and inconsistent quality.

**Reduced Handling Time**—Changing cylinders with their flowmeters and regulators when you need to change your gases or mix can be time-consuming and tedious. You can reduce setup time by using adjustable equipment with automatic bottle changeover.

**Improved Training**—Gas mixers are ideal for welder training because you can quickly change the blend and illustrate the effect of different shielding gas mixtures on weld quality, product appearance, and other properties.

The industrial laser is an important tool in today's fabricating shops. As fabricators diversify and process a greater variety of materials, an adjustable gas blender may be a *godsend*.