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# Choosing a gouging method

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Robert Fernicola More Content by Robert Fernicola

*Plasma gouging and air carbon-arc gouging have their advantages and disadvantages. The most distinct differences are in cost, fume production, and necessary postcutting operations.*

In recent years environmental and quality issues have taken center stage in the welding industry. This increased emphasis on safety and health often is accompanied by reconsideration of how certain tasks are performed, for example, cutting and gouging metal.

Gouging—a requirement for many years in several industries and applications—is one method to scrutinize. Especially in maintenance and repair, the ability to gouge or groove metal is critical and deserves proper consideration.

Two of the most common methods of gouging metal are plasma gouging and air carbon-arc gouging.

## A Brief History

In maintenance and repair, operators must remove any of the following: welds or metal to replace a worn or defective part; worn hardfaced deposits so that hardfacing can be reapplied; defects in a weld so the part can be rewelded. Backgouging welds to sound metal also may be necessary when both sides of a plate are to be welded. Gouging also is used in the foundry business to remove fins, risers, and defects from castings.

Common methods of gouging are mechanical techniques such as grinding, hand milling, routing, and chipping; oxyfuel gouging, which can be used only on carbon steels; and air carbon-arc gouging.

The plasma cutting process was invented in 1954 at the Tonawanda Laboratory of the Linde Division of Union Carbide. A young scientist, Robert Gage, discovered that by forcing a gas tungsten arc through a small orifice in a process similar to focusing a beam of light through a lens, the temperature and intensity of the arc could be increased. By passing a fairly high gas flow through this focused arc, it could cut metal.

Plasma gouging is a variation of plasma cutting, in which the arc is "defocused" slightly by increasing the hole size in the constricting orifice. A cutting arc is directed downward through the metal to blow the molten metal down and out through the kerf, forcing the two pieces of metal to separate. In plasma gouging, the torch is inclined at an angle to the workpiece, and the arc plows out a groove on the metal surface and blows the molten metal off to the side. A more intense cutting arc causes a groove too deep and narrow for most applications, so the defocused arc is used for gouging.

## Fume, Noise Production

In carbon-arc gouging, an electric arc at the end of a consumable carbon rod melts the metal, and a continuous blast of compressed air violently blows the molten metal away. The constituents of the molten metal react strongly with air, and the force of the air blast tends to vaporize much of the molten metal into fine droplets, creating a high level of fume consisting of metal vapor, carbon dust, and metallic byproducts. Typically, the fume level of an air carbon-arc gouging operation is higher than the allowed exposure level to welding fumes in a workplace. Depending on the material being gouged, exposure to particular toxins that are constituents of the base metal also can cause problems.

Plasma also uses an electric arc to melt the metal being gouged, but the plasma gas itself pushes the molten metal out of the groove. Because this is done less violently than in air carbon-arc gouging, less molten metal vaporizes, reducing the metallic vapor and reaction with the surrounding atmosphere. When air is used as the plasma gas, some reaction occurs, but the volume of air is lower than that found in air carbon-arc gouging. If inert gas is used, the molten metal in the gouge is protected from the surrounding atmosphere and has little chance to react with the air.

However, aluminum applications are an exception to this. This metal's lightness and strong affinity for oxygen do create fumes. Also, the strong ultraviolet content of the radiation from the plasma arc increases the carbon monoxide, ozone, and nitrogen oxides generated. These amounts generally are below threshold limits.

Noise also can be a concern for cutting operators. Plasma gouging can reduce noise production. Typically, when measured at conditions that create a similar gouge size, plasma gouging is 5 to 10 decibels quieter than carbon-arc gouging.

Depending on the current level, the noise level of plasma gouging still may be high enough to require hearing protection for the operator, but it can eliminate the need for such protection for nearby workers. As always, actual measurements should be used as a guide.

## Postcutting Cleanup

In air carbon-arc gouging, the carbon rod is consumed; this releases carbon. Usually a layer of molten metal remains and resolidifies in the gouge because it's not blown out completely by the air blast. When carbon dissolves in this solidified layer, a brittle, carbon-rich layer forms, posing possible welding and cracking problems. In stainless steel, this layer also can become a starting

point for corrosion. Also, when air reacts with the layer of molten metal on the surface, an oxidized layer can form. This doesn't cause much difficulty in carbon steel, but it must be ground off of stainless steel and other corrosion-resistant alloys before welding. In aluminum, an oxide layer can form that requires cleanup.

Plasma gouging uses no carbon rod. The gas used in plasma gouging determines the condition of the final groove. With carbon steel, any oxidation left by using air as the plasma gas usually is of little consequence.

Gouging with air on carbon steel can leave a thin, dissolved, nitrogen-rich layer on the gouged surface. In certain welding situations, this can cause microporosity. Normally, this is a problem only in very high-quality welding situations and can be removed with light grinding on the surface or by using inert gas as the plasma gouging gas.

But with stainless steel and other corrosion-resistant alloys and aluminum, an inert gas should be used as the plasma gas. This inert gas shields the groove from the contaminating atmosphere and generally is free of oxidation and other contamination. In most cases, the groove can be rewelded with almost any welding process without additional cleanup.

## Cost

The initial cost of air carbon-arc gouging is lower than that of plasma gouging. With air carbon-arc gouging, existing welding power supplies and air supply can be used; only a gouging torch must be added. Air carbon-arc gouging with compressed air also costs less than plasma gouging with an inert gas.

Maintenance costs for air carbon-arc gouging also can be less than in plasma gouging, in which the electrode and nozzle must be replaced periodically. An air carbon-arc gouging electrode also costs less than a plasma gouging electrode.

However, plasma gouging typically is four times faster than air carbon-arc gouging. Its rod is nonconsumable, and the gouging electrode and nozzle can last longer than their plasma cutting counterparts. In addition, the heat source used for plasma gouging generally is more efficient than that for air carbon-arc gouging.

Depending on the application, plasma gouging can pay a company back indirectly, as secondary cleanup, particularly on stainless steel and aluminum, is typically less than in air carbon-arc gouging. This can result in labor and material savings. In addition, depending on a variety of factors—including duty cycle, location, local environmental laws, and the size of the facility—fume extraction and ventilation needs may be less with plasma gouging.

*Robert Fernicola is business manager at ESAB Welding & Cutting Products, P.O. Box 100545, 411 S. Ebenezer Road, Florence, SC 29501-0545, 843-669-4411, fax 843-664-4258, www.esabna.com.*