Plasma and TIG processes
Automatic welding applications

Performance and high productivity in vessel and pipe work.
The term plasma applies to gases at temperatures exceeding 3,000 °C (5,000 °F) at atmospheric pressure. On the temperature scale, it can be regarded as the fourth state of matter after the solid, liquid and gaseous states.

The plasma arc is now widely used in the steel, chemical and mechanical engineering industries. It’s a powerful cutting and welding tool. It is generally accepted that the plasma welding process is the major technological advance in inert gas welding (the TIG process).

Plasma arc: high temperatures, a concentrated arc, better productivity.

The isotherm diagram shows clearly that the energy distribution is strongly modified within the plasma arc:
- the 16,000 to 24,000 °C (29,000 to 43,000 °F) temperature zone is outside the nozzle,
- the 10,000 to 16,000 °C (18,000 to 29,000 °F) temperature zone is entirely transferred to the workpiece and causes the keyhole effect (penetration of the workpiece).

With a free arc (TIG process), the highest temperature zone is too close to the cathode or tungsten to be usable.

The 4,000 and 10,000 °C (7,000 and 18,000 °F) temperature zone is narrow in plasma welding compared to TIG welding where the zone is much wider with a characteristic “bell” shape. This zone is not without its uses: it causes surface melting of decreasing depth relative to the plane of the joint, providing a gentle transition from the welded area to the base metal.

This zone is excessively wide in TIG welding and the excess limits performance.
The plasma is made up of excited ions, electrons, atoms or molecules; it occurs in nature, generated by lightning, for example. Since about 1960, the word plasma has gained a new meaning, referring to the high-energy state caused by constricting an electrical arc by means of a diaphragm or nozzle.

### Advantages of plasma

- **Speed of operation and low distortion.**
- Reduces post-weld straightening operations.
- **Low buildup** reduces polishing and grinding procedures.
- Weld metal integrity- keyhole fuses parent metal.
- High-quality weld integrity and appearance.
- **Reduction in the preparation times for assemblies** by eliminating bevelling for thicknesses up to 8 mm (5/16").
- **Reduction in welding time** in comparison to manual welding.
- **Assurance of complete and regular penetration** by virtue of the keyhole technique on butt joints.
- **Excellent reproducibility** typically used with automatic equipment.
- **Produces a perfect weld bead overlap** due to perfect control of the relevant parameters.

### Thickness limitation

Maximum thickness which can be welded, flat with butt-jointed surfaces, in one pass with 100 % penetration. Maximum thickness that can be welded is reduced for:
- vertical up and horizontal welding positions,
- small diameter and very thick tubes.

Depending on the thickness of the material, using keyhole plasma welding, deconfined plasma welding, TIG or microplasma welding.

### Example of productivity gain with carbon steel (5 mm / 0.2"): 
- Electrode: preparation + 2 passes at 15 to 20 cm/min (6 to 8 in/min) grinding.
- Manual TIG: preparation + 2 passes at 10 cm/min (4 in/min).
- Keyhole plasma: 1 pass at 40 cm/min (15 in/min).
Plasma + TIG welding process

When the length of the panels to be assembled reaches 3 to 4 meters (10 to 13’), welding speed can be increased by using a tandem process such as plasma + TIG.

Integrating the two processes into a single installation can improve productivity by as much as 30 to 50 %.

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>TIG cm/min (in/min)</th>
<th>Plasma cm/min (in/min)</th>
<th>Plasma + TIG cm/min (in/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (0.12)</td>
<td>50 (20)</td>
<td>65 (26)</td>
<td></td>
</tr>
<tr>
<td>4 (5/32)</td>
<td>35-40 (14-16)</td>
<td>50-60 (20-24)</td>
<td></td>
</tr>
<tr>
<td>6 (0.24)</td>
<td>25-30 (10-12)</td>
<td>40 (16)</td>
<td></td>
</tr>
<tr>
<td>8 (5/16)</td>
<td>15-20 (6-8)</td>
<td>25 (10)</td>
<td></td>
</tr>
</tbody>
</table>

Advantages of the plasma + TIG process

- High quality of plasma weld.
- 30 to 50 % increase in productivity.
- Can be adapted to varied boiler and tank-making processes due to its great flexibility.

In the plasma + TIG process, the plasma arc first melts the entire thickness of the joint by using a strongly confined plasma, which only affects the appearance of the back of the joint. The trailing TIG arc 250 mm - 300 mm (10 - 12”) behind is equipped with a magnetic oscillation system and wire feed. This magnetic oscillation, coupled with a trailing gas shield, ensures a perfect weld finish.

