Improved Heat Recovery in Biomass-Fired Boilers

Reducing Superheater Corrosion to Enable Maximum Energy Efficiency

This project will develop materials and coatings to reduce corrosion and improve the life span of boiler superheater tubes exposed to high-temperature biomass exhaust. This improvement in boiler efficiency will reduce fuel consumption, fuel cost, and CO_2 emissions.

Introduction

Industrial boilers are commonly used to make process steam, provide heating and cooling, and generate electricity. These boilers can use biomass fuels as an alternative to fossil fuels such as natural gas, coal, and fuel oil.

One important component of a boiler is the superheater, an array of tubes that uses hot combustion gases to raise the temperature of steam, converting it from a saturated or wet state to a dry state. Today, biomass boilers, and their superheater components in particular, are less efficient than those fired by fossil fuels.

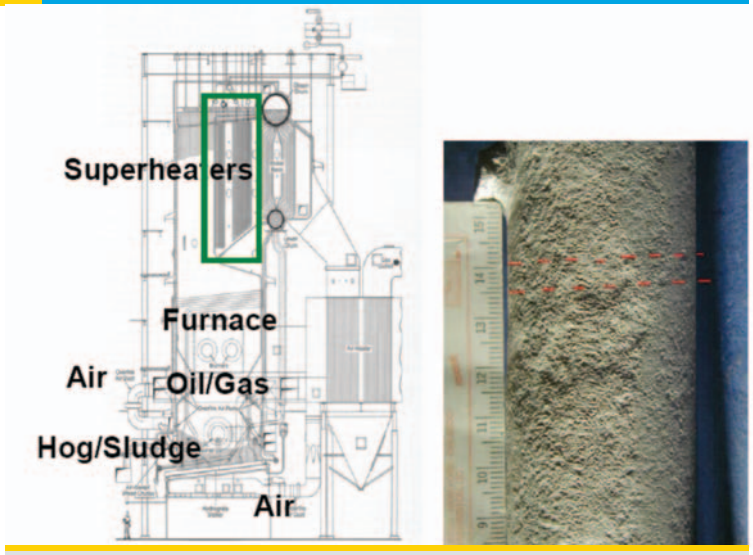
Biomass fuels often contain contaminants such as potassium, chlorine, sulfur, and sodium that deposit on superheater tubes that have been exposed to combustion exhaust gases. Some of these deposits have low melting points and can, in their molten state, lead to accelerated corrosion of superheater tubes.

To avoid this problematic corrosion, the standard industry practice has been to reduce the temperature in the superheater. However, reducing the superheater temperature also reduces the potential efficiency of the boiler.

This project will investigate corrosion mitigation strategies and related methods to improve the efficiency of biomass-fueled boilers. This effort will increase the use of renewable energy and reduce industry's dependence on imported fossil fuels.

Benefits for Our Industry and Our Nation

The development of more-efficient biomass-fired boilers will produce environmental, energy security, and economic benefits while reducing the cost of fuel supplies and boiler maintenance for industry.



Waste wood power boiler schematic (left) and superheater tubing showing corrosive effects of 36-month exposure to wood combustion gases (right)

Boiler schematic courtesy of Joey Kish, Doug Singbeil, Craig Reid, 2007. "Salt-induced Corrosion of Superheated Tubes in Waste-Wood Power Boilers." Presented at PAPTAC, Pacific Coast Branch 2007 Technical Mini-Conference, Parksville, BC, April 20. Image courtesy of Craig Reid, Acuren.

Applications in Our Nation's Industry

- Biomass-fueled boilers generate steam that can be used for industrial processes, for heating and cooling, and for electricity generation.
- Biomass-fired boilers can be employed wherever an adequate source of biomass fuels exists.
- Industries that will benefit from improved biomass-fueled boilers include the chemical, petrochemical, steel, wood and paper products, and food processing industries. Other users of biomass-fueled boilers include municipal landfills and crop and animal agricultural operations.

Project Description

The project goal is to reduce corrosion and improve the life span of boiler superheater tubes operating at temperatures above the melting point of ash deposits. The research team will test and analyze a range of high-performance materials and coatings. Cost-benefit analysis software will be used to assess the financial and environmental returns on upgrades to an existing boiler installation.

Barriers

- The susceptibility of metallic superheater tubing to corrode when exposed to molten boiler ash

- The identification of all operative corrosion mechanisms in the superheaters when they are operating at temperatures above the first melting point of the deposits

Pathways

- To achieve the goals of this project, a number of analysis, testing, and design tasks have been planned.
- A critical review of existing technology will be conducted to determine the state of the art in biomass superheaters around the world.
- A model will be developed to quantify the financial, energy, and environmental benefits of increased superheater temperatures.
- In the laboratory, corrosion studies will be run in environments simulating superheater conditions in biomass-fired boilers.
- To study real-world operating conditions, another experiment will measure corrosion rates of alternative materials in real-world superheater environments.

Milestones

- Completion of a critical review of the current state of biomass superheater technology (Completed)
- Completion of test plans and initiation of testing (Completed)
- Completion of oxide solubility tests in molten salt solutions
- Identify source of software for calculation of energy benefits
- Completion of corrosion probe testing
- Completion of the final report

Commercialization

Three boiler manufacturers are participating in the project and will contribute towards the design by furnishing specifications necessary for successful commercialization.

Other project partners include alloy and coating manufacturers that will provide existing developmental and commercial alloys and coatings to be used in testing. These companies will then be able to leverage the newly gained knowledge of material performance in their future products and marketing.

Project partners also include other companies that currently operate biomass-fueled boilers.

Project Partners

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Approximately 15 other industrial, cost-sharing partners

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