

# Cutting with (which) gas

Oxygen, nitrogen, compressed air, argon – laser profilers use all of these gases to cut materials. Andrew Allcock went in search of rules and found that there are few hard and fast ones



1

High speed (25 m/min) cutting with nitrogen gave clean edges, no oxide and limited discolouration



2

Cutting with air, also at 25 m/min, but there's oxide (although bonded securely), a minor burr and more discolouration



3

Processing with oxygen sees oxide that could become detached, burnt corners and a burr

**A** Trumpf Open House last year highlighted both the potential to cut aluminium up to 4 mm thick with oxygen, or mild steel up to 3 mm with compressed air. Following the visit, *Machinery* decided to get the low-down on which gas is used where and why. There appears to be few simple answers.

Things have certainly changed a lot in the last five years, offers technical support engineer Graham Jessop, adding that there are more cross-over points between the different gases. And Nick Damjanovic, general sales manager, underscores this by saying that there are no hard and fast rules that say you must cut any particular material with any particular gas; except in a few cases.

So, titanium is mostly cut using argon, while you would never use oxygen on

galvanised mild steel because of the dangerous fumes given off. Mild steel can be cut using oxygen, nitrogen or compressed air (which is 80 per cent nitrogen and 20 per cent oxygen); so can stainless steel. For copper it's oxygen and for brass it's nitrogen first and then air.

For aluminium, the choice was nitrogen or compressed air. But since the introduction of Trumpf's latest 6 kW laser source on the company's TruLaser 5030 and 5030 Classic models, that has changed – now oxygen cutting is possible (up to a maximum thickness of 4 mm for all grades). This also offers a better solution for high purity aluminium than did nitrogen, Mr Jessop confirms. Piercing in particular was difficult and slow, so piercing with oxygen and then cutting with nitrogen would have been the

favoured route. The ability to cut with oxygen also has cost implications because the amount of gas used is less – nitrogen and oxygen are not too different in price.

## WHAT'S THE DIFFERENCE?

To try to establish just what the effects of the three different solutions are on mild steel, *Machinery* witnessed cutting trials on 1 mm thick mild steel for a lamination part and also cutting trials on 3 mm thick mild steel (the current maximum for compressed air cutting). Both were undertaken on one of Trumpf's 5 kW TruLaser Classic machines.

While it is often the application that drives the choice, the results might surprise and cause users to reconsider their approach. In the case of the 1 mm thick laminations, the requirement for



4

*Cutting with oxygen sees some discoloration but there's little burning and no burr. And, of course, oxygen does not draw full laser power*



5

*With air the edge quality is poorer (rougher), edge discoloration is similar to oxygen, but there is more burning at corners and a burr all round*



6

*Finally, processing our 3 mm thick mild steel sheet with nitrogen gives us high edge quality, while there is no burning on the corners*

clean edges without oxide – either loose or fixed – and without burns will actually dictate the use of nitrogen, but on another component in the same material there might be room for choice and the *Machinery* cutting trials provide information on which that choice might be based.

First, nitrogen. There are, in fact, two possibilities with this gas; the first is 'standard cutting' the other is 'plasma assisted', or high speed cutting. In plasma assisted cutting, gas pressure of 7 bar and nozzle size 1.7 mm diameter are used in conjunction with a 3.75 inch head. The cutting speed is 25 m/min rather than the 11 m/min for 'standard' nitrogen, which employs a 5 inch head, 13 bar gas pressure and a 1.4 mm diameter nozzle. Gas consumption is similar.

High speed cutting was used in *Machinery's* example and gave a clean edge with no oxide and very limited discoloration of the small corners of the lamination detail (see pic 1).

Moving onto compressed air, the pressure setting was 5 bar, nozzle diameter was larger at 2.3 mm, the head was a 5 inch focal length unit, and cutting speed was 25 m/min – the same speed as with 'plasma assisted' nitrogen, but faster than standard nitrogen. Actual gas flow was similar to our nitrogen example, but with compressed air being much cheaper, the cost benefit is high.

It should be noted that Trumpf's use of 5 bar compressed air – standard workshop pressure – is something of a

differentiator, it is claimed. That's because others require higher pressure which itself requires additional compressor equipment. This, says Mr Damjanovic, will offset the benefit of employing lower cost compressed air in the first place.

While cost and speed criteria favour compressed air, nitrogen scores on edge quality. Compressed air gives an oxide coating, although it is bonded securely to the parent metal (the higher pressure has blown the loose material away), so there is no danger of it breaking off. There is also a minor burr and greater edge discoloration (pic 2).

#### POWER PLAY

Moving on to oxygen, the same 5 in head is used, gas pressure is 4 bar, nozzle diameter is 0.8 mm and speed of cutting is 8.2 m/min. The gas flow rate is less than for both nitrogen and compressed air which makes the process more cost-effective than nitrogen, although still not as cost-effective as compressed air. The speed is one third of the other two. However, with oxygen, only 1 kW of the 5 kW available is being used, whereas both nitrogen and compressed air require full power.

As to the quality, there is oxide on the cut edge which could become loose and there is more burning on the sharp corners of the lamination detail and a related burr (pic 3).

Moving onto the 3 mm thick material, using oxygen the pressure is 0.8 bar,

nozzle size 0.8 mm and power output is 2 kW – all resulting in a cutting speed of 4.9 m/min. It is an interesting point that as material thickness increases, the gas pressure, in the case of oxygen, is lowered – for nitrogen it is the opposite. There is edge discoloration, but very little burning at the corners and no burr on this occasion (pic 4).

For air the settings are full power (5 kW), 5 bar pressure, nozzle diameter is 2.7 mm and speed of cut 6.1 m/min. Edge quality is poorer (rougher), edge discoloration similar to oxygen, but there is more burning at corners and a burr all round (pic 5).

For nitrogen (standard cutting), the settings are full power, 17 bar pressure, 1.4 mm nozzle and 4.9 m/min cutting speed. Edge quality is very high and there is no burning on the corners (pic 6).

Now all the settings of gas pressure, power, nozzle size, cutting speed and laser head focal length are dictated by material and gas choice tables available from Trumpf, although choices are offered – these being appropriate for machines that have a nozzle changing capability (but where the laser head must stay the same).

These settings are not likely to be applicable to other manufacturers' laser cutting machines, and so the cost to cut something on different machines will vary in any given application. So, machine cost is one thing, but running costs and versatility must also be factored into the investment equation. □