ALL TIME'S ADVANCED TANK WELDING IN MAJOR MIDDLE EAST PROJECT

All Time's automatic vertical tank welder provided more productive and efficient welding for a large tank project

> **HONG KONG** company All Time, which has a production facility in Shanghai, China, has 20 years of experience in manufacturing specialist tank welding equipment. Its expertise was recently called upon by a major Middle Eastern engineering company, which had been awarded the engineering, procurement and construction (EPC) contract to deliver a network of 95 crude oil storage tanks for a leading oil company.

Each of the tanks is 110 m in diameter and 22 m in height, and has a storage capacity of 200,000 m^3. With only a year to complete this project, welding is a fundamental facet of the construction due to the sheer size and number of the tanks.

The storage tanks for the project are designed to be fabricated in nine courses with a shell thickness of 42.3 mm, 41.3 mm, 30.1 mm, 26.4 mm, 21.3 mm, 20.9 mm, 12.4 mm, 11.1 mm, and 10 mm from the bottom to the top, as internal pressure from the tank contents is progressively reduced upward, and so the weight of the shell. Each section is 2.4 m high, it was decided that fully automatic welding equipment should be implemented for all joints of the shells from the outset.

It is important to note that while the process of building tanks with an automated welding process is not new, advancements in the implementation has resulted in increased productivity and quality to be discussed in the following sections.

TANK VERTICAL JOINT WELDING

The electrogas welding process (EGW) is often used for welding vertical joints of high capacity flat-bottom storage tanks for maximum productivity. It is similar to continuous casting as the weld is produced between two water-cooled copper shoes, which progresses up the joint with the molten weld pool to hold it in place until it has solidified. Oxidation of the weld pool is prevented by the flux of self-shielded wire (EGW-SS) or a combination of the flux and shielding gas (EGW-GS).

The joints welded with this process are traditionally square edge butt welds. Plates should be fitted up so the copper shoes can prevent slag spillage between the plate and the shoes.

AUTOMATION AND INNOVATION

Compared to the use of a conventional flux-cored arc welding (FCAW) process, which takes more than five hours and requires multiple weld passes, EGW permits the welding of all vertical joints in one pass up to a shell thickness of 32 mm, taking only 1.2 hours to weld a 2.4 m vertical joint. This represents an improvement in productivity of over 400%. However, the high productivity process is traditionally limited for shell thickness over 12.7 mm due to the difficulty to control and monitor the weld puddle with heavy slag at high travel speed. In addition, there is a concern for weld metal properties and distortion caused by the extra heat input due to the large weld volume. These limitations mean the vertical joints of the top three courses out of the total nine courses with thicknesses ranged from 10–12.4mm would need to be welded by the less productive processes unless more advanced welding procedures can be implemented.

The EPC company evaluated a recently developed technique, based on the narrow gap EGW joint design with lower weld volume and smaller CO_2 shielded wire, that is easier to operate, with less slag and heat input. This is proven to improve the ease of operation for EGW process on thinner shell thickness as little as 9 mm, with the additional benefits of improved weld metal properties. This advanced EGW process can be referred as the narrow gap electrogas welding process (NG EGW), which also comes with the options for self-shielded wire (NG EGW-SS) for better fusion and gas shielded wire (NG EGW-GS) for lower heat input and ease of operation.

After a series of trials and evaluations, the EPC company concluded the most effective solution is to adopt the NG EGW process with 2.4 mm self-shielded wire for the first six courses of the tanks with shell thicknesses up to 42.3 mm, then switch to NG EGW-GS with 1.6 mm CO_2 shielded wire for the last three courses with shell thickness as little as 10 mm.

Once the implementation for a combination of narrow joint, self-shielded, and gas-shielded wires was decided, the focus of the project was shifted to the equipment that offers the required capability.

