Altering Perceptions: TIG welding in the Oil and Gas industry

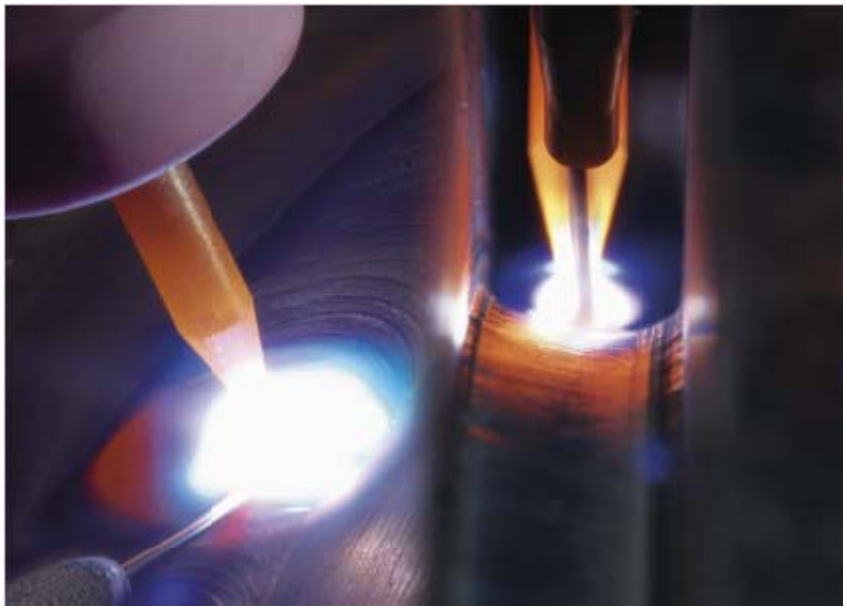


Fig.1: TIG welding

From Concept to Reality:

Gas tungsten arc welding (GTAW) commonly known as, tungsten inert gas welding (TIG), has always been considered to be a particularly complicated joining process. The necessary equipment was expensive and subject to significant investments, shielding gas of the required purity was difficult to obtain and, above all, only specially trained individuals with specific skills were able to complete the complex procedures.

Now, after decades of development and progress, Polysoude has mastered this aspect of the market and with technological dexterity is producing innovative, customer-focused solutions for both mechanised and automated TIG welding.

Problem-Solving:

In responding to the ambitious demands of the oil and gas industries, Polysoude has stepped into the world of increased productivity. A world, in which forward-thinking, excellent quality, competitive prices and the shortest of deadlines, can transform solutions into physical reality.

The field of offshore applications can be particularly problematic. The flow lines and export lines used to transport crude or processed oil or gas fluids, are subject to tremendously adverse forces, both external and internal. During the laying process, water pressure, strong currents and extremes of temperature must be contended with, whilst internally, piping can suffer from chemical attacks caused by aggressive production fluids. Polysoude has the power to weld pipelines capable of withstanding severe mechanical stress, absorbing high dynamic loads and providing corrosion resistance.

Polysoude S.A.S.
ZI du Bois Briand
2 rue Paul Beaupère - F - 44300 NANTES
Tél. : + 33(0)2 40 68 11 00 - Fax : + 33(0)2 40 68 11 88
www.polysoude.com - E-mail : info@polysoude.com
Société par actions simplifiée, au capital de 4 105 452 Euro,
R.C.S. Nantes B 858 800 931
TVA N° : FR 64858800931 - a member of Global Welding Technologies AG

Predictable precision:

Pipes can be welded manually, or by means of mechanised or automated welding. If no equipment for automated welding is available, the root pass and the hot pass can be produced by manual TIG welding with a filler material in the form of rods. However, the welding of the root pass is extremely delicate, deviations from the acceptable heat input can crucially alter the corrosion resistance of the pipe material. Hence, there are definite disadvantages to manual welding: the dependence on the skills and performance of the welders, a lack of sustained reproducibility, limited quality control and low productivity.

