# 0006 Hydrogen And Nitrogen Control In Ladle And Casting Operations

**Benefits**

- Reduction in $CO_2$ emissions
- Increased energy savings by an estimated 400 million kwh per year due to better control by saving one million tons of missed heats
- Estimated annual savings of $20 million when technology is in widespread commercial use

**Applications**

Models developed to predict and control final hydrogen and nitrogen concentrations in electric arc furnace and basic oxygen furnace steelmaking will benefit the steel industry by producing steels low in hydrogen and nitrogen content.

## Development Of Models Will Help Predict And Control Hydrogen And Nitrogen Levels In Electric Arc Furnace And Basic Oxygen Furnace Steelmaking

There is an increasing demand for steels low in hydrogen and nitrogen content, not only for flat and plate products but also for special rod and bar steels. Hydrogen and nitrogen can cause pin-holes and problems in casting. Many rod and bar products are produced in electric arc furnaces, in which it is more difficult to produce steels low in hydrogen and nitrogen. In addition, for both the electric arc furnace and basic oxygen furnace steelmaking, there is pick-up of hydrogen and nitrogen elements during ladle processing and casting.

There are numerous sources of hydrogen and nitrogen during melting, ladle processing, and casting. These sources include scrap, hot metal, stirring gases, carburizers, wet alloys, ladle slag additions, and the atmosphere. There are also important and special cases, such as hydrogen pick up on the first heat in a sequence cast. Consequently, it is difficult to control and predict hydrogen and nitrogen. Much of the fundamentals related to hydrogen and nitrogen are known. However, no useful model exists to predict the importance and the impact of the many factors influencing the final hydrogen and nitrogen levels.

The American Iron and Steel Institute (AISI) Technology Roadmap Program (TRP) and Carnegie Mellon University, in conjunction with the U.S. Department of Energy (DOE), are conducting a three-year project that will identify and quantify the sources of hydrogen and nitrogen in ladle and casting operations. Based on this research, Carnegie Mellon University will use the data generated as inputs to develop a model to predict hydrogen and nitrogen pick up and identify the major sources.

**Project Description**

**Goal:** To conduct experiments to determine the influence of the major factors on hydrogen and nitrogen content and to develop models to predict the final concentrations.

The purpose of this project is to identify and quantify the sources of hydrogen and nitrogen in ladle and casting operations. The data generated will be used as inputs to develop a model to predict hydrogen and nitrogen pick up and identify the major sources. The hydrogen pick up from water associated with slag making materials, such as Ca(OH)2, alloys, and carburizers will be examined. This will be accomplished in laboratory experiments using 25-pound heats. Controlled additions will be made of these materials and the hydrogen and nitrogen recovery or pick will be measured. A model for the electric arc furnace and tapping similar to the one previously developed for the basic oxygen furnace will be developed. The model will include decarburization, scrap melting, the use of direct reduced iron, and pick up during melting. A sensitivity and prediction model for hydrogen and nitrogen for ladle and transfer operations will also be developed.

**Progress and Milestones**

Specifically, the program will include the following tasks:

- Project start date, March 2001.
- Task 1: Hydrogen Pick Up from Ca(OH)2 in Slags
  - Design and build equipment
  - Run initial experiments
  - Complete research on task
- Task 2: Hydrogen and Nitrogen Pick Up from Alloys and Carburizers
  - Design and build equipment
  - Conduct initial experiments
  - Complete task
- Task 3: Transport of Nitrogen through Ladle Slags
  - Design and build equipment
  - Conduct initial experiments
  - Complete task
- Task 4: Model for Electric Arc Furnace and Tapping
  - Develop initial electric arc furnace model
  - Develop initial tapping model
  - Complete final model
- Task 5: Model for Ladle and Casting Operations
  - Develop initial model
  - Finish model
- Project completion date, March 2004

**Total Project Cost/Duration**

$372,000/3 years

**Research Organization**

Carnegie Mellon University,
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**Industry Participants**

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Gallatin Steel, Ghent, KY

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