SanRex

PLASMA

WELDING

PLASMA WELDING PROCESS & SYSTEM SELECTION GUIDE

Automation

Appliance Manufacturing

Metal Furniture Manufacturing

Electrical Manufacturing

Aerospace/Aircraft

Computer/Office Equipment

Medical Services

Fabrication

The Power you need

Introduction

Plasma The Fourth State of Matter.

The term Plasma refers to a gas that has been sufficiently ionized to conduct an electrical current. As we see matter in the world around us, we are usually conscious of its existence in three states... solid, liquid and gas. We are all aware of the difference between solids, liquids, and gases, and the fact that increasing the temperature changes a material from one state to another. When enough energy is applied to a gas, this will cause an ionization of the gases atomic structure.

This process is visible to us in the form of fluorescent lighting in our homes and offices, lightning in the night sky, or even our very sun. Most of the visible universe is a type of plasma.

When energy (heat) is added to a material in a gaseous state, the temperature of the gas keeps increasing. If enough energy is added, the temperature becomes high enough that the gas no longer exists as individual molecules. The molecules come apart and the material made up of individual atoms, if the temperature is further increased, the atoms will then lose electrons and become ions. This material then consists of a combination of ions (with a positive charge) and free electrons. Under these conditions, the matter now exists in a fourth state... the **PLASMA** state.

Plasma has many properties that are similar to those of a gas but also some special properties that make it unique. The most important property of the plasma, as far as welding is concerned, is that it contains free electrons which allows it to easily carry an electrical current. The plasma welding process does not have an exclusive on the use of plasma as it also exists in all other arc welding processes. Plasma welding utilizes the developed hot gases to provide unique benefits to the welding operation.

Dr. R. M. Gage is credited with the introduction of plasma into the welding industry in 1955, and in the 1960s it was integrated into microplasma and high-current applications.

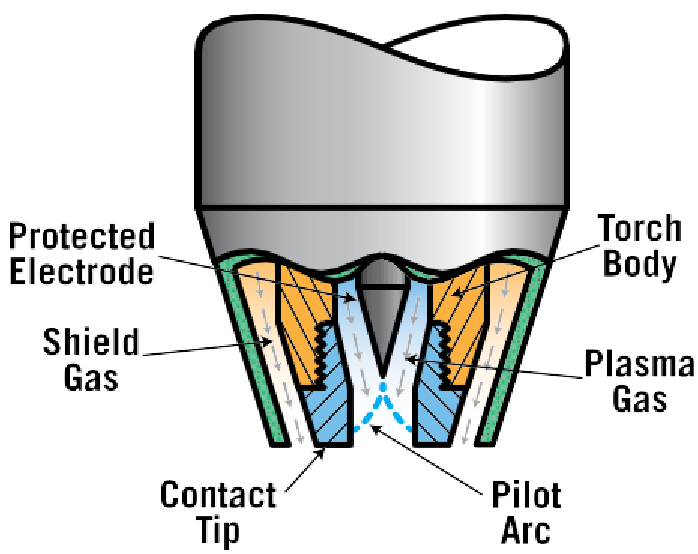
Plasma Arc Welding (PAW)

Plasma Arc Welding (PAW) is a welding process that heats an inert gas to an extremely high temperature so that the gas becomes ionized and electrically conductive. This plasma gas is constricted into a column by an orifice placed downstream of the electrode which is protected inside the nozzle of torch. The plasma is used to transfer an electric arc to the workpiece to obtain the melting and coalescence of most metals and to constrict the arc during the welding process.

Plasma welding is not a new process to the industry, but only in the past few years has it gained significant acceptance. Until recently, the process was considered exotic and difficult to understand. This was mainly due to the applications it was being adapted to.

Process Advantages

Plasma now has proven its value in the area of highly repetitive automated welds. The process provides increased reliability and repeatability to meet today's high standards of productivity. It is frequently used as an alternate to the gas tungsten arc welding process (GTAW).