Polysoude can create the seemingly impossible, by purely technological means. Using mechanised or automated TIG welding equipment, any desired quantity of welds can be produced, with each individual joint exceeding the requirements of the strictest production objectives - the 'Zero Risk/Zero Defects' approach. No longer dependent on the skills of the staff entrusted with the operation of equipment, results are excellent, sustainable and furthermore, quality is predetermined.

Polysoude's mechanised or automated TIG welding ensures that the procedure and all related parameters are optimised and approved separately in advance. Results are finally documented as welding instructions and the related programs are implemented into the machines in the workshop or on site. Manual welding skills are no longer required as proficient operators take over by running the automated TIG welding equipment.

Customised solutions:

Polysoude's expertise in fulfilling the requirements of individual customers was evident in the Shah Deniz 2 Project. A contractor needed to weld a number of 16in. CRA line pipes, flanges and bends. The carrier pipes with a wall thickness of 41.9 mm were made of API 5L X65 with a 3.0 mm internal ERNICrMo-3 clad. In the workshop, the 12 m length pipes had to be joined into 24 m sections. The company decided, as is usually the case for onshore girth welds, to use a manual TIG welding of the root and hot pass in the 5G Up position and Submerged Arc Welding (SMAW) for the filler passes. However, during approval they discovered that the filler welds did not comply with the technical requirements. Problems were caused at the start and stop zone of a welding pass, as well as lack of fusion and related repair work. Furthermore, the important heat input of the SMAW prevented the welds from reaching certain weld metal properties, such as toughness and yield strength.

Polysoude was able to offer the perfect solution and facilitated the change to automated hot wire TIG welding of the filler passes. A Hot Wire GTAW station (pipe rotating 1G) was ordered. As the pipe ends were already machined for manual welding with a 30° V-preparation, root and hot passes continued to be produced by manual TIG welding.

In the process of automated TIG welding, the filler passes are laid with the pipes in the 1G position. Adjustable supports allow fast and exact positioning and aligning of the CRA pipes, rotation of the pipes is ensured by a head stock, and the welding set is fixed in an optimised position at the end of a boom.

Fig.2: Welding set on a boom end

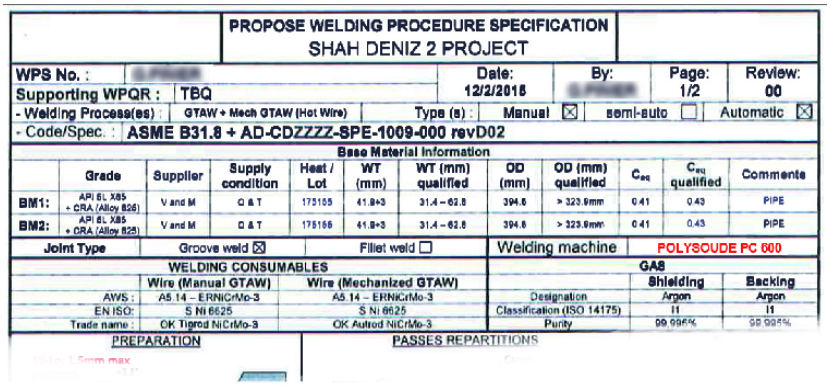
At the beginning of a weld cycle, before the ignition of the arc, the torch can be moved smoothly towards the workpiece. When the electrode touches the base of the groove preparation, it is retracted

until the programmed distance to the workpiece is reached.

The related device is called Arc Voltage Control (AVC). Once the arc is struck, it is used to keep the arc length constant, so that multipass-welding can be carried out without the need for further adjustments between passes.

Another useful and innovative feature of the installation is called Torch Oscillation Control (OSC), which allows the torch to move transversally to the direction of welding. The desired width of a welding pass is achieved by programmed periodical movements of the torch to both sides of the groove.

