

About Orbital Welding

1. Definition

The term Orbital-Welding is based on the Latin word ORBIS = circle. This has been adopted primarily by aerospace and used in terms of Orbit (n.) or Orbital (adj.) for the trajectory of a man-made or natural satellite or around a celestial body.

The combination Orbital and Welding specifies a process by which an arc travels circumferentially around a work piece (usually a tube or pipe).

The concept Orbital Welding is basically a loosely defined term that is usually used for processed only, where the arc is travels at least 360 degrees around the work piece without interruption.

Consequently, processes, which interrupt the full 360-weld sequence such as for better puddle control (often used for MIG/MAG welding, using the down-hand welding sequence in 2 half-circles), can not truly be called orbital welding.

2. Possibilities and Limitations

From welding terminology Orbital-Welding belongs to the category semi-mechanized (TIG-) welding.

Because of the need for good control of the weld puddle, the Orbital-Welding process is only practiced with the TIG process and relevant rules like selection of gases, cleanness, weldability of specific materials and consequential mechanical strength specifications such as tensile and bend loading, are very important.

Orbital-welding is presently used whenever the quality of the weld joint has the highest priority. These demands are not only limited to mechanical strength and X-ray qualification, but also to the important aspects of the aesthetics of the weld seam. For any users a uniform, flat and smooth root-pass is the main reason for using this process.

Consequently, it is favored in the following areas:

- * Chemical Industry
- * Pharmaceutical Industry
- * Bio-Technology
- * High-purity Water Systems
- * Semiconductor Industry
- * Aircraft- and Aerospace Industry

Moreover, because of the weld joint's uniform outside shape and almost complete absence of need for any post-polishing, Orbital-welding is even used for bends on door-handles, hand-guards, or in dead foot-elements for champagne-glasses!

Interested applicants for this technology should certainly note that they have to confirm a couple of indispensable premises.

The following presents the basic rules for this process, valid for all manufacturers and systems.

Even knowing that some competitors are announcing features, which would potentially violate the basic physical laws of nature and knowledge, moreover, making promises and statements which are at least detected as impossible to meet when the welding system must work under high duty-cycle production conditions.

Based upon our own experience and from long-standing users' confirmed experiences, the quality of an orbital weld seam is to at least 50% related to the joint preparation dictating careful attention to minimizing tolerance stack-up in the weld-joint preparation.

Indiscriminate and exactly defined dimensions with tolerances must be thorough and complete. The process can compensate for some single out-of-tolerance situations, but the sum of several out-of-tolerance situations can result in unacceptable welding results.

The much liked standpoint, that the welded tubes and pipes are in accordance to DIN or ASME standards are not acceptable criteria. These qualifications only define tolerances in percentage to the wall thickness relating to pressure loading and not to weldability using the Orbital-Welding-Process.

For the Orbital-Welding-Process absolute tolerance values are necessary, and furthermore, the more complicated the application, the tighter the tolerances must be. This means, that for an easy application like welding a stainless steel tube of 53 x 1,5 mm, a tolerance in alignment of about 0,5 mm (about 30% of the wall thickness) can be compensated, but for much more critical applications like welding a carbon-steel pipe of 114,3 x 3,6 mm, the same percentage can result in

unacceptable weld quality.

Therefore, the question of acceptable tolerances should be researched and defined for each application individually.

That Orbital-Welding can be used successful and economically is proven by the constantly increasing number of users.

Field experience has shown that Orbital-welding can be justified based upon economic reasons alone, where the welds can be done in squared-butt no-gap preparation utilizing a single pass. With advanced digital welding systems this is possible up to a wall-thickness of 4 mm, and with welding systems with lower performance capabilities (limited levels, no pulse-synchronized cold-wire-feeding), up to 3 mm.

Joint preparation is simple but requires high quality with an exact 90° angle to the tube/pipe axis; a high quality saw cut is usually enough. Of course, the joints should be deburred and cleaned out of corrosion, oil, tinder, etc. With appropriate quality-demands, this should be even obvious for manual welds!

The tube joints will be then fit together without any visible gap. This can be done with small autogenous tack-welds or with internal or external clamping fixtures.

For larger wall-thickness it is necessary to bevel the weld-joints, far as possible in a U-shape. Since a very precise and uniform root pass is important, a weld joint prepared with an. I.D. related and fixed bevelling-machine. Manual grinding or the use of bevelling saw blades is not precise enough for repeatable welding results.

Because an Orbital-Welding job usually requires a lot in time and money, the Orbital-multi-pass-welding is not used very often and only where it is strictly recommended on quality reasons. A good qualified manual welder will, in most cases, be faster than an Orbital-welding-system. Additionally, an Orbital-system for multi-pass welds will be much more expensive and even more complicated than a system without this option.

In regards to the question about the tolerances, you will be asked for the "Field-Qualification" of the system. The answer could be actually given very easily with the regard to the high number of field-used systems. But the true concern is based upon deeper aspects, namely, in the answer to the question: Are the in the field-working personnel able and ready to accept, beyond any doubt, the diligence necessary to provide specified higher requirements in care and accuracy?

Even this question can't be globally answered from the SUPPLIER, but has to be answered on a case-by-case basis individually from the USER!

Sometimes the almost philosophical question comes up whether a specific application can be solved from the supplier X with filler-wire or supplier Y without filler-wire.

The obvious answer can only be, that this is NEVER a question of design and manufacture of the Orbital-Welding system, but only related to the specification and therefore on the requirements for the quality of the weld.

Visual inspections of the weld-seam clone can never be sufficient as the sole criterion. Other quality controls, such as, corrosion, consistency, mechanical strength must also be considered.

Also, allowed tolerances in contents of alloys on specific materials, such as sulphur content, can result in significantly different welding results, even when the material code is the same.

Usually, you can expect that stainless steel materials up to 3 mm wall-thickness can be done without filler-wire. For higher wall-thickness applications, you have to decide on a case-by-case basis. In some eventualities even carbon steel can be done without filler-material, although it's even recommended on the thinner wall-thickness to use filler-wire in any way.