U.S. Department of Energy
Energy Efficiency and Renewable Energy
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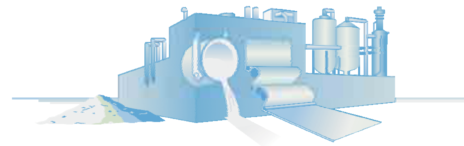
INDUSTRIAL TECHNOLOGIES PROGRAM

Materials for Industrial Heat Recovery Systems

Materials Improvements Will Result in Enhanced Heat Recovery, Better Reliability, and Prolonged Life

Heat recovery is an essential energy-saving part of almost every process system, and the proper selection of materials for these systems is complex, yet crucial for satisfactory performance. Enhancing heat recovery in industrial systems is a direct and very efficient way to substantially improve energy utilization and lessen environmental impact. To gain enhanced heat recovery and improved reliability of such systems, challenging materials problems in the areas of strength and environmental degradation must be overcome. These challenging and complex materials problems require an integrated approach that includes experimental characterization, field evaluation, and modeling efforts involving industry, research organizations, materials suppliers, and component manufacturers. This project will address materials improvements for enhanced heat recovery, reliability, and competitiveness in two industries: aluminum and forest products. The focus of the efforts will be on melting furnaces and recovery boilers. There are several common features for these applications—including flue gas temperatures, requirements for high duty cycles, and service in oxidizing and reducing environments—that result in similar materials requirements for these applications.

Improved materials for heat exchangers are required for various industries.



Benefits for Our Industry and Our Nation

The alloys identified in this project will lead to a number of benefits. The estimated energy benefits due to improved operational efficiency will exceed 12 trillion Btu/year by 2020. The improved durability of the materials will also lead to longer operational life, fewer shutdowns, and improved yield and productivity.

Applications in Our Nation's Industry

The new materials will be used in recuperators in the aluminum industry, in black liquor recovery boiler air port tubes, black liquor recover boiler mid-furnace walls, and superheater tubes. Results will also be applicable in various heat recovery operations in the chemicals, petroleum, and steel industries.

Project Description

The goals of this project are to identify corrosion mechanisms, perform prototype tests of alternate materials, and identify operational changes that modify the environment experienced by heat recovery system components. This will enable industrial heat recovery systems to operate in a more energy-efficient, productive, and reliable manner.

Barriers

Major barriers to be overcome include:

- Lack of knowledge and understanding of the materials' failure mechanisms and relationship to processing; and
- Insufficient knowledge of fluctuations in the operational parameters of equipment and impact on materials.

Pathways

The objectives of this project will be achieved through the following: (1) characterizing degradation, and identifying and understanding failure mechanisms; (2) measuring temperature and environmental fluctuations during the process; (3) performing computational fluid dynamics (CFD) modeling to understand the magnitude and extent of fluid flow and temperature fluctuations; (4) developing improved and new materials; (5) studying residual stress effects and the effect of environmental fluctuations on material behavior through measurements and finite element modeling; and (6) developing laboratory simulation test systems and inplant testing.

Milestones

- Acquire and complete examination of degraded parts
- Characterize the chemical, thermal, and mechanical environment to which components are exposed
- Complete CFD modeling, thermodynamic modeling, and finite element modeling
- Select alternate commercially available materials or develop new materials/coatings
- Evaluate alternate materials, coatings, and surface treatments in simulated and industrial plant environments
- Recommend the optimum alternative materials, repair conditions, and operational changes

Commercialization

Commercial adoption of the material recommendations and operating procedure recommendations will be achieved through the active participation of equipment designers/suppliers and end-user industries. Materials will be exposed in recuperator and recovery boiler conditions in partners' locations allowing companies to obtain first-hand information on the technology and to directly participate in the commercialization of the technology.

Project Partners

Weyerhaeuser Co.
Federal Way, WA
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Domtar Inc.
Montreal, PQ, and Ashdown, AR

E3M Inc.
North Potomac, MD

Institute of Paper Science and Technology, Georgia Tech
Atlanta, GA

Oak Ridge National Laboratory
Oak Ridge, TN

Process Simulations Ltd.
Vancouver, BC

Pulp and Paper Research Institute of Canada
Vancouver, BC

SECAT Inc.
Lexington, KY

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 more information contact:
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