

Welding with a digital root penetration technology

Welding by means of an advanced penetration technology

Ko Buijs, Van Leeuwen Stainless, The Netherlands

In November 2005, this journal contained an article on 'the root penetration side: an area that is often forgotten', in which the introduction of an advanced digital welding technology was discussed. The advanced aspect referred mainly to the automatic penetration control which guarantees controlled welding penetration at all times. The inside (root side) of the weld is an often forgotten area and it is this area in particular that usually matters. This applies especially to the circular seam welds of pipes; incomplete root penetration and a pockmarked appearance will cause corrosion and contamination during usage. This type of incomplete root penetration can also lead to mechanical attenuation.

The perfect root penetration guaranteed by APC (Automatic Penetration Control) results in a perfectly smooth root penetration that provides a basis for optimum corrosion resistance and cleanability. In recent years, the development of this welding technology has continued steadily, leading to impressive results. This article will present the latest collection of data to further convince welding companies of the particular benefits offered by this remarkable digital welding process.

In these times of economic revival, the need for automated systems on all fronts is particularly desirable, if not necessary. This need is further intensified by a shortage of trained employees and specialists. Much has happened in terms of automation within the welding industry, but as far as the quality of the root penetration side is concerned there are still considerable limitations in practice. This is why test welds are still required to be performed beforehand in order to achieve the correct welding parameters. It goes without saying that this is a time-consuming and costly process. The question is also whether the settings obtained from test welds are repre-

sentative for all welded joints during welding work. This is why there is a great need in practice for automatic and controlled root penetration. The APC offers the ultimate answer. The entire concept can be summarised under the notion of ServoTIG welding (SGTAW).

How does it work?

ServoTIG welding (SGTAW) combines the TIG welding process (GTAW) with a root penetration sensor (S) and automatic weld log production in Weldvision. In other words, this is a TIG welding process that performs its own checks. The root penetration sensor enables the melting bath vibrations (i.e. melting



Picture 1: The ModularTIG orbital welding machine is a modular system. With this particular configuration, one person can produce four welded joints simultaneously and independently from one another.

bath oscillations) to be measured, so that this data can be used to control the required energy during the melting bath phase; this achieves a perfectly controllable root penetration. The root penetration sensor operates on the basis of measured melting bath oscillations. As a relationship exists between the melting bath frequency and the level of root penetration, the ServoTIG determines the time of root penetration itself. In other words, it is an intelligent root penetration sensor. Diagram 1 illustrates this relationship as simply as possible. The ServoTIG uses the APC (Automatic Penetration Control) function to determine the time of root penetration

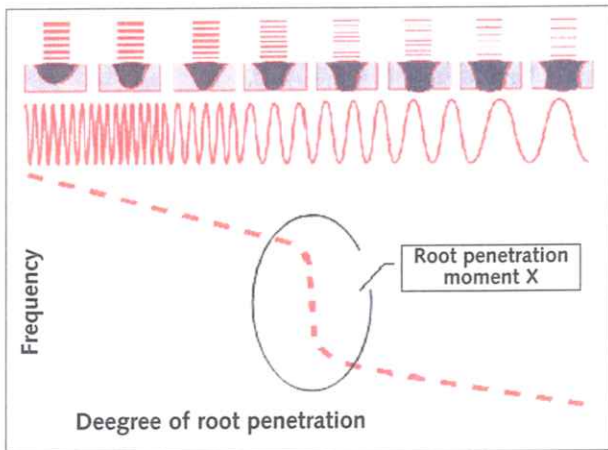


Diagram 1: Graphical representation of the moment of root penetration.

X. The root penetration sensor thus controls the entire orbital weld based on moment X.

Unique welding method

This welding method and the added value it provides is unique for the piping market. A welding procedure qualification (WPQR) for mechanised welding processes (produced on a specific machine) is normally not transferable to another machine. However, with this root penetration technology, all qualifications based on ServoTIG welding are simply interchangeable between all ModularTIG installations from Dynamicc Welding. This company and all its contractors are already qualified in accordance with NEN EN15614-1/EN 1418 and ASME IX for all accepted AISI 300 series austenitic stainless steel types. Several qualifications are to follow.

Weld Cruise Control (WCC)

In spite of automatic penetration control, it may sometimes be desirable to meet certain customer requirements, such as a specific surface condition or a more convex weld, for instance. Furthermore, in the case of metals that are more difficult to weld, it is not always easy to determine the desired welding result automatically. Take certain nickel alloys and cunifer, for example. This is why WCC has been introduced. Of course, the basic principle remains that the welded joint will also be inspected for root penetration with WCC. With the aid of WCC (Weld Cruise Control), a skilled welder can also determine the time of root penetration X on

the basis of his own experience, if required. The specialist will feel 'flattered' by this as he will not be made to feel redundant. Furthermore, his expertise can be used in welding work even if he is absent from work for a day or specific period.

However, when using WCC, the welder will have to produce a test weld to a limited extent. The fact remains that a welded joint created with APC is always of superior quality.

