Title:

Submerged arc welding of duplex stainless steels with additional cold wire - a comparison of different process variants

Abstract:

Submerged arc welding (SAW) is most frequently used for processing thick-walled components of duplex stainless steels (DSS) with wall thicknesses of more than 8 mm. Here, limit values for maximum permissible heat input must be complied with in order to ensure the formation of the two-phase structure (ferrite & austenite) and freedom from precipitations. The use of an additional cold wire (CW) allows an increase in the deposition rate without increasing the heat input. The increase in deposition rate leads to faster welding speeds and/or a reduction in the number of layers.

Karlsson et al. [1] presented the first results relating to the synergic cold wire submerged arc welding of duplex stainless steels, illustrating the benefits and potential of this technique. It was also shown that lowering the “effective heat input”, compared with conventional SAW, makes the method particularly well suited to the welding of steel grades where productivity is hampered by heat input restrictions. A so-called heat input reduction factor was calculated based on the diameters of the electrode and cold wire. Due to the reduced heat input it was assumed that the maximum limits for heat input could be increased. However, the reduction of the heat input was not proven experimentally.

This article informs about investigations on the influence of different process variants (single-wire, single-wire with cold wire, twin-wire & twin-wire with cold wire) on the cooling rates and the cooling time $t_{12/8}$. These investigations show that an additional cold wire has no significant influence on the cooling time. The reason for this is that part of the heat input is required to melt the CW. This means that less base material is melted. However, the volume of the molten pool hardly changes.

When SAW with CW, the CW wire speed must be adapted to the welding parameters to avoid process disturbances or insufficient melting of the CW. For this reason, the maximum CW content as a function of the heat input is shown.

The main focus of the presentation is on the comparison of the welding process variants single-wire SAW, single-wire SAW with additional cold wire as well as twin-wire SAW with additional cold wire with regard to a possible increase in productivity. Joint welds were produced in plate material with a V-seam preparation. For this purpose, EN 1.4462 plate material with a thickness of 14 mm and EN 1.4410 plate material with a thickness of 20 mm were used. The diameters of the electrode and the cold wire were each 2.4 mm. Details of joint preparation, layer structure and welding parameters are presented. Furthermore, the results of the radiographic inspection, the metallographic examinations, the corrosion testing and the mechanical testing are shown. In addition, a comparison of the deposition rates, welding speeds, number of layers and welding flux consumption is made. The results presented are intended to give fabricators an indication of possible savings potential depending on the individual process variants.

[1] L. Karlsson, H. Arcini, P. Dyberg, S. Rigdal und M. Thuvander, „Synergic cold wire (SCWTM). submerged arc welding of highly alloyed stainless steels, conference paper,“ Stainless Steel World, Stainless Steel World Conference & Expo, pp. 283-294, 2003.