E. Twin-Arc and Cold-Wire-Feed Submerged-Arc Welding of HSLA-100 Steel

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To achieve the required strength and toughness in the weld metal of naval ballistic armor steels such as HY/HSLA-80/100, maximum weld energy inputs must be observed. This results in large volumes of weld metal to be deposited using many beads and layers of weld metal. Use of conventional welding procedures for these structures requires thousands of production man-hours per ship and results in long production cycles. The objective of this task is to evaluate high productivity welding technology for large thick-section, high-strength steel structures. Two processes of interest were used to deposit additional filler metal with no increase in energy input.

Weldments were made in two-inch-thick HSLA-100 steel using the twin-arc and the cold-wire-feed submerged-arc-welding (SAW) processes and MIL-100S-1 electrode with a commercial flux in a double-Vee joint. Techniques were developed for depositing the root pass with little or no backgouging for both processes. All-weld-metal tensile, Charpy V-notch toughness, and dynamic-tear test specimens were obtained and tested.

At energy inputs of 85 kJ/inch satisfactory mechanical properties were achieved in twin-arc SAW weld metal at a deposition rate of 32.5 lb/hour and in cold-wire-feed SAW weld metal at deposition rates between 18 and 22 lb/hour. Deposition rates for the twin-arc process were 50 percent higher than the 15 lb/hour that was achieved using the conventional single-arc SAW at the same energy input of 85 kJ/inch. This is due to the wires being the same diameter and being feed at the same rate. Deposition rates for the cold-wire-feed process were between 16 and 42 percent higher than the 15 lb/hour that was achieved using the conventional single-arc SAW at the same energy input of 85 kJ/inch. This range was because the electrode and cold wire were of different diameters and were being feed at different rates.

Conventional SAW equipment can be readily modified for twin-arc or cold-wirefeed SAW with little capital expenditure and is operator friendly. These processes are thus cost-effective methods for improved productivity for naval ship or other structures.

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