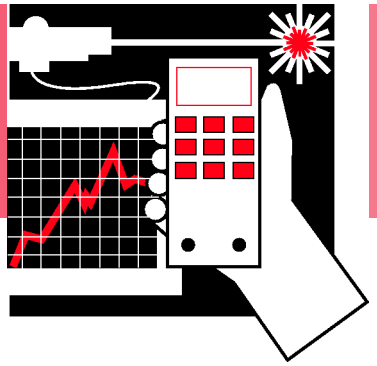
SENSORS & CONTROLS

Project Fact Sheet



SENSING AND CONTROL OF CUPOLA FURNACE

BENEFITS

- Increase in efficiency in energy utilization from optimizing furnace performance, with an annual savings of 3.4 million tons of coke and an equivalent reduction in carbon emissions
- Increase in the yield on castings due to reduction in process variability
- Longer furnace campaign with reduced refractory corrosion
- Reduction in disruptions in production through early detection of malfunctions
- Reduction in the use of holding furnaces designed to level out the variability in the produced iron

APPLICATIONS

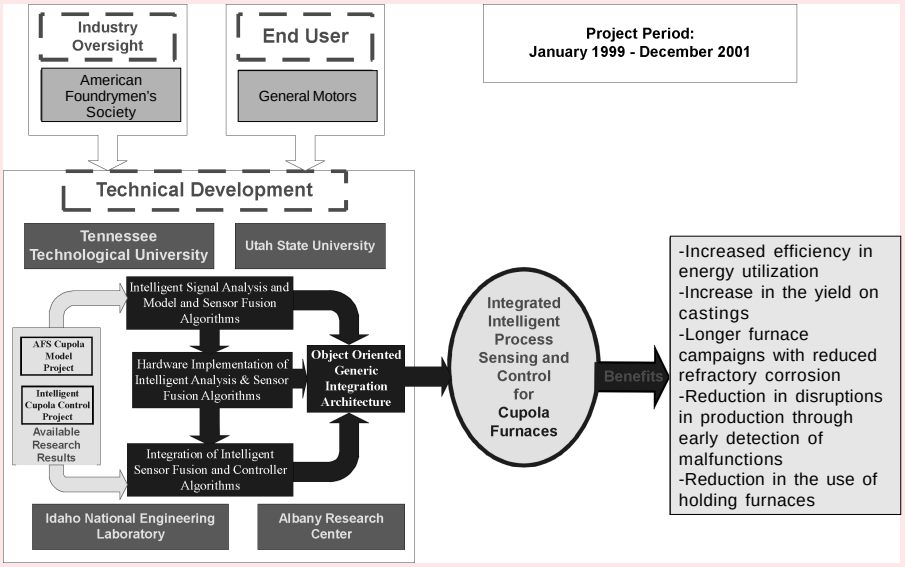
The primary application of the integrated sensing and control technology, I³PSC, is targeted toward approximately 400 cupola furnaces used by the U.S. iron foundry industry. However, the I³PSC addresses development of a generic integrated industrial process and sensing system that can have widespread application throughout the ferrous metalcasting industries as well as in other industrial environments. One such industry is glass manufacturing, which identifies the lack of better in-process sensors and process control systems as the major technology barrier to achieving production efficiency goals.

APPLICATION OF THE INTEGRATED SENSING AND CONTROL SYSTEM WILL IMPROVE CUPOLA FURNACE PERFORMANCE TO ACHIEVE A SIGNIFICANT ECONOMIC IMPACT

The cupola furnace burns coke with an air blast to melt scrap steel, cast iron, and alloying materials into a consistent grade of iron for casting purposes. The inevitable random variations in charge composition, blast effectiveness, and even local meteorological conditions, however, lead to a degree of variability in the cupola output. Controlling these phenomena is desirable for efficient energy use, for producing iron of acceptable quality, and for reducing the environmental impact of the melting process.

The economic and environmental costs of this variability can be substantial because cupola furnaces account for 70 percent of cast iron production and generate 1 to 2 percent of the total annual national production of greenhouse gas. Applying the intelligent, integrated, industrial process sensing and control system (I³PSC) that integrates intelligent sensor fusion data into the controller can reduce this variability to achieve enhanced operation of the cupola furnace.

I³PSC SYSTEM



By reducing variability, the intelligent, integrated, industrial process sensing and control system can enhance the operation of the cupola furnace.

Project Description

Goal: Test the developed intelligent, integrated, industrial process sensing and control system on a research cupola furnace for regulation of melt rate, temperature, and iron composition.

This project will develop a generic architecture for the integrated, intelligent, industrial process sensing and control system. The I³PSC architecture is characterized by four major interacting components:

1. An object-oriented generic architecture to integrate the developed software and hardware components
2. Generic algorithms for intelligent signal analysis and sensor fusion
3. Development of a supervisory structure for integration of intelligent sensor fusion data into the controller
4. Hardware implementation of intelligent signal analysis and fusion algorithms

The developed algorithms will be tested using experimental data available from a research furnace and a production furnace. The I³PSC technology will then be tested on an 18-inch research cupola furnace to demonstrate control of melt rate, temperature, and iron composition.

Progress and Milestones

- This project was selected through the Sensors and Controls Program FY99 solicitation and was awarded in January 1999. All tasks are scheduled for completion in 36 months.
- This project will integrate individual tools previously developed under two basic research projects (AFS cupola model and Intelligent cupola control) into a single, complete control package.
- By January 2000, use operating furnace data from Albany Research Center (ALRC) and General Motors Corporation to demonstrate a software program incorporating neural network pre-processing and self-validation algorithms; use model-based simulations to demonstrate an object-oriented generic architecture for intelligent control.
- By January 2001, demonstrate sensor and model fusion algorithms integrated into the object-oriented architecture; demonstrate a working hardware prototype of the reconfigurable-logic hardware implementation of neural network sensing techniques.
- By January 2002, during live operational runs at ALRC, demonstrate the complete I³PSC with incorporation of the reconfigurable-logic hardware implementation of neural network sensing techniques and the object-oriented integration software.
- Upon successful completion of this project, a vendor company will be chosen in collaboration with the American Foundrymen's Society to provide long-term support for the developed technology.

Project Partners

Albany Research Center
Albany, OR

American Foundrymen's Society, Inc.
Des Plaines, IL

Idaho National Engineering and Environmental Laboratory
Idaho Falls, ID

General Motors Corporation
Saginaw, MI

Tennessee Technological University
Cookeville, TN

Utah State University
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