All metals amenable to GTAW or TIG welding can be welded with the plasma arc process. Plasma arc welding shows its greatest advantages in the welding of high volume repetitive production operations. These applications normally demand repeatable welds on a near continuous basis using the melt-in fusion mode and include spot fusion welds, corner edge welds, lamination welds and circumferential / seam welds.

For most applications, the plasma arc process offers increased electrode life, reliable arc starting, improved arc stability, better penetration control and reduced current levels. In some cases plasma offers increased travel speeds, improved weld quality, and less sensitivity to operating variables.

Features & Benefits – The Protected Electrode

One of the most important features of the plasma arc welding process is the Protected Electrode which provides higher efficiency and reduces downtime in most applications.

The tungsten electrode, which is secured inside the plasma torch and behind the orifice, is protected from outside impurities that would normally attack its hot surface. With this protection, the electrode is shielded from materials that can constantly attack an “exposed” electrode. The protected electrode in the plasma welding torch normally requires a change only once every 8 hours for most operations. This reduction in electrode change allows for increased productivity.

The electrode is secured externally in the TIG welding process (GTAW). This exposes the electrode to the contaminants (stamping and forming oils, degreasers, oxides, etc.) present on the surface of the base material to be welded. These contaminants, under intense temperatures, will attack and erode the tungsten electrode requiring the frequent changing of the electrode on a repetitive basis.

It is not uncommon in many applications for the electrode in the GTAW torch to require replacement changes 1 to 2 times per hour depending on part cleanliness and production levels. The time required to change the electrode depends on the accessibility of the torches on the fixture apparatus. Five minutes or more may be spent on each electrode change in some cases, eating away costly production time.

Multiplying the number of electrode changes required in an 8 hour shift by the time required for each change, and dividing by the total amount of production time available, will yield the percentage of lost production time. Based on that number, it is now easy to figure parts lost due to frequent electrode changes. This reduction in electrode change allows for increased productivity.

Typical Plasma versus TIG welding productivity benefit analysis							
Comparison		TIG Electrode Changes			PAW		
Time	Total Parts @ 100% Capacity	TIG Electrode Changes	Minutes to Change Electrodes	Parts Lost with TIG	Plasma Electrode Changes	Parts lost with Plasma	Net Gain Plasma over TIG
Hour	208	1	5	17	0	0	17
Day	4,992	24	120	416	3	52	364
Week	24,960	120	600	2,080	15	260	1,820
Month (= 4.33 wk)	108,160	520	2600	9,013	65	1,127	7,886
Year	1,297,920	6240	31200	108,160	780	13,520	94,640
Shift hours per week:		24				Value per Part	1
Days Worked per week:		5	Production Parts/Dollars Gained with Plasma/yr				94,640
Application: Outside corner welds home appliance. Note: 4 welds required on each part.							

Reliable, easy-to-operate Sanrex Plasma Welding Systems boost profits and productivity by helping you achieve consistently high quality repeatable welds – manually or automatically.

Whatever your application needs, the broad, versatile line of Sanrex consoles, torches, power supplies, and accessories provide the right tools for the job.

Plasma arc welding is measurably the lower cost process with savings gained through increased productivity, reduced scrap, reduced downtime and fewer electrode changes.

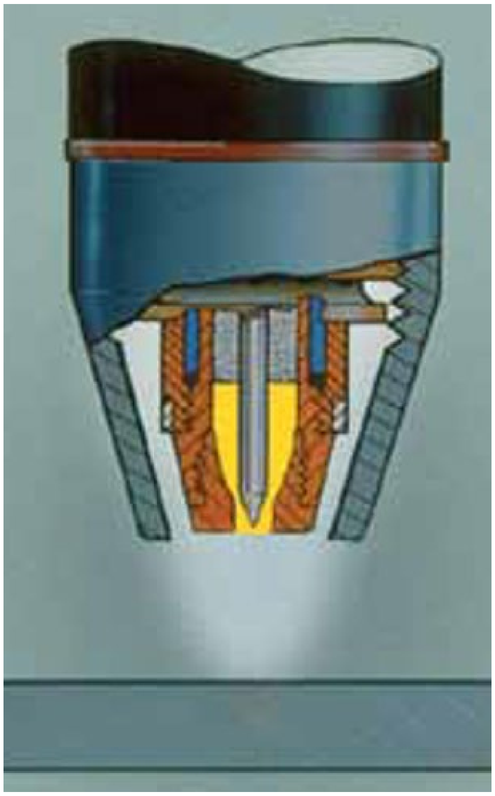
Plasma arc welding offers many advantages over TIG Welding (GTAW - Gas Tungsten Arc Welding):

