Press Release

POLYSOUDE
THE ART OF WELDING

TIG welding and TIG^{er} technology – sophisticated techniques for economic welding and cladding of customised CRA line pipe

TIG/GTAW welding and TIG^{er} weld overlay cladding of components for corrosion resistant pipelines, a guarantee for Zero-Defects manufacturing and sustainable safe operations

1 Introduction

Modern oil and gas pipelines are especially assembled for the oil and gas market manufactured line pipe and further components like flanges, fittings, branch pieces (Tees) etc. To absorb the induced mechanical stresses, most of these parts consist of high strength low alloy steel (HSLA). If increased corrosion resistance is required, the interior can be reinforced by a CRA coating. CRA stands for Corrosion Resistant Alloy, this group of materials consists of austenitic and martensitic stainless steels as well as nickel-base and titanium-base alloys.

In case of CRA line pipe, two different types are distinguished: the product is referred to as CRA lined steel pipe if the outer host and the inner CRA segment are joined together by a mechanical bond. This kind of pipe is manufactured by industrial mass production. In case of a clad pipe, the connection between host and CRA is established by a metallurgical bond.

Applicable on standard steel pipes, internal CRA cladding can advantageously be carried out by overlay welding. The horizontally positioned pipes are rotated around their longitudinal axis, the torches with the attached wire feeding devices are mounted at the end of a welding lance and guided along the inner wall. POLYSOUDE SAS France have recently developed a bi-cathode TIG/GTAW cladding process named TIG^{er} that stands out for its particularly smooth surface of the corrosion resistant layer, low dilution rates and reliable metallurgical bonding between deposit and substrate, and contributes to noticeably enhanced productivity. Based on two separate current supplied tungsten electrodes, which are situated next to each other in a specially designed welding torch, resulting in a combined arc that offers unique features with high deposition rates of CRA alloys without any losses in quality.

For CRA cladding of shorter pipes with lengths up to 2 metres as well as flanges or valves and similar rotation-symmetric workpieces the advantages of the TIG^{er} technology can be exploited as well. To enable fast pre-positioning, the torch is mounted on a column and boom device; fine-positioning and moving in the direction of the different axes is carried out by means of particular slides. The workpiece itself is fixed to a turning gear, a turntable or a positioner. The movement of the torch and the rotation of the workpiece must occur in exact synchronisation with the progress of the weld cycle, the control of the whole process is entirely embedded into the power source.

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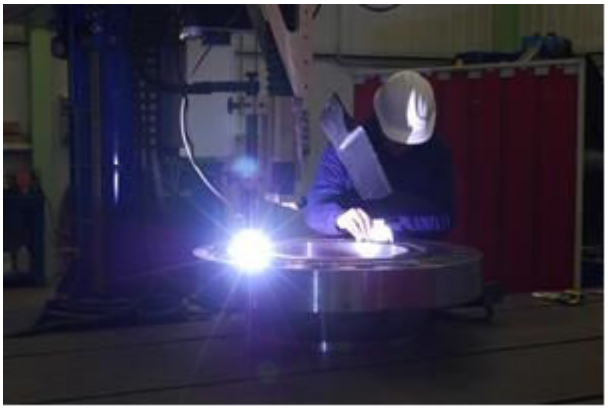
Standard steel pipes are delivered in lengths of 6 or 12 metres. To minimize butt welding operations on site several tubes are often directly joined together on site, the obtained segments are shipped with lengths of 12 or even 24 metres. The connection of flanges, valves etc. is also carried out as far as possible during prefabrication. The design of the joints must guarantee an uninterrupted CRA layer at the inner wall, the characteristics of the deposit, especially its corrosion resistance, are not at all to be compromised by welding operations.

2 Manufacturing of customised CRA clad pipe

Based on their essential experience, professional expertise and adequate equipment the Spanish company Nuevas Tecnologías de Soldadura S.L.U. (NEWTESOL) manufactures customised CRA clad pipe with different types of welding connectors, flanges and other components.

