Mechanized Welding Field Repairs Tubing

If there is one thing a chemical plant possesses in abundance, it is tubes—miles of both small and large diameters made of materials ranging from mundane carbon steel to highly exotic custom-formulated alloys that may require exacting weld procedures.

Most repair welding of pipe and tubing in a chemical plant is done in the field. Because of the demanding nature of such in-place welding, one would expect a more extensive use of mechanized pipe welding in the chemical industry. Yet despite the fact that orbital mechanized welding of pipe and tubing has been around for 20 years, it is rarely used for chemical plant maintenance operations.

Interrupting the operation of a large chemical facility involves a loss of revenues in the tens of thousands of dollars per hour. Several routine maintenance operations require shutting down major portions of a facility until all work is completed. One such operation is the replacement of steam cracking furnace tubes used in the production of ethylene.

The tubes used for furnace applications, such as steam crackers, have typical service temperatures ranging from 1400° to 2000°F. To withstand these high service temperatures, a number of high-carbon austenitic stainless steel alloys are used, usually in the form of centrifugal castings. Some common alloys for this application are HK-40 (0.4C-25Cr-20Ni) and HP-45 (0.4C-25Cr-35Ni). These alloys are specifically formulated for desirable properties, such as creep strength, but they pose significant welding problems.

The Exxon Baytown Olefins Plant was faced with the prospect of an extensive program of cracking furnace tube replacement at a time of high demand for ethylene. Gary Arnold, mechanical supervisor, realized he had a problem. Because of the high cost involved, the scheduled plant shutdowns for furnace tube replacement were extremely short. This meant that a large pool of qualified tube welders would be required for a short duration. The first outage required 198 welds to be made on 3-in.-OD, ½-in.-wall furnace tubes in a 30-day period. Past experience indicated that to do the task manually in the set time frame would require 32 welders. The problem at the time was a shortage of welders in the area with the necessary skills to perform the job. Another important factor was the time and cost associated with testing potential welders. Testing costs the company $400 per welder and in the past only one in four welders proved qualified for tube welding.

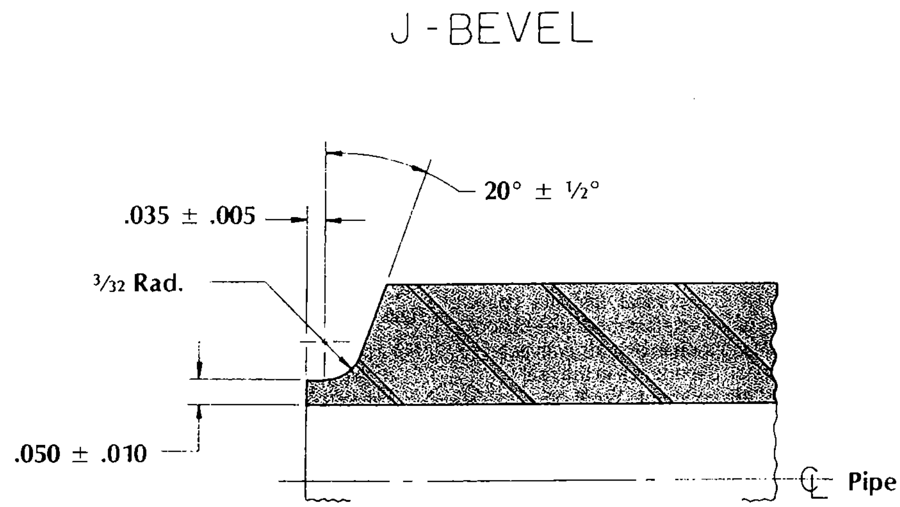

Fig. 1—Typical joint design used in orbital mechanized welding of furnace tubes.

Presented with this dilemma, Gary Arnold sought a new approach. An expert welder himself, Arnold had been introduced to orbital mechanized welding in the past, but he felt that the technology was unsuitable for a field maintenance project. He decided to give the technology another look. Encouraged by what he saw, he leased four systems for the upcoming repair. The equipment he chose was the Series 500 system manufactured by Magnatech.

