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PLASMA VS. OXYFUEL

Comparing the cost, safety and productivity benefits of plasma and oxyfuel helps companies determine which cutting method to use

When it comes to cutting metal, several processes are available today. Two of the most widely used thermal cutting technologies are oxyfuel and plasma. Although oxyfuel is a tried-and-true method, plasma is a more versatile – and less expensive – alternative with an equally good performance record. Here's a look at how these two processes compare, beginning with an explanation of how each works.

OXYFUEL CUTTING

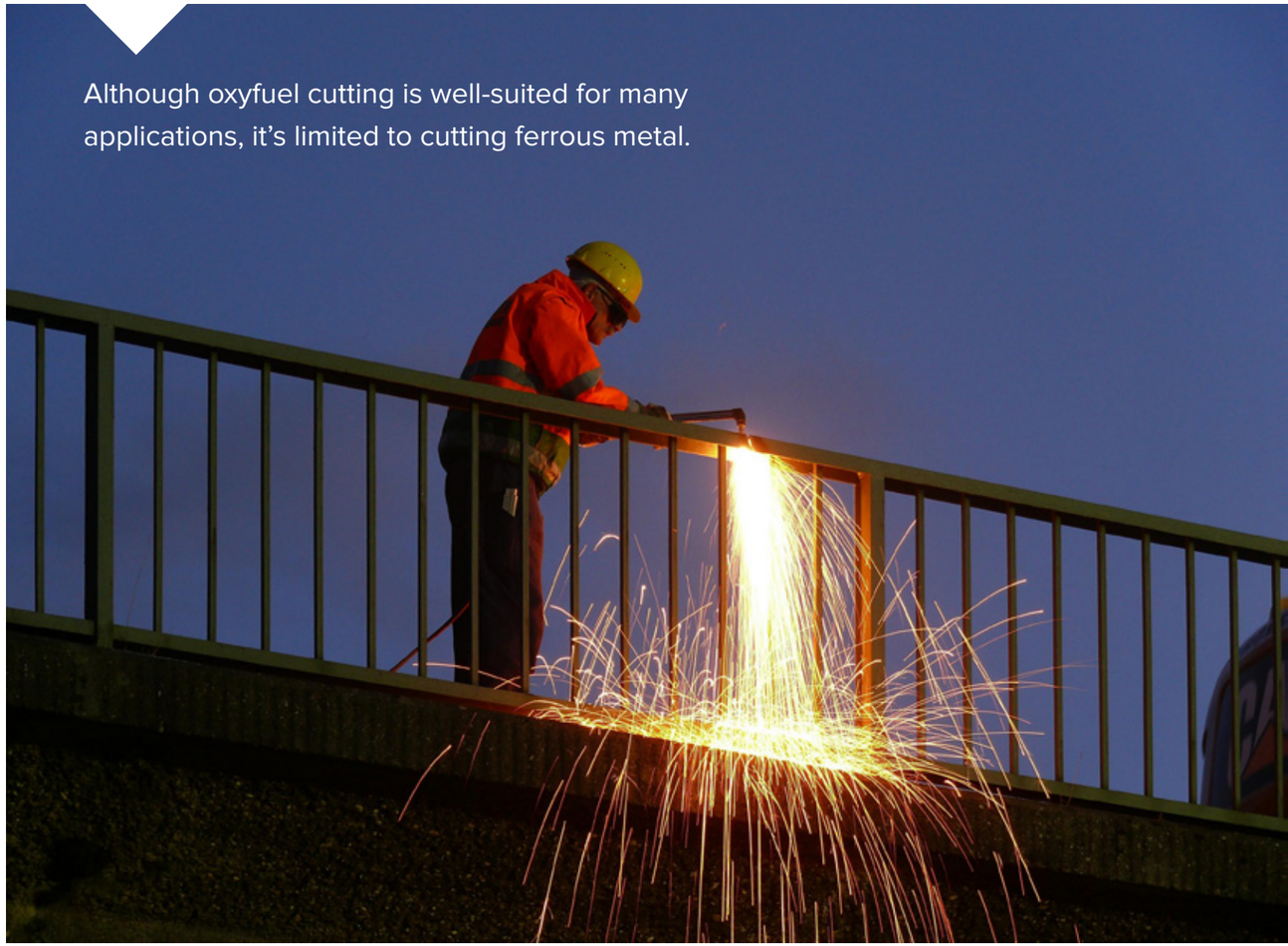
Oxyfuel cutting heats metal to ignition temperature with an oxygen and fuel gas flame. A chemical (exothermic) reaction between the oxygen and carbon steel creates iron oxide, referred to as slag, which is blown out of the gap by the high pressure of the gases used. Fuel gases include propane, propylene, natural gas and, most commonly, acetylene.

