9754 Development of Submerged Entry Nozzles that Resist Clogging

Benefits

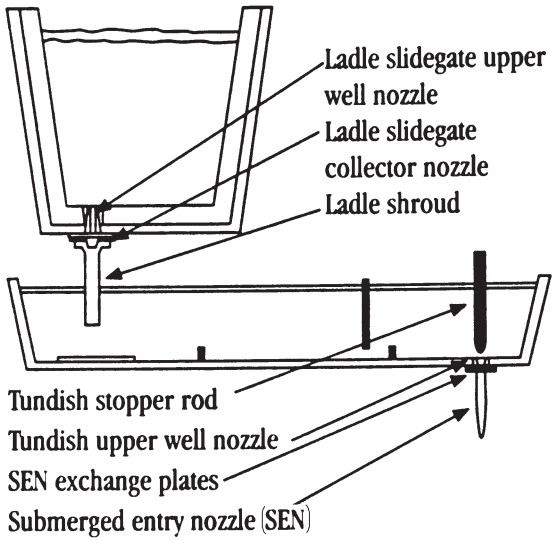
- Reduced refractory costs.
- Increased steel quality/cleanliness.
- Increased steel production through elimination of unscheduled shutdowns and consistent throughput.
- Increased energy efficiency.

Applications

Submerged Entry Nozzles (SENs) are used in the steelmaking process to prevent reoxidation of the molten steel directly from stream contact with the surrounding environment and from air entrainment and splashing when the molten stream strikes the liquid surface in the mold. Elimination of accretion formation and the associated clogging of SENs will lead to increased strand speed, greater time between changes of SENs, or no strand termination.

Improvements in induction heating technology can increase yields and improve quality

This project is a comprehensive refractory research program that will provide the data necessary to define the mechanisms controlling nozzle accretion, providing the basis for developing new technologies for reduction or elimination of nozzle clogging. The project consists of five major activities: 1) A detailed post-mortem microstructural characterization of multiple nozzle accretions from steelmaking facilities using a range of casting conditions; 2) Development of a high temperature simulation that accurately reproduces the accretion so that materials can be evaluated under controlled conditions using a design of experiments approach; 3) Development of mathematical and finite modeling of fluid flow, heat transfer, and thermal/mechanical stress development and texture simulations to predict the effect of SEN surface conditions on nozzle accretion; 4) Documenting a detailed wetting behavior of nozzle materials by molten steel as a function of steel chemistry and temperature; and 5) Development of a simulation that accurately reproduces the thermal shock conditions that are present during use of nozzles.



Typical submerged nozzle configuration.

Project Description

Goal: Develop a materials model sufficient to identify new technologies for reduction or elimination of nozzle clogging.

Progress and Milestones

- The project began in August 1998.
- Evaluation of nozzle material: August 1998 to June 2000.
- Modeling of nozzle system: September 1998 to March 2001.
- Simulative test development and use: May 1999 to April 2001.
- Fabrication and testing of anti-clogging nozzles: January 2000 to June 2001.
- Phase 1 completed on February 28, 2002.

Total Project Cost/Duration

$654,000/four years.

Research Organization

University of Missouri - Rolla
Rolla, MO

Industry Participants

Acme Steel Company
Riverdale, IL

AK Steel Corporation
Middletown, OH

Bethlehem Steel Corporation
Bethlehem, PA

Ispat Inland Inc.
Chicago, IL

National Steel Corporation
Mishawaka, IN

Rouge Steel Co.
Dearborn, MI

Stelco Inc.
Hamilton, Ontario, Canada

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