

FCAW ORBITAL PIPE WELDING TECHNOLOGY IMPROVES FAB SHOP PRODUCTIVITY



Norwegian offshore platform, one of several structures to benefit from the use of orbital welding.

Fabricators on both sides of the Atlantic are increasing use of orbital FCAW in several types of applications

BY JOHN G. EMMERSON

Fabricators, like all companies facing increasing competition, are reevaluating and redesigning work flow and plant layout, and implementing new techniques to improve productivity and reduce work-in-process times. Submerged arc welding (SAW) has been widely used for years to produce high-quality mechanized butt joint welds in pipe, but requires workpieces to be rotated under a fixed torch. Submerged arc welding can provide high deposition rates, but requires considerable capital expenditures for turning rolls and positioners, especially if the pipe work consists of larger-diameter pipe, long lengths and heavy assemblies. Spool pieces with complex or asymmetrical configurations

(elbows, for example) often cannot be conveniently rotated without special and time-consuming fixturing. Many assemblies may consist of pipe connections that must be made in position. Traditionally, these welds have been made using manual techniques: shielded metal arc welding (SMAW), gas tungsten arc welding (GTAW) or a combination of processes by skilled welders. With the growing shortage of skilled welders worldwide, fabricators are increasingly evaluating different processes and techniques to compensate for less-skilled welders or to improve the productivity of their skilled work force.

One technique increasingly being used is mechanized orbital flux cored

arc welding (FCAW) — Fig. 1. FCAW might be thought of as the submerged arc process turned inside out. With SAW, a solid wire electrode is simultaneously fed into the weld pool along with powdered flux. Instead of solid wire, FCAW substitutes a metal “tube” or sheath, wrapped around a core of flux. The orbital systems on the market today use additional gas shielding of the weld pool. All-position FCAW wires are formulated with fluxing agents that promote rapid pool solidification, which allow welds to be made in all positions.

In the 1980s, Texas-based Best Equipment provided custom-engineered and fabricated pumping systems — almost exclusively to the oil indus-

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Fig. 1 — Orbital flux cored arc welding machine prepared for use on a pipe section.

try. Pumping systems are used in all phases of the industry, from exploration and drilling, through production, refining and subsequent use in the petrochemical industries.

Modular Pumping Systems

In the early to mid 1980s, after years of seemingly unstoppable growth, the many companies supplying the oil industry faced their first major downturn in decades. Many did not survive.

Faced with the imminent loss of a major portion of their business, Best Equipment management quickly looked for other markets seeking their expertise in pumping systems and identified the growing leisure industry of golf. Golf courses require sophisticated irrigation systems; not only in dry climates, but in areas with adequate, but unpredictable, rainfall. Irrigation requires pumping systems. Initial success in this new venture led to further expansion.

In 1986, Flowtronics International was formed as a division of parent com-

pany Best Equipment to design and manufacture Modular Pumping Systems (MPS™) for a wide range of markets and applications. The Modular Pumping System is a pre-engineered system of pumps, motors, valves, piping, instrumentation and controls integrated into a skid-mounted package. This modular concept allows shipment to customers throughout North America and the world. The systems range from chemical feed systems used both for chemical handling and the accurate injection of chemical dosages into process systems, to snow-making systems for ski resorts, to pumping modules for offshore crude oil production.

Flowtronics operates a 100,000-sq-ft manufacturing facility in Tyler, Tex. Samples of projects in 1998 include snow-making systems to Vail, Beaver Creek, Jackson Hole, Stratton, Sundance and Centre de Mount Blanc (Switzerland); oil production packages for Petromer/Petrobras (Brazil), Apache Petroleum Texaco, Aramco (Saudi Arabia) and Elf Exploration (France); pump

systems for power generation to Waukesha Power; and for the chemical industry, Brown & Root and Daewoo Heavy Industries.

Welding plays an important role both in the basic structural elements of these modular units, as well as the extensive pipework — both pipe to pipe and pipe to fitting. Flowtronics has a staff of welders capable of meeting ASME Section IX and AWS D1.1 standards using a variety of weld processes, including SMAW, GTAW, semiautomatic FCAW and SAW. For spool pieces that can be rotated in rotary fixtures, manual GMAW root passes are followed by SAW fill passes for speed. But, a significant amount of welding must be done "in position" during final assembly.