The major downside to oxyfuel is that it's only suitable for cutting ferrous metal. It's not effective on non-ferrous metals, such as aluminum or stainless steel. Generally, it's only used to cut thicker metal, approximately 2 in. or greater. This is because other methods, namely plasma, are faster on materials any thinner.

PLASMA CUTTING

Plasma cutting uses a high-temperature, electrically conductive gas to cut through any material that can conduct electricity. It's suitable for ferrous and non-ferrous materials, and can also handle metal in any condition – even rusted, painted or grated. It is most commonly used to cut metal between gauge and 2 in. in thickness, though recent advances have led to the introduction of plasma systems that can pierce 3-in.-thick metal and sever metal in excess of 6 in. in thickness.

Some companies can decide which cutting system to use based on these differences alone. However, for most companies, the decision is not as clear-cut. They need to weigh ▸



Although oxyfuel cutting is well-suited for many applications, it's limited to cutting ferrous metal.

Plasma cutting uses a high-temperature, electrically conductive gas to cut through any material that can conduct electricity.

Plasma cutting is heralded for its ability to cut ferrous as well as non-ferrous material and at speeds often faster than oxyfuel can achieve.

additional factors, such as safety, ease of use, cut quality, productivity and cost against specific business needs.

WEIGHING SAFETY

When it comes to safety, oxyfuel is at a disadvantage for two reasons. First, it requires a fuel gas; and second, it uses an open flame. The highly flammable nature of fuel gases means proper storage and handling, especially when using acetylene, is critical to prevent accidental fires or explosions. Plasma does not require the use of a fuel gas, with many systems requiring only compressed air.

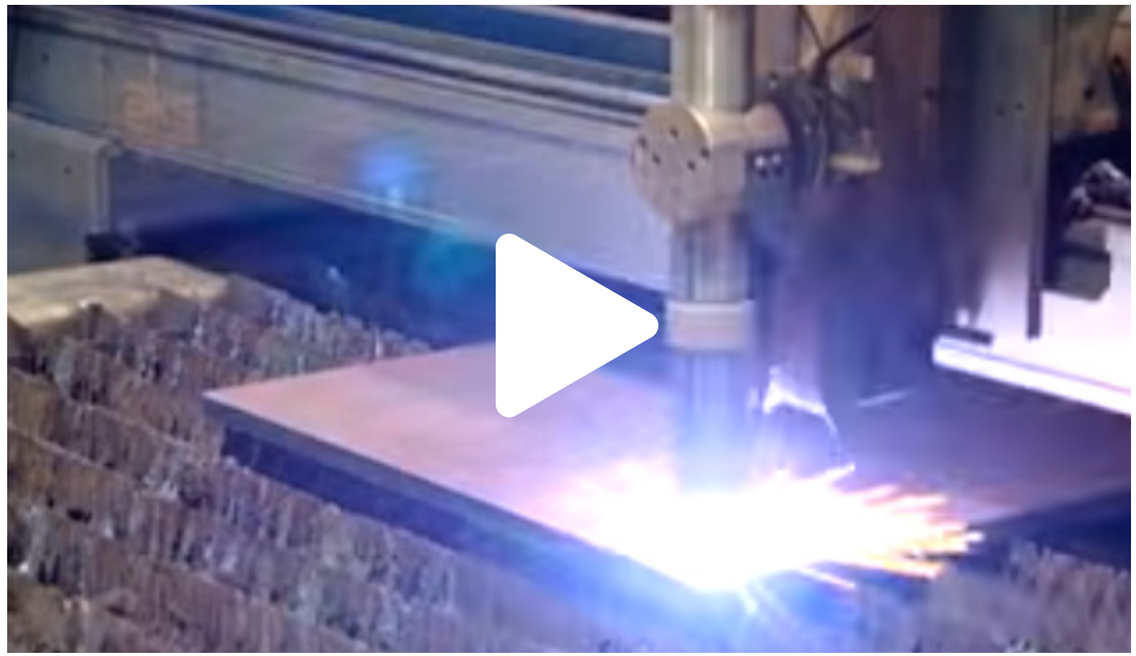
In addition, the open flame of an oxyfuel torch is a significant hazard. Once the oxyfuel torch is lit, the flame will stay on until the gas regulator knobs are manually adjusted to stop the gas flow. This poses many hazards before and after cutting.

