Optimisation of Weld Overlay for Productivity and Corrosion Resistance

PUBLISHABLE SUMMARY

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Background

Corrosion-resistant weld overlays are often used to improve the service life of components made with an otherwise corrosion-prone material. One of the major concerns in arc welding overlay is dilution. Many of the Codes and Standards restrict heat input to control dilution. However, a required heat input can be achieved by proportionally varying the welding current and the welding speed, both of which will have entirely different effects on dilution. Hence the above stipulation is not adequate for ensuring the 'chemistry' of the weld overlay and its integrity. Due to uncertainties involved in the quality of the weld overlay, a conservative approach is taken when specifying the permissible dilution, resulting in substantial productivity losses, and increase in cost and associated issues such as distortion of components.

Improved process control has been achieved with new generation arc welding equipment through digital control, giving the benefits of reduced heat input and improved arc stability. Hence, the consistency of weld quality achieved is much greater than that achieved with conventional equipment. In addition, a TWI investigation, on alloy 625 weld overlay using a corrosion testing technique which sampled individual weld beads on weld overlay, showed that the corrosion resistance was maintained at significantly higher levels of 'Fe' in the weld overlay than the current limits followed in the industry. Thus, there appears to be an opportunity for relaxing the current permissible limits for %Fe in the weld overlay.

This JIP was undertaken to identify the effect of different 'Fe' content on corrosion and corrosion fatigue performance of alloy 625 weld overlay on a carbon steel substrate.

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Objectives

- Identify the effect of varying 'Fe' on corrosion and corrosion fatigue performance of overlay for a range of simulated environments, including severe sour service.
- Investigate the process capability of a set of high productivity weld overlay processes

Benefits

- Quantified capabilities of different arc processes, consumables and the influence of process parameters on dilution have been established. This facilitates the selection of the right process and process parameters to maximise productivity and performance. For a given environment, it may be possible to find a cheaper alternative procedure satisfying the environmental conditions, thereby reducing the cost of overlaying.
- Increased confidence in the integrity and the uniformity of the weld overlay will help reduce the overall corrosion protection cost by reducing the minimum number of layers. The results generated in this programme may also form the basis for relaxing the current dilution limits specified for a given service environment.

Industry Sponsors

- Petrobras;
- Polysoude SAS;
- Aquilex Corporation;
- ConocoPhillips Company;

Work Completed

- Quantified the effect of process variables on dilution in weld overlays produced using hotwire TIG welding and MIG welding techniques.
- Manufactured weld overlays with 5 specified ranges of dilution (5-53% Fe) on carbon steel substrate, using alloy 625 consumable.
- Characterised the electrochemical behaviour of the weld overlays in accordance with ASTM G61.
- Determined the critical pitting temperature (CPT) of the weld overlays in accordance with ASTM G150 and ASTM G48-C.
- Determined critical crevice temperature (CCT) according to ASTM G48 Method D.
- Carried out SCC tests in 25%wt NaCl solution containing H_2S and CO_2 at 177°C and 53bara.
- Carried out corrosion fatigue testing in air and sour environment to identify the effect of 'Fe' content on corrosion fatigue resistance.
- Investigated the process capability of MIG and tandem MIG welding processes.
- Investigated the influence of welding position on productivity and quality of the weld overlay.

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Project Outcome

This project quantified the effect of 'Fe' content in alloy 625 weld overlay cladding. The results showed that the current limits on 'Fe' in alloy 625 weld overlay cladding could be relaxed significantly without compromising on its quality. The results are supported by corrosion and corrosion fatigue data. A review of state-of-the-art equipment and novel processing and inspection techniques was also provided to sponsors.

Price and Duration

This project had a duration of 3 years and a budget of £400,000. The project results are available for purchase at a sponsorship fee of £80,000.

Further Information

For further information on how a Joint Industry Project (JIP) runs please visit:

http://www.twi-global.com/services/research-and-consultancy/joint-industry-projects/

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