SYNRAD

The Role of Assist Gases

Assist gases perform a number of functions in material processing applications, depending on the application type. Some of these functions include the following:

To aid removal of cut or drilled debris
Minimize heat-affected zones
Shield/ shroud processing area
Protect optics

While determining the appropriate assist gas type and its optimal delivery can be a complex task and varies with each application, the following outlines a few general guidelines to using assist gases.

The expense of gases means that its usage and delivery should be optimized as much as possible. A few considerations include optimizing the nozzle exit orifice diameter, optimizing nozzle standoff, and tailoring the gas pressure to process requirements. While the first two points are self-explanatory, tailoring the assist gas pressure requires a bit more experimentation to achieve optimal conditions.

Plastics and organics

When processing these materials, the gas jet must cool the sides of the cuts to reduce melt-back, charring, and surface discoloration.

For thermoplastics, the gas assist set-up is straightforward: low pressure (<5psi) air (clean), or nitrogen. There is little difference between the two. Increased pressure tends to cause excessive burring on the underside of the cut. For thermosets and composites, the pressure is usually increased (>5psi) as charring and surface discoloration become more of a problem. In thicker materials, this problem is more apparent. The appropriate gas pressure must be determined by balancing the requirements of the exact material itself, and the overall cut quality.

To improve edge quality and reduce surface discoloration, the best solution is often to use greater than adequate power to cut the material, and to increase gas pressure. This effectively widens the cut, allowing more gas to flow through, thereby minimizing charring and surface discoloration. Reducing this width by increasing speed causes a larger percentage of the gas to simply flow across the material surface, reducing the efficiency of the gas assist, and possibly aiding surface discoloration by drawing in and moving vapors along the material surface that would otherwise pass through the cut. If speed is critical, a lower gas pressure is advised.

A number of thermosets eject vapor out and back along the cut length. In such cases, increasing gas pressure can worsen the effect. The gas pressure should be minimized, and some form of top extraction should be implemented. It is also worth noting that if the surface appearance is critical, the side from which the cut is made can be important. The best surface may be facing or away from the laser, depending on the material. As thermoset and composite materials tend to cut by burning, the use of air can sometimes offer a slight speed advantage over nitrogen. This is particularly relevant when cutting wood.

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Metals

When cutting and drilling metals, the primary function of assist gases is to aid cutting by means of an exothermic reaction with the iron, and to force the molten material through the cut or hole. Most often, an oxygen gas is delivered through a coaxial nozzle at high pressure, typically 20-100psi. Consider cutting 1.5mm-thick steel. Cutting fine details requires higher pressure, typically 60psi, than does less detailed cutting. The excess pressure actually cools the cut and the surrounding material adjacent to the cut, helping to reduce any over-burning effects. A less detailed pattern could use less than 30psi, as the jet is not required to assist part cooling.

Requirements for welding metals are more dependent on the type of gas and the delivery strategy being used. Each material has well-documented shielding gas requirements based on arc welding, which can usually be applied to laser welding. The primary role of the gas is oxidation protection by shielding the molten pool with inert (argon) or pseudo-inert gases (nitrogen). Occasionally, the gas or gas combinations need to be modified, and the means by which the gas is delivered to the process area, defined.

In order to achieve blanket coverage, welding commonly uses fairly diffuse side jets angled toward the weld area. Typical bore diameters of 0.125, and pressures less than 20psi are used. The jets should be directed slightly above the weld pool to avoid disrupting the solidification of the weld, or made diffuse enough to have no significant effect.

The role of the shielding gas in relation to the formation of the plume has a different emphasis in low power applications. For low power applications (<500W), inducing a plume aids welding penetration and weld width. For high power applications (>1 kW), the plume should be minimized.

In the majority of applications, the processing operation will generate a certain amount of fumes, vapors, and particles that will potentially harm the optics of the laser system. The assist gas, therefore, also serves as a means of protecting the optics by blowing these substances away from the lens. An assist gas will benefit even applications that do not require its use for any of the other above-mentioned reasons.

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