Plasma and TIG processes. Automatic welding applications

2003-665

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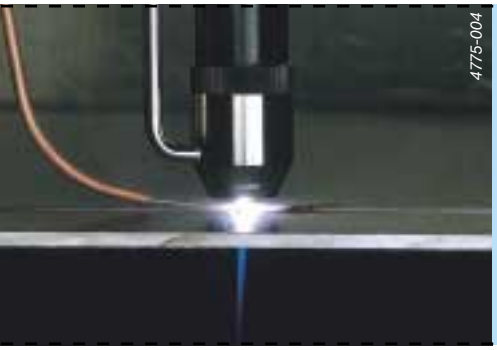
AIR LIQUIDE WELDING

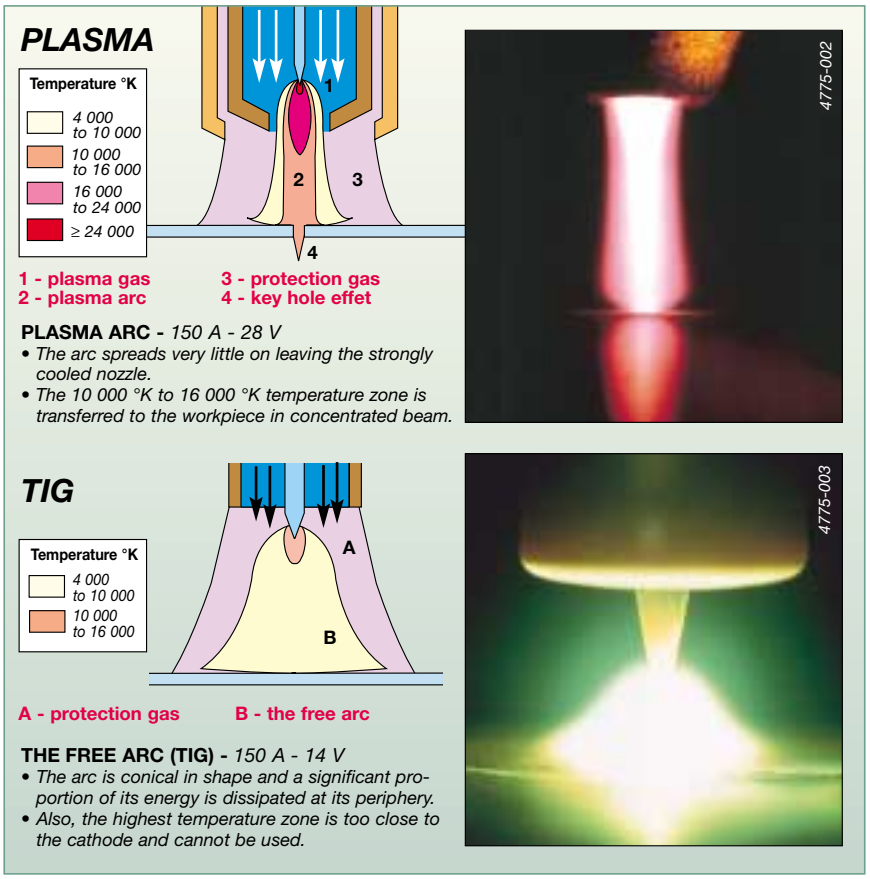
Plasma and TIG processes used in automatic applica



The plasma arc: a natural phenomenon tamed by SAF. The term plasma applies to gases at temperatures exceeding 3000 °C 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. As market leader in this sector, SAF has turned it into a powerful cutting and welding tool. It is generally accepted that the plasma welding process is the major technological advance from inert gas shielded free arc welding (the TIG process).

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



The isotherm diagram opposite shows clearly that the energy distribution is strongly modified within the plasma arc :

- the 16 000 °K to 24 000 °K temperature zone is outside the nozzle,
- the 10 000 °K to 16 000 °K temperature zone is entirely transferred to the workpiece and causes the "key hole" effect (penetration of the workpiece).

With a free arc (TIG process) the highest temperature zone is too close to the cathode to be usable.
The 4 000 °K and 10 000 °K temperature zone is narrow in plasma welding compared to TIG welding where the zone is much wider with 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 basic metal.
This zone is excessively wide in TIG welding and the excess limits performance.

tions

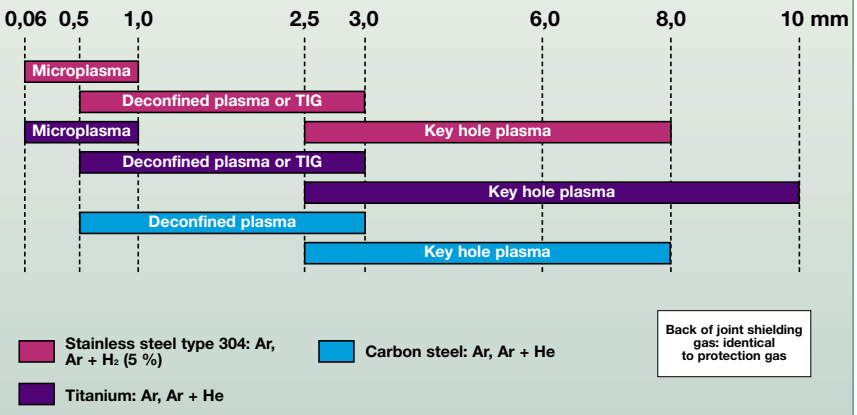
The plasma is made up of excited ions, electrons, atoms or molecules; it occurs in nature, generated by lightning, for example.
Since about 1960, and largely due to SAF, the word plasma has gained a new meaning, referring to the high-energy state caused by constricting an electrical arc by means of a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