Fig.3: Oscillated passes appearance



PROPOSE WELDING PROCEDURE SPECIFICATION
SHAH DENIZ 2 PROJECT

WPS No. :	[redacted]						Date: 12/2/2018	By: [redacted]	Page: 1/2	Review: 00	
Supporting WPQR :	TBQ										
- Welding Process(es) :	GTAW + Mech GTAW (Hot Wire)				Type (s) :	Manual ☒	semi-auto ☐	Automatic ☒			
- Code/Spec. :	ASME B31.8 + AD-CDZZZZ-SPE-1009-000 revD02										

Base Material Information

	Grade	Supplier	Supply condition	Heat / Lot	WT (mm)	WT (mm) qualified	OD (mm)	OD (mm) qualified	C_{eq}	C_{eq} qualified	Comments
BM1:	API 5L X65 + CRA (Alloy 825)	V and M	Q & T	175155	41.8+3	31.4 – 62.8	394.8	> 323.9mm	0.41	0.43	PIPE
BM2:	API 5L X65 + CRA (Alloy 825)	V and M	Q & T	175156	41.8+3	31.4 – 62.8	394.8	> 323.9mm	0.41	0.43	PIPE

Joint Type	Groove weld ☒	Fillet weld ☐	Welding machine	POLYSOUDE PC 600

WELDING CONSUMABLES			GAS		
	Wire (Manual GTAW)	Wire (Mechanized GTAW)		Shielding	Backing
AWS :	A5.14 – ERNiCrMo-3	A5.14 – ERNiCrMo-3	Designation	Argon	Argon
EN ISO:	S Ni 6625	S Ni 6625	Classification (ISO 14175)	I1	I1
Trade name :	OK Tigrod NiCrMo-3	OK Autrod NiCrMo-3	Purity	99.995%	99.995%

PREPARATION

PASSES REPARTITIONS

Fig.4: WPS

The filler wire comes from a spool ingeniously fitted inside the motorised wire feeder; this particular innovative arrangement means that wire feeding can be started or stopped at any moment and, if necessary, the wire end can be retracted. Wire feeding speeds and pulsed wire feeding are programmed and managed by the power source.

Before mechanised or automated TIG welding takes place, the particular procedure is developed and approved. All functions and movements of the installation are initiated and controlled by the power source and programming is carried out by using the touchpad, which has an easy-to-understand, intuitive graphical user interface (GUI). The virtual synoptic of the GUI is presented on a tactile screen. It not only allows for complete weld data management, but also offers numerous auxiliary functions to support the development and finish of any TIG welding sequence. Some of the main features are:

Fig.5: Polysoude Power Source P6-HW

- A complete documentation of the workpiece data.
- The creation of chained weld cycles to carry out a complete multi-pass welding sequence.
- A detailed description of non-programmable parameters (i.e. mechanical adjustments of the devices, type and characteristics of used gases, electrodes, filler wire etc.) appended by instructions and comments.
- A data base with a search function to deal with more than 8 parameters at the same time.

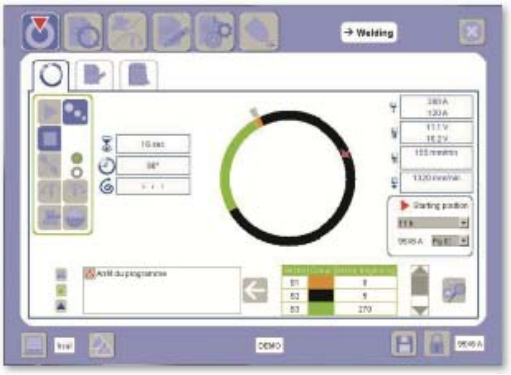


Fig.6: Intuitive graphic user interface GUI

- Simulation of a programmed welding cycle and real-time monitoring of welding parameters and progress of the sequence in process.

Finalised and approved customer-specific welding sequences and instructions can be stored and transferred to the designated welding equipment by means of a PC or a USB flash drive.

Before a welding sequence of mechanised or automated TIG welding can begin, the operator must ensure that the workpieces are correctly positioned. However, after the welding cycle has started, the equipment is completely controlled and monitored by the uniquely designed power source. Unlike GMAW processes, TIG welds do not require any machining or grinding operations either at their start or end, or between the passes. Perfect precision is attained time after time.