According to John Emmerson, president of Magnatech, "Gary Arnold is somewhat unique among our customers. Many of our customers tend to think of mechanized welding as a simple, direct substitution for manual welding. They fail to realize that mechanized welding requires a careful review of details such as joint geometry, acceptable fit-up tolerances, and ID purging techniques. Many of our customers come to us a week before a job is to begin, which leaves totally inadequate time to accomplish the job."

Arnold went about the task of preparation methodically. He set out to win over

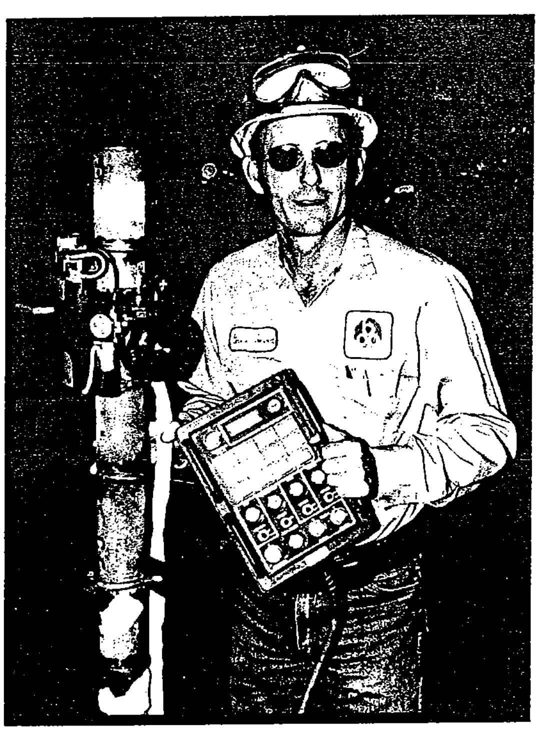

Fig. 2—Welding variables of the mechanized equipment can be adjusted with a hand-held pendant.

Based on a story from Magnatech, The DSD Co., East Granby, Conn.

his skeptical team of experienced welders by first qualifying himself and several key people in the machine operation.

A J-groove is a superior joint geometry for mechanized tube welding because it makes the root pass far more tolerant to fit-up variations as compared to a V-groove. Arnold decided to use a J-groove (Fig. 1), and purchased pneumatically powered portable beveling equipment. An instruction program to train and certify the machinists and welders was set up. No more than two days were required to train a qualified welder to become certified on the orbital equipment.

The application consisted of welding new tubes to new Y-fittings inside the confines of the furnace. The return bends of the Y-fitting dictate a clearance between the adjacent tubes of 2¼ in., but the Model D heads on the equipment operate within 2 in. radial clearance.

A metal guide ring, which can be changed for different tube sizes, is first clamped around the tube. The weld head is then clamped onto the guide ring. The weld head mounts on one side of the joint only. The ten-lb weld head incorporates functions for torch rotation, oscillation, filler metal feed and electronic control of arc length. A pendant control (Fig. 2) allows the welder to enter weld head speed and other operational variables without moving to the power source.

Although more sophisticated programmable units can do the job, the basic units are recommended for field applications. The exacting fit-up tolerances of a field job dictate that the welder have a greater degree of override capability. A pulsed current was used to minimize heat input. Welding time was 40 min per joint, including setup.

The company used a combination of manual welding and orbital mechanized welding (approximately 50/50) for the 312 welds required to retube the two furnaces. With this approach, total furnace downtime was reduced by 11 days. The orbital welding reduced the number of welds required, and no defects were recorded with the machine welds. The value of the increased production was $450,000, and the total welding cost was lowered by $125,000. It was decided to purchase the four mechanized systems for upcoming outages. This project demonstrated that with proper preparation and planning, orbital mechanized welding is practical for use in the field and it can improve quality. ♦

References

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