9903 Quantifying the Thermal Behavior of Slags

Benefits

- A projected $10 million cost reduction per year throughout the U.S. steel industry
- Increased productivity and decreased defect formation in continuous cast product
- Improved castability of difficult-to-cast grades
- Reduced energy consumption
- Understanding solidification behavior of slags
- Slags designed without fluorine, thus reducing environmental pollution
- Development of rational design criteria for use in the applications of slags in ladles, tundishes, and molds

Applications

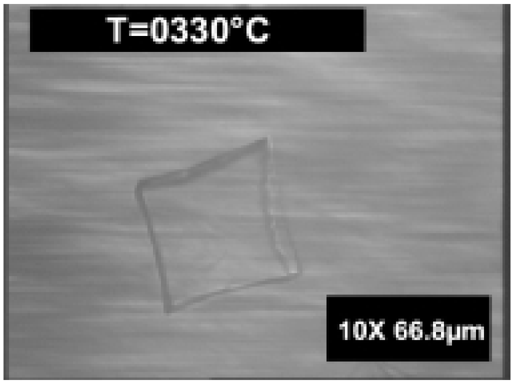
By quantifying the thermal behavior of slags, the outcomes entail further development of a tool which will have broad use in the quantification of slag melting and solidification behavior and development of a set of meaningful criteria for slag application in steel mill environments.

Quantifying the thermal behavior of slags will improve productivity, increase yield, and decrease pollution in steel production

Successful operation of a continuous caster is based upon control of heat transfer in the mold. The mold slag is the key component in the success of continuous casting.

Recently, a new experimental technique was developed at Carnegie Mellon University that allowed the solidification behavior of a slag to be observed and quantified under conditions that stimulate the thermal conditions that occur in steelmaking environments. This technique allows ladle, tundish, and mold slags to be characterized. Initial studies have shown that the solidification behavior of a slag is a function of its cooling rate and its environment.

The project is being conducted under the American Iron and Steel Institute (AISI) Technology Roadmap Program. The project will allow slag design to become an engineering science rather than an empirical exercise. The project will allow the operation of the continuous caster to be better understood and lead to increased productivity and decreased defect formation in continuous cast product. This information will also be a key to improving the castability of difficult-to-cast grades on all types of casters. In addition to operational issues, the understanding of the solidification behavior of slags is a key to the understanding of the response of the inclusional material to subsequent thermo-mechanical processing. Thus, this work will aid in reducing overall energy consumption of the steel industry by aiding in increased productivity and decreased defect ratio, both key components of successful hot charging. Moreover, an environmentally positive outcome of this project will be the ability to design slags which do not contain fluorine.



Project Description

Goal: To develop a detailed understanding of the solidification behavior of a slag to allow slag design to become an engineering science.

Objectives:

1) Develop a systematic understanding of the effect of the cooling rate on slag solidification.
2) Develop a systematic understanding of the effect of slag chemistry changes on slag solidification behavior.
3) Develop a method to characterize slag melting.
4) Develop an understanding of the role of the environment in slag solidification and melting.
5) Develop the ability to understand slag solidification under the conditions that occur in the continuous caster.
6) Develop the ability to predict the solidification behavior of slags.
7) Develop the criteria for optimization of slags in steelmaking environments where they are under thermal gradients.

Progress and Milestones

- Project start date: February, 2000
- Quantify standard slags (nine months).
- Quantify effect of heating rate (23 months).
- Gather experimental data and correlate.
- Develop ability to characterize slag solidification in casting; develop ability to predict solidification behavior of slags; and develop criteria for optimization of slag engineering (35 months).
- Complete development of solidification model (35 months).

Total Project Cost/Duration

$367,000/36 months.

Research Organization

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Industry Participants

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