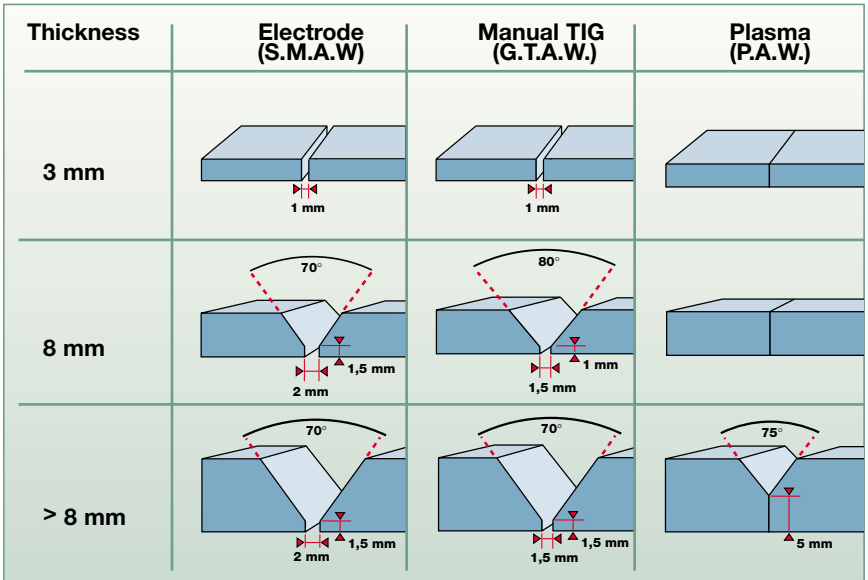
Thickness limitation

Maximum thickness which can be welded, flat with butt-jointed surfaces, in one pass with 100 % penetration. Maximum thickness which can be welded in a single reduced pass for:

- vertical up and horizontal welding positions,
- small diameter and very thick tubes.

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





Welding in one pass without preparation:
carbon steel and stainless steel, austenitic up to 8 mm, titanium up to 10 mm.

Example of productivity gain with carbon steel (5 mm):
- Electrode: preparation + 2 passes at 15 to 20 cm/min grinding.
- Manual TIG: preparation + 2 passes at 10 cm/min.
- Key hole plasma: 1 pass at 40 cm/min.

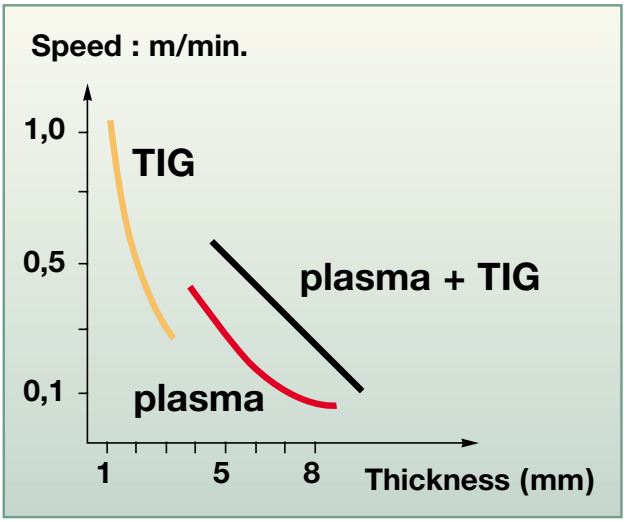
Advantages of plasma

- ***Rapidity of operation*** and ***low deformation*** to avoid or reduce reconforming operations as well as ***low buildup*** to eliminate polishing procedures with ***respect for the chemical composition of the base material*** to avoid problems of corrosion.
- ***Excellent visual appearance*** which is a quality factor as more and more welds are visible, with ***repeatability of the quality*** obtained and ***a reduction in the preparation times for assemblies*** by eliminating bevelling for thicknesses up to 8 mm.
- ***4- or even 5- fold reduction in welding times*** in comparison with manual welding, with ***assurance of complete and regular penetration*** by virtue of the traversing jet technique on butted joints.
- ***High quality*** proof against stringent inspections ***with excellent reproducibility.***
- ***Produces a faultless weld bead overlap*** due to perfect control of the relevant parameters.

Plasma + TIG welding process

When the length of the panels to be assembled reaches 3 to 4 meters, a boiler-making or tube fabrication workshop using a discontinuous forming process (rolling mill or press) can be restricted by the welding speed obtained with a single-torch plasma process.

SAF, an innovative specialist in TIG and plasma processes, has been able to integrate the two processes into a single installation which can improve productivity by 30 to 50 %.

