Developments in weld purge gas oxygen monitoring technology

The importance of gas purging when welding stainless steels has long been recognised in the more sensitive sectors such as aerospace and pharmaceuticals. The presence of oxygen causes, at best, an unsightly appearance but more significantly friable deposits produced by contamination of unprotected weld underbeads become detached and can lead to serious damage.

By Michael Fletcher

More recently, research has highlighted the previously unrecognised corrosion problems in stainless steels arising from weld bead contamination. Other manufacturing sectors such as petrochemical, power engineering and motor racing have now adopted more stringent control over weld purging. Specialist manufacturers have risen to the demand for improvements in weld purging equipment (Figure 1) but with this has come the need to monitor purge gas oxygen accurately and reliably.

Measuring oxygen content
Although electrochemical or amperometric principles have been in use for many years, this ‘wet cell’ concept is quite unsuitable for continuous operation in industrial environments. Advances in automotive engine management systems included work at Bosch and Honda to develop solid state oxygen monitoring devices from the 1960s. These instruments were based on zirconium oxide sensors and this concept forms the basis of contemporary oxygen weld purge monitors. Early instruments however suffered from a series of problems, not least poor response time, unreliability and lack of sensitivity. The last 20 years have witnessed the evolution of instruments specifically designed for the welding sector. These coped with the shortcomings of earlier devices.

Weld Purge Oxygen Monitoring
The weld oxygen monitor operates by sampling and analysing purge gas. Early devices, referred to often as ‘oxygen analysers’, were developed for laboratory work. These are

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Figure 1. Advanced inflatable weld purging equipment. The multi-use inflatable concept has become the global standard for pipe and tube fabricators because of its reliability and ruggedness.

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multipurpose instruments and not suited for industrial applications. The simplest weld purge instruments rely on gas flow through a tube between the purge volume and the analyser, (Figure 2), but improved models also incorporate manual or pumped extraction to speed the gas flow.

Recent research has shown that oxygen levels considerably lower than those previously considered adequate are necessary. 1-7 Whilst a recommended maximum of oxygen in purge gas of 50 ppm has hitherto been considered acceptable, this new research shows that 20 ppm is essential if loss of corrosion resistance is to be avoided. These observations led quickly to the development of purge monitors capable of measuring oxygen levels down to 10 ppm. Furthermore they are robust, accurate and offer extended sensor life. Whilst these monitors can be applied confidently to take measurements close to the welding source i.e. within one metre, they have been shown to be unreliable beyond this distance (Figure 3). Most stainless steel welding operations, especially tube and pipe fabrications in the petrochemical, food and pharmaceutical sectors, require monitoring to take place some distance from the joint. A different approach to monitoring has become necessary. The latest monitors eliminate the delays and errors introduced by the established method of gas sampling. Exploiting advances in sensor technology it is now possible to take measurements close to the weld and then transmit signals electronically up to 1km (Figure 4).

Commercial monitoring equipment is now available that is rugged and sensitive. It can be coupled directly to instrumentation that not only displays oxygen level but also records results and provides data processing for quality control purposes.

References
1. Microbiologically influenced corrosion of stainless steel. Titz. 2nd symposium on orbital welding in high purity industries, La Baule, France.