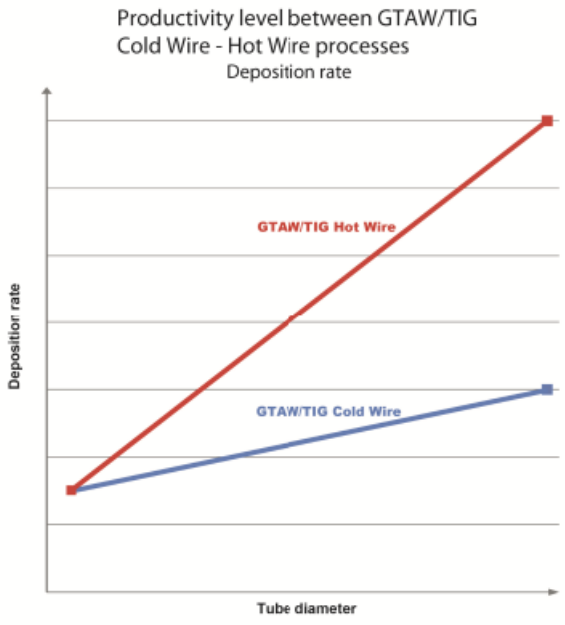


Fig.7: Hot wire process for increased productivity

The melting rates of cold wire TIG welding are quite moderate when compared with competing processes. The filler wire entering the weld pool is cold, and the energy to melt it is delivered entirely by the electric arc. As a result, the melting rate is slower, which consequently affects the weld speed. Hot wire TIG welding, on the other hand, substantially increases both the melting rate and welding speed. The hot wire current is supplied by an additional, separate power source and transferred to the wire via a contact nozzle in the wire guide. The wire is heated by electrical resistance within the wire nozzle, on entering the weld pool, so that less energy is necessary for its final melting. As shown in Fig. 5, hot wire application allows the welding time of carbon steel pipes to be reduced to less than half the time needed when using the cold wire process. Moreover, significantly the hot wire TIG process does not reduce the achievable quality of the welds in any way.

In the Shah Deniz 2 project, by using automated hot wire TIG welding equipment, the time needed for filling and capping of a girth weld of the 16in. line pipe was 7hr 30min. The resulting sound, defect free joint brought about an immense increase in productivity, as time-consuming repair work was no longer necessary and the controlled heat input of the process guaranteed that the required mechanical properties of the welds were achieved, without additional attention.

Finally, due to the use of Polysoude equipment, the project has been finished within the intended time, furthermore it is clear that in future projects, the technical possibilities of the automated TIG welding equipment will be fully employed: volume-reducing J-preparation or even narrow groove welding will be introduced, so that root pass and hot pass can also be produced by automated TIG welding.

Further proof of the proficiency of Polysoude's state of the art welding technology, has come from an experienced contractor of the Khazzan project in Oman, where a different approach has been adopted. The company needed to execute approximately 19,000 welds on 12in. and 16in. 22% Duplex Stainless Steel pipes. From the beginning, it was the intention to utilise the advantages of automated TIG welding to its limits. J-preparation for orbital GTAW of root and hot pass of the 12in. pipes and orbital GTAW for the cap pass ensured increased productivity. As an additional measure for the 16in. pipes, a narrow groove preparation was executed. All welds were executed successfully within the scheduled period of time.

Narrow groove preparation of pipe ends is an efficient option, to improve overall productivity of the joining operations of line pipes. The mechanical characteristics of the pipe material and behaviour in terms of welding shrinkage are considered in order to determine the slim profile of the weld groove (the angle of the weld groove is kept as small as possible). This preparation of the pipe ends requires the removal of less material, so that machining becomes easier and faster. As less material is removed, less material is required to be replaced by the weld: welding time becomes shorter, and filler material consumption decreases.

