Orbital Welding 101

Automatic orbital Gas Tungsten Arc Welding (GTAW) is utilized in a variety of industries in which maximum leak integrity, high performance, or ultra cleanliness is of paramount importance. Automatic orbital welding provides enhanced precision and reliability compared to manual techniques, giving operators the ability to make controlled, repeatable, high-quality, and well-documented welds.

Small, portable inverter power supplies, advanced control systems and other advancements have made orbital welding systems practical for a range of applications. The systems provide precise control of variables such as weld current, electrode speed, and shield and purge gas flow to produce consistent and repeatable weld results. With easy-to-use touch-screen operation for data input and programming, the power supplies help to enhance operator efficiency and accuracy.

Open Platform Design

Orbital welding power supplies incorporate a wide variety of welders' skills into the welding system itself to enable efficiencies in automation, programming, and documentation. To achieve these efficiencies, a power supply must utilize an open platform that interfaces with standard devices. It also must have the ability to expand as technology evolves.

Automation. Automated welding power supplies manage aspects of the welding process that welders would historically handle manually. The systems control various settings, such as travel speed, arc gap, current control, and gas flow, via electronic and mechanical means. Doing so minimizes many of the variables in the welding process that can lead to errors or defects and enables welders to focus most of their attention on overseeing the process and completing welds. The result is a more streamlined process that enhances productivity, weld consistency, and quality.

Programming. Every orbital weld requires the creation of a program, which controls the output characteristics of the welding system. User-friendly systems simplify programming by providing step-by-step procedures to create programs for a variety of tube diameters, wall thicknesses, and base materials. Rather than building programs manually, the operator can create a program by selecting data from “pick lists” or dropdown menus. The system then creates the initial program, which can significantly reduce the chance for human error and reduce start-up time. This is also helpful when welding materials that are unfamiliar to the user.
Orbital Welding 101

Newer orbital welding systems offer numerous preset programs and enhanced user interfaces for programming ease. Models with integral USB ports enable operators to plug in a keyboard, mouse, and/or a bar code scanner for easier data entry. Operators may download welding programs or update operating system software via a USB flash drive. Durable, integrated color touchscreens also help with programming ease.

Documentation. In some industries, documentation of the weld is important for quality assurance and control. Traditionally, the documentation process is costly and time consuming, requiring operators to maintain detailed, written weld logs that must be entered into databases and formatted into reports. Documentation can easily account for 30 percent of a project’s total construction labor hours when performed manually. However, today’s orbital welding systems enable data to be stored automatically within the power supply for retrieval and simple transfer to databases. To ensure accurate data collection, some power supplies highlight required data fields and do not permit welding to start until operators fill them in. Data management can help an organization track trends, review production rates, and calculate costs per weld to improve efficiency, reduce costs, and enhance bidding accuracy.

Automated electronic data collection can also help operators improve their chances of passing in-process inspections. Passing these inspections is critical, as a failure can lead to costly rework, project delays, and system downtime. Depending on the project, inspectors may review weld log data, examine welds visually, or conduct non-destructive tests on welds. Searchable electronic records help inspectors locate data faster compared to leafing through hard copy weld logs. An inspector can quickly find information about a weld, as well as any welds performed during the same time period or under similar parameters, in the database.

High-speed thermal printers built into newer orbital welders also help with documentation, enabling users to print a hard copy reference of weld details. Operators may need to “coupon in” by creating a schedule, completing a weld, performing a destructive test to examine the weld, and documenting these actions by printing a coupon. At specified intervals, the operator will perform similar actions to “coupon out.” Coupon printouts provide a record of verification to meet quality control requirements. In addition, coupon data becomes part of the searchable electronic weld log for a project.

Weld Repeatability, Consistency and Efficiency

The automated orbital welding process aids in achieving weld repeatability and consistency over extended periods of time. With manual welding, human fatigue can become a factor. Although the operator may be highly skilled and experienced, he may produce inconsistent results because he literally is completing each weld by hand.
Orbital Welding 101

With orbital welding, the process is highly controlled, ensuring that operators can consistently produce high-quality welds. Housed in the weld head, an electrode rotates in a fixed orbit around the weld joint, ensuring proper joining of components. The orbital welding system automatically starts and completes each weld, stepping from one variable setting to the next at a specific location along the joint or at a predetermined time during the process.

Some power supplies present detailed live weld progress data to help operators better evaluate welds. Graphics show the progression, performance levels, and stop/start for each level of a weld in real-time. If the weld deviates from the selected schedule, the graphic indicates where those variations occurred so the operator can evaluate the weld and make adjustments.