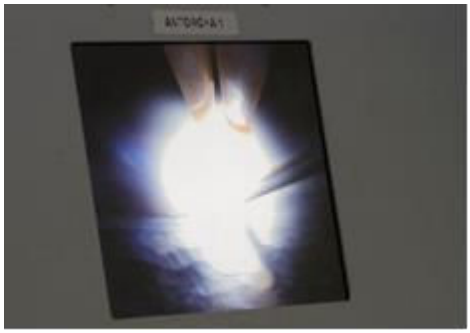
The company's area of activity covers the whole bundle of tasks from the acceptance of an order to the packaging and shipping of the finished parts. To decide, whether a project is inside the scope, the customer requirement specifications have to be analysed and compared to the available resources: personnel, equipment (machinery /tools), experience, capacities etc. Once the order is placed, the technical details of the production have to be decided and the related fabrication drawings and work instructions must be issued. At the same time, accurate purchase specifications have to be prepared: the provision of primary products and appropriate welding material must be ensured. The necessary auxiliary operations have to be planned and organized as well: welding qualification procedures with destructive and non-destructive testing, approval and issue of Welding Process Specifications (WPS), final tests, painting, packaging, marking and shipping of the goods.



2.1 Preparation: weld overlay cladding

The 16” line pipe API 5L X60 PSL2 is purchased as a standard product on the market from a supplier qualified by the customer. After having passed successfully the incoming goods inspection it is released for processing.

The line pipe with a wall thickness of 12.7 mm is made of carbon steel and agreed for “Sour Service”. Additional protection against corrosion and wear is achieved by an internal INC 625 coating. This coating with a total thickness of 3 mm is composed of two layers, realised by weld overlay cladding with Polysoude’s TIG^{er} technology. During the welding qualification procedure the cladding process samples have been taken, including a cross-section of the base material underneath the coating and the deposit of the two CRA layers. The results of chemical analyses at a distance of 2 mm from the base material, i.e. in the second layer, have shown clearly that the Fe content of the exterior layer of the coating remains far below the specified limit. After further testing, as required by ASME or upon specific request of the customer, e.g. bend tests, dye penetrant examinations, hardness measurements and corrosion resistance determinations has been passed without objection, the final WPS can be issued. All welding operations must be preceded by a Positive Material Identification (PMI) or Filler Material Conformity Test (FMCT).



To compensate longitudinal shrinkage caused by the cladding operation the pipes are cut with an over-length of 2%. A supplementary add-on at each side of the pipe is designated to allow the final end preparation of the groove for subsequent butt-welding. The necessary clean surface at the interior of the pipes is achieved by a sandblasting operation immediately before the cladding process.

The equipment for weld overlay cladding is designed for pipe lengths from 6 up to 12 metres. The pipe has to be positioned horizontally on non-motor-powered supports, it is clamped by the chucks of a height-adjustable hollow-shaft positioner (the device is settable for 5” to 39” pipes). A welding lance with 2 in a row mounted bi-cathode torches is then guided through the pipe until the torches arrive at its opposite end. The weld cycle begins with the ignition of the first torch, the welding lance is pulled out at a controlled speed while the positioner rotates the pipe synchronously. As result of the combined movements a first layer of CRA is deposited at the inside of the pipe.

The second torch, which is mounted on the welding lance at a certain distance to the first one, starts cladding of the superposed second layer when it arrives at the begin of the already deposited first layer.

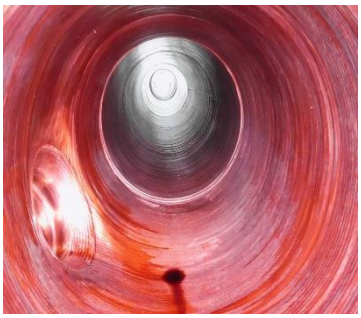
The functional construction with the two torches arranged one behind the other allows to deposit the two layers of the coating during just one single pass of the welding lance. The TIG^{er} technology guarantees accurate quality of the deposit with excellent bond between coating and base material. Still boosted by the hot wire welding technology, welding speeds between 700 and 900 mm/min and deposition rates of 3 to 3,5 kg/h per torch can be reached, which means a total deposit of 7 kg/h

Flanges are purchased as forged parts. For cladding, they are clamped on a turntable, which generates the rotation of the workpiece, whereas the movement of the bi-cathode torch comes from a column and boom device. The TIG^{er} technology in combination with hot wire feeding allows fast welding speeds and enhanced deposition rates.