ADVANTAGES:

- Reliable Arc Starting
- Protected Electrode
- Less Sensitive to Stand-Off Changes
- Improved Arc Stability at Low Current
- Lower Current Levels Required
- Reduced Heat Input or Distortion
- Arc is More Directional (Less Arc Wander)
- Improved Weld Geometry and Penetration Control
- Less Filler Material Required
- Reduced Current Levels
- Single-Pass Welds
- Minimized Weld Preparation
- Narrower Weld Beads
- Visual Proof of 100% Weld Penetration
- Improved Weld Geometry

What is Plasma Arc Welding?

Simply stated, Plasma Arc Welding (PAW) is a superior variation to TIG welding (GTAW) that encloses the tungsten electrode in a protected environment and delivers the arc through a cooled copper tip. Enclosing the electrode protects it from contamination, thus substantially extending its life.



The constant stable arc shape of plasma results in consistent welds for eight hours or more of operation as compared to automated TIG welding, where deterioration of the exposed TIG electrode can result in weld arc variations in one hour or less of operation. Plasma arc welding uses a pilot arc to consistently transfer the arc to the work without the repeated use of high frequency current.

Pilot Arc

Another outstanding feature of the Plasma arc welding process is the Pilot Arc which provides reliable arc starting and contributes to the repeatability and increased productivity of plasma welding.

The Pilot Arc is a low current DC arc that is sustained in the tip area of the torch to ionize a gas as it passes around the electrode and through the orifice. Arc initiation is provided by the pilot arc that transfers between the tungsten electrode and the tip. It is started by imposing high frequency (from a small high frequency generator or C.D. arc starter inside the control console) on a low DC current for a short duration of time to ionize the gas. Once the pilot arc has been established, the requirements for high frequency are no longer needed. The pilot arc now remains on to reliably assist the starting of the main transferred welding arc from a separate DC power source.

Without the need for high frequency used in TIG welding (GTAW), the erosion of the electrode by constantly etching its surface is diminished. This eliminates the phenomena of inconsistent arc starting, resulting in the loss of arc directability. The use of a pilot arc instead of conventional high frequency circuitry provides extremely reliable arc starting. This repeatable arc initiation nearly eliminates significant downtime and minimizes the number of rejects or reworks due to poor welds thus reducing scrap.

Constricted Arc

An orifice (also called a nozzle or a tip) which is inserted into the front end of the torch body provides for the laminar flow of the plasma gas and constriction of the arc. The magnitude of this constriction is normally controlled by three variables ... the orifice diameter, the plasma gas flow rate, and the electrode setback (the distance the electrode is recessed within the tip). The arc will be most constricted when the torch is operated at higher plasma gas flow rates and the electrode placed at maximum setback. This type arc is typically used when trying to achieve keyhole single pass welds requiring maximum penetration, narrower weld beads, minimized heat affected zone, and reduced base material distortion. Keyhole welding is generally used on material thickness ranging from .090” (2.3 mm) to .250” (6.4 mm).

By reducing the electrode setback and plasma gas flow rates, a softer, less constricted arc will occur. This type arc is typically used for the melt-in fusion (non-keyhole) mode and allows for faster travel speeds on reduced base material thickness .010” (.3 mm) to .187” (4.7 mm).

Plasma Welding Step-by–Step Selection Guide

Choosing Your System

This manual has been created to simplify a complicated process for the selection of the components required for your Plasma Arc Welding System. We have developed this step-by-step guide to determine the equipment you need for your specific application.

