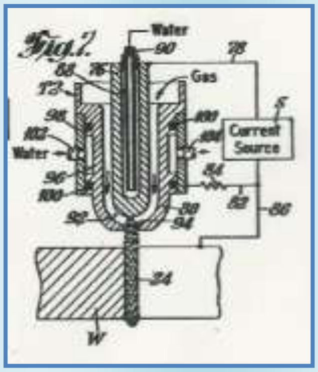
History, Applications, Advantages for Plasma Gouging
(It's Time Has Arrived- See Why!)

by Jerry Uttrachi

Plasma for both welding and cutting invented by Bob Gage working for the Linde Labs, a pioneer in welding and cutting processes. Bob was a brilliant scientist and became the manager of all of welding and cutting R&D locations for Linde (now renamed Praxair.) Managing one of those welding Labs involved in developing welding gases and filler metals, Bob was a great boss. He could always make you think about ways to solve problems, often with a critical statement such as, "*You're solving a problem not known to exist, using a method known not to work!"* Bob's first Plasma patent was filed in July 26, 1955, # 2,806,124 entitled "Arc Torch and Process,"-patent figure right.



In 1985, a new, independent company was formed from Linde's welding filler metals, equipment and CNC cutting business in the US, Canada and Germany. That company, L-TEC, focused on increasing the development of plasma processes, which up to that time had been mainly used for cutting on CNC cutting machines that utilized nitrogen and oxygen gases. Having no ties to selling industrial gasses, L-TEC developed systems that used compressed air. We introduced one of the first inverter based, portable Plasma Cutters, weighing only 39 pounds and using air. It was a tremendous success in North America and Germany.

I recall an L-TEC person working in the applications lab, Randy Stone (photo left), developing procedures for Plasma Gouging that had just been introduced the metal working industry. The process was an instant success, displacing carbon arc gouging in many applications.

Visiting with our Canadian company, I saw a very successful implementation of Plasma Gouging at a large railroad engine repair shop. Numerous Plasma Gouging systems had replaced Air Carbon Arc Gouging to remove most of the hundreds of welds in a locomotive.

Problem Found When Plasma Gouging

It was found that Plasma torches could not withstand the extreme environment when Plasma Gouging. Since plasma-cutting torches operate at relatively high voltages, the torches must be built using an insulating material on the outside of the torch, to protect the operator. In normal cutting use, the torches stay cool, because the hot metal and gases are ejected below the plate. In Plasma Gouging, however, the heat stays on the top of the plate, exposing the torch to intense heat and metal splash back. The result is unacceptably short torch body life.

A PLASMIT torch protector was developed during the 1980's, by Richard Hadley, who was at the time a region manager for L-TEC Welding and Cutting Systems. (That business was subsequently sold to ESAB.) Shortly following large sales of Plasma Gouging equipment to the railroads (photo left); it became evident that plasma torches could not withstand the abuse from repair of railroad equipment. In this difficult application, Plasma Gouging can take place on painted and greasy surfaces. Quite often, the paint or grease ignites. The operator does not or cannot see that their torch is being damaged by the flames, until too late! Another example of a severe environment is when gouging into a corner. The molten metal splashes back onto the torch, melting the torch body. The Plasma torch is also subjected to being dragged across railroad rails, through locomotives and rail cars, physically breaking the torch head.

A solution had to be found if Plasma Gouging was going to be viable in heavy industry. There was no readymade product, so Hadley created PLASMIT. Incorporated in 1988, he expected that the plasma torch builders might find a better solution to this problem, but so far, PLASMIT is the only proven torch protector on the market.