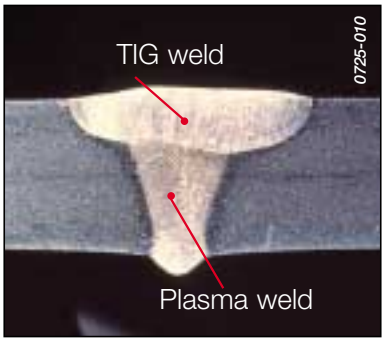


Welding speed (cm/min.)

Thickness (mm)	plasma	plasma + TIG
3	50	65
4	35-40	50-60
6	25-30	40
8	15-20	25

Advantages of the plasma + TIG process

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

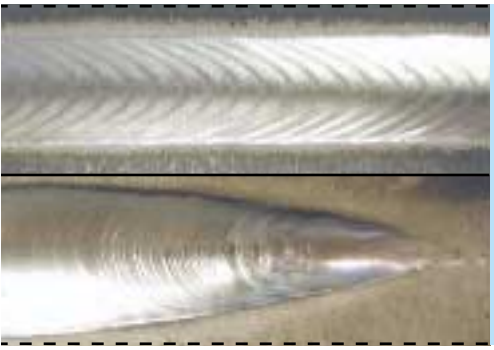


In the plasma + TIG process, the plasma arc first melts the entire thickness of the joint by using a strongly confined plasma which only affects the appearance of the back of the joint.
250 to 300 mm away, the TIG arc equipped with filler metal and a magnetic oscillation system prepares the final appearance of the surface. By virtue of the magnetic oscillation and a 120 mm gas shield, this gives a perfect finish.

The plasma + TIG process works on thicknesses between 3 and 8 mm.
Thicknesses less than 3 mm can also be welded perfectly but only a single-torch TIG process is used.
Thicknesses greater than 8 mm 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,
- diameter > 2.2 meters,
or manufacture of large stainless steel tubes welded in one piece.

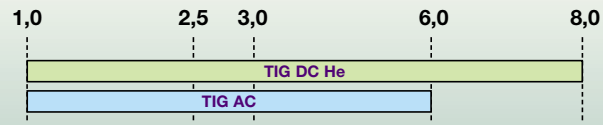
Aluminium welding using the automatic TIG process



SAF have developed a variation of the TIG process to guarantee success in your automatic welding work. Variable polarity TIG ensures continuous decoating, a high-quality weld bead, total control of the weld pool and perfect fading for finishing off the weld bead.

Thickness limitation for the TIG process used for aluminium welding.

Maximum thickness which can be welded, flat* with butt-jointed surfaces, in one pass with 100 % penetration:



Aluminium TIG AC: Ar or Ar + He

Aluminium TIG DC He: 100 % He

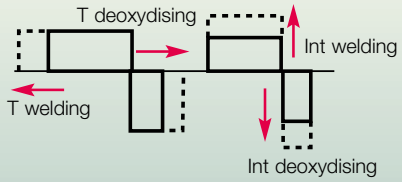
** (in horizontal position, the maximum thickness is reduced)*

Alternating variable polarity TIG

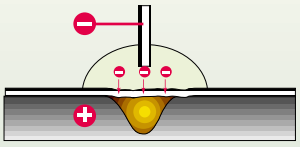
The flexibility of variable polarity lies in the total independence of the welding and deoxydising parameters. This means it is possible to optimise the welding and deoxydising phases independently.

This results in better control of the weld pool and better weld bead appearance. The alternations improve weld bead compactness as aluminium and its alloys only too easily show inclusions (Al_2O_3) and blisters (H_2).

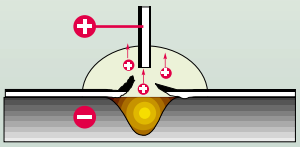
Variable polarity: parameter independence



Electronic deoxydising



Direct polarity for welding

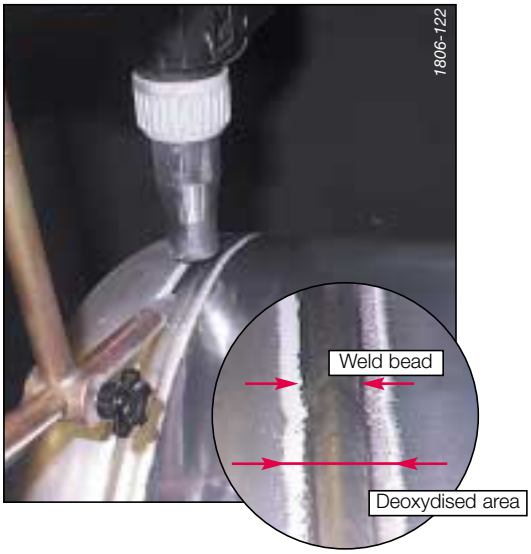


Inverse polarity for deoxydising

Weld bead comparison

Variable polarity weld bead smooth weld

Weld bead with variable polarity welding pulsed at low frequency



DC TIG under helium

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

Operations to be carried out:

- mechanical oxide loger,
- mechanical support using a backing bar is required for the weld pool.

Current application: longitudinal on seamer bench.

