

Mechanised pipeline welding in the Saudi desert

Magnatech orbital welding system and ESAB cored wire do the job.

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In 2006, Nacap-Suedrohrbau Saudi Arabia Ltd. (Nacap-SRB), a subsidiary of Dutch international contractor Nacap BV, was granted a Euro 70 mio contract by Saudi Aramco, the state-owned national oil company of Saudi Arabia, for the engineering, procurement and construction of the Khurais Sea Water Injection & Distribution Headers Project. This included the construction of 507 km of 8 inch to 36 inch non sour and sour sea water transfer lines and headers. For 16 inch pipes and above, (Nacap-SRB) applies automatic uphill welding for filling, relying on Magnatech's Pipeliner II orbital welding system and ESAB's PZ6113 all-position rutile cored wire.



The Khurais field is an existing field with an output of some 300,000 barrels per day. It is located in the area of Khurais, halfway along the motorway between Dammam and Riyadh in the middle of the "red dunes" desert. It is envisaged that water injection will boost production to 1.2 million barrels per day. The seawater is supplied from the Arabian Gulf, and is then distributed throughout the Khurais field. The project is scheduled for completion in October 2008.

Welding in the desert

In principle, welding in the Saudi desert is not

very different from cross-country pipeline \ construction anywhere else. It follows the same pipeline laying principles; pipe stringing, bending, positioning, welding, NDT, and cleaning and coating – the front-end speed being the decisive factor. One of the complicating factors to overcome, however, is often the remoteness and the associated logistical problems in the supply of nourishment and technical services to the front-end teams. Another, very obvious problem is the tough working conditions. During summer, temperatures reach 40 degrees and upwards, requiring the utmost from the welding and supply

Table 1. Pipeline filling options

Manual welding	Mechanised welding	Mechanised welding
SMAW/GMAW	Downhill short circuit GMAW	FCAW uphill
Advantage	Advantage	Advantage
Standard bevel	Fast, more welds per day J-bevel minimises fill time	Tolerant process Standard bevels Low defect rate Less passes to fill joint
Disadvantage	Disadvantage	Disadvantage
Slower Variable quality	High defect rate Special bevel More passes to fill joint	Requires interpass brushing Higher weld volume Slower than downhill short circuit GMAW, due to higher weld volume
	Short circuit process poorly controlled High speed is difficult to control for welders	

teams, in order to maintain the laying speed of a pipeline. In this respect, mechanised welding helps considerably, as it reduces the physical effort required to weld an often pre-heated pipeline.

Mechanised welding - Aramco requirement

For various reasons, Saudi Aramco stipulates the use of mechanised welding equipment on its pipelines – the most important being that they are in a great hurry to boost oil and gas production, making them demand short time frames for their projects. Mechanised welding makes the planning more predictable, and, since it is less strenuous for the welders, leads to better weld quality. Also, manual pipeline welders, hired mainly from Asian countries, are not as plentiful as in the past. Mechanised welding requires less welders and simplifies the associated logistical organisation. A last reason is the increasing use of X70 quality pipeline steel and higher, requiring low-hydrogen welding consumables and therefore excluding the use of cellulosic downhill electrodes.

The Magnatech Pipeliner II

Aramco's requirement for mechanised welding applies to the filling of the joint – the root pass may be done manually, semi-automatic or mechanised. The Magnatech solution for filling, used by Nacap-SRB and brought on the Saudi market by Pangulf Welding Solutions, is based on uphill welding with flux-cored wires (FCAW). For

the Khurais project, it is applied on pipe diameters of 16 to 36 inch in X65 and X70 grade steel, accounting for 331 km of pipeline. The root pass is performed by semi-automatic, controlled downhill welding with the STT process (modified short circuit transfer mode). The Magnatech solution can, however, equally be used in combination with downhill or uphill MMA for the root pass.