The machine operates with closed and open heads. Up to a wall thickness of 3.5 mm stainless steel, welders can work without wire feed if desired, which means that a closed head can be used. In Picture 3, you can see the perfection of the root penetration and the smoothness of its surface. To avoid too much repetition here regarding the technological aspects, please refer to the article concerned that was published in 2005 if you would like more detailed information.

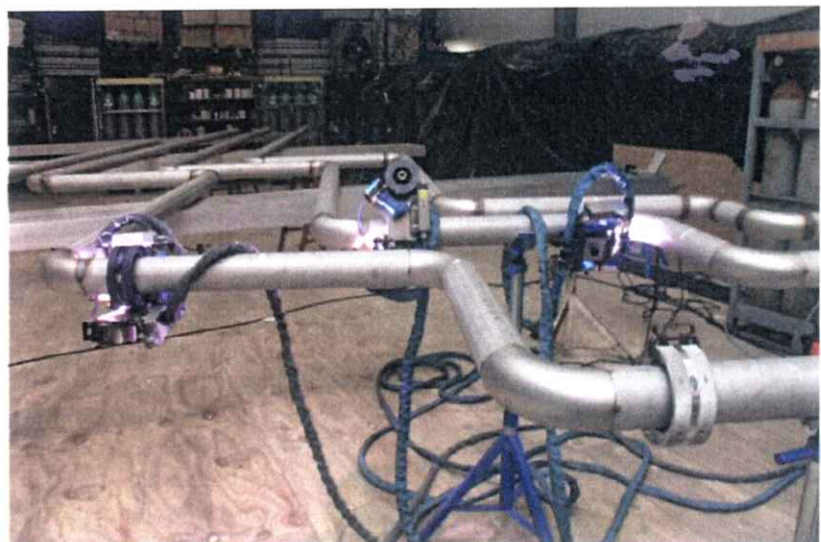
Investment

It also goes without saying that this type of machine is not a cheap investment, though, in most cases, the rate of return will justify its pur-

chase. You can in any case assume that cheaper machine operators will be required instead of highly trained and skilled workers, thus allowing you to make considerable savings in wages. Furthermore, use of this digital welding machine will allow you to attain 50 to 500% of the output that was possible up until now. It all depends on the working conditions; welding with additive metal, for example, will require additional visual inspection.

As such an investment is not always easy to make in practice, the franchise concept was introduced to allow mechanical contractors to reap the benefits of this technology on all fronts. In many of these piping companies, conventional 'automatic welders' are only used for a proportion of the welding work. This is due to the high costs involved in achieving a reproducible root penetration. These conventional machines can therefore regularly be seen standing unused in the workshop while several welders are busy welding manually. A stop can be put to this phenomenon with the ModularTIG orbital welding machine in combination with the ServoTIG welding process. The welding duty of the ModularTIG is many times higher than that of conventional welding machines.

This concept enables welding work to be outsourced to skilled welders operating as a franchise of Dynamicc



Picture 2: An unmanned ModularTIG welding machine operating with three open welding heads with cold wire feed. This photo was taken in the prefab workshop of Hamer Installatietechniek b.v.



Picture 3. A smooth and perfect root penetration can be seen on the transition between the pipe and the collar. This photo was taken at Hamer Installatietechniek immediately after welding without post-treatment.

Main points	Manual welding	Conventional orbital welding Automatic welders	Orbital welding with the ServoTIG welding process + APC/WCC
Root penetration guarantee	No	No	100%
Welding duty	Approx. 25% excluding root penetration check.	Low ($\pm 25\%$) in connection with checks regarding root penetration uncertainty and test welds.	High, 80% to 320%. Including guaranteed registered root penetrations.
Time and material wastage searching for root penetration.	No, not if a specialist is used.	Yes, after a minimum of 5 to 6 test welds. However, there is still no penetration guarantee.	No, as all welds are production welds; there is therefore no wastage of time or material.
Production of one to ten welds.	Yes, if a specialist carries this out. The cost per hour is high though.	No, this is particularly cost-ineffective due to test procedure to find penetration.	Yes, very cost-effective. No wastage of time or material.
Weldclock with welding progress visible during welding.	No	No	Yes
Documented penetrations with listing and diagram.	No	No	Yes
High purity work for pharmacy, semiconductor, etc.	No	Yes, only with 100% inspection, continuous re-programming and a lot of test welding. This results in a high price per weld.	Yes, very efficient. Inspection rate can be substantially reduced. Relatively low price per weld.
Welding duty	Low	Low	High
Sanitary piggable systems (food, dairy)	No	No	Yes
Multi-technology	No	No	Yes, very efficient. One operator performs several weld processes simultaneously.
Personnel	Costly specialists.	Trained orbital specialists.	Operator. Relatively cheap.
Tolerances and high-low	Yes, thanks to expensive specialists.	Difficult to do; therefore preference for expensive manual welding.	Yes, automatic control. Tolerances and high-low easy to do in accordance with ASME and AWS. Low price per weld.
Cost of weld inspection	High	Three or more times the control cost of a manual weld.	Considerably lower than the control cost of a manual weld.
Reproducibility	No	No	Yes, can automatically perform thousands of sanitary root penetrations based on a single APC reference.
Cost per weld	\$ X	3 to 8 times \$X (or even more).	\$ X or even less.