Indicative parameters for DC TIG helium

Thickness (mm)	*Current (A)*	*Voltage (V)*	*Weld Speed (cm/min)*	*Wire Speed (cm/min)*	*Gas flow rate (l/min)*
1,6	100	13	75	110	30
2,0	150	13	75	110	30
2,5	210	13	75	130	30
3,0	220	14	65	200	30
4,0	250	14	45	200	30
5,0	250	14	45	220	30
6,0	300	15	30	220	30
8,0	360	15	18	140	30

One pass with 100% penetration, butt-jointed, position flat.

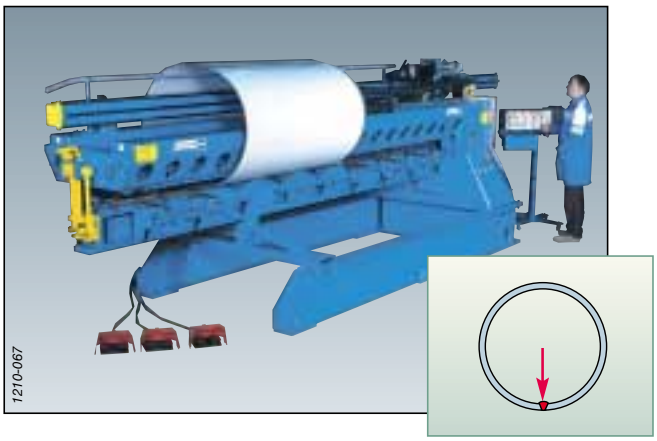
Plasma welding in the workshop

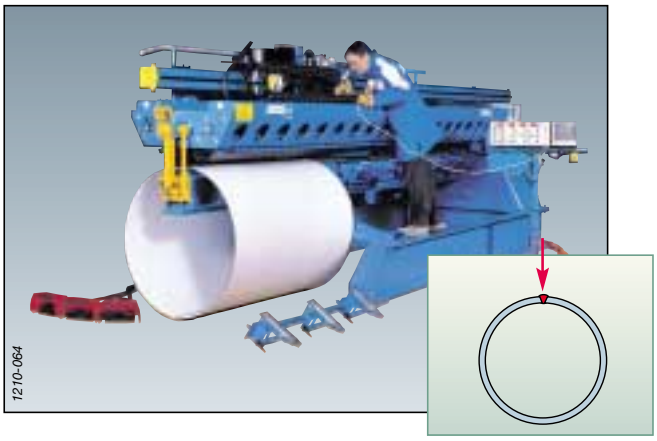
Use of plasma or TIG processes or flat longitudinal or circular welding of stainless steel, noble metals, steels or aluminium. Manufacture of all types of product for the petrochemical, agriculture/food processing, aeronautical industries etc.

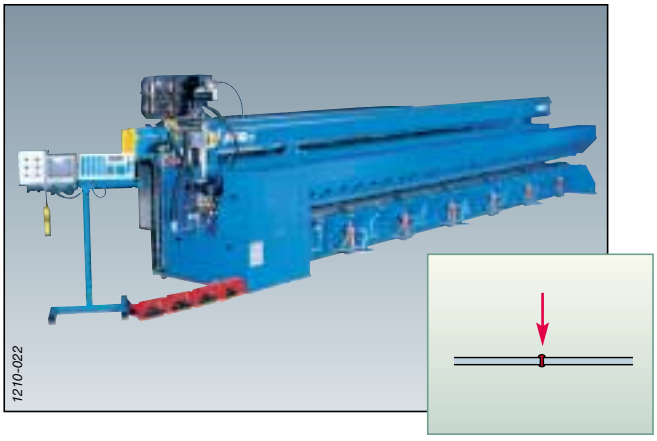
Longitudinal welding on seamer bench

Closing the vessel and even butt-jointing

Start and end of weld on root face.







Standard example of welding in boiler making

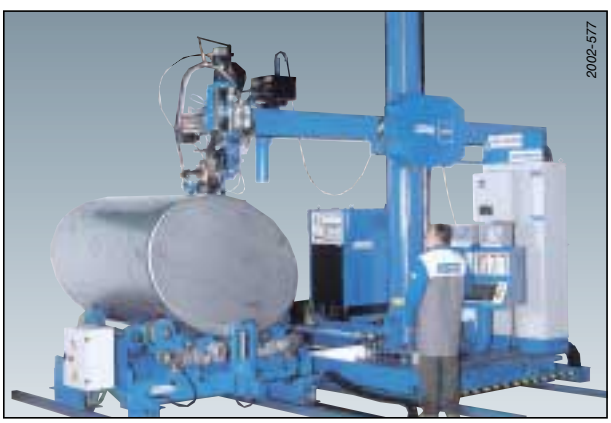
Welding with column and boom

- Maximum standard travel:
  4.3 m horizontal, 6.2 m vertical.
  For other requirements please do not hesitate to contact us.