Whether it is the 150PW Plasma Arc Welding System with its compact self contained package to fulfill the light to medium duty Melt-In Fusion mode processes for welding materials less than 3/16” (4.7 mm) thick. Or for the Keyhole mode requiring higher amperage needs, a 300PW might be the better choice.

This guide will assist you in choosing the exact equipment to complete your system. Sanrex can provide the components you want that have been carefully designed to work together in producing high quality welds in most metals such as stainless steels, carbon steels, high-nickel alloys, high-strength alloys, copper, copper/nickel alloys and brass alloys. All the optional accessories are available from Sanrex to fine tune your system, whether mechanized or manual, melt-in fusion or keyhole, argon or a argon/hydrogen mixture of gases.

Determine Your Plasma Arc Welding System Requirements

Microplasma welding (typical current range 0.1 – 15A) Microplasma is used for welding thin sheets [down to 0.004” (0.1 mm) thickness], and wire and mesh sections. The needle-like, stiff arc minimizes arc wander and distortion.

Medium current welding in the Melt-in Fusion mode (typical current range from 15 – 200A) This is an alternative to conventional TIG. The advantages are deeper penetration (from higher plasma gas flow), greater tolerance to surface contamination including coatings (the electrode is within the body of the torch) and better tolerance to variations in electrode to workpiece distance, without significant change in heat input.

Keyhole welding (typically over 100A) By increasing welding current and plasma gas flow, a very powerful plasma beam is created which can achieve full penetration in a material, as in laser or electron beam welding. During welding, a keyhole is formed which progressively cuts through the metal with the molten weld pool flowing behind to form the weld bead under surface tension forces. This process can be used to weld thicker materials [up to 3/8” (10 mm) of stainless steel] in a single pass.

Please answer the following questions to help us guide you through the selection of the proper Plasma Arc Welding System for your needs.

Step 1 – Will you be welding in the Melt-In Fusion or Keyhole Mode?

Melt-In Fusion _____	**Keyhole _____**
(Continue to Step 2)	(Consider the 300PW)

Step 2 – What is the thickness of the material you are welding?

3/16" (4.7mm) or Less _____	**More than 3/16" (4.7mm) _____**
(Consider the 150PW)	(Consider the 300PW)

Step 3 – What are your DC Amperage Welding Requirments?

Low Amp (.5 – 200 Amp) _____	**High Amp (150 – 300 Amp) _____**
(Proceed to 150PW systems)	(Proceed to 300PW Systems)

Step 4 – Determine what input Power you have available and list for reference?

AC Volts ______	**Phase _______**	**Hertz _____**
(208, 240, 380, 480)	(Single or Three Phase)	(50Hz or 60Hz)

Step 5 – What Material will you be welding?

Mild Steel ______ **Stainless Steel _____** **Other _____**

Step 6 – Will you need a Weld timer, Weld Pulser, or Current Pulser?

Yes ______ **No ______** **Specify ______________________**

Step 7 – Do you need to add filler Metal to the weld?

Yes ______ **No ______** **Specify Size __________**

See brochures for ordering information.

150PW Selection

A 150PW system includes the 150PW unit, Gas Hoses, Dinse Plug, Coolant and the appropriate torch with a torch spare parts kit.

Note: Systems do not include the Work Lead, Regulators or remotes.

Note: The 150PW has an internal Water Cooler.

Should a standard system not fit your application use the 150PW Easy Find Guide to build your own.

300PW Selection

A 300PW system includes the 300PW unit, Water Cooler, coolant, Gas & Water Hoses, appropriate torch with a torch spare parts kit.

Note: Systems do not include the Input Cable, Work Lead, Regulators or remotes.

Should a standard system not fit your application all components can be ordered separately.

SanRex

Sanrex Corporation

50 Seaview Blvd.

Port Washington, New York 11050

Telephone: (516) 625-1313

Email: info@sanrexwelding.com

www.sanrexwelding.com