SPECIAL FEATURE

Cutting-edge technologies

Thermal cutting processes have become more advanced, but the key ingredient remains the same...

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GASES ARE imperative to the smooth cutting of metals and other materials for industrial use. Whether using a chemical, electrical or optical process, various gases must be introduced into the mix, in order to penetrate the surface and make a clean cut.

The cutting sector has seen substantial advances in equipment and guidance systems since the first thermal cutting machines were manufactured over 100 years ago, therefore making processes more efficient, but gases remain the vital ingredient.

Processes and gases

Oxyfuel cutting is the original process used for cutting metals. A chemical process, it uses a high temperature flame to heat up the metal and burn through it, making a clean cut.

The high temperature of the flame is achieved by combining oxygen with a fuel gas, which fuel gas depends on how high the quality of the cut needs to be, time available, and the thickness of the metal.

Oxyfuel gas flames are used to preheat the metal, and a high pressure oxygen stream is then directed at the surface and cuts through it; the process is creating iron oxide.

Acetylene is a popular choice for this type of cutting, as it is the hottest burning gas.

Oxy-acetylene cutting, as it is referred to, requires a 1.1:1 ratio of oxygen to acetylene. It is best suited to cutting thin materials, as it is not economically viable for cutting heavy materials only, given the high fuel cost and large volumes needed to achieve the required heat.

Propane has a lower flame temperature, but is cheaper than acetylene, so is often used for oxyfuel cutting. It is a popular choice for cutting jobs where cut quality is not of great importance, such as on scrap yards.

Natural gas, hydrogen and propylene are also frequently used as the fuel gas in oxyfuel cutting.

Plasma and laser cutting are relatively new processes in comparison.

Plasma cutting is an electrical process which was introduced in the 1950s; gas is heated and ionises, becoming electrically charged plasma, which is able to conduct an electrical current. An arc of electricity passes with the gas out of a small nozzle and onto the focused area, melting the metal to separate it.

Nitrogen, argon, hydrogen, oxygen, and dry compressed air are all used in plasma cutting, which one, or which mixture, depends on the specifics of the job.

Nitrogen is very versatile, and is therefore used in dual gas torches for cutting a range of different metals, especially stainless steels and aluminium; it is also used as the shielding gas when using an argon/hydrogen mixture as the plasma gas.

Argon and hydrogen are mixed and used for cutting heavy thicknesses of up to 60-80 mm. Stainless steel, aluminium, copper and titanium are among the metals most commonly cut by this gas mixture; the percentage of hydrogen varies depending on the metal.

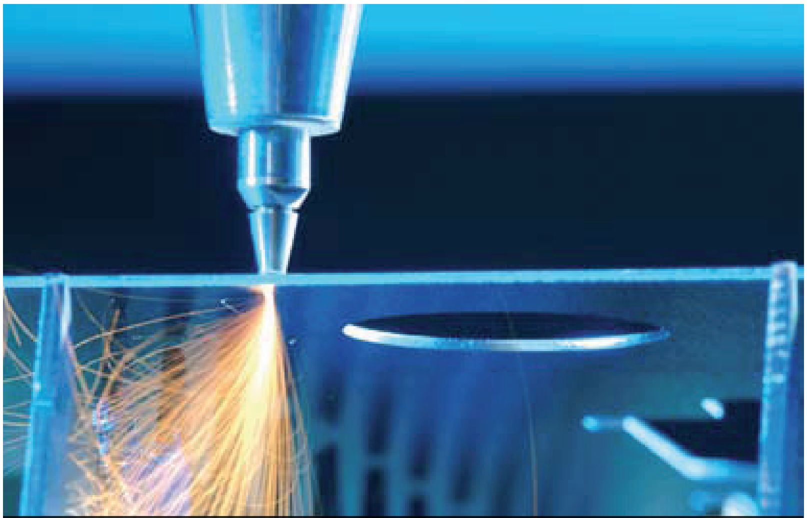
Oxygen is sometimes used as the plasma gas when cutting carbon steels and low alloyed steels of up to 20mm; and dry compressed air is used for small jobs, usually with manually operated units for cutting sheet metal.