Table 1 gives an overview of solutions available for the filling of pipeline joints, along with their individual advantages and disadvantages. The characteristics listed for FCAW are valid for all-positional rutile cored wires, such as ESAB's FILARC PZ6113 (AWS A5.20: E71T-1 H4/E71T-1M H8) It has a fast solidifying slag system that supports the fluid weld metal well and allows the placement of thicker beads, so less passes, but at a high deposition rate. The wire always operates in the spray arc mode, making it a tolerant process with a low weld defect rate.

Figure 1 reviews the Magnatech Pipeliner II. It is easy to understand and operate, light-weight equipment that is easily mounted and dismantled. The head is removed from the guide ring in seconds with a push button switch using the gas bottle pressure. The patented guide ring is not to be seen as a consumable, because it does not wear out, and is tolerant for weld spatter and grinding debris. The Positive Drive System guarantees a uniform rotation speed. The 300A water-cooled torch can be programmed in three independent ways; travel speed, weaving width and endpoint dwell. A remote control allows cross weld steering and vertical adjustment, as well as the facility to override the programmed weaving width and travel speed.

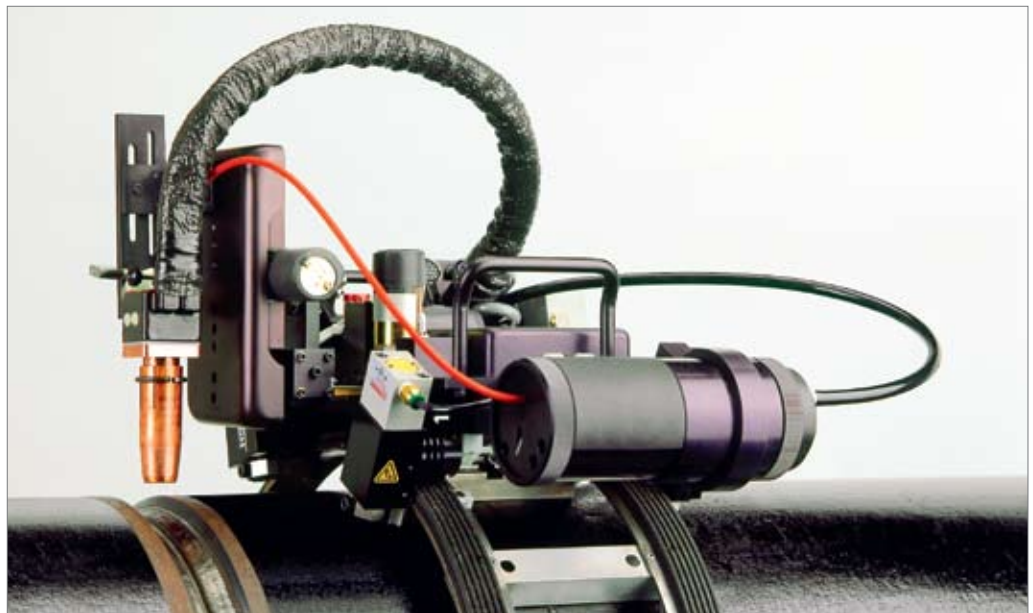


Figure 1. Magnatech's Pipeliner II orbital welding system.



Figure 2. STT root pass welding

The Pipeliner II can be used on pipes from 6 inch up to 36 inch diameter and above, simply by changing the guide ring - an advantage relative to downhill mechanised equipment which starts at approximately 30 inches. Another advantage is that its use becomes economical with significantly shorter pipeline lengths. Moreover, pipeline contractors will own the equipment and not have to rent it.

The Pipeliner II forms the heart of a complete welding system with a digital power source with synergic programmes for FCAW, a floor standing wire feeder for 16 kg spools (less spool changes compared with common head-mounted 5 kg spools), a programming unit with memory positions for four individual beads, a gas mixing unit and a power generator. All can be mounted on a truck or tractor for transport along the pipeline, together with the welding heads, while the guide ring is the only component remaining on the pipe. It is easily removed, by hand.