Welding B.V. without the need for investment. Dynamicc Welding B.V. is the company that developed this root penetration technology. These contractors are well-equipped when they go to the customers (see Picture 5 and www.orbital-contracting.eu). Further in this article you can read a reaction from a user that provides further insight into the remarkable benefits offered by this technology. Firstly, however, a list is given of the specific features of this welding method.

- 100% guaranteed penetration
- Perfect welding quality without test welds
- Good reproducibility
- Real-time controlled heat input based on APC reference
- Digital root penetration information which is unique in itself
- Considerable improvement in corrosion resistance through root penetration technology
- Results in optimum cleanability of piping systems
- Digital weld log book including all root penetration information
- Multi-technology - multiple weld processes can be performed simultaneously
- Advantageous price/performance ratio

It can therefore be concluded that joints welded with a ServoTIG and root penetrations registered in Weldvision can be produced for the price of a manual weld or even less.



Picture 5: Franchisees go to customers well-equipped.

Weldvision

Weldvision automatically logs information on the weld produced. In addition to all the usual weld log data such as weld number, operator, material, welding head and, management information, Weldvision also

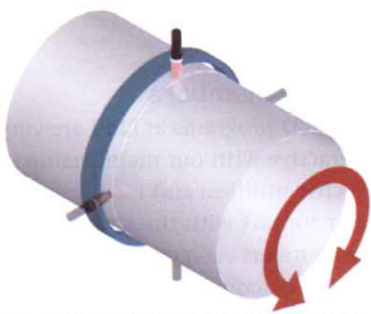


Picture 4: Weldclock, with the progress of four root penetrations and other weld information visible in real-time on the touch screen.

logs all real-time measurements and values relating to the root penetration, including the heat input. Furthermore, it can also include the project name and piping and weld numbers of the isometrics, as well as the ppm values. In itself, this represents significant added value for a company as everything is traceable. Think, in particular, of the Weldvision current view, Weldvision heat input view and Weldvision listing view.

Electrode presetting system

The high welding duty cycle, flexibility and orbital welding of single products and more requires different machine specifications. It must be possible to quickly convert the welding head to a different diameter. For this purpose, an electrode setting system is available which includes software. Whilst the ServoTIG is welding, the electrodes can already be adjusted for other pipe sizes and welding heads. The welder can thus use the valuable time that is made available as the machine performs its task unmanned.



Picture 7: Graphic representation of time-saving multi-linking.

A case study

Hamer Installatietechnik b.v. in the Netherlands is a well-established installation company that is building a major piping project in Rotterdam for Brenntag. Brenntag is a distributor and exporter of chemicals and raw materials. Their respective websites can be found at www.brenntag.nl and www.hamer.net. In addition to a favourable price/quality ratio, the customer also required root penetrations with excellent corrosion resistance that are easy to clean. This is why the ServoTIG procedure with APC was chosen. As a large number of welded joints are involved, the multi-technology was chosen to enable the operator to produce three welded joints simultaneously. It also allows multi-linking, which is particularly important with larger diameters or in the production of drums as welding can be started at four places on a circumference simultaneously (see Picture 7). It only takes a quarter of the time to produce a circular seam weld using this method. Another advantage is thermic stability during welding.

For this article, the Technical Director of Hamer Installatietechnik b.v., John Dijkman, sums up his experience of this welding process as follows:

Practical experience has shown that the welding concept with franchisees as used by Dynamicc Welding for Hamer Installatietechnik B.V. works well after an

initial period of familiarisation. All the pre-fab welding work for the Brenntag project has been delivered on time and to the required quality. Even Hamer's certified welders were enthusiastic about the welding procedure used. In addition to providing a consistent quality, it has also helped save time and the work was delivered on schedule. Hamer Installatietechnik B.V. intends using this welding technology for future projects.

Conclusion

The digitalisation of all kinds of processes is a clear phenomenon in the welding industry. In particular, the demands of organisations concerned with the quality of our food such as the FDA and the EHEDG (European Hygienic Equipment Design Group) applaud improvements in the area of sanitary welding. Other sectors also benefit considerably from controlled smooth root penetrations because of the improved corrosion resistance and cleanability. There is also the problem of a shortage of skilled workers, which is further exacerbated by the many projects currently in existence. It can therefore be put forward that orbital welding with a penetration sensor provides an ultimate answer to all demands and requirements associated with this. An added bonus is that this advanced method of welding offers an advantageous cost price. If you would like further information, please contact the author of this article at nwbuijs@hetnet.nl

About the author



Ko Buijs is a recognized metallurgical / corrosion specialist on stainless steels as well as special metals. He works for

Van Leeuwen Stainless. In addition, Mr Buijs is a lecturer for various organisations such as steel associations, technical high schools and innovation centres. He has published over 100 papers in a number of technical magazines. In close co-operation with Barsukoff Software Mr Buijs has developed the computer programme Corrosion Wizard 2.0. Info www.corrosionwizard.com