Combating a Shortage of Welders

Flowtronics once again found itself with a new challenge — improving productivity despite a shortage of skilled welders. Typically, "in-position" welds were made with a GTAW root pass followed by SMAW fill passes. Looking for methods to speed the pipe welding portion of the manufacturing process, company welding personnel investigated various technologies at the 1998 AWS Exposition with their local supplier, Tyler Welding Supply. The decision was made to evaluate mechanized pipe welding. Orbital pipe welding systems on the market today utilize either the GTAW or the GMAW/FCAW process. While the need to maintain or improve quality was a significant factor, the GTAW process was considered too slow. A pipe welding system manufactured by Magnatech was first rented for evaluation, and subsequently purchased.

The Pipeliner II System (Fig. 2) consists of a track-mounted weld head that rotates and manipulates the water-cooled torch (with torch oscillation and torch proximity control). A power source, water cooler and wire feeder complete the system. The wire feeder can be mounted on the rotating head, an advantage for work on site in pipe racks. Another configuration uses a floor-mounted feeder, allowing use of larger spools with resulting lower wire costs. The head is adapted to various sizes of pipe by changing the track or guide ring. Guide rings allow pipe 4 in. (10.16 cm) and larger to be welded. (Long flexible tracks are available for large workpieces, allowing welding of 12 ft [3 m] diameter vessels, for example.) The Pipeliner II is configured to allow use of a variety of commercially available power sources from Lincoln Electric, Miller, Panasonic,



Fig. 2 — The Pipeliner II System from Magnatech.

Table 1 — Typical Operating Parameters Used in Fabrication of Piping Assemblies by Aker Maritime

Material:	X60 Grade, API 5L Standard							
Diameter:	508 mm (20in.)							
Wall thickness:	28.5 mm (1.12in.)							
Pass NR	Diameter	Process	A	V	Polarity	Travel Speed mm/min	Gas L/min	kJ/mm
1	2.5 mm	SMAW	70-80	19-20	DCEN-	40-50	—	1.6-2.4
2	3.2 mm	SMAW	100-130	21-22	DCEN-	115-140	—	0.9-1.5
3-10	1.2 mm	FCAW	200-265	23-25	DCEP	105-135	18-20	2.0-3.8
Gravity Position:	5G							
SMAW Electrode:	E7018G							
FCAW Electrode:	E81T1G							
Preheat/Interpass:	50 °C minimum-250 °C maximum							
Postweld Heat Treatment:	590 °C minimum-620 °C maximum							
Shielding Gas:	80% argon/20%CO ₂							
Pass Sequence:	See sketch							
Charpy Impact Test Temperature:	-46 °C							
Welding Progression All Passes:	180-deg double up							
Bevel Geometry:	25-deg V-bevel							

OTC and Fronius. Flowtronics chose a model incorporating a floor-mounted wire feeder.

The company uses the system for welding carbon steel pipe, primarily in the 6-14 in. (15.24-35.56) Schedule 40 and 80 size range. The wire used is 0.045-in.-diameter E71T-1 all-position flux core, using a shielding gas mix of 75% argon/25%CO₂. The root pass is done manually using semiautomatic GMAW. A standard 37.5-deg bevel angle is machined on pipe ends.

According to Wayne Camille, shop supervisor, "After the learning curve, we made 100 welds without a reject. The Pipeliner System has cut our weld time in half, which would improve if we were welding pipe with a heavier wall than Schedule 80. We estimate that we save 50-60 hours per week." In addition to using the system in an orbital capacity, the weld head is often mounted above the pipe, using a rotary positioner. Although the system uses a process slower than sub-arc, it allows welds to be done when the sub-arc stations are occupied. "The system is more flexible than submerged arc," Camille said.

Aker Maritime Utilizes Orbital Welding

Aker Maritime is a Norwegian fabricator and contractor specializing in the offshore oil and gas industry. One contract for Statoil (the Norwegian gas and oil production company) was for the fabrication and field installation of riser assemblies. Riser are complex assemblies of pipe

of different diameters and materials that connect a subsea well head to a pumping platform. They control the output of the well, as well as transporting the oil/gas to the platform for further processing, storage or transmission to shore via subsea pipelines. A recent contract required welding 36-in. (0.91-m) up to 48-in. (1.22-m) carbon steel pipe with a wall thickness ranging from 1.12 to 1.89 in. (28.5 to 48 mm). Prefabrication in one of Aker's pipe shops was done as much as possible to minimize field welding — Fig. 3. Many butt joints could not be made using SAW, so Aker purchased an orbital FCAW system from Magnatech to reduce weld-out times on the heavy-wall pipe.

