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Effect of Si Content in Electrode and SiO2 Additions to the Slag during Electroslag Remelting

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Evolution of Si concentration in 316 stainless steel electrodes was observed during a melting campaign consisting of recycling electroslag remelted (ESR) ingots to make new electrodes using vacuum induction melting (VIM). This campaign consisted of iterations of VIM + ESR operations to optimize melting parameters. The effect of Si content on the melt parameters and ingot quality was further evaluated and additions of SiO2 to the slag chemistry were studied using research-scale experiments, x-ray fluorescence (XRF), visual inspections and computational tools. The Si concentration was found to decrease by approximately 600 ppm following ESR of 150 lb. research-scale electrodes. Eventually, this led to failure of the slag skin and direct ingot/crucible contact. Additions of SiO2 to the slag at levels matching the calculated Si loss resulted in significant decrease in slag resistivity (measured) and the current during steady state increased to maintain a constant melt rate. By lowering the SiO2 addition by an order of magnitude the resistivity was closer to the baseline ESR condition and slag skin failure was again observed. Computational fluid dynamics simulations were performed to model the ESR process under the various slag conditions and elucidate the relationships between slag properties and melt characteristics.

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