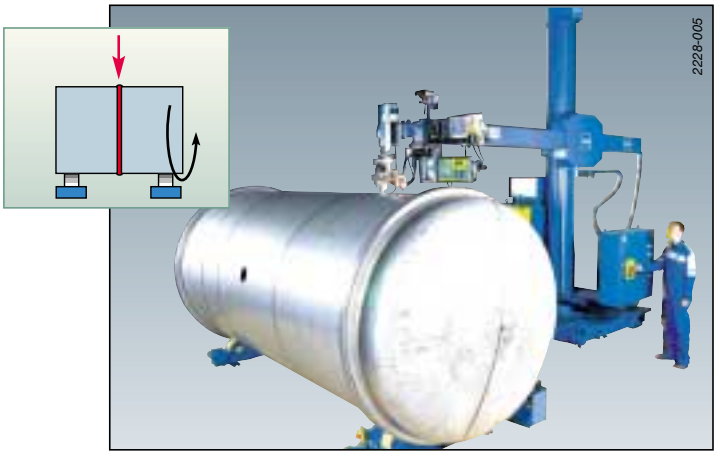
Welding on seamer bench

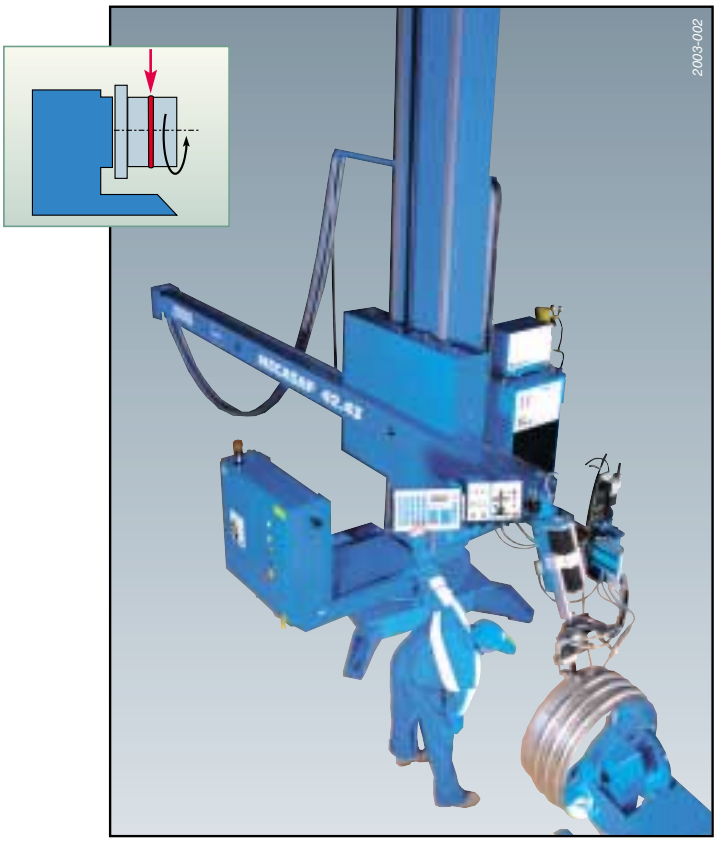
- Allowable thickness up to 10 mm,
- Maximum weldable length according to type of bench: 4 m (exter), 6 m (exinter) or 7 m (inter).
  For other requirements please do not hesitate to contact us.

Elliptical welding with column and boom on rotator.



Circular welding with column and boom on rotator or positioner.



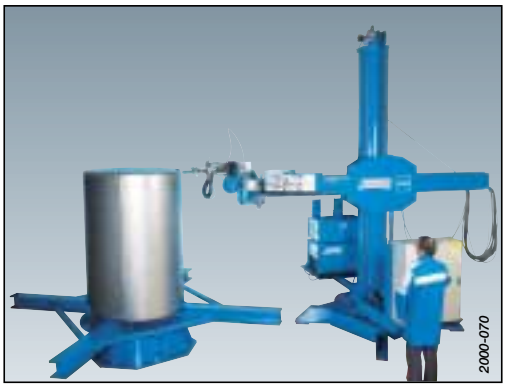


Vertical boiler work

Use of plasma or TIG processes for horizontal welding of stainless steel, noble metals, steels or aluminium. Manufacture of 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 because of the large variety of parts used, SAF has produced equipment enabling welding to be carried out "in the vertical axis" where 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, 10T and 15T.
For other requirements please do not hesitate to contact us.

Plasma welding for prefabricated pipe work

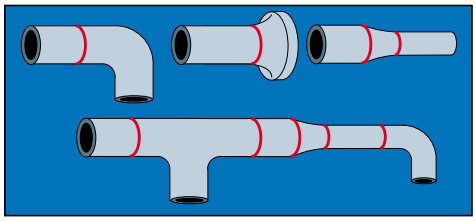
Prefabrication of pipe work is carried out upstream of installation. It enables sub-assemblies to be prepared and welded from basic components (pipes, flanges, elbows etc...) in the workshop. It is used in a variety of industrial sectors:

- **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 as follows:

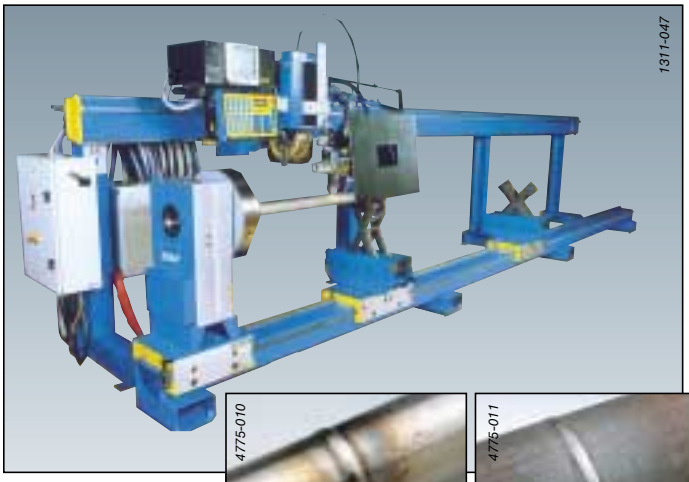
- carbon steels,
- stainless steel,
- noble metals and titanium.