All welds were extensively tested to the rigorous standards of DNV (Det Norske Veritas) for marine pipeline applications. The specification required a SMAW root pass, which was made manually. All fill passes were done with the orbital welding system using a double-up technique for 5G (pipe horizontal-weld vertical), or an orbital technique for 2G (pipe vertical-weld horizontal) welds. One requirement of the welds was very high impact strengths at low temperatures (Charpy impact tests were done at -50.8°F [-46°C]). Several years ago, this might not have been achievable, but new flux-cored consumables are now available to meet these extreme requirements.

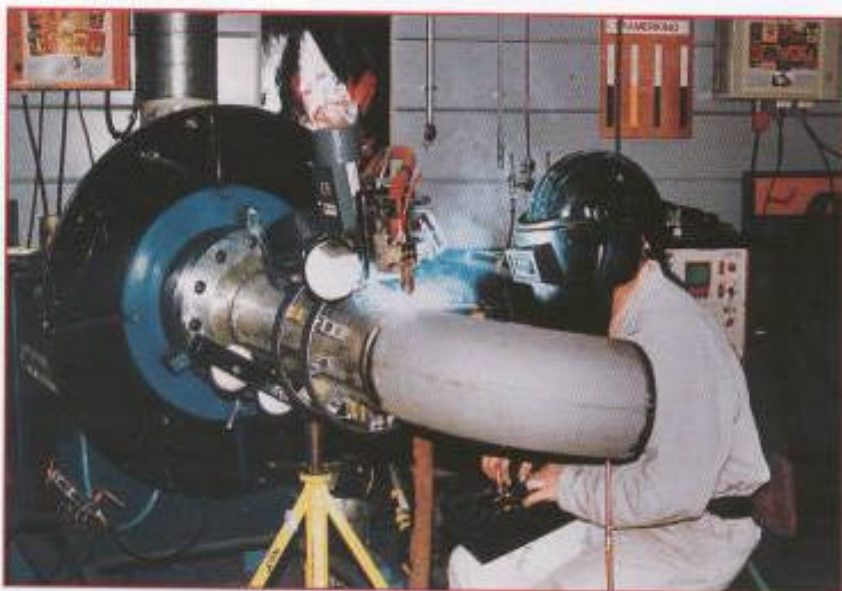


Fig. 3 — Aker Maritime prefabricated in-house to minimize field welding.

Each joint required 57.3 lb (26 kg) of weld metal to be deposited, and were made in 13 h, with an average deposition of 5.5 lb/h (2.5 kg/h). The field installation at the platform was also done by Aker personnel using the orbital pipe welding equipment. A head-mounted wire feeder allowed use of the equipment 50 or 100 ft (15 or 30 m) from the power supplies, which was necessary to access welds on an offshore platform.

Welding an Offshore Platform

Another contract for Statoil required welding pipe 8 to 25 in. (20.32 to 63.50 cm) in diameter for a sour processing plant to be installed on an offshore gas production platform. One of the Duplex stainless steel alloys was chosen for its combination of high yield strength and corrosion resistance to the untreated sour


gas. All of the Duplex and Super Duplex alloys require weld procedures that will maintain low heat input. Failure to maintain defined heat inputs can result in loss of corrosion resistance of the finished welds, which will be rapidly attacked by the corrosive gas. Aker again chose to use mechanized FCAW for its ability to maintain precise control of heat input throughout the weld cycle. (Many fabricators are unaware that even relatively exotic filler materials are now available in smaller-diameter, all-position flux cored wires.) The root pass was done with manual GTAW. Interpass temperatures were limited to 302-347°F (150-175°C). All X-rays were "water-clear." Once again, all welds were tested to DNV standards.

Both Flowtronics and Aker Maritime received operator training at their facilities for a two-day period. Welders at both companies were experienced in semi-automatic FCAW, which greatly simplified instruction because they understood the weld process. However, programming and operation of the orbital welding equipment is simple, so even much less

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experienced welders can become proficient after several days of direct instruction and a week of experience.

Although GMAW was first introduced fifty years ago, many companies experienced weld quality problems earlier in the development of the process, making them reluctant to reevaluate it and related technologies. They frequently are unaware of the huge strides power supply and consumable manufacturers have made in process control. The sophistication of today's power sources compared to those of thirty years ago is similar to the evolution of the computer industry. A power source that, in the past, required an expert to properly set up now incorporates sophisticated process controls that are transparent to the user. Much of this technology is the result of a greater use of welding robots in many industries and the need for a more "forgiving" process. Orbital FCAW today is a viable option because of the efforts of many manufacturers in the welding industry. ♦



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