Carbon dioxide is used to cool the nozzle when nitrogen is used as the plasma gas.

Laser cutting uses light as heat and is the most accurate of all the processes; this, added to the fact that it can run unattended, means the machinery is costly and requires a high investment cost.

It is very fast at cutting through thin materials, being used mainly on mild and stainless steels in the automotive and food industry, but is also suitable for cutting through other metals, as well as wood, fabrics and plastics.

There are two types of lasers most commonly



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used for cutting metal.

The first, most widely used type is the CO_2 laser, which uses a gas mixture of carbon dioxide, nitrogen and helium (and sometimes also small amounts of carbon monoxide, xenon, oxygen or hydrogen).

These lasers emit laser light when exited ('pumped') by an electrical or radio-frequency (RF) discharge through the gases mixture. The light is produced by the carbon dioxide molecules, while the other gas components are needed to optimise the efficiency of the transfer of electrical or RF energy into laser light.

CO_2 lasers produce light in the far infrared part of the spectrum, invisible to the human eye (10.6 micrometer wavelength), and require special mirrors to relay the laser beam from the laser source to the cutting head.

The second type of lasers used for cutting are solid-state lasers, such as Nd:YAG, fibre, and disk lasers.

These lasers do not use a gases mixture to produce the laser light, but a doped crystalline medium. They are pumped with a bright light source such as a flashlamp or, increasingly by diode lasers.

Fibre lasers and disk lasers are comparatively new developments, which distinguish themselves by having a very high electrical to laser light conversion efficiency and a much shorter wavelength (1.06 micrometer, one tenth of the wavelength of a CO_2 laser). The latter means the light can be transmitted through an optical fibre and these lasers are therefore ideally suited to robotic 3-D cutting applications, whereby the fibre simply transfers the light from the lasers source to the cutting head, almost like gas molecules that flow through a flexible pipe to the point of use.

To achieve laser cutting, both lasers require a laser cutting process assist gas. Oxygen is used when cutting mild steel; the chemical reaction of the oxygen with iron releases heat, thereby helping the cutting process. Up to 25 mm mild steel is cut in this way.

If an oxide-free cut edge is required, nitrogen is often used, especially with stainless steel. As with mild steel, the maximum thickness that can at present be cut is approximately 25 mm. However, since there is no chemical reaction to help the cutting process, a very high nitrogen pressure is required (to remove the molten steel), and very high laser power (up to 7 kW).

The market

The financial crisis has had a profound effect on production levels in the industrial sector; consumers have cut their spending, which has meant decreased demand for products, which has meant a cut in production.

Decreased production in industries such as automotive has caused steelworks to cut their production, meaning far less demand for thermal cutting.

Further to this, the decrease in customer spending and therefore production has resulted in a reduced market for new laser systems. Companies have reduced their output and are making old laser cutting systems work for longer, rather than choosing to invest in new ones.

The gases market will inevitably reflect these trends; less thermal cutting will require less gas and equipment from suppliers, making their sales drop.

"Plasma and laser cutting are relatively new processes in comparison"

Grouping Cutting and Welding under one bracket, Tier 1 company Air Liquide reported a 2.7% rise in revenue in the sector, in 2008. However, the company noted that after a good first half for the sector, a slowdown was observed in the third quarter, followed by a decline in sales in the last quarter, it said, "The decrease in the demand for consumables and equipment was due to a major reduction in customer inventories in a difficult economic climate."

Furthermore, its Q1 2009 results, published in April 2009, showed a -29.4% disparity between the 2008 and 2009 results for the same quarter. The company noted, "The Welding-Cutting activity was impacted by the economic slowdown, particularly in the metals and automobile sectors."

It's clear that tremors in the cutting business have indeed reached the gases industry; however, the economy will rebound, and when it does the nature of the manufacturing sector means that positive results will be seen quickly.

Special thanks to The Linde Group. ❑