The sealing face of a flange has to be build up by a circular weld. The offset can be continuous or performed in step-over mode after each revolution of the workpiece. In every case, to get a regular deposition at a constant linear welding speed, the rotational speed must be increased in line with the reduction of the rotation diameter. A precise control of the rotational speed is offered by a special feature of the implemented software, thus an unproblematic programming of an adequate welding cycle becomes possible.

Cladding of connecting tubes and pipes can be carried out with a positioner and a column and boom device, the TIG[er] technology is applicable on horizontally or upright positioned cylindrical workpieces.

To ensure sufficient thickness of the coatings electromagnetic test methods are applied from the clad side, the unaffected integrity of the second layer is determined by a 100 % dye penetrant test.



2.2 Realisation: butt welding operations

Welding of flanges to connecting tubes or pipes can be carried out as well using the turntable and the column and boom device. Suitable for hot wire TIG welding is a J-preparation of the parts, where the collars consist of the clad coating. As filler material ERNiCrMo-3 (DIN W. No. 2.4856) is used, the selected high quality wire is delivered with low Fe content and a residue-free surface, leading to limited ferrite in the weld, better feeding characteristics at high speed and, during production, less or no interruptions for maintenance. The filler metal is also qualified for welding of joints between dissimilar materials.

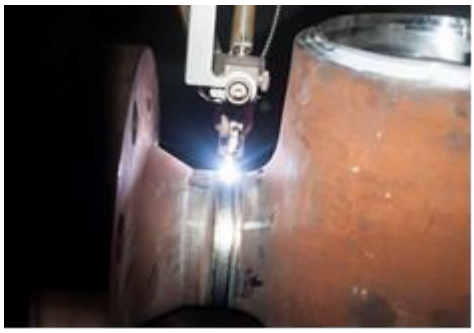
Particular attention has to be paid to the preparation of the workpieces. As mechanised welding reacts quite sensitive to thickness differences of the collar, the bevelling must not exceed the specified tolerances and the weld joints have to be perfectly aligned at the inside. Gaps between the collars cause perforation and are not allowed at all.

Cleanliness is another imperative prerequisite to obtain quality welds. The machined extremities of the workpieces have to be deburred, afterwards any remaining oil, grease or other contaminants, e.g. contaminants from dye penetrant tests, must be removed accurately with a compatible solvent.

To avoid oxidation or heat tinting at the inside of the weld and the heat affected zone (HAZ), during welding of the root pass and the following two filler passes the interior of the workpieces must be flooded with backing gas. The oxygen content of the argon flow is constantly monitored, welding operations can begin if values of less than 10 ppm O2 are attained.

The welding parameters, as specified in the WPS, are programmed and stored in the command unit of the power source. The torch with the tungsten electrode has to be positioned in the welding groove by means of a remote control pendant, afterwards the welding cycle can begin. The welding operation itself is carried out automatically, all necessary functions and movements are initiated and monitored by the control unit. Arc Voltage Control (AVC) is used to keep the distance between the workpiece and the tungsten electrode constant, thus the root pass, the filler passes and the cap pass can be welded without interruption. Torch oscillation generates a cyclic movement perpendicular to the welding direction, allowing to alter the width of the welding seam as required by the specifications.

Radiographic Testing (RT) and hydrostatic tests are applied to finalize the quality controls, painting and packaging of the workpieces are carried out as required by the customer.



3 Conclusion

Mechanised TIG welding and cladding with the TIG^{er} technology are powerful workshop facilities if customised CRA line pipe shall be produced. After a period of thoroughly planning, careful purchase of primary products and welding materials, making available experienced and trained personnel, approval and issue of Welding Process Specifications the sophisticated welding equipment guarantees joints and coatings which meet the strictest specifications and quality requirements. The service life of pipelines extends over decades and, as experience shows, little or any maintenance is provided during this time. The use of CRA clad pipe is an economic way to enable sustainable safe operation of oil and gas pipelines.

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Images:
Courtesy of Newtesol