To ensure the open flame doesn't inadvertently cause injuries or fires, the operator must stay alert and attentive. A plasma arc is somewhat safer as it depends on an electrical connection, causing the arc to automatically shut off as soon as the torch is removed from the metal.

This isn't to say that there aren't safety concerns when using plasma. The cutting arc is quite hot and as with any industrial process, care must be taken. At a minimum, experts recommend wearing safety glasses with side protection and an adequate shade rating. Wearing leather welding gloves that come half way up the forearm and a long-sleeved flame retardant lab coat or welding jacket also is recommended.

EVALUATING EASE OF USE

Ease-of-use is gaining importance as a key decision factor, primarily because it minimizes training, improves results and ultimately increases profitability. When comparing oxyfuel to plasma,



This video compares Hypertherm plasma cutting systems to oxyfuel cutting. Watch how the plasma system provides faster cutting speeds and better cut quality with lower operating costs.

HEAD-TO-HEAD COMPARISON

Before deciding on a cutting method, it's important to understand the process' benefits and shortcomings. It's also important to remember that a combination of processes may be best for a particular application.

Cutting process	Plasma		Oxyfuel
	CONVENTIONAL	HIGH PERFORMANCE	
MATERIALS	Most electrically conductive metals	Most electrically conductive metals	Carbon steel
THICKNESS	Up to 75 mm (3 in.) handheld Up to 32 mm (1 ¼ in.) mechanized pierce	Up to 75 mm (3 in.) mild steel Up to 150 mm (6 in.) stainless steel	Range of thicknesses
CUT QUALITY	Good quality, may require some secondary operations	Very good quality, virtually dross free	Ranges from poor to very good quality, depending on the operator's skill
PRODUCTIVITY	Medium	Medium to high, depending on material thickness	Low, though can be improved by running multiple torches simultaneously
SPEED	Medium cut speeds	High cut speeds	Slow cut speeds, multiple torches can help increase productivity
SECONDARY OPERATIONS	Grinding sometimes needed	Occasional dross removal needed	Grinding and surface oxidation removal almost always needed
OPERATING COST	$	$	$ $
CAPITAL EQUIPMENT COST	$	$ $ $	$
PORTABLE	Yes (air plasma systems only)	No	Yes
HEAT-AFFECTED ZONE	Yes	Yes	Yes

the latter prevails. As mentioned, many plasma systems only need compressed air, and there are no gases to mix or regulate.

With oxyfuel, operators need to set and maintain the flame chemistry while holding a steady distance between the tip and surface being cut to enable proper gas flow from the tip. This is a skill that takes time and practice to master.

Many handheld plasma torches, on the other hand, have an electrically isolated shield on the front so the operator can touch and drag the torch right on the material being cut. This technique, often called drag cutting, makes cutting easy.

Also, compared to oxyfuel, plasma is more flexible because it can cut a wider range of metal types and thicknesses. In addition, plasma can ▸

Hypertherm's new Powermax45 XP is the latest in its line of plasma cutters. Watch it in action.

bevel cut or cut expanded metals, which are difficult to cut with oxyfuel.

COMPARING CUT QUALITY

Manufacturers now have to compete on product quality more than ever. This makes cut quality another driving factor when companies select metalcutting equipment. Overall, plasma produces more precise and cleaner cuts than oxyfuel. Specific factors explain why.

Angularity. Both oxyfuel and plasma processes produce different edge qualities in terms of angularity. Plasma cutting produces a lower edge deviation.

Angularity is further improved when operators put together the right set of equipment for a comprehensive, integrated plasma system, especially for cutting holes. Such new technology uses a specific combination of cutting parameters to produce perfectly round holes. The system virtually eliminates tapers so holes have even diameters front through back.

