

Response of Exothermic Additions to the Flux-Cored Arc Welding Consumable

Electrode

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Presently, battle field repair welding is hindered due to the bulk complexity of self-contained electrical power sources, supplemental gas bottles and the dependence on operator skill inherent with typical arc welding processes. Incorporation of chemical heat into the welding process can potentially eliminate and at least minimize the electric power source dependence. Arc voltage, and hence the arc gap, would become much less critical. In previous work, exothermic chemical additions to the flux formula of the Shielded Metal Arc (SMA) welding process were shown to increase the arc efficiency, but suffer from marked limitations in heat transfer due to spontaneous and uncontrolled reaction with the atmosphere. The flux of the SMA system is bonded coaxially along the outside of a consumable steel-rod electrode and tends to burn up and away from the arc, limiting the effectiveness of the exothermic additions at the electrode tip. In the Flux-Cored Arc (FCA) welding system, the flux forms the internal core of a tubular wire spool electrode. Exothermic additions to the flux in the FCA welding process have corrected the problem of uncontrolled or spontaneous chemical reaction and have reduced by fifty-percent the electrical dependence of the welding process.

Phase I of this work consisted of FCA electrodes fabricated with rich mixtures of magnesium and hematite flux in an effort to utilize atmospheric oxygen in a self-shielded formulation. The weldments from these electrodes were calorimetrically evaluated for heat input at several melting rates, and resulted in measured peaks in heat input with no evidence

of uncontrolled reaction. Phase I proved the controllability of the reaction, and identified the upper limit in melting rate for effective use of this exothermic FCA welding electrode as being near 200 inches per minute (85mm per second) for the test parameter schedule chosen.

Phase II studied the manufacture and heat delivery of stoichiometric mixtures of aluminum, magnesium and a 50-50 mix of the two, with the mineral hematite systematically displacing iron powder in an experimental self-shielded FCA flux formulation. All Phase II electrodes performed adequately with a set parameter schedule. The aluminum flux electrode produced a 32 percent increase over the baseline in specific deposit (grams per kiloWatt consumed) at 20 weight-percent to the flux. The magnesium flux yielded a 38 percent increase in specific deposit at 40 weight-percent addition, and the 50-50 Al-Mg electrode shows a 49 percent increase in specific deposit at only ten weight-percent concentration. All Phase II electrodes welded acceptably at the same pre-assigned welding schedule, indicative of an increase in parameter space. A 50 percent reduction in electrical dependence was demonstrated when compared to a baseline electrode formulation that innately exhibits strong exothermic properties with its 50 percent iron powder composition. Self-shielding behavior incorporated into these electrode consumables, eliminating any need for shielding gas, results in an overall simplification of system component hardware. A further benefit of reduced electrical requirement is manifested in a perceived reduction in needed operator skill level via a broadening of the acceptable weld parameter space and a minimization of arc length criticality.