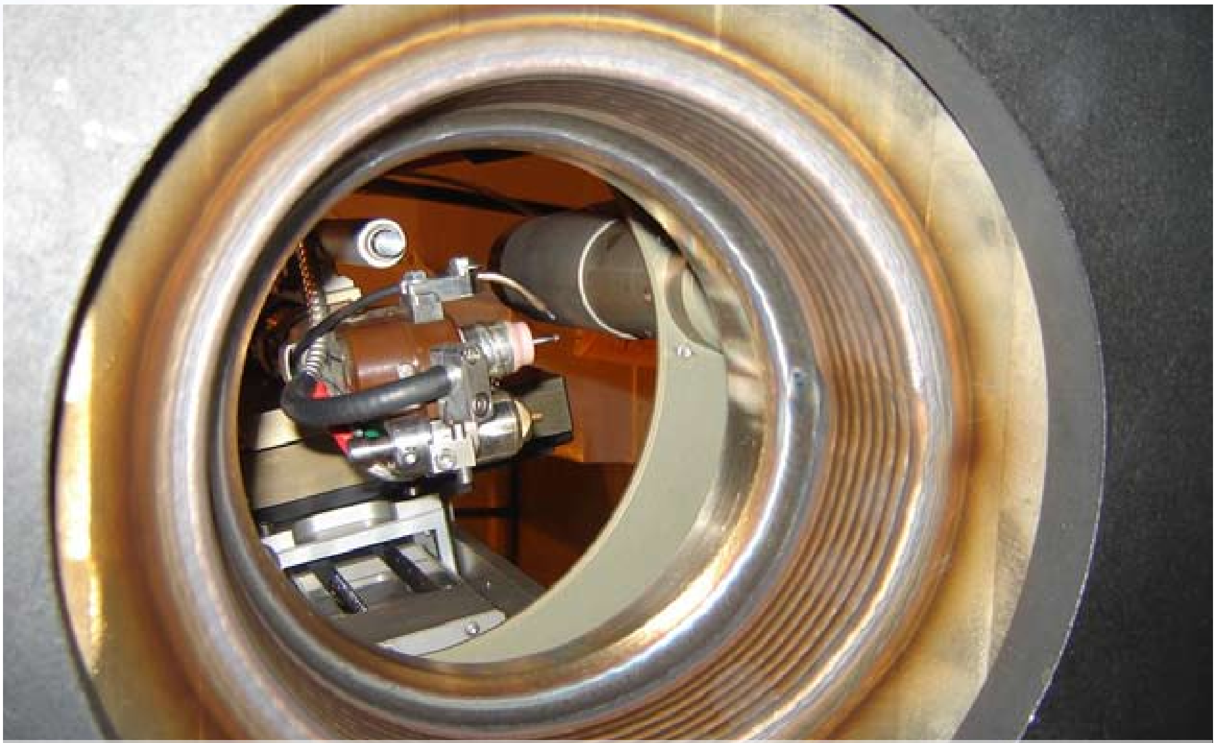
POLYSOUDE
THE ART OF WELDING

Cladding in the Field of Industrial Applications



Repair work with orbital welding equipment. Repair welding on the primary circuit of a nuclear power plant: a branch pipe is reconditioned by internal cladding (stainless steel 316 L). The welding head is positioned at the inside of the piping, the weld is carried out via remote control. The welding head is equipped with an endoscope and the collector type welding head permits endless rotating.

Utilised as an independent process during the manufacturing of wear resistant components, or applied as a process for the repair of damaged or worn-out workpieces, cladding operations are widely found in the field of industrial applications. Special equipment has been designed to meet the various technical and economical requirements as well as the expected quality level of the process.

Generally, cladding operations are used for the following types of application:

- Repair of workpieces which, after a certain time of service, show severe signs of wear or damage,
- Preventive protection of particular areas or whole workpieces to resist harsh wear conditions (abrasion, corrosion, ...),
- Deposition of buffer layers (buttering) allowing different base materials to be welded together.

To satisfy the specific requirements of these different applications, a wide range of individual cladding equipment is available on the market.