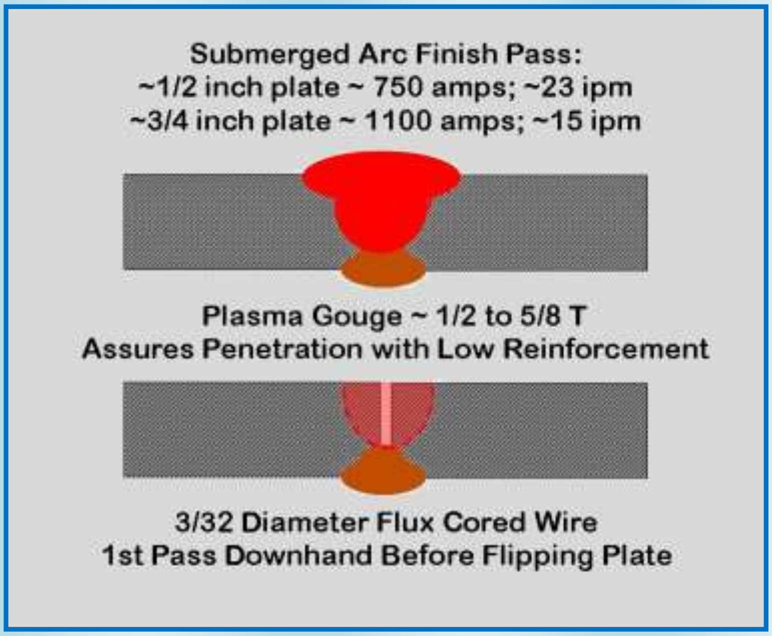
Plasma torches have improved over the years, but it is a simple fact that to build a torch to withstand the occasional heavy gouging abuse would make it heavy and likely not very user friendly. Note the torch on the right with a PLASMIT has seen severe use but is still functional. It would have been destroyed long before if it were not for this inexpensive and durable plasma torch protector. The PLASMIT also cushions the torch head so it can withstand some physical abuse.

Metal shields are an apparent solution, but there are serious drawbacks to using metal. Metal shields make it more difficult for the operator to maneuver the torch during gouging. In addition, plasma torches operate at high voltage and high amperage. Metal shields are electrically conductive. Should the arc power short circuit to the shield, and if the operator was touching the shield, there is a serious risk of electrical shock and injury. That is why there are no handheld plasma torches with metal near the operator handle. Although not a frequent occurrence, sometimes a torch will short circuit to the side of the nozzle or torch body, usually because a metal guide was used, and the torch was already damaged. There are very explosive fireworks when this occurs!

PLASMIT has allowed industry to benefit from the tremendous advantages of Plasma Cutting and Gouging in heavy industry applications, which is why PLASMIT celebrates 25 years in business!

Plasma Gouging in Japan

I visited the Engineering Co that sold our Plasma Cutting and Gouging products located in Japan, Aichai Sangyo. They had purchased about one hundred 150-amp systems that could be combined into a 300-amp system called a Duce Pack when needed. They had detailed application information about the fabricators where the systems were being employed. Many were used for shipyard and bridge beam fabrication. Even for the short web and flange splicing, the system was saving a great deal of time and money. Both for ship, web and flange plates, square butt joints were often used starting with a relatively high current flux cored wire first weld-backing pass. It was also possible to weld over normal gaps in the square butt joint with flux-cored wire so mill edges could be used. Then the plates were turned over and a Plasma Gouge made on the top side. There was no need to grind the finished, uniform gouge. A single pass submerged arc weld was made over the Plasma Gouge and penetrated into the first pass. It was not necessary to gouge fully into the first pass, as the Plasma Gouge is wide and the submerged arc weld has significant penetration. The accompanying schematic provides a summary of approximately what they were able to accomplish.



Air Carbon Arc Gouging versus Plasma Gouging

Carbon Arc Gouging is a noisy, messy process. The high airflow creates large amounts of smoke, and it is very difficult and costly to effectively capture the smoke and fumes. In addition, Carbon Arc Gouging leaves carbon on the gouged surface. If the gouged surface is to be welded, it must be cleaned with a grinder, adding even more dust to the worker's environment. This post gouge grinding is also labor intensive.

Plasma Gouging offers a significant reduction of smoke and fume compared to Carbon Arc Gouging. Because the gas flow with plasma is much lower than Carbon Arc Gouging, the small amount of smoke that is generated is much easier to capture. Plasma Gouging offers productivity improvements as well. Plasma Gouging can be a continuous operation, (no carbon electrodes to replace), the travel speed can be high, and the gouged groove is clean and ready to weld. The noise level of Plasma Gouging is typically 5 to 10 dB lower than with Carbon Arc, which makes the workplace more comfortable for all workers. As a comparison, a motorcycle creates about 90 dB and a Jet taking off 100 dB.

The table below provides fume measurement data from a production case study comparing total fume levels from Plasma Gouging and Air Carbon Arc Gouging. For both processes, specific elements must be measured depending on what materials are being gouged. More on that critical step after reviewing the case study.