Additional advancements related to shield and purge gas control further help with weld consistency and operator efficiency.

**Gas Control.** Automated orbital welding generally uses the GTAW process, which operates by establishing an arc between a nonconsumable tungsten electrode and the base material that is being welded. Heat produced by the arc melts the base material, and the electrode moves along the joint and progressively melts and joins the adjoining surfaces. The weld site must be protected from atmospheric contamination to ensure a quality weld. A shielding gas, which is fed through the weld head to the outside diameter (OD) of the weld location, protects the electrode, molten weld puddle, and solidifying metal from contamination. Newer power supply designs feature automatic OD shield gas control to the weld head to enable more reliable and efficient welding. Older systems require operators to manually control gas flow using a flowmeter.

Manual adjustments introduce the possibility of human error and reduce operator efficiency if the flowmeter is located far from the welding site. Systems with automatic shield gas control eliminate these variables. Forgoing a flowmeter, an integrated flow controller adjusts gas flow automatically based on the weld program. The controller also prevents users from initiating a weld without gas flow to prevent damage to the weld head or workpiece.

Control of inside diameter (ID) purge gas is also critical to welding reliability and efficiency. Orbital welding requires purge gas to flow through the ID of the components being welded. The pressurized gas keeps the molten weld puddle from intruding into the interior of the components being welded. ID purge gas control is a major variable, as some applications require constant pressure adjustments throughout the welding process. Managing these adjustments manually is very difficult. Orbital welding systems that employ mass flow controllers and external pressure sensors to automatically control ID purge gas make precise adjustments to maintain proper ID pressure at the weld joint, creating smooth, uniform welds.

**Blast Purge.** Additional gas controls enable operators to improve efficiency when long distances exist between the power supply and weld head. A sufficient gas volume must be present at the weld head to start welding. In traditional orbital welding systems, an operator may encounter a long wait for purge gas to reach the weld location. Newer systems utilize a blast purge feature to rapidly fill the lines and then automatically return gas flow to normal levels, allowing operators to start a weld sooner.
Orbital Welding 101

Power Considerations

When choosing an orbital welding power supply, operators should look for systems that enable them to perform welds for a wide range of applications. They should also look for systems that limit electrical interference.

Higher Amp Outputs. Welding larger diameter and heavier-walled tubing and/or piping requires high power output to maintain consistent welds. Newer welding systems offer the power needed to weld the heavier-walled components found in applications like oil and gas, while still enabling welding of smaller diameter, thin-walled tubing for R&D or semiconductor applications.

Electromagnetic Interference. Initializing the welding process requires a high-frequency, high-voltage arc start, which can result in electromagnetic interference (EMI). EMI is an electrical disturbance that may cause interference with computers or other sensitive electronics. Frequent EMI resulting from a welding project could prove to be a nuisance or worse in the case of EMI shutting computers down unexpectedly. Welding systems with low EMI arc start technology limit interference on nearby equipment, allowing for nuisance-free operation.

Portability and Accessibility

Small, lightweight orbital welding systems are a practical option for many industries, including welding contractors. Weld system power supplies can be moved easily from one job site to another. Remote controls and detachable weld heads and fixtures allow joints to be pre-positioned and enable orbital welding to be conducted in hard-to-reach places. The weld head needs just enough clearance to make a full 360-degree orbit around the tubing. With manual welding, an operator typically needs full body access to the weld location, which literally can require the dismantling of walls.

Because a single welding system may be utilized across broader cultures and geographies, some systems let users easily switch between multiple languages. Numerous operators can use the same power supply by adjusting the display to their native language. In addition, some systems feature universal voltage input capabilities to automatically adjust to a country’s voltage input.

While operators can complete the majority of project welds via automated orbital welding, they may also need to perform manual welds. To prevent operators from transporting a separate welding system to the job site, newer power supplies offer a manual mode that enables manual TIG welding with some of the features and benefits of orbital welding. Operators can plug a hand torch accessory into the power supply and review all weld output data, gas controls, and other adjustments on screen, just as they would for automatic welding. This setup enhances weld consistency and quality compared to completely manual welding.

Training

Automated welding does not diminish the requirement for an educated and well-trained workforce. Welders must still possess all the most basic knowledge concerning material composition, metallurgy, purge and shielding gases, power, electrode size, and more. In addition, they must understand how the automated welding system operates and reacts to different inputs.

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