Plasma welding is suitable for prefabricating pipe work of diameter greater than 1.5 inch. Parts with smaller diameters can be TIG welded using the same equipment.

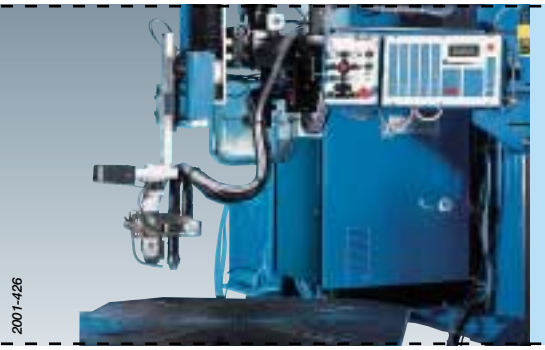


Example of welding times, assemblies are pre-tacked using manual TIG.

Exterior tube Ø	*Thickness of wall in mm*	*Type of steel*	*Joint preparation*	*Time taken for plasma welding not counting positioning of assemblies*	*Time taken for same operation carried out manually*
60	*2,9*	*carbon*		*2 min (2 consecutive passes)*	*15 min*
133	*3,8*	*carbon*		*4 min (2 consecutive passes)*	*24 min*
406	*9,52*	*carbon*		*14 min (2 consecutive passes)*	*24 min*
114	*8*	*AISI 304*		*4,15 min (2 consecutive passes)*	*38 min*
170	*3,2*	*AISI 304*		*2 min (1 pass)*	*55 min*



MANAGER plasma installation



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, transformation and transport as well as prefabrication of gas and petrol pipelines etc.

MANAGER uses automatic plasma welding which can assemble butt-jointed 8 mm stainless steel, titanium or alloy steel in a single pass without the need for bevelling. The plasma process controlled by MANAGER can assemble carbon steel or stainless steel tubes from 40 mm 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 displays all messages in multi-lingual cleartext on 4 lines of 20 characters.

Overall control: process + movement

- 100 welding programs (U, I, Vf, movement),
- 100 non-welding movements,
- 100 chaining programs,
- 100 repeated programs,
- Cleartext screen display,
- Parameter modification while welding,
- Cycle start/stop,
- Manual controls for gas, wire, AVC 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.

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.

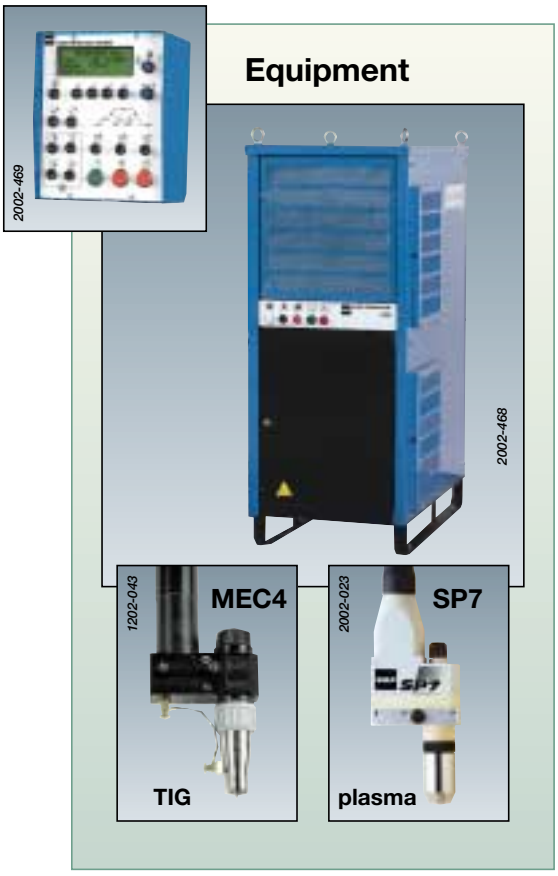
MANAGER add-ons

- Gas, wire, AVC and movement control boxes.