The plasma + TIG process works on thicknesses between 3 and 8 mm (0.12 and 5/16”). Thicknesses less than 3 mm (0.12”) can also be welded perfectly but only a single-torch TIG process is used. Thicknesses greater than 8 mm (5/16”) require an additional single-torch TIG filling pass.

The plasma + TIG process is specially designed for large capacity stainless steel boiler work:
- length > 3 meters (10”),
- diameter > 2.2 meters (7”),
- the manufacture of large stainless steel tubes or pipes welded in one piece.
Variable polarity TIG or squarewave AC ensures continuous deoxidation, a high-quality weld bead with total control of the weld pool for terminating the weld bead.

### Alternating variable polarity TIG (Squarewave AC TIG)

The flexibility of variable polarity lies in the total independence of the welding penetration or cleaning parameters. This permits optimization of the welding penetration and cleaning phases independently. This results in better control of the weld pool and better weld bead appearance as well as soundness.

### DC TIG under helium

This process can also be used to weld aluminium with the advantage that, for thicknesses up to 8 mm (5/16”), it needs only one pass with no preparation.

**Operations to be carried out:**
- mechanical oxide remover,
- mechanical support using a backing bar is required for the weld pool.

**Current application:** longitudinal welding on seamer bench.
Plasma welding in the workshop

Use plasma or TIG processes for flat position, or circular welding of stainless steel, noble metals, steels or aluminum. Manufacture all types of products for the petrochemical, agriculture/food processing, aeronautical industries, etc.

Longitudinal welding on seamer bench

Standard example of welding in boiler making

Welding with column and boom
- Maximum standard travel: 4.3 m (14') horizontal, 6.2 m (20') vertical.

For other requirements, please do not hesitate to contact us.

Welding on seamer bench
- Allowable thickness up to 10 mm (0.4”).
- Maximum weldable length according to type of bench: 4 m (13’) (external), 6 m (20’) (external-internal) or 7 m (23’) (internal).

For other requirements, please do not hesitate to contact us.
Elliptical welding with column and boom on rotator.

Circular welding with column and boom on rotator or positioner.
Vertical tank and boiler work

Use plasma or TIG processes for horizontal welding of stainless steel, noble metals, steels or aluminium. Manufacture storage equipment for agriculture/food processing, petrochemical industries, etc...

**Vertical welding**

In order for a workpiece to be welded on a rotator, it has to be rigid enough (relationship between diameter, thickness and dimensions) to ensure satisfactory stability while welding takes place. For cases where rigidity is not sufficient, or costly (vessel sizing tools), difficult or even impossible to improve, welding can be carried out “in the vertical axis”; the workpiece is rotated using a horizontal turntable and the torch remains static in the horizontal welding position. This allows very large dimension workpieces to be produced without the use of complex tools.

**Turntable capacities:**

- 5T (11,000 lb)
- 10T (22,000 lb)
- 15T (33,000 lb)

**For other requirements, please do not hesitate to contact us.**
Prefabrication of pipe work is carried out upstream of installation. It enables sub-assemblies to be prepared and welded from basic components (pipes, flanges, elbows, etc) in the workshop. It is used in a variety of industrial sectors:

- shipbuilding and off-shore platforms,
- refineries and power stations,
- chemical and agriculture/food processing plants,
- gas expansion and distribution stations etc.

The materials used are:

- carbon steels,
- stainless steel,
- noble metals and titanium.

Plasma welding is suitable for prefabricating pipe work of diameters greater than 38 mm (1.5”). Parts with smaller diameters can be TIG welded using the same equipment.

Example of welding times, assemblies are pre-tacked using manual TIG.