Kerf. This refers to the width of the material removed during the cutting process. For plasma, this typically varies from 5/8 in. to 4 in., depending on the thickness of the plate. Oxyfuel kerfs are in excess of this, which wastes more metal and compromises cut quality.

Heat-affected zone. Another factor that affects cut quality is the size of the heat-affected zone (HAZ). Intense heat changes the chemical structure of the metal, discoloring the heat-affected edge (heat tint) and warping it. This makes the workpiece potentially unsuitable for secondary welding operations until the heat-affected edge is removed. Oxyfuel produces a much larger HAZ than plasma.

Dross. Plasma and oxyfuel both produce a certain amount of dross or slag. As dross is formed, it melts and re-solidifies, welding itself back to the metal. It adheres most easily to hot surfaces, which means oxyfuel, with its larger HAZ, produces a greater amount of dross. In addition, due to the slower cutting speed of oxyfuel, the resulting dross is often harder to remove at the end of the process.

Alternatively, plasma offers virtually dross-free cutting up to certain thicknesses, beyond which some dross is produced. Even then, dross produced by plasma is typically easy to remove, first of all because there is less of it, and second, because plasma produces a narrower HAZ so the dross has less hot surface area to adhere to.

Finally, more secondary operations, such as dross removal, will need to be carried out with oxyfuel. Not only is cut quality then compromised, the amount of time needed for a single part to be produced is increased, subsequently decreasing overall productivity.

COMMON QUESTIONS

To make an investment that meets current needs just as much as future needs, there are several considerations to keep in mind. According to Hypertherm, these are some of the top questions to ask when assessing an operation's cutting needs:

- What are your cut quality and part tolerance requirements?
- What type and thickness of material do you need to cut?
- What is your productivity requirement? How many parts per day, feet per shift, etc. do you need to complete?
- What is your target operating cost?
- Do you need to reduce energy consumption or achieve other environmental goals?
- What are your safety requirements?
- How much manufacturing flexibility will you require?
- Do you expect to bring outsourced work back in-house?

At a minimum, plasma users can expect speeds that are twice as fast as oxyfuel for metals 1 in. thick or less.

PRODUCTIVITY, OPERATING COSTS

Productivity boils down to the number of parts produced within a given time period, impacting the number of orders a business can fulfill. Several factors affect productivity with the most critical being cutting speed. At a minimum, plasma users can expect speeds that are twice as fast as oxyfuel for metals 1 in. thick or less. As thickness decreases, those speeds increase, enabling speed advantages that are up to 12 times faster than oxyfuel.

This increased speed means operators can cut more parts in less time. Other than cutting speed, productivity is also affected by delays due to piercing. It can easily take up to 30 sec. to pierce 5/8-in.-thick steel with oxyfuel because the metal needs to be pre-heated to nearly 1,000 degrees C, so the number of parts the system can produce in a given time is further reduced. Plasma takes less than 2 sec. to pierce 5/8-in.-thick steel and is, therefore, more efficient.

One final and equally important factor to consider is operating cost. In general, three factors affect the operating cost of oxyfuel and plasma cutting systems: consumables, power and gas. Consumables make up the largest portion of operating costs when cutting with plasma. However, long-lasting consumables are now available to help keep operating costs low. Power costs are negligible for oxyfuel, but a small expense is needed for plasma. Gas costs are higher for oxyfuel if using air plasma, and are more for plasma if using oxygen.

While the operating cost of oxyfuel is seemingly lower than plasma, it is not the most economical or efficient system to operate. The faster cutting speed of plasma produces more parts so operating costs are spread out over a larger number of parts. In addition, it's common to simply use compressed air for plasma cutting when cut speed and edge quality requirements are less stringent, eliminating gas costs. The lower cost per part coupled with faster cutting speeds support the fact that plasma results in higher profitability when compared to oxyfuel.

Oxyfuel and plasma cutting are both well-established thermal processes for cutting metals. Each has advantages and shortcomings. In deciding which method to use, companies need to weigh the above factors against individual business needs. However, when taken as a whole, plasma is the most advantageous process for most applications. It's safer and easier to use, produces better cuts and is the faster of the two processes. ■

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