During repair work it is often inconvenient or impossible to disassemble the affected workpieces. They must be machined in their mounted position, which often means welding under restricted access conditions in all positions. In these cases many problems can be solved by cladding with mobile orbital welding equipment.

Workpieces to be repaired are mostly characterised by severe signs of wear (cracks, hard spots, erosion, ...), the concerned base material must be removed by machining, afterwards it is replaced by cladding with filler metal of the same kind.

The manufacturing of workpieces where cladding operations are already planned from the very beginning are usually carried out by means of fixed installations in the workshop (cladding to avoid corrosion or buttering to prepare welding of non homogeneous welds).

Mechanized welding equipment designed as fixed installation in the workshop.
Cladding of the inside of workpieces with nickel base alloy.

Depending on the level of mechanisation and automation, these installations are suitable for the production of small lots or medium batches. In many cases, even heavy or voluminous workpieces can be moved or rotated making the cladding operations less complicated.

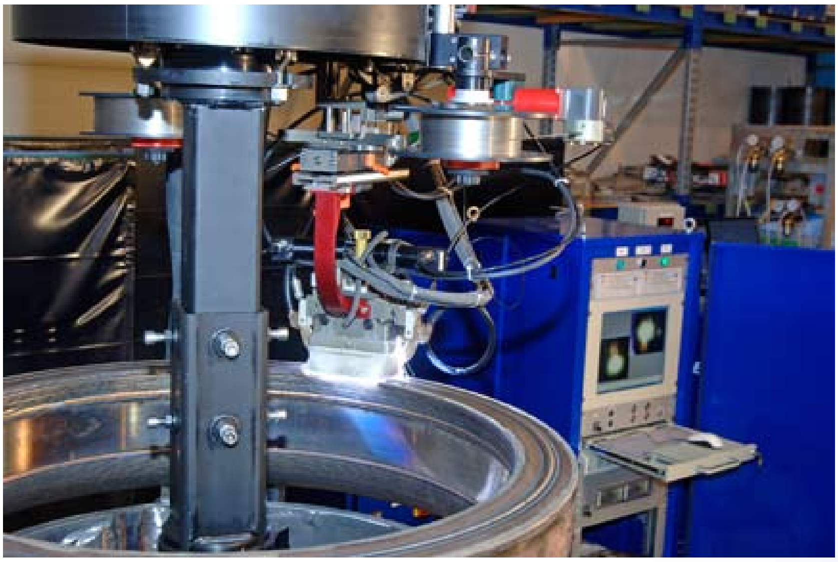
The restoring of undersized workpieces, e.g. caused by machining errors, can be carried out in a similar way by cladding, but in most cases automated welding is not possible due to a lack of adequate clamping devices.

The cited examples already show the wide diversity of requirements to be satisfied by cladding processes. Some typical load types are listed below; often the workpieces are exposed to combinations of different stress patterns:

- Corrosion or high-temperature corrosion in dry or wet environments,
- Different kinds of wear (abrasive, cavitation pitting, ...),
- Impact stress,
- Thermal shocks.

Deposition of buffer layers has to be considered as the special application of cladding, either the workpiece shall be protected against wear or removed or eroded material will be replaced; instead the buttering process is used to prepare an intermetallic joint between two different metallic alloys to be welded. As the active forces absorbed by the joint are entirely effective at the buffer layer a reliable buttering quality becomes necessary. Generally, the requirements from buffer layers are on the same level as quality demands on welded joints; in many cases they can be met only by means of TIG hot wire welding.

TIG hot wire cladding and buttering will be the most appropriate procedure for a wide range of applications.



Buttering on a tube end of a steam generator in preparation of the non heterogeneous weld with an orbital welding equipment. (Average welding current 180 to 280 A, travel speed 250 to 450 mm/min., melting rate between 0,6 to 1.2 kg/h).

The fine grain structure of the deposited material, the evenly formed surface of the layers, the possibility to weld in all positions and the extraordinary flexibility of the process management are reasons to prefer TIG hot wire welding for delicate cladding applications.

TIG welding allows precise control of the energy input released by the electric arc independently from the addition of filler wire, so workpieces with complex geometries or irregular shapes can be treated (there is also the possibility to deposit layers of different thickness, to vary welding parameters during ignition or downslope within wide limits etc.).