<table>
<thead>
<tr>
<th>Exterior tube Ø</th>
<th>Thickness of wall in mm (in)</th>
<th>Type of steel</th>
<th>Joint preparation</th>
<th>Time taken for plasma welding not counting positioning of assemblies</th>
<th>Time taken for same operation carried out manually</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>2.9 (0.11) carbon</td>
<td></td>
<td></td>
<td>2 min (2 consecutive passes)</td>
<td>15 min</td>
</tr>
<tr>
<td>133</td>
<td>3.8 (0.15) carbon</td>
<td></td>
<td></td>
<td>4 min (2 consecutive passes)</td>
<td>24 min</td>
</tr>
<tr>
<td>406</td>
<td>9.52 (0.37) carbon</td>
<td></td>
<td></td>
<td>14 min (2 consecutive passes)</td>
<td>24 min</td>
</tr>
<tr>
<td>114</td>
<td>8 (5/16) AISI 304</td>
<td></td>
<td></td>
<td>4.15 min (2 consecutive passes)</td>
<td>38 min</td>
</tr>
<tr>
<td>170</td>
<td>3.2 (1/8) AISI 304</td>
<td></td>
<td></td>
<td>2 min (1 pass)</td>
<td>55 min</td>
</tr>
</tbody>
</table>
This installation meets the highest quality standards for welding and productivity for industries as diverse as boiler-making using stainless steels, aeronautics using noble metals, chemical engineering, energy production, processing and transport as well as prefabrication of pipelines, etc.

**MANAGER uses automatic plasma welding, which can assemble butt-jointed 8 mm (5/16”) stainless steel, titanium or alloy steel in a single pass without the need for beveling. The plasma process controlled by MANAGER can assemble carbon steel or stainless steel tubes from 40 mm (1.58”) diameter for pipe prefabrication work.**

The MANAGER control unit is programmable and controls both the process and all peripheral equipment whatever the complexity of the application. It is a decentralised and modular control and management system. The programming and control unit box display all messages in multi-lingual cleartext on 4 lines of 20 characters.

**Overall control: process + movement**
- 100 welding programs (voltage, amperage, wire feed speed, travel speed),
- 100 non-welding movements,
- 100 chained or linked programs,
- 100 repeated programs,
- Cleartext screen display,
- Parameter modification while welding,
- Cycle start/stop,
- Manual controls for gas, wire, arc voltage control and movement.

**TIG/plasma direct current basis**
- Pulser 300 A/100 %,
- Control arc circuit 25 A/100 %
- Primary three-phase power supply 50/60 Hz - 230/400/415/440 V (adapted to 575 V).

**To order:**
standard offer LD 04-011

**Basic installation**
- NERTAMATIC 300 TR power source (300 A at 100 % with peak at 500 A in pulsed mode),
- MANAGER control system,
- Connecting harness length 10, 17 or 22 m (32, 56 or 72’).

**Compléments MANAGER**
- coffrets gaz, fil, AVC, mouvements.
Multi-purpose welding installation for the following processes in automatic applications:

- DC TIG with smooth or pulsed current
- AC TIG with variable polarity (squarewave),
- DC plasma with smooth or pulsed current,

This equipment is offered in several versions.

**Process control**
- 50 welding programs (voltage, current, wire speed, movement)
- Cleartext LCD screen display
- Parameter modification while welding
- Cycle start/stop, manual control of gas/wire, arc voltage control

**TIG/plasma direct current basis**
- PC 104 central unit and interface
- Pulser 450 A/100 %
- Control arc circuit 25 A/100 %
- Primary three-phase power supply 50/60 Hz - 230/400/415/440 V (adapted to 575 V).

**Optional alternating module**
- Variable polarity TIG operation on aluminium
- Variable polarity current 450 A/100 %
- Variable polarity frequency from 50 to 200 Hz

**Basic installation:**
- NERTAMATIC 450 power source
- HF module + torch connection
- Remote control unit box, welding control with 50 preset programs (display/control of current, voltage, wire speed)
- Diskette drive for uploading or downloading programs
- Parameter print-out
- Power controller module
- Harness length 10, 17 or 22 meters (32, 56 or 72’) compatible with cable hanger chain

**NERTAMATIC 450 add-ons**
- Wire, AVC, gas control box

**Machine add-ons**
- Movements, meccycles, PLCs etc

*Mixed AC/DC TIG and DC plasma version is available.*
This installation was developed and built to weld large-capacity stainless steel vessels makers with series 300 stainless steels, thickness from 3 to 8 mm (0.12 to 5/16”).

This tool is ideal for assembling panels for the prefabrication of vessels longer than 4 meters (13’) and carrying out circular welds for diameters greater than 2 meters (6.5’).

It uses plasma + TIG process whereby the first “plasma” torch penetrates the butt-jointed panels. The second “TIG” torch equipped with metal filler cold wire feed, electromagnetic arc oscillation and a gas protection carriage produces a perfect surface finish, which can often be left without further treatment. This process of using 2 torches in tandem gives a productivity gain of 30-50 % over a single-torch plasma installation.