Location of Fume Measurement	Ventilation	Process	Fume Measurement Total mg/m^3
Reported as Breathing Zone; Usually a Lapel Measurement	With Local Ventilation	Plasma Gouging	0.45 mg/m^3
		Carbon Arc Gouging	192 mg/m^3
	Without Ventilation	Plasma Gouging	< 0.1 mg/m^3
		Carbon Arc Gouging	136 mg/m^3
Reported as Inside Helmet	With Local Ventilation	Plasma Gouging	< 0.1 mg/m^3
		Carbon Arc Gouging	1.7 mg/m^3
	Without Ventilation	Plasma Gouging	0.42 mg/m^3
		Carbon Arc Gouging	1.9 mg/m^3
Reported as Measured 6 feet from the Arc	With Local Ventilation	Plasma Gouging	< 0.1 mg/m^3
		Carbon Arc Gouging	41 mg/m^3
	Without Ventilation	Plasma Gouging	2.9 mg/m^3
		Carbon Arc Gouging	124 mg/m^3

Summary of Fume Measurement:

As noted, Plasma Gouging has from 5 to several orders of magnitude less fumes! Note the fume levels 6 feet from the arc are not much lower with Carbon Arc Gouging than measurements made in the breathing zone, assumed to be the standard lapel measurement location. However, all elements in the fume must be measured to assure specific elements, as well as gases such as ozone, do not exceed allowable levels.

Measurement of Critical Fume Constituents: In the past, it was sufficient to measure total fumes or even observe fume levels to estimate what might be excessive. Recent reductions in allowable levels for specific elements have changed that scenario. When gouging (or welding) stainless steel, for example, the latest maximum levels of allowable fumes cannot be detected or estimated visually. The TLV (Threshold Limit Value) defined by the ACGIH (the accepted body who defines such levels) are currently a very low level of 0.05 mg/m^3 for water-soluble Chrome VI and 0.01 mg/m^3 for insoluble Chrome VI. For Nickel, the other critical element in stainless steel, the TLV is 1.5 mg/m^3.

The Time Has Come for Plasma Gouging

Perhaps the greatest issues related to fume generation occurred in January 2013. The ACGIH lowered the TLV for a very common element in carbon steel, by far the largest material welded and gouged. Through 1979, the TLV for Manganese was 5 mg/m^3, which was the same level as total fumes. Therefore "total fumes," was the only measurement needed since other elements usually did not exceed their maximum permissible levels if total fumes were within allowable levels. However, in 1995 the TLV was lowered to 0.2 mg/m^3. Published information shows that welding fumes, measured behind the welder's helmet, are typically close to that value even with quality ventilation. In January 2013 the ACGIH, after saying for several years they would lower the Manganese level, reduced it by a factor of 10! The TLV for Manganese is now a very low 0.02 mg/m^3. This will probably be a difficult level to achieve in production. However, using a process that produces an order of magnitude less fumes will generally provide lower operator exposure measurements. If lower operating cost was not sufficient incentive to invest in Plasma Gouging equipment in the past, the lower fume generation rate may be now!

Cost Differences Between Plasma Gouging and Carbon Arc Gouging

The American Welding Society Handbook, 9th Edition Volume 2 on page 666 presents cost data comparing Plasma Gouging and Air Carbon Arc Gouging. They show for a specific gouge, the cost for Plasma Gouging is \$0.16 per foot of gouge while Air Carbon Arc Gouging cost \$0.42/foot.

That can be started as a percent reduction in total cost of (\$0.42-\$0.16)/\$0.42 or 38%. The payback for the capital cost can be calculated based on the amount of gouging performed.

Bottom Line:

Plasma Gouging has lower operating cost than Air Carbon Arc Gouging (shown operating in photo right.) There are no carbon electrodes to buy or stubs to discard. If using compressed air as the plasma gas, gas cost is minimal. Even if Nitrogen or Oxygen gas is employed for some applications, the cost is low.

Welding fumes, as noted above, may be over 10 times lower with Plasma Gouging. However when gouging carbon steel, fume measurements must still be made with Manganese being the element that will probably be the deciding factor to define adequate ventilation to protect the operator. For stainless steel, Chrome VI will usually be the element requiring measurement and control. Gases, such as Ozone, could also be an issue depending on venation conditions.

Plasma Gouging may be 10 dB lower in noise level, although the operator and those workers in the area will still require hearing protection.

To help protect the Plasma torch from metal spatter and the operator from increased risk of electrical shock a PLASMIT (photo right) is an inexpensive addition to the system. You can purchase one to fit your Plasma torch at:

http://www.netwelding.com/Cable_Hose_Cover.htm