Back to the desert

Figure 2 shows the semi-automatic STT root pass welding of a 36 inch diameter, 28 mm WT pipeline for the Khurais Sea Water Injection & Distribution Headers Project. It is welded by two

motion, while changing from standing, to squatting, to sitting, until they lie under the pipeline. When hands meet, one of the welders grinds away his end crater while the other finishes the weld. These are the operators that determine the front-end laying speed of the pipeline. No time to be lost. When ready, they immediately move to the next weld. The internal clamp is removed directly after the root pass. They make about 30 root passes a day, in a 12 hour shift.

From here, mechanised uphill FCAW with the Pipeliner II takes over, accounting for almost the full weld volume. There are two operators depositing only the hot pass and filler pass (Figure 3) with two Pipeliners walking the guide ring, from 6 to 12 o'clock. The total hot pass and first fill team comprises not only two welders, but also a number of helpers and the truck driver. The hot pass is deposited at a high travel speed (19.5 inch/min) to avoid burning through the root pass, and the first filler pass at 10 inch minimum.

welders simultaneously, from 6 to 12 o'clock – clockwise and counter clockwise. They are 'true artists', able to continue welding with a weaving

Six additional teams are individually responsible for filling the joints left behind by the hot pass and

Figure 3. Welding of a hot pass. The welder supervises the process and, when needed, fine-tunes the parameters with the remote control. For the first filler pass, the Pipeliner is transported back to 6 o'clock and the second set of pre-programmed parameters is chosen.





Figure 4. Typical weld appearance of a mechanised welded joint.

filling team, to a total of 10 layers. Split beads (two) start after 4 layers and weaving is applied following the the hot pass. All passes are performed at the same current of about 200-240 A at a wire feed speed of 7.5-10 inch/min. The cored wire diameter is 1.2 mm and the shielding gas is Ar/20% CO₂.

Productivity

Mechanised uphill welding with the Magnatech Pipeliner II and FILARC PZ6113 rutile cored wire is very productive. Nacap-SRB takes full benefit from the high deposition rate of 3-4 kg/h at 250 A, by achieving a duty cycle of 80%, due to clever organisation of the filling procedure.

Equally important, it is a very secure technique. Uphill welding with PZ6113 in the spray arc mode, at a relatively high welding current, is a very tolerant method for filling when compared to mechanised downhill short circuit welding. The latter method is faster due to a reduced weld volume, but is based on a more expensive J-preparation, and one must expect comparatively high defect rates and associated repair work. Moreover, Aramco would additionally require 100% ultrasound testing, which is costly and, often, difficult to organise in remote areas. Using the uphill technique, Nacap-SRB has recorded their weld defect rate to be consistently below 0.5%, measured by common X-Ray testing - prescribed by Aramco to be 100% for the first 40 joints and 10% thereafter.

Magnatech

Magnatech International BV is the sales and service organisation for Magnatech Limited Partnership, East Granby, USA, for Europe, Middle East and Africa. Magnatech Limited is the manufacturer of specialised equipment for Orbital Pipe and Tube welding, using the GTAW, FCAW and GMAW welding process. Magnatech International BV is located in Dronten, The Netherlands. It supplies innovative systems to both manufacturers and contractors, who

require precision welding tools for tasks from simple fusion welding to multipass applications requiring wire feed, torch oscillation and arc voltage control.



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Nacap - a global player

Nacap-Suedrohrbau Saudi Arabia Ltd. is a subsidiary of Dutch international contractor Nacap BV, with headquarters in Eelde, The Netherlands. Nacap is a global managing contractor, asset manager and preferred supplier specialised in underground infrastructures, providing multidisciplinary solutions for transporting oil, gas, water, electricity and data.

Pangulf Welding Solutions

Pangulf Welding Solutions is part of the Pangulf Group, the principal steel products supplier to the Saudi Arabian market and listed in the top 100 Saudi companies. It is a "one-stop" welding solutions supplier with competent and experienced personnel. It stocks an extensive product range of consumables and equipment of world class brands such as ESAB and Magnatech. Pangulf's services to the industry include consultation and training.