

0034 Real-Time Melt Temperature Measurement In A Vacuum Degasser Using Optical Pyrometry

Benefits

- ❖ Reduction in process time enabling processing an additional heat of steel per day, which results in an increased production value of approximately \$15 million per year per installation
- ❖ Increased energy savings of \$1.2 million per year per installation derived from reductions in processing time
- ❖ Estimated annual savings of \$160 million when technology is in widespread commercial use
- ❖ Emissions reductions of 550 tons per year of CO₂, 2.5 tons per year of NO₂, 5.3 tons per year of SO₂, and 1.93 tons per year of particulates are possible per installation

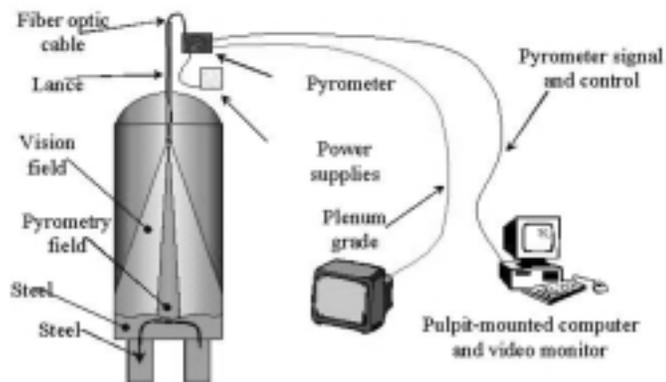
Applications

This lance-based sensor technology has general applicability for real-time temperature measurement of solid/liquid surfaces at temperatures above 2,200°F. Temperature measurement data are crucial for efficient degasser operation and to downstream processing of heat, especially when a continuous caster is in use.

Development Of A Fiber-Coupled, Optical Pyrometer For Continuous Melt Temperature Measurements In A Vacuum Degasser Will Reduce Process Time, Enhance Process Control, And Eliminate Manual Or Robot-Operated Thermocouples

The vacuum-degassing furnace is a practical and efficient means for producing Ultra-low carbon steel through ladle treatment. As with all ladle treatment operations, temperature control in the ladle is crucial to downstream processes, especially in plants where a continuous caster is in use. To produce the desired grade of steel, process models based on melt temperature and chemistry are used to determine degassing duration, amount of additive addition (if any), and the amount of oxygen blowing required. Melt chemistry and temperature are typically measured immediately after tapping from the iron conversion vessel (BOF, Q-BPO, or EAF) and often again at the ladle treatment station. Because of the importance of melt temperature monitoring during vacuum degassing, the development of a lance-based optical pyrometer is proposed for real-time temperature measurements of melt temperature in the degasser before and after oxygen blowing.

The degasser is a common ladle treatment process for producing low-carbon steel. Melt temperature is a crucial input to the model used to define the heat recipe and to subsequent processing of the heat, especially if a continuous caster is in use. This project, by the American Iron and Steel Institute (AISI) Technology Roadmap Program, emphasizes on the development of a lance-based optical pyrometer for real-time measurement of melt-temperature in a degasser. The effort incorporates technology developed under a prior AISI effort.



Project Description

Goal: To develop a lance-based optical pyrometer for real-time measurement of melt-temperature in a degasser.

The objective of this project is to develop a fiber-coupled optical pyrometer for continuous melt temperature measurements in a vacuum degasser that reduces process time, enhances process control, and eliminates manual or robot-operated thermocouples. The lance-based sensor will measure melt temperature automatically before and after oxygen blowing. Such data are crucial for efficient degasser operation and to downstream processing of the heat, especially when a continuous caster is in use.

This project is structured in a two-phase program. Alpha-phase development will occur at LTV Steel, Cleveland Works, where a lance-based camera system is already in operation at the degasser. Once the pyrometer has been optimized and shows good agreement with the immersion thermocouple data, a beta-site installation will be completed at U.S. Steel, Edgar Thomson Works. Differences in degasser practice between these two sites facilitate a more thorough evaluation of the pyrometer under a broader range of operating conditions.

Progress and Milestones

Specifically, the program will include the following tasks:

- ❖ Project start date, January 2001.
- ❖ Task 1: Assemble and test fiber-coupled two-color pyrometer system for combined viewing and temperature measurements in the vacuum degasser.
- ❖ Task 2: Calibrate assembled system using a high-temperature black body source. Verify 24-hour stability and temperature accuracy over a +/- 50°F temperature range.
- ❖ Task 3: Install system at LTV Steel. Couple plant signals (process start/stop, lance oxygen flow) into a data acquisition system. Configure system to run in unattended mode, collecting data automatically during each heat.
- ❖ Task 4: Conduct first field trials of temperature monitoring system. Compare optical temperature measurements with immersion thermocouple measurements, both made before oxygen blowing. Develop statistical database over 50-75 heats to characterize measurement accuracy.
- ❖ Task 5: Assuming acceptable pre-oxygen blow accuracy, investigate effects of wall radiant emission on optical measurement accuracy, calculate pre- and post-oxygen-blow emissivities, implement emissivity-based post-blow temperature correction. Identify delay time required before temperature measurement accuracy returns to acceptable level. Investigate whether delay time changes with each heat, and if so, can it be correlated to process variables (e.g. length of oxygen blow?).
- ❖ Task 6: Develop a statistical database over a series of heats comparing optically-derived and immersion thermocouple-based measurements made after oxygen blowing.
- ❖ Task 7: Assuming acceptable post-oxygen blow measurement accuracy, begin second beta-site development at U. S. Steel's Edgar Thomson Works. Repeat tasks 1-6, investigating if variation in degasser practice affects measurement accuracy and post-oxygen-blow measurements.
- ❖ Task 8: Prepare final report. Project completion date, September 2002.

Total Project Cost/Duration

\$157,000/21 months

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