Heat-Transfer and Pressure-Drop Considerations in the Design of Sirosmelt Lances

CB Solnordal[1] and NB Gray[2]
GK Williams Cooperative Research Centre for Extractive Metallurgy

[1]CSIRO Division of Minerals, Box 312, Clayton South, 3169, Australia.
[2]Department of Chemical Engineering, The University of Melbourne, Victoria 3010, Australia.

Abstract

The Sirosmelt submerged combustion smelting process utilizes top injection lances to deliver fuel and air into a metallurgical melt. Helical vanes are used within the annular lance to impart swirl to the flowing air and enhance heat transfer from the lance wall to the air. To improve the understanding of transport phenomena within the lance, a detailed study of the fluid-flow and heat-transfer characteristics of decaying swirling flow in a heated annulus has been performed. Swirl strength and type were varied, the outer wall of the test section was heated uniformly, and Reynolds numbers ranged from 85,000 to 175,000. The swirl decay characteristics, heat-transfer coefficient, pressure losses, and heat transfer per unit pumping power were determined, and heat-transfer mechanisms were identified. It was found that the entrance pressure losses associated with the helical vane swirlers contributed up to 80 pct of the total pressure loss, indicating that improved swirler entrance design could significantly reduce operation costs. Recommendations are made for optimizing the shape of the swirler by using variable pitch/variable span swirlers and optimizing swirler position by aligning the entrance of the swirlers with the local flow angle. These changes will significantly improve the heat transfer per unit pumping power within a Sirosmelt lance.