Fig.8: Macrographic section of a narrow groove TIG weld

An example of a macrographic section of a joint between CRA coated workpieces shows the perfect geometry of the narrow groove TIG weld. Line pipes are usually produced in length of 6 or 12 m and often welded together to 12 or 24 m long sections. As the pipes can be rotated during this procedure, automated welding equipment, as shown, can be used. However, during the laying of a pipeline, either from a barge or as landline, the pipes cannot be rotated. In these cases orbital welding equipment is required.

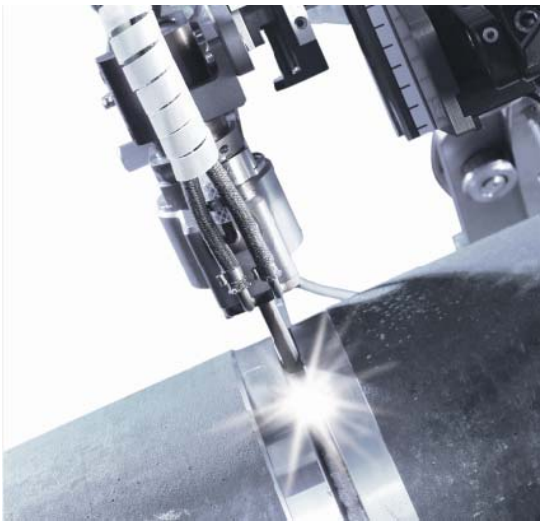
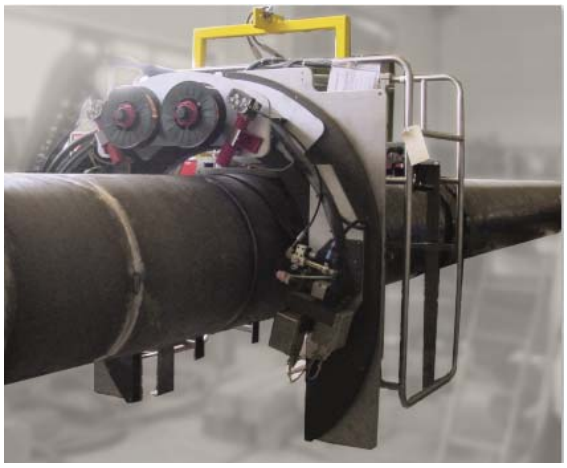


Fig.9: Welding torch for narrow groove joint



or pipe ODs of up to 20in. dia. (510 mm), Polysoude's open orbital "hot wire" welding heads, such as the type MU 510 HW might be the perfect tool of choice. When fitting a certain range of different pipe diameters, the welding head is clamped onto the pipe, thereby enabling a choice of the full gamut of state of the art features, including: AVC and OSC, 2 integrated wire feeders, clutch for quick rewinding, hot wire welding etc.

Fig.10: Hot-Wire (HW) automatic welding head

If the line pipe OD exceeds 20in, then Polysoude's impressive open carriage welding heads, of the POLYCAR type are perfect for the job. A guide ring fitting the particular OD is mounted on the pipe allowing the POLYCAR to move precisely and safely around. The modular design of the POLYCAR allows for both cold and hot wire TIG welding, whilst the rugged construction resists difficult conditions in the workshop or even on site.

Fig.11: Orbital carriage-type welding head

Polysoude technology - embracing the future!

Polysoude mechanised and automated welding equipment represents modern industrial technology, incorporating future design ideas.

It is a fact that the TIG welding technology offers astounding results in industrial application, with unrivalled joint quality.

It is a fact that Polysoude is able to offer a range of different options to increase the productivity of the process.

It is also a fact that industries may be less familiar with the new, avant-guarde Polysoude technological processes, than with the traditional competing process of Gas Metal Arc Welding (GMAW), a process, coincidentally, with which Polysoude equipment has reached comparable results in quality and weld cycle time.

Ultimately, however, it is a fact that the use of mechanised and automated TIG welding, is a serious incentive to industries striving for a 'Zero Risk/Zero Defects' approach in joining technology.

It is time to look to the future and to accept the possibilities which Polysoude equipment has to offer!