System for Detection and Control of Deposition in Kraft Chemical Recovery Boilers and Monitoring Glass Furnaces

Immediate Benefits Will Be Derived Through the Reduction and Control of Recovery Boiler Pluggage

At the end of the twentieth century, over 80% of the wood pulp consumed at U.S. paper/paperboard plants was produced via the Kraft process. Kraft chemical recovery furnaces are large and expensive. It is difficult to economically add small incremental units of capacity, and the capacity of the chemical recovery boiler is often the factor limiting the capacity of the entire pulp mill. Processes governing the deposition of fume and carryover on heat transfer surfaces and attendant plugging of gas passages affect the recovery boiler’s effective burning capacity. However, there are still no reliable on-line methods for systematically detecting the presence and the build-up rates of these deposits. Control efforts have therefore necessarily been based on indirect measurements and considerations and have often yielded unsatisfactory results.

Near-IR smelt-bed imaging systems have been used for smelt bed imaging in recovery boilers for many years and attempts have been made to use near-IR cameras for direct monitoring of pendant deposits. However, it has been difficult to get good images in the near-IR, while devices operating at longer wavelengths have, until recently, been impractical for boiler-side use because of prohibitive expense and the need for reliable cooling to low (liquid nitrogen) temperatures.

Recently, ferroelectric and microbolometer detector arrays have become commercially available; these devices are relatively inexpensive and do not require cooling, making them suitable for boiler applications. Moreover, the price of computing power continues to plummet, making sophisticated multi-point data processing schemes quite practical for on-line application. This project focused on applying these technologies to produce clear images of boiler tube deposits throughout the convective sections of operating Kraft recovery boilers and applying computer image analysis techniques to these images so as to accurately detect and measure the deposition of pluggage-causing materials.

Benefits for Our Industry and Our Nation

- Provide the energy savings for the project technology versus the comparable competing technology.
- Increase in heat transfer to the superheater tubes
- Industry-wide energy savings attributable to I&I project technology is ~2 x 1013 BTU per year.
- Reduction in emissions.
- Total economic benefit $650,000 per year; possible $147,000,000 per year, US industry
- Reduced sootblower steam usage
- Increase of boiler up-time
- Reduction of other pluggage-related problems
- Better environmental compliance through increased operating stability
- Reduced consequences of pendant tube leaks due to earlier detection

Applications in Our Nation’s Industry

- A system to monitor and control deposition on the pendant tubes of recovery boilers and glass furnaces.
- Combined sootblower/Deposit inspection probe
- Applicable infrared imaging sensor for a glass furnace
- Widespread use of the technology will increase the production capacity and efficiency of the entire Kraft pulping industry.
**Project Description**

**Goal:** The purpose of this project was to finish the development of a system to monitor and control deposition on the pendant tubes of recovery boilers and investigate the applicability of the system to utility power boilers and glass furnaces.

The critical R&D challenges identified in the original proposal were: 1) Development of survivable off-axis imaging optics to capture images of deposits deep in boiler convection passes; and 2) Development of software needed to process the captured images to reliably detect deposits in different locations from different viewing angles. In addition, the following technical goals were identified: 1) Integration of the system output with the sootblower control system; 2) Demonstration that the system works properly through extensive testing in recovery boilers; and 3) Demonstration of infrared imaging in a glass melting furnaces and utility boilers.

**Pathways and Milestones**

The goals of this project have been achieved.

- Survivable off-axis imaging optics have been developed and images of deposits deep within the convective sections of several recovery boilers have been obtained.
- Image analysis software has been developed and demonstrated.
- A detailed design has been developed for the integration of the imaging system with a Clyde Bergemann sootblower and a Solvera sootblower control system using off-the-shelf components.
- Numerous tests have been performed in three recovery boilers and the ability to obtain clear images deep in the convective sections has been demonstrated.
- Images have been obtained in a glass melter and several tests were performed in coal-fired utility boilers to assess the utility of infrared imaging in those applications.

A commercial partner has been identified and further federal funding will be sought to support a project to develop a commercial prototype sootblowing control system employing automated deposit imaging.

**Project Partners**

Enertechnix Inc.
Maple Valley, WA

University of Washington
Seattle, WA

Weyerhaeuser Company
Springfield, OR

DanzCo
Tenino, WA

Port Townsend Paper Co.
Port Townsend, WA

MeadWestvaco
Covington, VA

International Paper Riverdale Mill
Selma, AL

Pacificorp
Centralia, WA

Longview Fibre
Longview, WA

**A Strong Energy Portfolio for a Strong America**

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

For additional information, please contact:

**Drew Ronneberg, Ph.D.**
Industrial Technologies Program
Phone: (202) 586-0205
Fax: (202) 586-9234
E-mail: Drew.Ronneberg@ee.doe.gov

**Peter Ariessohn, Ph.D.**
Enertechnix Inc.
Phone: 206-251-2505
Fax: 425-432-1557
E-mail: peter.a@combuspec.com

**For more information, visit www.eere.energy.gov/industry or call 1-877-337-3463**