To order:
standard offer LE05- 020

Basic installation:
The TIG + plasma installation is made up of two NERTAMATIC 450 installations:

• a plasma installation with SP7 torch and arc voltage regulation,
• a TIG installation with MEC4 torch, arc voltage regulation, wire feed, arc oscillation and gas protection carriage.

Each installation memorizes and manages its own welding parameters. The unit is equipped with a digital control in order to synchronise welding torch starts and stops, and to control the speed and length of weld. This digital control memorizes and manages the movement parameters.
Suitable for all machine types:

- video surveillance,
- oscillation or magnetic deviation of TIG arc,
- hot wire feed.

### Video system

The TIG/plasma video system can be easily integrated into typical installations. It uses a greatly enlarged image, which enables the precise position of the welding torch to be viewed, thus making the operator’s work easier and improving the quality of the welding operation.

### OSCILLARC 2

**Deviation or electromagnetic oscillation of the TIG arc**

**Arc deviation**

This technique is used to electrically deflect the TIG arc, which considerably increases the heat-affected zone along the weld axis, and increases speed by 30 to 50% for thicknesses of less than 2 mm (5/64"). This facility is particularly suited to the continuous welding of thin tubes formed from strip, cable conduit, electrical resistance shielding etc. i.e: all mass-produced parts welded without filler metal.

**Arc oscillation**

An extension of the arc deviation technique described above, arc oscillation is used to deposit metal over areas up to 20 mm (0.8") wide to fill bevels or cap the weld bead.

### Hot wire TIG and plasma

**Productivity improvement by increasing the deposition rate**

For filling bevels 40 mm (1.6") deep, the use of hot filler wire provides a good solution and is particularly suited to applications where a high-quality weld joint is required. This special technique uses an auxiliary current to bring the end of the wire to nearly melting point. Viable for plates of thickness 10 mm (0.4") and above, the use of hot filler wire enables 2.5 to 3 kg (5.5 to 6.6 lb) of metal per hour to be deposited for filling bevels using multiple passes or for quality hard-surfacing.

### AVC (Arc Voltage Control) and wire feed autonomous units

These devices can be used to update older automatic TIG and plasma welding installations, and to create simplified installations for manual welding stations.
The microplasma process is used for welding fine thicknesses of noble metals, such as stainless steel, inconel, titanium, zirconium, alloys of silver and gold etc. It is suitable for electric and electronics components, small containers, metal filters and tool repairs as well as watchmaking, jewellery and medical industries.

Special installation for manual or automatic microplasma or TIG welding

- 100 programs
- Cleartext LCD screen display
- Parameter modification while welding
- Program print-out
- Integrated process control
- Smooth or pulsed continuous welding
  - plasma from 80 mA to 50 A at 100 %
  - TIG from 0.8 A to 50 A at 60 %
- Pulse frequency from 1 Hz to 10 kHz
- Three-phase primary power supply
  50/60 Hz - 230/400/440 V (adapted to 575 V)

1 - Mould repairs
2 - Motors and transformers
3 - Probes
4 - Measuring instruments
5 - Expansion bellows
6 - Fine sheet metalwork
7 - Jewellery
8 - Filters
The INVERTER 180 plasma unit is specially built for automatic welding using the deconfined or soft plasma process. It is used for intensive production and is suitable for all machine types. The most recent applications are the production of melt-runs, small weld beads or very repetitive welding.

The installation can also use the control arc double-flux TIG process using smooth or pulsed current. Plasma is an evolution of the TIG process which brings many opportunities for increasing your productivity.

Using a permanent pilot arc
- No more HF (high frequency) starting for each weld bead, only the transfer of a pilot arc which guarantees repeated starting with less waste.
- Reduction of down time between two welds.

By using an electrode protected by the nozzle,
The life of the electrode is increased with a consistency of weld maintained over 8 hours (sometimes more, depending on the material and weld types) resulting in a reduction of machine stoppages for tungsten grinding.

Applications of deconfined or soft plasma

In boiler making and sheet metalwork
Fine thicknesses from 0.4 to 2 mm (0.015 to 5/64").

In mass production
Household appliances, radiators, automobile engine safety points, electrical construction (welding electrical sheets for alternators or transformers).

Basic installation:
- INVERTER 180 plasma power source,
- SP150 welding torch equipped for plasma or doubleflux TIG,
- torch connection block,
- harness of length 10 m (32") specific to INVERTER plasma.

Equipment