TIG cladding processes can be kept stable at weld current intensities from about 80 A up to 450 A.

The attainable melting rates start at a few hundred grams per hour and, if two synchronised torches are used, can be increased up to 2.5 kg/h or sometimes 3 kg/h.

Additional functions like Arc Voltage Control, oscillation, movements synchronized with the pulsed weld current etc. can be applied for TIG cladding processes without restriction; however, in cases where highest melting rates are to be achieved, a strong constant weld current must be selected.

In case of cladding with addition of dissimilar filler material the choice of weld parameters mainly depends on following criteria :

- Limitation of dilution of the deposit (attaining the required density of the layer while respecting the specified limits of the different constituents of the alloy)

- Attaining the expected surface quality of the coating

- Guaranteeing the promised melting rate (economy of the operation).

To keep the dilution of the layers as low as possible the right order of weld beads and electrode positioning must be known and respected.

The wire can arrive in front or added from the side. In this case it acts like a shield and protects the substrate against direct effects from the arc; a more significant portion of the released energy is used to melt the filler material and only a smaller part remains to melt the base material.

As already mentioned, the order of weld beads and electrode positioning are important parameters which can be exploited to decrease the degree of dilution. Similar to the method of using the wire as protection against the effects of the arc an already deposited bead can serve in the same manner, if the following bead is positioned with an important overlay and only a small lasting contact zone with the substrate.

The dilution is mainly taking place between the existing and the new weld bead, alloying with the basic material becomes significantly reduced. The result can even be improved if the electrode is positioned as much as possible above the existing weld bead.

The basic device of any cladding equipment is a TIG hot wire power source with a modular structured control centre which processes the entire movements of the different units.

The software is especially adapted to the needs of programs for cladding operations.

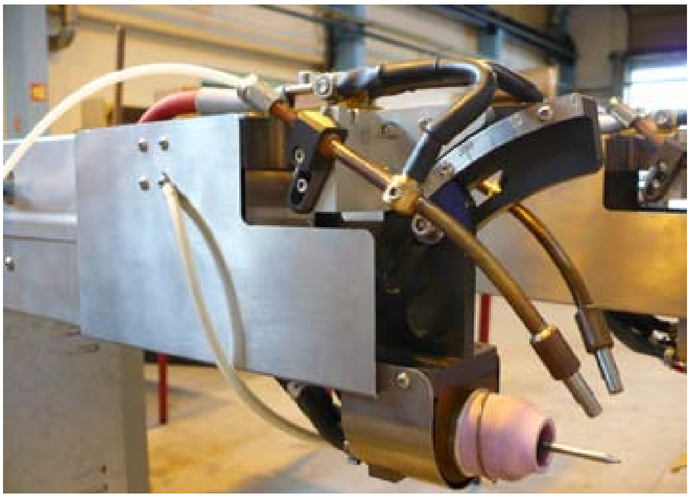
To cover various fields of application, differently designed torches are available.

For the best choice of a torch the following criteria should be considered :

- Workpiece dimensions,
- Thermal conditions of the weld (with or without preheating),
- Accessibility of the area to be treated,
- Shape of the workpiece (bottom, cylinder, fillet, ...),
- Welding positions.

A few of the numerous torches with a special design shall be presented:

- Torches with an automatically moving nozzle allow to modify the stick-out of the electrode during a cladding operation of e.g. cranks or sealing grooves, so the weld can be finished without interruption.
- Two torches which are mounted one behind the other on a welding lance, each equipped with two hot wire nozzles, are used to produce inside a tube a layer of two weld passes by only one passage of the lance; this method is extremely economic.
- Torches with integrated sensors avoid the interruption of the weld at the front of the hole and continued as soon as its rear is reached.
- Slim torches are suited for cladding of holes with diameters of less than 50 mm diameter.
- Torches with a motorised device to adjust their setting angle are used to weld continuously specific shapes like internal or external radius.



Welding torches for cladding.

Examples of torches for cladding the inside of holes, straight or inclined models (single or double hot wire feeding), designed for weld current intensities up to 400 A.

