Carnegie Mellon

Materials Science and Engineering Seminar Series

Materials Research at Carnegie Mellon

George Shannon
Graduate Research Assistant
Department of Materials Science and Engineering
Carnegie Mellon University

"Oxide Inclusion Behavior at the Steel-Slag Interface"

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11:00 A.M. Seminar in Doherty Hall 1212
Refreshments precede seminar at 10:30 A.M. in 2325 Wean Hall

The various steps in the steelmaking process all involve the possibility that certain non-metallic phases will form in the steel melt. This includes alloy component reoxidation and slag entrapment during steel pouring. Nonmetallic inclusions are detrimental to many steel properties, serving as crack initiation sites and surface defects, so it is beneficial to remove these particles during liquid state. Some fluid flow models exist, but assume the particle is removed once it comes close to the steel-slag interface. Here, we examine (1) the motion of an inclusion in contact with the steel-slag interface, and (2) the particle behavior as it approaches the interface.

Oxide particles are typically less dense than the steel phase, and rise accordingly. A previously-described force balance is used to determine the movement of a particle once in contact with the slag phase, and expanded to include alternate shapes, and a sensitivity analysis presented that determines important parameters and primary forces in this process. Though viscosity and the capillary force can affect the inclusion's motion, separation is typically quite quick. Experimental investigation of one parameter, the interfacial tension between slag and inclusion phases, is presented. In the separation model, certain values of this parameter can cause the particle to become 'trapped' at the interface.

One of the areas of interest is in the initial approach of the inclusion. In addition to interfacial effects that slow the inclusion due to a restricted drag field, the interface will deform as the particle 'pushes' into the slag phase. Previous models have simplified this greatly, and here we have developed a film deformation model based on a pressure balance across the phases and Navier-Stokes hydrodynamics using 'stick' boundary conditions. Initial results show that the capillary length of the interface causes a 'wide' lift effect rather than a wrapping effect for small particles. A sensitivity analysis is planned, as well as experimental verification in a water-oil model.

George received his Bachelor's degree in Materials Science and Engineering from Lehigh University in Bethlehem, Pennsylvania in 1998 and his Master's degree from Carnegie Mellon University in 2005. He is currently a Ph.D. candidate under the guidance of Prof. Sridhar Seetharaman in the Center for Ironmaking and Steelmaking Research.