

John Emmerson, Magnatech Limited Partnership, Connecticut, USA

Pipeline industry looks to new processes for mechanised weld quality

John Emmerson has a Bachelor of Science degree from Boston University and a Master of Science from Cornell University. He has spent 24 years in the welding industry and serves on the AWS D.10



Committee of Piping and Tubing. For the last 14 years he has been President of Magnatech, based in Connecticut, USA, with a European office in The Netherlands. Magnatech specialises in the manufacture of orbital pipe and tube welding equipment. The author would like to extend his gratitude to the following companies who contributed material for this article: Lincoln Electric, USA, Per Aarsleff, Denmark, JV Kaarstoe Pipeline Contractors, Norway.

In 2000, more than 149,665km (93,000 miles) of pipeline construction were underway, planned, or actively under study worldwide. This consisted of gas, crude oil, refined products, as well as offshore pipelines. In 1999, 29,413 km (18,277 miles) were actually laid, with a 2000 forecast slightly higher than this.

The Shielded Metal Arc (SMAW) remains by far the most common welding process, using cellulosic electrodes run in the vertical down direction. This electrode type has advantages as it generates a significant amount of shielding gas in use and produces significant arc force for better root pass and puddle control at high surface speeds. In recent years, there has been a move by transmission pipeline operators to design new lines to withstand higher maximum allowable operating pressures (MAOP). To withstand these pressures, the industry has moved to using high strength steels which minimise required wall thickness as an alternative to simply using heavy wall pipe.

Use of higher strength steels results in considerable savings in steel (a large pipeline project may be measured in thousands of tons), as well as transportation/handling costs and reduced costs for filler metal. These higher strength steels, such as APL 5L Grade X70 and X80, must be welded using a low hydrogen process. Levels of diffusible hydrogen must be kept to a minimum to prevent crack formation.

Use of low hydrogen-type electrodes, while reducing the risk of cracking problems, have several negative aspects. They are chiefly designed for uphill welding, and require wider root gaps to achieve sufficient root penetration, resulting in slower welding speeds and reduced productivity.

This factor, in addition to more severe operating environments and more stringent governing codes which must be met, has caused pipeline owners and operators to demand tighter control of weld quality and has increased the use of mechanised welding by contractors to produce welds of more consistent quality.

Many pipeline owners around the world have adapted the acceptance standards and practices of the ANSI/API Standard 1104 *Welding of Pipelines and Related Facilities*. However, this standard accepts defects of numerous types when compared to

other pressure pipe standards such as ASME IX, B31.3, etc., that are much more stringent concerning allowable defects. In the past, pipelines were designed to provide an adequate safety margin within the allowable defects of API 1104. With the increasing use of thinner wall higher strength pipe, the rejectable fault criteria has had to be re-evaluated, and many owners have adapted higher quality standards, such as the DNV (Det Norske Veritas) or Lloyd's standards used for offshore pipelines.

Mechanised pipe welding has now been used for over 30 years in the pipeline industry. While it is extensively used for marine pipeline applications, only a small percentage of all cross country lines have been done using mechanised equipment. (The 2,973 km Alliance Pipeline, constructed in 1999-2000, was the first significant project to use mechanised welding in the USA.)



Pipe ready for welding in the deserts of Dubai

There are a number of suppliers to the mechanised pipeline welding industry. Although the systems vary considerably in configuration and operation, one common factor is that virtually all of the systems use the GMAW process in a short circuiting mode, welding downhill. The equipment presently being marketed generally consist of the following components:

- **Weld power supply**
- **Weld head**, which mounts the torch and manipulates it with motions similar to those of a manual welder.
- **Band or guide ring** that clamps on the pipe, provides mounting for the head, and is involved in weld head propulsion.
- **Filler wire feeder** which may be mounted either on or off the rotating head. (Most cross country applications use miniature head-mounted feeders to minimise potential feeding problems.)
- **Weld head programmer/controller** which may be integrated with the power supply or built into the weld head. (A remote controlled pendant is sometimes provided.)

In pipeline industry parlance, these are referred to as "bug and band systems".

While the main discussion is to be on advances in welding ►