NERTAMATIC 450 installation

Multi-purpose welding installation to enable the following processes to be used in automatic applications:
- **DC TIG with smooth or pulsed current**
- **AC TIG with variable polarity,**
- **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, AVC

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

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 memorised 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 compatible with cable hanger chain

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

Machine add-ons
- Movements, mecacycles, PLCs etc

To order:

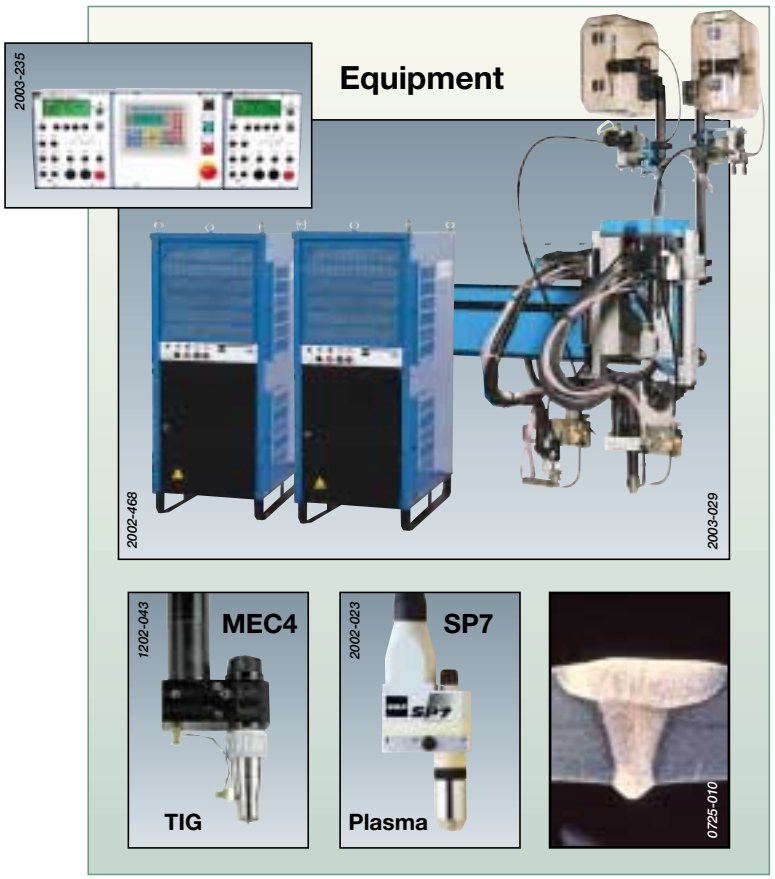
standard offer LC 03-012
DC TIG and AC/DC TIG versions: this installation can assemble butt-jointed stainless steel panels up to 3 mm thickness and light alloy steels up to 8 mm thickness (DC TIG under helium) and 6 mm (AC TIG under argon) in a single pass.

standard offer LD 04-032
The DC plasma version uses automatic plasma welding and can assemble butt-jointed 8 mm carbon steel, stainless steel, titanium or alloy steel in a single pass without the need for bevelling.

Mixed AC/DC TIG and DC plasma version is possible

NERTAMATIC 450 plasma + TIG bicathode installation

This installation was developed and built for large-capacity stainless steel boiler makers (basic activity transport and storage of chemical products and foodstuffs with series 300 stainless steels, thickness from 1 to 8-10 mm).



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

It uses SAF's original plasma + TIG process whereby the first "plasma" torch penetrates the butt-jointed panels. The second "TIG" torch equipped with metal filler, 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.

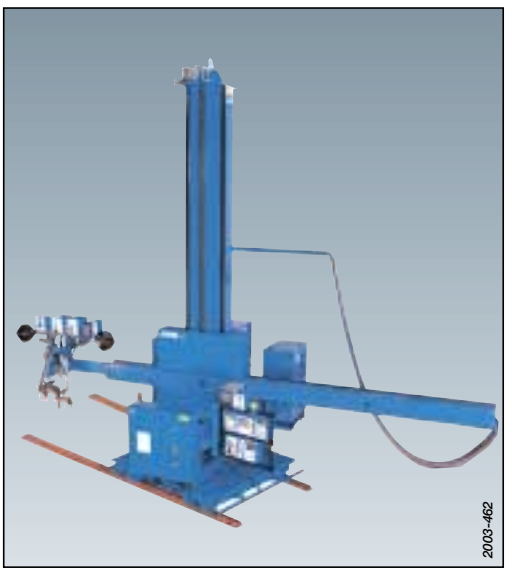
To order:
standard offer LE05- 020

Basic installation:

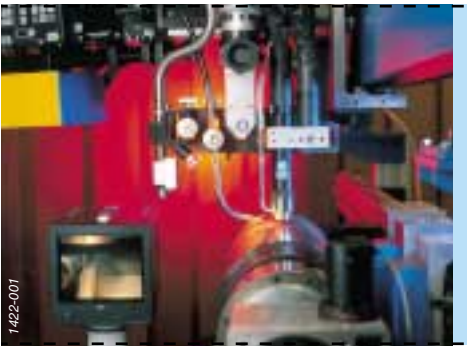
The TIG + plasma installation is made up of two NERTAMATIC 450 installations:

- **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 memorises 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 memorises and manages the movement parameters.



Add-ons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Suitable for all machine types:
- **video surveillance,**
- **oscillation or magnetic deviation of TIG arc,**
- **hot wire feed.**

Video system

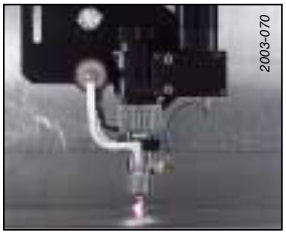
The TIG/plasma video system can be easily integrated into SAF installations.