AUTOMATIC VERTICAL WELDER FOR EGW

The demand for multiple EGW processes was long considered by All Time based on their experience in the design and manufacturing of vertical welders for international contractors with different backgrounds and requirements. As a result, via its manufacturing programme for continuous improvements, All Time developed the latest version of its vertical

tank welder, with multi-process capability, and a quick switch over function from one process to another, e.g. between EGW-SS and EGW-GS, for welding storage tanks in different sizes and operational environments.

The All Time EGW Vertical Welder is made up of five key components:

1. Weatherproof work platform with motorised lateral travel between joints
2. Motorised vertical welding carriage with electric magnetic rail for quick alignment and weld travel
3. Variable speed operator lifts for safety and operator monitoring
4. Close loop arc current control (ACC) to maintain a fixed wire extension relative to the weld puddle
5. Standard constant voltage (CV) welding power supply and automatic wire feeder

There are two key features of the All Time vertical welder, the first is its fully enclosed work platform design that creates an indoor welding environment that makes gas shielded welding feasible for site erection. The second is the continuous close-loop ACC with a calibration module, which can switch the arc current to travel speed in relation to EGW-SS on thick plates and to EGW-GS for thinner plates by a dip switch.

Since the start of the project, a total of 31 sets of All Time vertical welders had been set up on three different tank sites.

JOINT DETAILS

The variation in joint volume has a critical impact on the EGW process in terms of operation, productivity and weld metal properties. After trials, two types of narrow gap joints for NG EGW-SS and NG EGW-GS processes have been adopted, the double V joint (Figure 3), and the single V joint (Figure 4).

OSCILLATION

For conventional EGW, the electrode is held in a fixed position in the centre of the joint without oscillation. Such a technique requires a large diameter wire (e.g. 3 mm) and a wider joint with high weld volume to achieve sufficient fusion with adequate build-up on both sides of the joint. Conversely, the narrow gap EGW process uses smaller wires and an oscillation system to achieve full joint fusion.

When the shell thickness exceeds 20 mm, oscillation is required to ensure sidewall fusion. The equipment has a mechanical oscillator built for this purpose. Control of oscillation amplitude, speed, and dwell times need to be preset before welding commences.

Optimum oscillation is a key factor to improve weld metal properties in high heat input EGW welds. Oscillation amplitudes and position, in conjunction with the groove profile of the copper shoes, are proven to have a significant impact on the front and backside of the weld profiles.

The oscillation speed or frequency also has a significant influence on the weld metal grant structure due to the stirring effect.

EGW CONSUMABLES

Consumables for EGW-SS and EGW-GS are commonly classified as AGW EG72T-1 or EG70T-2 under American Welding Society standard AWS 5.26. The EPC company selected EGW consumables from Lincoln Electric and Kobelco as they are two of the most proven manufacturers for the welding materials of the process.

SITE TRAINING

Onsite there were challenges related to the shortage of qualified welders, which could not be solved by automatic welding alone. This challenge was further reinforced by the adoption of the NG EGW SS and NG EGW GS processes, where welders are required to possess tailored knowledge and understanding of the advanced welding process and parameters.

The EPC company and Automatic Welding Consultant (AWC), the local service agent of All Time, responded by introducing training onsite. AWC employs six engineers and technicians and dispatched them in three teams of two to support the training.

CONCLUSION

All parties who participated in the shell erection welding of the Strategy Tanks Project recognise the importance of investing in innovation, development and training. With this recognition in mind, we are thus enabling more productive and efficient methods of welding and construction in hopes to deliver an end result with a higher value.

For more information:

This article was written by All Time Mechanical & Electrical Equipment Co. Ltd. To learn more, email info@alltimewelding.com
All Time Mechanical & Electrical Equipment Co. Ltd. To learn more, email jason@allfitwelding.com

www.alltimewelding.com

01 Electrogas welding of the storage tank with automatic vertical welder

02 Vertical welder interior with electrogas welding carriage, arc current control, and operator lift

03 Double V joint on shell thickness over 30mm

04 Single V joint for shell thickness under 30mm