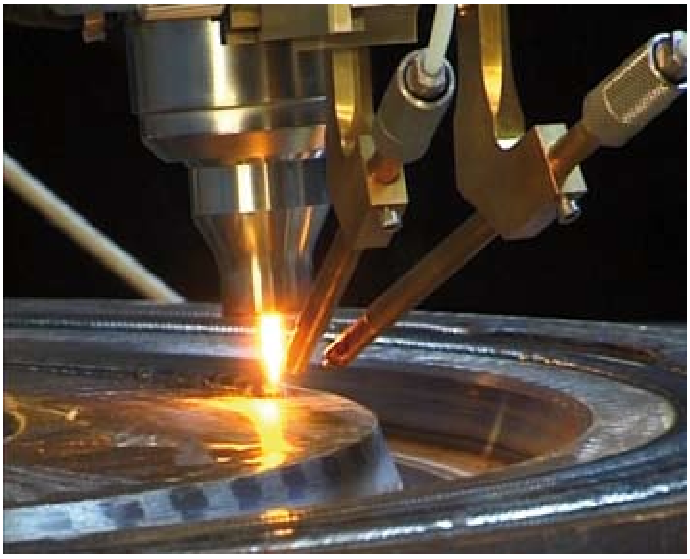
To process workpieces which can be brought into a suitable welding position the equipment can be completed by additional turntables, column and boom devices and roller blocks.

Unlimited number of rotations and move combinations between collector welding head ad the column & boom enabling cladding operations of unusual geometries.

Classic applications for cladding operations are the weld overlay of tank bottoms (in flat position) and coating of the inside or outside of vertically positioned cylindrical workpieces.

Special equipment has been developed for the weld overlay of the inside of long tubes (8 m to 12 m length) with diameters above 220 mm.

Two torches, each with a double hot wire nozzle, are mounted one behind the other on the lance. The lance itself slides on the ropes, before the start of the welding sequence it is moved to the rear end of the tube.



TIG 500 welding torch with double hot wire feeding and motorized electrode stick-out adjustment, allowing continuously welding with programmed stick-out depending on the actual depth of the weld gap. This configuration guarantees best protection of the deposit against oxidation.

During the cladding operation the lance is pulled through the tube, thus creating the longitudinal movement of the welding tools. Two synchronised hot wire TIG sources control the longitudinal movement of the lance, the rotation of the tube and the intrinsic displacement of the torches, i.e. Arc Voltage Control and oscillation.

In most cases of those kinds of tubes to be coated with nickel based alloys on the inside; a total layer thickness of 5 mm is usually requested.

Cladding operations become more complicated if due to its weight, dimensions or geometry (boreholes in large workpieces or not axially symmetrical zones) the workpiece cannot be moved.

As this kind of problem occurs frequently, Polysoude offers a product line where the welding head can be rotated without twisting the associated supply cables. The welding heads are equipped with collectors, a technique which has been originally developed for certain orbital welding applications.

In extreme cases if complex parts of the workpiece must be coated, the collector welding heads themselves can be mounted on slides and moved longitudinally or laterally.

The superposition of the endless rotation of a collector welding head with the motions of associated slides increases the flexibility of the equipment substantially and opens access to a multitude of cladding applications.

Polysoude supports those industries interested in this process and offers or develops cladding equipment which meets and often exceeds the demands of the respective customer.

In so doing over the course of time a diverse range of standard equipment and special installations for various cladding purposes has been created.

Whenever major focus is put on the quality of produced weld overlay coatings, the first choice would be the easy to automate TIG hot wire cladding process.

The TIG cladding process being in current competition with other high-performance welding methods, in all cases of complex workpieces, difficult environmental conditions or the general demand for flexible to use equipment it should be thoroughly examined whether its application offers technical and economical advantages.

Welding samples :

Authors:

Jean-Pierre Barthoux, EWE, Head of Technological Dept. POLYSOUDE, Nantes

Jürgen Krüger / ALFALANG Technical essays and translations,

Lippstadt/Germany

More information required? Please contact us:

POLYSOUDE S.A.S.

2, rue Paul Beaupère

(F) 44300 Nantes

Tel.: + 33 (0) 2 40 68 11 00

Fax: + 33 (0) 2 40 68 11 88

Mail: info@polysoude.com

Web: www.polysoude.com