4810-001

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


2003-070

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 the order of 30 to 50 % for thicknesses of less than 2 mm. 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 wide to fill bevels or reconstitute surface coating.

Hot wire TIG and plasma

Productivity improvement by increasing the deposition rate

For filling bevels 40 mm deep, the use of hot filler wire provides a good solution and is particularly suited to applications where a high specification of the welded 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 and above, the use of hot filler wire enables 2.5 to 3 kg of metal to be deposited per hour for filling bevels using multiple passes or for quality hard-surfacing.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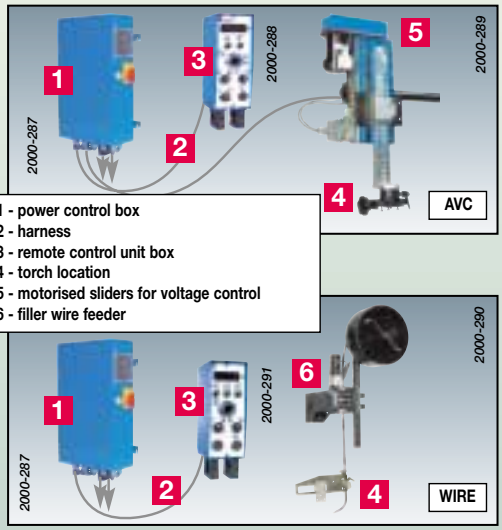
AVC (Arc Voltage Control) and wire feed autonomous units

These devices can be used to update older automatic TIG and plasma welding installations, but also to create simplified installations for manual welding stations.



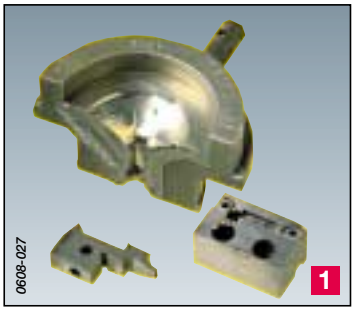
Microplasma

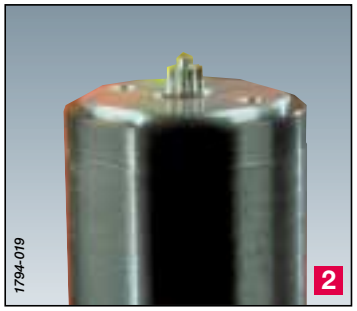
The microplasma process is used for welding fine thicknesses of the noble metals such as stainless steel, inconel, titanium, zirconium, alloys of silver and gold etc. For the electric and electronics components industries, small containers, metal filters and tool repairs as well as sectors of the horology, silversmith and medical industries.

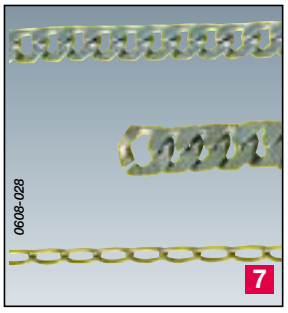
Equipment

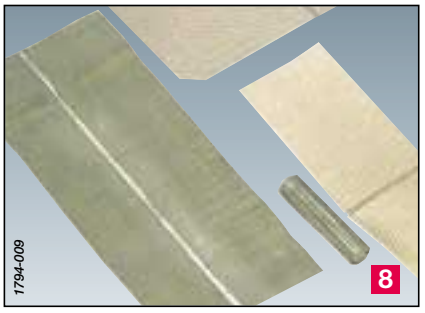
Special installation for manual or automatic microplasma or TIG welding

- 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









1 - Mould repairs
2 - Motors and transformers
3 - Probes
4 - Measuring instruments
5 - Decompensator bellows
6 - Fine sheet metalwork
7 - Jewellery
8 - Filters

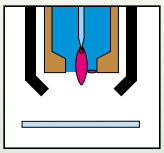
Deconfined plasma

The INVERTER 180 plasma unit is specially built for automatic welding using the deconfined 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.

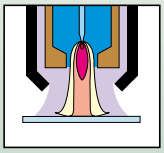
The installation can also use the control arc double-flux TIG process using smooth or pulsed current. Plasma is an evolution of the TIG process which brings many opportunities for increasing your productivity.

Using a permanent control arc

- No more HF priming for each weld bead, only the transfer of a control arc which guarantees repeated priming with less waste and client peripherals protected.
- Reduction of slack time between two welds.



Control arc ready to weld



Transfer of control arc and welding

By using an electrode protected by the nozzle,
The lifetime 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 grinding.

Applications of deconfined plasma

In boiler making and sheet metalwork

Fine thicknesses from 0.4 to 2 mm.

In mass production

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

1 - Alternator or motor cores,
2 - Automobile pipe work,
3 - Welding gates onto radiator segments,
4 - Deburring beer barrel handles by plasma refusion.

Basic installation:

- INVERTER 180 plasma power source,
- SP150 welding torch equipped for plasma or double-flux TIG,
- torch connection block,
- harness of length 10 m specific to INVERTER plasma.

Equipment

Contacts

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